PD-ABK-164

PEANUT

COLLABORATIVE RESEARCH

SUPPORT PROGRAM

THE EXTERNAL EVALUATION PANEL REPORT FOR THE PEANUT CRSP 1994

Supported by USAID Grant No. 263-0152-G-00-1019-00
and the Participating U.S. Universities
and Host Country Institutions

ACKNOWLEDGEMENT

The Peanut CRSP External Evaluation Panel interacted intensively for over a year in reviewing and preparing Evaluation Documents, beginning with the organizational meeting in Huntsville, Alabama in July 1993. We came to appreciate the varied experiences of the seven member panel and relied on the strengths of each one to conduct the review and prepare the report.

David Hsi served as general coordinator and organizer of the full Trip and Project Summary reports. John Cherry guided the preparation of the Executive Summary.

Appreciation is expressed to the Peanut CRSP Board of Directors, Technical Committee, U.S. and Host Country scientists and institutional administrators, and the Management Entity Staff for their many courtesies, patience and professional help extended during the course of the evaluation.

Overall, we recognize the Peanut CRSP as a strong program, with demonstrated impacts and the potential for many more contributions in the future and we strongly recommend an extension of the program. To encourage improvement and strengthening of the program we have pointed out perceived weaknesses and shortcomings.

We trust that our observations will be constructive to all concerned.

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John P. Cherry

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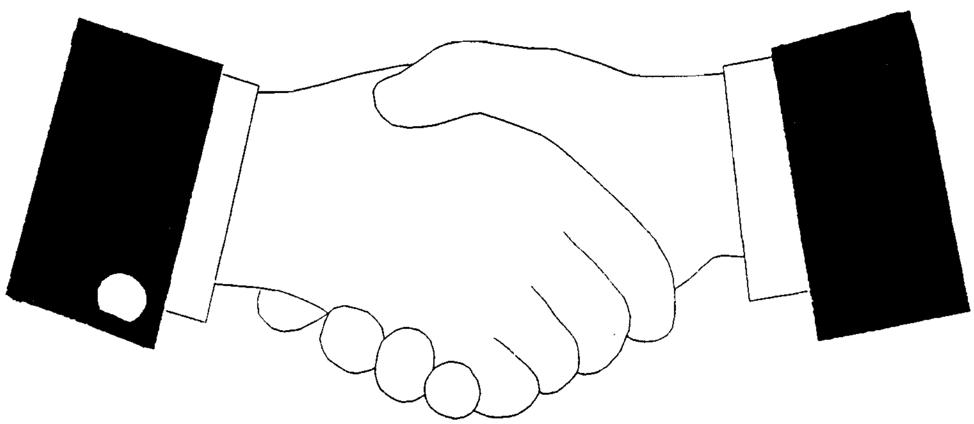

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THE EXTERNAL EVALUATION PANEL REPORT FOR THE PEANUT CRSP 1994

EXECUTIVE SUMMARY

Recommendations

The Collaborative Research Support Program (CRSP) was an exceptionally imaginative concept and, as put into practice by the Peanut CRSP, extraordinarily successful. The results obtained in its twelve years of operation are an excellent return on the total investment of some $20 million. In view of this success, the External Evaluation Panel (EEP) strongly supports a five-year extension of the Peanut CRSP and puts forward the following recommendations with a view to reinforcing the success already achieved and with the realistic expectation that an extension of the present program would lead to further success.

1. The United States Agency for International Development (USAID) should continue to fund those programs which are near completion so that full value may be obtained from past investments. High priority should be placed on the following areas.

- Incorporation of leafspot and virus resistance into high yielding, adapted varieties of peanut. Evaluation of crosses made with the NCAc343 line that gives broad-based insect resistance.

- Refinement of biotechnological procedures for introducing new genes into cultivated peanut.

- Integrated pest management strategies using varietal resistance and biocontrol agents to lower chemical requirements.

- Aflatoxin management through final development and application of tools for screening varieties for resistance, biocontrol agents, and decontamination of peanut and peanut products.

- Development of new and improved uses of peanut with particular emphasis on establishment of women's processing and marketing cooperatives, weaning foods, and interaction with manufacturers.

2. USAID should continue and enhance support to technology transfer programs to capitalize on the significant achievements of the Peanut CRSP. Particularly these should include:

- Seed multiplication and distribution constraints in developing countries,

- Reduction of aflatoxin and maintenance of quality in post-harvest handling systems, and

- Cooperative conduct of workshops, information exchange, and other outreach activities.

3. USAID should support new programs that concentrate on strategic research, particularly in the following areas:

- Quantifying and conserving peanut biodiversity and the diversity of other organisms in the natural communities of wild peanut relatives, and

- Marketing and socioeconomics of peanut-based farming and product development systems, and impact assessment of research generated.

4. Those host countries and their participating institutions that are more scientifically advanced should be encouraged to provide more leadership for Peanut CRSP activities in their respective regions. Notable are Thailand as a regional center for Southeast Asia, and Burkina Faso and Ghana to link francophone and anglophone West Africa.

5. Principal investigators in host countries and the U.S. should pursue private sector support and feedback, including joint research planning, to enhance transfer of benefits from Peanut CRSP studies in the host countries and the U.S.

6. The administration of the Peanut CRSP should continue with the University of Georgia-based team who have successfully guided this program since its inception.

7. The Global Plan proposed for the extension from 1995-2000 is endorsed by the EEP. Regional coordination of multidisciplinary Country Research Teams enhances host country participation in establishing priorities and planning of research to address country and regional constraints. Global Response Teams allow U.S. collaborators to enhance capabilities of host country researchers, and provide for field response services to USAID Missions. The plan also provides for targeted and strategic short-term and degree oriented training and the inclusion of workshops and other recommended outreach or technology transfer activities. Consideration should be given to needs of Regions in addition to West Africa, Southeast Asia, and the Caribbean (i.e. South America, Southern Africa, Eastern Europe) and the expansion of the U.S. technical resource base.

Clearly, the Peanut CRSP has an important role in contributing to the following: 1)sustainable and environmentally sound use of land; 2) increased production of food with improve nutritional value; and 3) a stable source of cash income for both producers and processors. The relative stability of production and the market for peanut provides a reasonably secure basis for further developing this crop.

Background Information

Introduction and Objectives

In 1975, Title XII - Famine Prevention and Freedom from Hunger of the United States International Development and Food Assistance Act initiated the CRSP coordinated by USAID through U.S. Land Grant universities and developing host country institutions. To attain program goals, the research capability of both developing country and U.S. institutions was to be enhanced through training and support of research programs.

In 1982, the Peanut CRSP was initiated to enhance the potential of peanut as a crop for human food in developing countries and the U.S., as it contributes to the increase of real incomes and sustains agricultural land. Peanut is grown worldwide with an annual production estimated at 18 million metric tons on 18 million hectares. It is important in both developing and developed countries. More than half the peanut production is in developing countries, where yields are often much lower that the world average.

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Peanut CRSP contributes to the needs of the U.S. and host countries by developing more efficient, sustainable production through cultivars with disease, insect and drought tolerance; for improved integrated pest management practices to lower chemical use; for reduction in aflatoxin contamination through resistant cultivars and better methods to detect and remove contaminate peanut from the food chain; and for a broader base of domestic use of peanut. As a food, peanut is high in protein, oil, and calories and easily processed into healthy nutritious products, thereby enhancing the food supply.

Constraints

Growth in the world supply of peanut products for human consumption is primarily constrained by low yields due to infestations of diseases and pests and unadapted cultivars, to aflatoxin contamination, and to the lack of suitable consumer food products. Solutions to there problems are handicapped by shortages of scientists and research facilities. The Peanut CRSP was designed to focus on these constraints in four major world regions - Semi-arid Tropical Africa, Southeast Asia, the Caribbean, and the United States. Thirteen countries: in Africa - Senegal, Mali, Burkina Faso, Niger, Nigeria, and Ghana; In Southeast Asia - Philippines and Thailand; the Caribbean - Jamaica Belize, Trinidad, St. Vincent and Antigua; and the United States were selected for participation in the Peanut CRSP because they had the capacity and interest to initiate a program that could address their constraints through research projects.

In 1990, the Peanut CRSP reaffirmed its global commitment to strengthening research capacity to address the major constraints to peanut as a crop for human food and animal feed. The constraints guiding research planning are:

- Low yields because of unadapted cultivars that lack resistance to diseases, insects and drought;
- Yield loses due to infestations by weeds, insects, diseases, and nematodes;
- Health hazards and economic losses due to mycotoxin contamination;
- Food supplies inadequate and lack of appropriate food technologies to exploit a relatively well adapted peanut crop that is not generally considered a primary food source;
- Physiological and soil microbiological barriers to higher yields;
- Resource management (agronomic, engineering, economic and sociological) situations preventing efficient production and utilization;
- Inadequate numbers of trained researchers and support personnel;
- Lack of adequate equipment to conduct research; and
- Information not available to beneficiaries for support of production and utilization efforts.

Projects

These constraints are covered by nine projects as follows:

Disease Resistant Peanut Varieties for Semi-arid Environments - Texas A&M University/Breeding and Cultural Practices/West Africa; Senegal, Mali, Burkina Faso, Niger.

Peanut Varietal Improvement for Thailand and the Philippines -
North Carolina State University/Breeding and Cultural Practices/Thailand and Philippines.

Mycotoxin Management in Peanut by Monitoring and Prevention of Contamination - Texas A&M University/Mycotoxin Management/Senegal and Ghana.

IPM Strategies for Peanut Insects in Semi-Arid Tropical Africa -University of Georgia/Insect Management/Burkina Faso.

Management of Arthropods on Peanut in Southeast Asia - North Carolina State University/Insect Management/Thailand and Philippines.

Peanut Viruses; Etiology, Epidemiology, and Nature of Resistance - University of Georgia/Peanut Viruses/Nigeria, Thailand, Philippines.

An Interdisciplinary Approach to Optimum Food Utility of the Peanut in Semi-Arid Tropical Africa - Alabama A&M University/Food Technology/Burkina Faso, Ghana.

Appropriate Technology for Storage and Utilization of Peanut - University of Georgia/Food Technology/Thailand, Philippines.

Postharvest Handling Systems for the Small-Scale Peanut Producer - University of Georgia/Postharvest/Caribbean

External Evaluation

Extensive reviews of the Peanut CRSP were made in 1985 by an EEP of five members, and in 1989 with four members. The present and third EEP team has seven members of renowned international scientists that was expanded to include sociologic and economic disciplines. The EEP membership and Scope-of-Work was approved by the Peanut CRSP Board of Directors and USAID and had its first organizational meeting following the American Peanut Research and Educational Society Meeting in Huntsville, AL, July 1993. The evaluations were made from November 1993 to April 1994. All four U.S. Universities and all host country institutions in Asia, Africa, and the Caribbean were visited by at least one and usually two or three EEP members, with the exception of Nigeria where the U.S. Embassy withdrew travel clearance just prior to the planned visit. The EEP members were reunited in Griffin, GA in April 1994 for discussions and information exchange in preparation of the 1994 EEP Report.

1993 - 1994 EEP

Dr. Bo Bengtsson, Professor in International Crop Production Science, Swedish University of Agricultural Sciences, Uppsala, Sweden (formerly Director General of Swedish Agency for Research Cooperation with Developing Countries and presently Chairman, CIFOR Board of Trustees), research management, crop production,

Dr. John P. Cherry, Director, USDA/ARS, Eastern Regional Research Center, Philadelphia, PA, food technology, research management,

Dr. Milton Coughenour, Professor of Rural Sociology, University of Kentucky, Lexington, KY, sociological change, technological change, international agricultural development, Dr. David Hsi, Emeritus Professor of Plant Pathology, New Mexico State University, Albuquerque, NM, peanut pathology, peanut crop management systems, past-President (1982-83) American Peanut Research and Education Society.

Dr. Robert Schilling, Senior Scientist, CIRAD-CA, Montpellier, France, peanut production and use systems/West Africa, research management,

Dr. Joseph Smartt, Reader in Biology, The University of Southhampton, United Kingdom, genetics of peanut, peanut production and use systems/Southern Africa, and

Dr. Handy Williamson, Jr., Professor and Head of Agricultural Economics and Rural Sociology, University of Tennessee, Knoxville, TN., economic and rural development, research management, impact analysis.

The directions for external evaluations in the "Guidelines for the CRSP's" under Title XII of the International Development and Food Assistance Act of 1975 were followed. The orientation, trip accompaniment and support by the Program Director Dr. David Cummins and later by the Associate Director Dr. Keith Ingram were extremely helpful. Full cooperation by the administrators and researchers were received by the EEP throughout the visits while making objective, impartial, and detailed evaluation of all nine Peanut CRSP projects.

The Scope-of-Work for the 1993-94 EEP review included an overview of program and a detailed review by project. The detailed review considered the achievement of objectives, implementation and management of projects, institutional development, adequacy of science, applicability of research, observations, and recommendations.

Global Plan for 1990-1995

Three general aims or thrusts have been the basis for Peanut CRSP's program planning; 1) research to enhance the sustainability of the production and delivery of food to people in the developing world, 2) resource management research to improve the efficiency of production systems, and 3) communication of outputs to clientele. The paramount goal of the Peanut CRSP is to provide valuable information to host country and U.S. farmers, food processors and consumers. As the five-year period ends, there has been substantial attainment of all project objectives resulting in a continuing stream of client information and new technologies addressing all major constraints.

Selected Outputs and Impacts in Developing Countries

Breeding

- In Senegal, the variety Fleur 11 is now under seed increase for distribution to farmers. It yields 25% more than current varieties and could increase the annual value of the crop in Senegal by $18 million.

- Four new varieties have been released in Thailand which have increased yield potential and market value compared to local varieties.

- Five new varieties have been developed and released in the Philippines which are higher yielding, disease resistant, and larger seeded with improved quality for the edible peanut market.

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- The variety CARDI/Payne was released in Jamaica with a recorded yield improvement of 42% over traditional Valencia varieties and is now established on 10% of the peanut area with a increase of $600,000 in added value to producers.

- A peanut line NCAc343 was identified in the Philippines as having multiple insect resistance which was confirmed in West Africa and the U.S. It is being used in varietal improvement programs and has enormous potential in insect resistance breeding programs worldwide.

Insect Pest Management

- In the Philippines and Thailand insect pest control is approached through integrated pest management (IPM) using cultural and biological controls to reduce the need for chemicals based on CRSP research. There is increasing farmer acceptance of IPM, and annual workshops on these methods are being held to train research and extension personnel. There are excellent prospects for controlling pest population with reduced pesticide use, reduced environmental impacts, and improved profitability.

- Peanut CRSP studies in Burkina Faso showed that early and timely harvest of peanut reduced pod damage from termites and subsequent contamination by aflatoxin. On-farm trials have demonstrated this yield and quality enhancing practice to farmers.

Socioeconomic Development

- In a Mayan Indian Village in Belize on the fringe of the rain forest, increased profitability from peanut stimulated by Peanut CRSP supported production and postharvest practices have caused improvement of farming from slash and burn agriculture to sustainable, rotation based farming. Peanut has provided the economic base to enhance the local economy and greatly improved the farmers' lifestyle.

- The possibilities of production areas benefiting from added value to the crop by processing have been successfully demonstrated in the Chiangmai Province, Thailand, Letye, Philippines, and Accra, Ghana through development of women's cooperatives. Both processing and marketing skills are being learned. A socioeconomic evaluation of the Thailand site revealed an almost two-fold increase in profitability for women farmers who marketed processed peanut.

Aflatoxin Management

- In Senegal, a technique has been developed in collaboration with Texas A&M University for detoxification of aflatoxin contaminated peanut meal by use of adsorbent clay enabling it's use for animal feed. Estimates are that $5 million could be contributed annually to the economy by use of this technology.

- Development and use of rapid monitoring techniques for aflatoxin detection in the Philippines have resulted in policy interventions by the Food and Drug Agency by identification and withdrawal of aflatoxin contaminated products from the markets.

- In Burkina Faso (also cited earlier), timely harvest to reduce termite damage to pods reduces to acceptable levels the aflatoxin content of seed.

Food Products and Processing

- In Thailand wheat noodles enriched with peanut flour are acceptable to consumers. Market tests revealed that consumers would purchase the new product.

- In the Philippines, traditional peanut products have been surveyed and recipes published and made available to manufacturers. Encouragement to adopt new processes is being given particularly to cottage scale processors through workshops on product development and marketing.

- Cheese-flavored spreads with a peanut rather than milk base have been developed and found acceptable to consumers in the Philippines.

- In Burkina Faso, a private company has been assisted in the improvement and packaging of peanut paste. New products such as fruit-peanut paste blends are new marketing strategies.

- In Burkina Faso, surveys on market quality of peanut products and research to solve the problems leading to poor quality are becoming standards for quality improvement.

Training

- During the five year period under review, 85 students with full or partial support from the Peanut CRSP have completed M.S. and Ph.D. degrees. Most are active in research in the host countries, or in non-host countries and the U.S. depending on their origin.

- At least six lead collaborators in host countries have received M.S. or Ph.D. degrees in the U.S. under the guidance of U.S. collaborators.

- As an example of the value of short term training, Dr. Luthgarda Palomar in 1992 worked at the University of Georgia for two months and after returning to the Philippines became a Peanut CRSP collaborator. She has established a sensory evaluation unit for food analysis, and in addition is working with village women in developing women's cooperatives to process and market local peanut products.

Workshops and Networks

- Network linkages exist with several international groups, including ICRISAT (International Crops Research Institute for the Semi-Arid Tropics), IDRC (International Development Research Centre-Canada), ACIAR (Australian Centre for International Agricultural Research), CIRAD-CA (International Agronomic Research Center for Development-Annual Crops, France), and CARDI (Caribbean Agricultural Research and Development Institute) with synergistic effects for all involved.

- For example, the Peanut CRSP participated in and co-sponsored the 1991 International Groundnut Workshop in India in cooperation with ICRISAT and CIRAD; the active involvement of both U.S. and host country CRSP collaborators communicated research results to a worldwide audience. Similarly, the Peanut CRSP and ICRISAT have co-sponsored Regional Workshops, the last at the ICRISAT Sahelian Center in Niamey, Niger, with the results being a coordinated, efficient, and productive program of interactive research and support activities.

- A training course on quality evaluation and utilization of food legumes and coarse grains was held in cooperation with FAO and the Department of Product Development, Kasetsart University, Bangkok, Thailand (a Peanut CRSP supported institution). Thai, Philippine, and Georgia collaborators in the University of Georgia/Thailand-Philippine Food Technology Project served as coordinators and trainers for participants from several Southeast Asian countries in a month-long activity.

Publications

- Peanut CRSP research results are published in journals and other normal outlets.

- Special publications have been used to target particular audiences. Noted is the series of information bulletins published in cooperation with ICRISAT.

- The International Arachis Newsletter developed and published in cooperation with ICRISAT provides an excellent outlet for research information for developing countries.

Selected Outputs and Impacts in the United States

- North Carolina State University released the cultivar 'NC10c', the only Cylindrocladium black rot resistant cultivar available to farmers. In 1992 and 1993, NC10c occupied about 20% of the North Carolina-Virginia peanut acreage with a net farmgate value of about $4.5 million per year.

- The new cultivar, 'Tamspan 90', released by the Texas Agricultural Experiment Station and USDA, yields 11% more than 'Starr', the previous most popular cultivar. Tamspan 90 has partial resistance to important soil-borne diseases. Sclerotinea blight and Pythium pod rot. Tamspan 90 was grown on about 28% of the total peanut area in Texas and Oklahoma in 1992 and 1993 with a net value of about $25 million per year.

- In Georgia, peanut virus research thwarted a potential peanut stripe virus epidemic thus avoiding extensive yield losses and restrictions on interstate movement of seed. This effort annually saved growers about $100,000.

- A new integrated pest management technique developed in North Carolina uses pheromone traps to monitor populations of southern corn rootworm in peanut. By applying pesticides only when pest populations reach economic threshold levels, growers can reduce pesticide use by 42 tons per year. When fully implemented, this system can reduce annual peanut production costs in Virginia and North Carolina about $840,000.

- In Georgia, Pseudomonas aeruginosa, genetically engineered with the delta endotoxin gene from Bacillus thuringiensis, plus Sunspray Oil was as effective as the chemical Lannate in controlling both corn earworm and the velvetbean caterpillar. This new technology, when implemented, can reduce the use of potentially polluting chemicals for insect control in peanut production.

- A nutritionally superior quality, high protein, food product, "Kisra" (a thin pancake-like leavened bread), from of sorghum and peanut flour blends for use in West Africa was developed. This technology was extended to another of Peanut CRSP's similar products "Toe".

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- Studies on Chinese-type noodles were extended to include wheat flour fortified with defatted peanut (7-21%) and cowpea (4-12%) flours. This is an example of collaborative studies of Peanut CRSP and Bean/Cowpea CRSP.

The Administration of the Peanut CRSP

One of the strengths contributing to the Peanut CRSP and its attainment of goals has been the relatively low turnover of management personnel, members of the Board of Directors, Technical Committee, and U.S. and host country participating scientists. Peanut CRSP has always been a "bottom up" research planning operation rather than "top down". Peanut CRSP has encouraged interdisciplinary cooperation across departments and colleges to solve the peanut constraints. The vision of participating agricultural scientists had expanded from one of provincialism to world challenges, with a broader perspective of the biological, physical and socioeconomic constraints to world food production. This in turn has led to improved technologies, better trained researchers (degree and short-term trainees), and more meaningful research. University administrators in the U.S. make the point that Peanut CRSP has operated as a model of efficiency and throughout its life has generated fewer problems necessitating their attention than other CRSP programs.

Moreover, the leadership of the Peanut CRSP has shown excellent foresight in guiding programs since its inception in 1982. Peanut CRSP's priorities have evolved as new constraints have become paramount. This includes research and development, technology transfer, socioeconomic program concepts and information-educational-sharing publications, the latter three priorities being implemented in the late 1980's to present with the availability of research achievements. Peanut CRSP is applauded for this progressive programming which has led to substantial benefits to farmers and consumers in the U.S. and host countries.

Future Tasks

Research institutions in host countries have been strengthened to the point that they are able to lead national programs of research and technology development and to maintain channels of communication and information flow. There is clear evidence that effective technology transfer is occurring, and it is critically important that this thrust not be weakened but rather that it be strengthened further.

Where the research and technical imputs of the Peanut CRSP in host countries have been deployed they have demonstrably improved farmers' competitiveness and economic statuses. This has been achieved in an environmentally friendly way with prospects of improved nutritional quality of food-stuffs and reduction on deleterious aflatoxins.

In a program which has extended over 12 years, it is not surprising that some problems have emerged whose previous existence was not suspected and that other problems have been redefined in order to address them more effectively. Constant review of constraints and re-formulation of research problems are required to continue program success. Such periodic updates of Peanut CRSP research and technology agenda have provided the basis for current and future goals for host country and U.S. food supplies.

A major constraint that needs to be resolved is the surprisingly low level of yield which appears to be endemic to the humid tropical areas of Southeast Asia. The level of 1000-1500 kg/ha commonly reported does not seem to be comparable with the yield levels of rice and sugar cane in the humid tropics and that of the peanut itself in the semi-arid tropics and warm temperate production areas. It is desirable that the reasons for such low levels of yield be ascertained. Possibly environmental resources are not being most effectively exploited by the most productive peanut genotypes. This implies no criticism of the breeders, they must operate within the current farming systems but does imply that an open-minded agronomic investigation be conducted introducing a much wider range of genetic material and a broader exploration of the possible exploitation of a very long potential growing season. Such an investigation would be of significance not only to Thailand, but also Indo-China, Malaysia, Indonesia, and the Philippines. In practice it might not necessarily be possible to exploit the optimum genotypes/potential growing season if this exacerbated aflatoxin problems or was incompatible with production of the staple rice crop. This is a question that is well worth pursuing.

Seed production, multiplication, and distribution is a worldwide problem in peanut production in developing countries. A major reason is the relatively large quantity of seed required, 100 plus kg/ha. The problem appears to be infrastructural and economic as well as technical. A high priority item to address in future work would be to determine production and socioeconomic constraints to peanut seed production and distribution.

High yield potential of new cultivars requires protection from the attacks of pests and diseases. The lessons learned from earlier activities of entomologists in controlling pests and the plant breeders and plant pathologists in attempting to control pests and diseases by vertical resistance breeding, have taught agriculturists to seek less simplistic solutions. The concept of IPM which has arisen from recent reappraisals and work in this field has not by any means yet reached a definitive stage; there is ample justification for this continuing work. In the field of disease resistance similar conditions apply and work needs to be continued in parallel with that on pest resistance to safeguard yield levels, reduce cost of agrichemicals and the insults to the environment that arise from over-use.

A better understanding of how the peanut originated and was able to survive in its area of origin under various biotic and abiotic stresses would help resolve some of the major problems of production worldwide. Environmental and human pressures affecting the biodiversity of peanut in its natural habitat should be studied and the collaborative nature of the CRSP lends to such a study and should be considered in a program extension.

Food technology research and development clearly has a continuing concern especially with regard to aflatoxin contamination. Over thirty years of research has still not adequately solved this problem and it must be continued. A single, solution is unlikely to be found and the present studies of the biology of the pathogen and its interactions with the host offer the best hope of reducing the problem to negligible proportions. The additive effects of environmental manipulation to produce conditions unfavorable for the Aspergillus fungi, manipulation of host genotype to reduce invasion levels and growth rate of the fungus and to reduce levels of toxin production, need continued study.

Food technology research and development clearly has a continuing role to play in improvement of the quality of life for peanut producers and their communities. It is not sufficient to produce highly nutritious and palatable products, they must be acceptable to local tastes and by their nature lend themselves to efficient production and marketing. The socioeconomic impact of enhanced peanut production has been significant already and the momentum generated should not be lost.

One of the most significant and encouraging developments of the Peanut CRSP initiative has been the changing role of the U.S. and host country personnel. The latter are assuming a more confident and capable leadership role which should be encouraged. The U.S. contribution thus can increasingly concentrate on the development of new initiatives. By so doing, the U.S. is enhancing an important aspect of the current world structure of science on which future benefits to the U.S. as well as the developing world depend. Two notable examples of the benefits of this structure can be mentioned. In biotechnology - the development of gene mediates virus resistance. In economic botany - native and/or antixenotic effects on pests and pathogens. These could be especially important in seed and food storage during difficult seasonal (e.g., rainy) periods. Both of these initiatives are outside the capabilities of developing county institutions and will remain so for years. But, with U.S. institutional collaboration developing country research and technology development programs can realize theses benefits.

Market research at local, regional, national and international levels should be continued. Effective marketing is the final link in the chain from producer to consumer, and without marketing improvements food production goals can not be realized.

Finally, the transformation in food production and distribution systems, which improved technology brings, has impacts that range far beyond the food production system itself. These impacts on farm families and communities create socioeconomic strains. Some technology development. Others might be mitigated by changing domestic socioeconomic policies. But, recognizing the impact of technology development and the emergence of strains on families and communities is the first step in undertaking corrective action. The Peanut CRSP which has the mandate to develop new technology bears some responsibility for monitoring the impacts of the technology it creates. This capability should be extended.

The constraints as outlined in 1990-1995 remain generally valid. Despite much progress, substantial future gains can be realized through continued research. Future research programs should reflect EEP recommendations regarding high priority research on the important constraints to peanut production and food supply.

Conclusion

In the first eight years the Peanut CRSP confirmed two major premises of Title XII, that the production and utilization of the peanut can very effectively be enhanced by a collaborative endeavor between U.S. and host country scientists working in cooperation with local clientele. Secondly, that the initial successes achieved provided a sound basis for the planning of future efforts to safeguard and enhance host country and U.S. food production. This gratifying outcome has been the result of the imaginative and innovative thought which went into the development of the CRSP concept. In practice it has been one of the most productive and cost-effective international agricultural research programs ever. The perceptive psychological insights of the initial planners in making all participants in the program beneficiaries effectively avoided any hint of patronizing the host countries and built up an excellent working partnership of equals. Peanut CRSP has in both the U.S. and the host countries attracted a very able and highly competent cadre of research scientists and supporting staff. The quality of leadership provided by Principal Investigators, Co-Principal Investigators, and cooperating scientists has been exceptional. Metaphorically speaking a chain was forged which has few weak links.

Based on this necessary and appropriate review, the External Evaluation Panel strongly urges that USAID continue, and even increase support to the Peanut CRSP from 1995-2000.

PEANUT

COLLABORATIVE RESEARCH

SUPPORT PROGRAM

EXTERNAL EVALUATION PANEL

REVIEW PROCEDURES

1993 - 1994

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Peanut CRSP External Evaluation Panel

REVIEW PROCEDURES, 1993-1994

Introduction

An External Evaluation Panel (EEP) is an integrated and mandated part of all Collaborative Research Support Programs (CRSPs). The external evaluation by the EEP is most important to the CRSP operations to assure objectivity in decision making on important and sometimes difficult program issues.

Consistent with these criteria, the Peanut CRSP grant document established an EEP consisting of three to five eminent scientists recommended by the CRSP Management Entity to AID/BIFADEC. Periodically as appropriate the EEP shall:

1. Review projects and programs of the CRSP and provide written evaluation.

2. Make recommendations for the addition, elimination, or modification of component projects and overall objectives, to include retention, elimination, or addition of new overseas or U.S. sites.

The EEP should make an intensive review as a part of planned extension or renewal of the CRSP grant, in addition to less intensive annual reviews. The present documents report the results of an intensive review and include combined or separately an Executive Summary, Project Evaluation, and Trip Reports. In particular the individual Trip Reports of the EEP members have been maintained separately in order to retain their individual views from very different experiences and backgrounds.

EEP Members

The previous EEP was approved in 1988 and served until 1993. A new slate of members was proposed by the Principal Investigators, Technical Committee, Board of Directors, and Program Director during mid-1993, approved and submitted to BIFAD/AID.

Basic criteria used in choosing the EEP were:

a. A background in and a basic understanding of science.

b. Experience in international agricultural research and/or development and knowledge of developing country problems.

3. Specific experience in peanut research.

4. An understanding of the U.S. land grant research system.

The EEP members selected were:

1. Expertise: International Research Management, Cropping Systems

   Dr. Bo Bengtsson, Professor in International Crop Production Science, Swedish University of Agricultural Sciences, Uppsala. He served as Director General of the Swedish Agency for Research Cooperation with Developing Countries (SAREC) and earlier as Senior Research Officer and Research Officer with SAREC. He had field experience in a Swedish supported crop production project in Ethiopia. He has been active in the Consultative Group for International

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Agriculture and is or has member and chairman of the Boards for CIFOR, ICRAF, ICIPE. AERC. and ISNAR. Over the past two or three years he has spent - in addition to being member of the Peanut CRSP Evaluation Panel - close to full time on the establishment and development of development of CIFOR, the Center for International Forestry Research located in Indonesia, on being Chairman of a eight man Panel of the European Union on the Evaluation of Science and Technology Cooperation with ALA/MED Countries in (1993-1994) and Member of a Study Panel on the CGIAR's Long-Term Governance and Financing Structure (1994).

2. Expertise: Genetics and Breeding

Dr. Joseph Smartt, Reader in Botany/Biology at the University of Southampton, United Kingdom. His expertise is in the effective application of genetical and other biological principles in the improvement of crop production especially of grain legumes in the Third World. He had seven years experience as a peanut/grain legume breeder in Zambia. He has authored or edited a number of key books and chapters on grain legumes, the latest 'The Groundnut Crop - the scientific basis for improvement". He is a recognized expert on genetic resources with specialization on peanut.

3. Expertise: West Africa peanut sector, farming systems, research management

Dr. Robert Schilling, Assistant Head of the Smallholder Food Crop Programme, CIRAD-CA, Montpellier, France. He has had extensive experience since the mid-60s in West Africa. He has peanut research experience in Burkina Faso and Senegal in peanut production and cropping systems, He served as advisor to the Senegalese Minister of Rural Development for seven years. He coordinates the peanut component of a Crop Research Network (CORAF) supported by France, which in total is active in some 20 African Countries.

4. Expertise: Plant Pathology and Pest Management

Dr. David Hsi, Professor Emeritus (recently retired) of Plant Pathology and Genetics, New Mexico State University. He is a naturalized U.S. citizen; born and lived in China until 1948. He spent almost 40 years at New Mexico State University and conducted research on winter wheat, grain sorghum, sweet potatoes and peanut. He has participated in academic exchanges with scientists in Asia and South America and as a consultant on peanut improvement and disease management in South Asia and South Africa. He has been president of the American Peanut Research and Education Society and of the National Association of Academies of Science.

5. Expertise: Food Technology and Research Management

Dr. John Cherry, Director of the U.S. Department of Agriculture's Eastern Regional Research Center, Agricultural Research Service, Philadelphia, PA. In addition to being director of a major center he has had a wide range of research experience in the general area of food biochemistry, processing, and particularly peanut product development. He also has research experience in the U.S. Land Grant University System. He has been active in USDA programs to open new and expand existing domestic and foreign markets (including Japan, China, Ireland, Poland, the former Yugoslavia and Hungary). He is the only returning member of the previous EEP.

6. Expertise: Agricultural Economics, USAID experience

Dr. Handy Williamson, Jr., Professor and Head, Department of Agricultural Economics and Rural Sociology at the University of Tennessee. He formerly served as Deputy Director for Research and University Relations, Bureau for Science and Technology, U.S. Agency for International Development, Washington, DC. Prior to that assignment he served on the faculties of Tennessee State University-Nashville and Tuskegee University-Alabama. He has been a consultant and reviewer for a number of projects in Africa, the Caribbean, the Far East, and the United States.

7. Expertise: Rural Sociology

   Dr. Milton Coughenour, Professor of Sociology (since retired), University of Kentucky. Specializes in social organization, technological change, farming systems, agriculture structure, and international agricultural development. Experience in Africa and Australia. He was formerly a co-investigator on a Sorghum/Millet CRSP project in Sudan and coordinated a recent Workshop on 'Social Sciences and the CRSPs'.

Organizational Meeting

The seven member EEP first met with the Board of Directors, Technical Committee, Principal Investigators and Program Director in Huntsville, Alabama at the American Peanut Research and Education Society Meeting and Peanut CRSP Annual Meeting, July 15-17, 1993.

A Scope-of-Work for the intensive review was developed and agreed upon, with additional plans for the Socioeconomic component developed later.

Tentative travel plans and availability of the various EEP members was developed.
The EEP is rather large in number, which was necessary to meet USAID expectations and desires for complete coverage of the program. Grouping of team members to fit research locations were to be followed to cost effectively reduce as much as possible numbers traveling to particular locations.

Travel Itineraries

West Africa

Burkina Faso, Mali, Niger, and Senegal - November 4-19, 1993. EEP Members: David Hsi, Robert Schilling, and Handy Williamson. Accompanied by David Cummins, Program Director. Projects: Texas A&M University-Breeding (four countries) and Mycotoxin Management (Senegal).

Ghana and Burkina Faso - February 19-28, 1995. EEP Member: John Cherry. Projects: Alabama A&M University - Food Technology (both countries), Texas A&M University - Mycotoxin Management (Ghana).

Nigeria: Plans were made to travel to Nigeria to evaluate the University of Georgia - Virus Disease Project in September 1993 (Joe Smartt and David Cummins), but travel was canceled by the U.S. Embassy due to political unrest.

Southeast Asia

Thailand - January 22-30, 1994. EEP Members: Bo Bengtsson, Joe Smartt, and David Hsi. Accompanied by David Cummins, Program Director, and Dianne Janczewski, AID Peanut CRSP Program Manager. Projects: North Carolina State University - Breeding and Insect Management; The University of Georgia - Virus Disease and Food Technology.

Philippines - January 22-February 1, 1994. EEP Members: Robert Schilling, Milton Coughenour, and John Cherry. Accompanied by Keith Ingram, Assistant Program Director, and Dianne Janczewski, AID Peanut CRSP Program Manager. Projects: North Carolina State University - Breeding and Insect Management, The University of Georgia - Food Technology.

Caribbean

Belize - April 25-28, 1994. EEP Member: Milton Coughenour. Accompanied by David Cummins, Program Director. Project: The University of Georgia - Post Harvest Technology.

Jamaica - April 27-30, 1994. EEP Member: Handy Williamson, Jr. Accompanied by Keith Ingram, Assistant Program Director. Project: The University of Georgia - Post Harvest Technology.

U. S. Universities

The EEP split up and visited U.S. University sites.

North Carolina State University - Milton Coughenour, March , 1994.

Alabama A&M University - John Cherry, April 16-17, 1994.

Texas A&M University - David Hsi, April 17-18, 1994.

The University of Georgia - Milton Coughenour, John Cherry, and Joe Smartt, and Handy Williamson, Jr., April 17, 18, 1994.

Summarization Meeting

Milton Coughenour, John Cherry, David Hsi, Handy Williamson, Jr., and Joe Smartt met at the Georgia Station with David Cummins and Keith Ingram on April 19-20, 1994 to review findings of Host Country and U.S. site visits and develop an evaluation summary of the Program.

The EEP Report for 1993-1994 consists of three parts: an Executive Summary that gives an integrated and brief statement of their combined opinions; a Project Summary that provides opinions of individual projects and the Management Entity, which combines Host Country and U.S. University site visit information; and individual Trip Reports from each EEP member to provide an evaluation from an individual vantage point.

Scope - of - Work

U.S. University and Host Country Site Visits

I. Background - This section will be completed for EEP information prior to travel.

   A. General information will be provided for the location, either U.S. University or Host Country site.

   B. Project Title(s): each site may involve one or more projects. EEP team visiting that site will have general observation responsibilities and particular responsibilities for a particular project(s). Other information on project funding, etc will be provided..

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C. EEP members: Team for a particular site.

D. Collaborating Entities: U.S. University - Administrative, and departmental involvement/individuals involved, etc. Host Country - primary institution/individuals, other cooperating institution(s).

E. USAID Mission Staff:

G. Other information as provided or requested

II. General overview of program

A. Background information to be provided

Items B-F. EEP would add to this section based on discussions during visits.

B. Peanut industry
- importance of crop (is it a traditional crop, a recently introduced crop, new enterprise? Are there any local taboos associated with the cultivation, preparation and use of peanut?)
- cropping systems, etc. (General role of peanut in farming systems, and present production constraints that would be removed by improvements in yield and area under the crop).
- domestic uses, markets, etc. (In addition, value of haulm as livestock feed, hulls as fuel. Potential for new or novel uses.
- other items (Effect of change in technology on sociological significance of crop, i.e. use of animal power).

C. Relationship of CRSP to State/Host Country Research and Development Program - information collected by EEP during visits

- extent of local program, priorities, etc (Has the program changed thinking on target problems?)
- complementarity of CRSP to local program (What arrangements are in place for reorientation of program in view of experience in CRSP research?)
- relationship to other programs/donor programs/IARCs/etc.

D. How does the Peanut CRSP program fit into the USAID Mission current and future country strategy? How does the Mission view the interface of agriculture/sustainable agriculture in the environment/natural resource management program area? Other items may arise in discussions with Missions that can be reported.

E. Assess the level of commitment of each organization for the near-term (1-2 years), and long-term (2-5 years).

Opportunities for additional support for research - AID Mission, other entities in country/region.

F. Other

III. Review of individual project - Primarily consider progress since program extension in July 1990, but may at times need to consider the long-term, from 1982 forward.

Review and collection of following information will be done for U.S. and Host Country components separately. We will decide as a group how to prepare report to eliminate duplication, integration of both components in report.

1. Achievement of objectives.................... _______
(Are the original objectives or evolved objectives still conceptually reasonable, realistic, or achievable; especially with objectives 3 or more years old?)

1.1.-1.n. List

2. Implementation and Management of Projects

2.1. Administrative involvement

2.1.1. Attitude towards, support and perceived relevancy to the institution....................._________
(Is there free flow of information and prompt response to needs of individual programs?)
Adequacy of current management; University, Host Institutions, Management Entity.

2.1.2. Fiscal/logistical assistance.. ....________

How adequate is funding? Is funding too small to be effective? Is there balance in funding that allows program progress without over or under spending?

Problems regarding funding; procurement, release of funds, timely reporting for reimbursement, etc.

Institutional contributions to funding

Cost effectiveness

Are imaginative solutions to funding being sought, such as linkages with PVOs, etc?

2.1.3. Resource commitment (faculty/facilities).____

2.2. Adequacy of planning....................____

Annual Work Plans,

Communications between and among participants, team approach to planning etc.

2.1.5. Comments

3. Institutional Development - Would particularly apply to Host Country institutions, but some items relate also to U.S. institutions

3.1. Complementarity to ongoing research efforts..______

Integration of domestic and international research programs with CRSP projects. This can prevent unnecessary duplication, but adaptive research can be valuable and not considered duplicative.

3.2. Strengthening of scientist/equipment/facility capabilities................................______

Has the program had an impact on general capability to do research? Has the ability to analyze problems, define them and formulate appropriate strategies for their solution improved?

Faculty/scientist recognition for international activities. Are there reward systems in place for meritorious achievement?

3.3. Extent of collaborative actions.............______

Has the collaborative mode been effective; interaction between scientists,etc. How could improvements be made to improve the impact of program? Are the scientists encouraged to be collaborative rather than loners in their work?

3.4. Training....................................______

Longterm student training, shortterm training of scientists or technicians. Can the program developed in a country sustain itself after CRSP support ended?

3.5. Comments

4. Adequacy of Science - technical merits of program

4.1. Progressiveness and innovativeness of the science/research...........................______

Concern with biodiversity, sustainability, natural resource conservation, food supply, etc. Are there situations unique to the location that are recognized and taken into account in research programs?

4.2. Social science/economic implications.........______

Income generation, gender concerns, fit of technology into social scheme, etc. Has development changed the role of gender in production of food crops, i.e. mechanization increasing the male role? Are producers able to store crops to take advantage of better prices?

4.3. Appropriateness of research (basic/adaptive).______
While much research needed is adaptive there may well be problems of a more fundamental nature. To identify the latter requires incisive analytical thinking in producing adequate definition of such problems. Fundamental research problems may more appropriately be tackled at the U.S. University concerned with some host country input.

4.4. Comments

5. Applicability of Research

5.1. Relevancy and transferability of research to Host country or U.S. programs...........................______

Publications, efforts to make information available.

Is the technology developed being used (i.e. new variety, IPM practice, post harvest handling, new of improved food product), or is there potential for impact? What are impediments or constraints to use of technology? Extension, pilot efforts to use technology. Important constraints which occur in the production a peanut crop are the labor bottlenecks - land preparation, weeding, harvest, stripping, shelling - is appropriate technology available to reduce these constraints?

5.2. Relationship to other international research programs.................................. ________

Is there evidence of networking in country/region, IARCs and other entities? ICRISAT is important with its peanut mandate. Other institutions are important because of cropping system research that may be ongoing. Transfer of technology through networks, short courses, workshops, etc. Are technology dissemination programs becoming self sufficient in countries?

5.3. USAID/host country perceptions of Peanut CRSP.______

Relate specifically to project. It is desirable that the general perception of the Peanut CRSP is positive. Are researchers encouraging the application of information developed? Are communication channels effective?

5.4. Comments

6. Observations

6.1. Strengths

6.1.1.-6.1.n. List

6.2. Weaknesses - ways to improve

6.2.1.-6.2.n. List

7. Recommendations

Code: E=Excellent, HS=Highly Satisfactory, S=Satisfactory, NS=Not Satisfactory. Insofar as possible, put Host Country comments before U.S.

Note: Attached to this Assessment Rating Form is a list of questions in regard to the socioeconomic component of the evaluation. There are some overlaps with questions in the above document, and the general outline covers most of these socioeconomic concerns. These have been developed with much thought by the Economist and Sociologist on the EEP, and there is a continuity of thought in arriving at an understanding of the socioeconomic status of the Peanut CRSP. These questions should remain intact for the two members to use in the site reviews, and then the information integrated into the final report in logical order.

Peanut CRSP Questions in Regard to Socioeconomic Evaluation

Evaluation Strategy

The evaluation task is to collect and evaluate data on Peanut CRSP (1) inputs, (2) system and human capital development, (3) research output-communication, and (4) utilization of technology by clientele. The Peanut CRSP inputs include information (e.g. constraints, concepts, theories, etc.), financial and human resources. System and human capital development includes networking and research capacity building of the Peanut CRSP itself as well as networking, i.e. building relationships, not merely with other scientists and CRSPs but most especially with various clientele or user groups. On the human side this includes the training of scientists and technicians. Research output-communication includes publications, workshops, conferences, seminars, etc. for Peanut CRSP and/or other scientists and clientele. Technology utilization includes information, technology prototypes (e.g. varieties released), and trained personnel obtained from the Peanut CRSP by clientele or their research systems, and the use of these "products".

I. Questions for Peanut CRSP Management: U.S. and Host Country

1. Research Planning

   1.1. How are decisions made as to documents such as a "A Strategic Plan for the 1990s", "Global Plan and Extension Proposal for 1990-1995", and "Detailed Project Plans for 1990-1995"?

   1.2. What is the process by which such planning documents are developed?

   1.3. How is information regarding constraints developed, evaluated, and research goals determined and prioritized?

   1.4. Who are the users/audience for such documents?

   1.5. How useful/effective has such research planning been? What is the downside?

2. Intra-CRSP Research Cooperation/Coordination

   2.1. How would you characterize the working relationships with U.S. institutions in research policy formulation? Host country? AID Missions? The Management Entity?

   2.2. How would you characterize the working relationships with U.S. institutions in regard to research resource allocation? Host country? AID Missions? The Management Entity?

   2.3. Apart from administrative channels of communication between Management, institutional administrators, and PIs, what kinds of inter-scientist and/or administrative networking are desirable for effective program attainment? How has this been encouraged?

3. Research Collaboration: Other research institutions

   3.1. How would you characterize your relationships with ICRISAT in research policy formation? CARDI? Other CRSPs? ARS?

   3.2. What factors have constrained collaboration?

4. Peanut CRSP Training: research and technical

    4.1. How are manpower (Ph.Ds, M.S.) training numbers determined?

    4.2. Where have the persons trained been employed?

5. Peanut CRSP Information Clientele: Demand Side

    5.1. Who are the Peanut CRSPs clientele? What groups are not Peanut CRSP clientele, or only poorly so, but should be?

    5.2. What kinds of information/technical support have each of the clientele groups requested?

    5.3. What are the constraints to clientele development, i.e. improving clientele relationships or generating informational requests? (What has the Peanut CRSP done to identify constraints?)

    5.4. How important is clientele development? Whose responsibility?

6. Peanut CRSP Clientele: Supply Side

    6.1. With respect to Peanut CRSPs clientele, how would you characterize the relationship(s) to extension? PVOs? Seed reproducers? Others?

    6.2. What kinds of information/support do you provide clientele? What kinds would you like to provide?

    6.3. What constraints exist to providing better information and/or support?

    6.4. How important is it to supply clientele information - support requests? Who is responsible?

II. Clientele Groups: Extension, Seed Reproducers, etc.

1. Clientele of Client Groups, Goals, Resources

    1.1. What is the group's purposes, goal, mandate?

    1.2. Who are its clientele?

    1.3. What informational and/or technical resources do you draw on?

2. Clientele (market) development

    2.1. What service or products do clientele request?

    2.2. What would you like to provide clients? What constraints?

    2.3. How do you try to overcome constraints?

3. Peanut CRSP Collaborating Host Country Research Institution as a Resource

3.1. Have you obtained information or support from a Peanut CRSP collaborating institution?

3.2. Have you requested information or support from a Peanut CRSP collaborating institution? What information/support have you requested?

3.3. How would you characterize your relationship to the Peanut CRSP collaborating institution? Should it be better?

3.4. What constrains a better informational/support relationship with Peanut CRSP collaborating institution?

3.5. Would you be able to serve your clientele better if you had a better relationship with the Peanut CRSP collaborating institution? How better?

III. Peanut CRSP Principal Investigators

1. Research problem formulation

1.1. How did you go about selecting/formulating the research problem? What were the particularly important considerations?

1.2. What are the research and/or technical goals?

1.3. What constrained the structuring of the research problem and the goals?

2. Operational Support Coordination

2.1. Have you had the financial and administrative support to attain stated research goals?

2.2. What have been the principal constraints to attaining research goals?

2.3. How and in what ways have you worked with colleagues from other disciplines? For what purposes?

3. Research Products

3.1. What have been the principal products, i.e. information and/or technical prototypes, of the research? What is anticipated?

4. Clientele and Relationships

4.1. What individuals, groups are interested in the products of the research project? What individuals or groups should be interested in the research products?

4.2. What information or support have you provided to....? How (by what means) have you provided this information/support?

4.3. Who inquired or requested support information from you? What? (Why haven't they?)

4.4. What is your relationship to....? What would be desirable relationship?

4.5. How have you tried to establish a relationship with...? What seems to be the main constraints?

PREVISIT QUESTIONAIRE

The Peanut CRSP External Evaluation Panel has requested information and background materials on social, economic, environmental and sustainable agricultural impacts from various CRSP groups prior to travel that would save time of obtaining it during site visits. Individuals to receive the questionaire could include: U.S. Principal Investigators, Host Country Principal Investigators, Technical Committee, Board of Directors, Management Entity; USAID Missions, Host Country Institutional Representatives; and responsible officials from local, state and national governments. A compilation of responses, even if partial, will provide a good overview for the countries and projects.

Social, Economic, and other Considerations at the Producers' Level

1. Competition of intensive labors at certain critical times in view of requirements for other cash crops and/or small industries.

2. Proportions of the peanut crop used for home consumption, local markets, and domestic and/or export markets.

3. Impact of increase in unit production on market prices and on the net profits to producers.

4. Importance of nutrition consciousness on home consumption and on increase in acreage planted to peanuts on small farms.

5. Increase of peanut production as a result of net profits realized.

6. The extent of acceptance of newly improved varieties by producers.

7. The extent of readiness in adopting the newly developed technology.

8. The short term and long term effects of small scale industries, such as peanut processing, to net incomes of producer or producers.

9. The environmental impact from biological control of pests integrated pest management and reduction in the amounts of chemicals used for pests control.

10. The sustainable agricultural benefits from the use of disease, insect, drought and/or shade resistant varieties and the benefits of peanuts as a nitrogen fixing legume in the intercropping and crop rotation systems.

Social, Economic, and other Considerations at the State or National Levels

1. Peanut acreage planted, harvested and average yield per acre or hectare for each of the CRSP states or countries since 1982 or 1989.

2. Sources of varieties and acres or hectares planted to each variety by states or countries impacted by CRSP (1982; 1985; 1989; 1992).

3. Peanut and peanut product(s) consumption data for each CRSP state or country.

4. Change in peanut processing capacity (1982-1992) for each CRSP HC or for certain localities in that country.

5. Listing of CRSP technology transfers which have reduced production costs, crop losses and which have increased state or national incomes as a result of financial benefits to individual producers or potential impacts that may arise from technologies developed and available for transfer.

6. Any constraints still existing in the technical, titutional or financial considerations in the domestic commodity system of the CRSP host countries in relation to the technology transfer.

7. The number of professionals trained and the status of their placements.

8. The perception and assessments of CRSP benefits from producers, researchers, educators, administrators, USAID Missions, and state and government officials.

9. The environmental impact from biological control of pests, integrated pest management and reduction in the amounts of chemicals used for pests control.

10. The sustainable agricultural benefits from the use of disease, insect, drought and/or shade resistant varieties and the benefits of peanuts as a nitrogen fixing legume in the intercropping and crop rotation systems.

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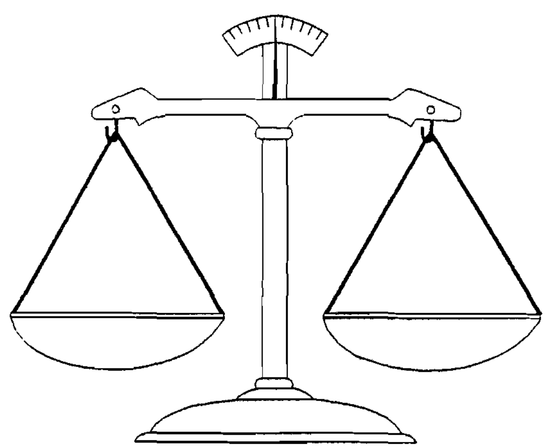
PEANUT

COLLABORATIVE RESEARCH

SUPPORT PROGRAM

EXTERNAL EVALUATION PANEL
ASSESSMENT RATING
for
Peanut CRSP Projects



Supported by USAID Grant No. 263-0152-G-00-1019-00
and the Participating U.S. Universities
and Host Country Institutions

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EXTERNAL EVALUATION PANEL ASSESSMENT RATING FOR PEANUT CRSP
Project TX//BCP/WA Disease-Resistant Peanut Varieties for Semi-Arid Environments.

In addition to the first hand discussions between EEP members and PIs and administrators, the project profile evaluation is based on visits to research laboratories, field plots, and on the oral and written reports and other written materials provided by the host countries and U. S. institutions and by Dr. D. G. Cummins, Program Director.

1. Achievement of Objectives. **Rating 4.2**

The objectives stated have been achieved in varying degrees of success at the host countries and U. S. Long term training of graduate students and short term training of established scientists from the host countries have taken place at the Texas A&M University. Significant achievements are listed by host countries and U. S. institution, as follows:

1.1 Burkina Faso - The three superior lines from the five-station mean yields are TX89-6314, TX89-6315, and TX89-6317. They are from crosses made in Senegal and are closely related. Seed of five germplasm lines introduced from Peru and possessing leaf spot resistance have been given to INERA and incorporated into their hybridization program.

1.2 Mali - Four lines from ICRISAT were superior for yield under drought stressed conditions near same as compared with 2 local check varieties.

1.3 Niger - T31-89 compared in short cycle tests at Miradi (low rainfall) and Bengou (high rainfall) exceeded the check variety in yield at both locations. Three Texas lines selected in 1991 for greater apparent tolerance to drought than 55-437 were included in the 1992 crossing block.

1.4 Senegal - Newly released variety Fleur 11 consistently yielded 30% more pods than the check variety 55-437 in multiple tests. Under drought stressed and reduced stand conditions, it produced 50% higher seed yield than check at Bambey in 1992. Breeding lines from Fleur 11 crossed with germplasms having superior fresh seed dormancy and Asperigllus flavus resistance have been selected that have at least 90% dormancy one month after harvest but they yield less than Fleur 11.

1.5 Texas - Tamspan 90 is a Spanish cultivar with useful levels of partial resistance to several soilborne diseases in Texas. Two breeding lines derived through interspecific hybridization with resistance to root knot nematode were released as germplasm lines. Hundreds of advanced generation lines bred for termite, leaf spot, rust, rosette, spotted wilt resistance, and for agronomic attributes were evaluated in multiple tests in West Africa and several locations in Texas.

2. Implementation and Management of Projects. **Rating 4.0**

2.1 Administrative Involvement

2.1.1 Burkina Faso - The collaborating institution has been the University of Ouagadougou. University Rector is extremely supportive of this project. The Principal Investigator is Dr. Phillipe Sankara, Director of the U O.'s Rural Development Institute. Dr. Sankara is also the Scientific Director of CNRST, Supervising INERA. It was encouraging to note that the University is working closely with INERA in the area of applied research and transfer of technology to extension service and production sector.

2.1.2 Mali - Extensive reorganization of the IER is underway. All projects funded by 23 International Donor Programs, including Peanut CRSP, will be administered by a newly formed National Science Foundation.

2.1.3 Niger - The new Director General of INRAN received his advanced training in the U. S. He is very supportive of the Peanut CRSP and also interested in exploring possible inter-CRSP linkage. Even without formal collaboration, certain interaction existed between INRAN's researcher and the scientists with the ICRISAT Sahelian Center (ISC).

2.1.4 Senegal - The Director General of ISRA understood the importance of international collaboration and appreciated CRSP's contribution. Bambey Station is being developed into a regional research center by adding scientists transferred from outlying stations. The Station Administrator, Dr. Amadou Ba, is also serving as the Coordinator of the CORAF Peanut Network for eight countries in West Africa. Three senior scientists and two student interns at the Bambey Station are French nationals and their salaries are paid by CIRAD.

2.1.5 Texas - The CRSP project funds are managed by the TAMU Research foundation. the Institutional Representatives are the Head of the TAMU's Soil and Crop Sciences Department and the Associate directors of Texas Agricultural Experiment Station. All of them have expressed their strong support for this program.

2.2 Researcher Involvement.
The researchers involvement on this project by the U. S. PI's and host country collaborators was highly satisfactory.

2.2.1 Burkina Faso - As stated previously, the PI of this project is also the Scienctific Director of CNRST, supervising INERA. It was therefore encouraging to note that in addition to inter-disciplinary collaboration within the University of Ouagadougou, the University scientists were taking the initiative to work closely with their counterparts in the INERA in the area of applied research and transfer of technology to extension service and production sector.

2.2.2 Mali - Due to moving of the main peanut research activities to Kayes-Same, which is located northwest and a considerable distance from Niamcy, the previous collaborator who received extensive training at Texas A&M has left the peanut program. He is replaced by Mr. Moussa Sanogo. Mr. Sadio Traore, a long time agronomist, will remain with the program.

2.2.3 Niger - Mr. Amadou Mounkaila has been the collaborator since the project's inception nearly 10 years ago. He now assumes additional responsibility as Chief of the Bangou Station where INRAN's peanut research is conducted. Field research plots of the ISC agronomic and breeding programs are also located there. The station has an irrigation well but has not been connected to the main electric trunk line. Efforts have been made to employ another scientist to assist Mr. Mounkaila in peanut research.

2.2.4 Senegal - Mr. Ousmane N'Doye, who received his M. S. degree and training at the TAMU, has been transferred from the Nioro Station to the Bambey Station. He still has field plot research responsibility at the Nioro Station. The Bambey Station is being extensively remodeled to meet the needs of refined laboratory analyses, physiological studies disease screening, and plant protection studies.

2.2.5 Texas - The Principal PI at the TAMU in College Station has been with this project since its inception. He and his two Co-PIs (located at Stephenville and Lubbock) and their graduate students have developed hundreds of peanut lines with the purpose of adapting to important ecological aspects of Sahelian West Africa and Texas, resisting to principal destructive diseases and insects and possessing drought tolerance. They have strengthened peanut improvement programs in the collaborating countries through encouragement and training in peanut research.

3. Institutional Development. Rating 4.3

3.1 Many of the scientists or administrators at the host countries have received either long term or short term training or both at the Texas A&M University. They have been able to obtain modern equipment and instruments and to upgrade facilities with the help of CRSP funds.

3.2 By attending international meetings and presenting papers or reports of progress, the researchers in the host countries and in the U. S. have increased collaboration and exchanged ideas with world wide scientists.

3.3 Research programs at Mali and Niger have been strengthened as a result of peanut CRSP and subsequent collaborative effort with other pertinent national or international programs.

3.4 Research programs at Senegal are the strongest of the four host countries in Sahelian West Africa. In addition to funding and technical support from Peanut CRSP, peanut research in Senegal involve three senior French scientists and two French student interns-volunteers financed by CIRAD. In addition, the host country PI is also coordinating CORAF Peanut Network for eight countries in West Africa. The Bambey Station is developing into a regional research center for all West Africa.

3.5 In addition to training their own undergraduate and graduate students at the University of Ouagadougou in Burkina Faso, students from neighboring countries also came to the University to receive valuable short or long term training.

3.6 The research output and technical publications by the Texas A&M scientists have increased from supervised research or thesis studies conducted by graduate students from host countries, other countries or other states in the U. S. with financial assistance from Peanut CRSP.

4. Adequacy of Science - Technical Merits of Program. Rating 4.3

4.1 The scientific principles of this project are sound and adequate.

4.2 The development of new cultivars partially funded by the Peanut CRSP has realized considerable economic benefits to the Texas peanut growers and processors. The major constraints for full realization of monetary gains by small peanut farmers in the four collaborating countries in West Africa have been the adequate seed multiplication, storage and wide scale distribution of improved peanut varieties which are superior in yield and other agronomic attributes than the locally grown varieties.

4.3 Adaptive type of research is appropriate for the collaborating countries. Some basic type of research is being conducted in Senegal by CIRAD supported French scientists. Both adaptive and basic types of research are conducted by PI and Co-PIs in Texas and by their cooperating scientists in the U. S.

5. **Applicability of Research.** **Rating 4.0**

5.1 All the PIs in the host countries and U. S. are fully aware of the practical application of their research results and improved peanut varieties specially suitable and adaptable to their local growing conditions and environment.

Many technical publications have been published by U. S. PIs available to their peers, but the actual use of the technical information by the farmers, even in the U. S., will have to depend on its dissemination and rewriting in popular type of language by the extension personnel.

5.2 There has been close collaboration with ICRISAT and CIRAD engaged in Peanut Varietal Improvement.

5.3 The perception of Peanut CRSP contribution is definitely positive by all the host countries and by nearly all the USAID mission officers.

6. **Observations.**

6.1 Strengths

6.1.1 Burkina Faso has excellent testing programs and the P. I. is working closely with the pathologist and entomologist. The P. I. of this project is also the Scienctific Director at CNRST, the national research institute, coordinating all scientific activities.

6.1.2 The Mali program has a new P. I. but still retains the long term agronomist.

6.1.3 The Niger program has a new facility at Bangou Station. ISC scientists conduct their varietal trials there.

6.1.4 Senegal is concentrating its peanut research at the Bambey Station while retaining large testing program at Nioro.

6.1.5 P. I. located at Texas A&M has many years of breeding experience and working with highly competent Co-PIs located at Stephenville and Yoakum..

6.2 Weaknesses

6.2.1 Burkina Faso - Better cooperative relationship is being developed between the University scientists and INERA researchers.

6.2.2 Mali - The main peanut research location is remote and considerable distance from Bamako.

6.2.3 Niger - The P.I. is also the manager of the Begou Station and thus needs a competent scientist to assist him in peanut research. The new station has good facility but without electricity. The P. I. needs to developer a closer relationship with ICRISAT and ISC.

6.2.4 Senegal - The P.I. needs to commute a long distance from Bambey to his main research plots at Nioro.

6.2.5 Texas - Longer and more frequent visits by P.I. to the WA host countries will be desirable.

7. Recommendations.

Another 5-year extension is recommended in view of the long term proposition of the breeding program and the varying developing stages of advanced breeding lines in WA and Texas.

Ph.D. training in U.S. of Senegal's P.I. O. N'Doye in U. S.

EXTERNAL EVALUATION PANEL ASSESSMENT

External Evaluation Panel Assessment Rating for Peanut CRSP
Project NCS/BCP/TP-Peanut Varietal Improvement for Thailand and the Philippines.

1. Achievement of Objectives **Rating 5.0**
The objectives stated are still conceptually reasonable, realistic, and achievable.

In the case of the host countries, the best yardstick of achievement is release of new cultivars.

1.1 Two new cultivars, IPB Pn 85 2-40 and IPB Pn 85 10-68, have beenrecommended for seed increase in the Philippines.

1.2 The new cultivar, Khon Kaen 4, has been released in Thailand and five additional lines have been identified as promising.

1.3 On-farm trials comparing a range of cultivars have been carried out in the Philippines.

1.4 Training in peanut seed production has also been given in the Philippines.

1.5 Training programs in Thailand have been concerned with peanut production technology instruction to extension personnel.

In the U. S., the significant achievements are as follows:

1.6 Two Thai graduates are receiving training in Plant Pathology at NCSU.

1.7 Progress in developing CBR resistance has been achieved in line N 90013.

1.8 Four breeding lines from wide crosses with early and late leafspot resistance have been selected.

1.9 Development of transgenic plants incorporating virus resistance from vinal protein sources is in trial.

1.10 Plasmid vectors for transformation are also under development.

2. Implementation and Management of Projects. **Rating 3.0**
The attitude to the project appears to be supportive at the institutional level. There has been a free flow of information and materials, as evidenced by the appearance of NC7 in the parents of cultivars under selection in both, Thailand and the Philippines.

There are no apparent constraints of an institutional nature which are impeding the operation of the U. S. component of the program. In Thailand, it was mentioned that the flow of funds to the projects could be delayed because of financial bureaucracy, since this had to go through "proper" channels. This appears to have been a more serious difficulty in the Philippines. Unfortunately, this was not helped by the inter-personal difficulties noted by Dr. Coughenour in his trip report to N. C. State between Drs. Isleib and Dr. Abilay. Dr. Coughenour also has indicated the valuable linking and liaison role played by Dr. Barbara Shew in coordination at NCSU, it is possible that she might also have been able to have been a troubleshooter in this unfortunate situation. Such a role should certainly be considered in the event of a time extension of the project. The dearth of direct personal exchanges between the institutions has been regrettable and while it has not adversely affected useful output of the program in any readily quantifiable way, there has not been the personal intellectual development and stimulation and cross-fertilization that is the usual (and highly desirable) outcome of such contacts.

This situation also had an inhibitory effect on development of training needs at graduate student and post-doc level. It has also led, perhaps, to rather more introverted thinking than is desirable in the long term.

In terms of financial provision, all three programs no doubt could have made good use of additional funding. All were able to operate within current financial limits, apart from difficulties already noted.

This aspect of project management has shown weakness which could and should be addressed in any renewal.

3. Institutional Development **Rating 4.0**

There is no doubt that all three participating institutions have benefited from the Peanut CRSP program. The two host country institutions are maturing fast (in Thailand, that can be considered as having come of age) and operates smoothly and productively. There have been very positive developments in the Philippines and when the difficulties discussed have been resolved, could very soon be in a similar position. Certainly in terms of productivity and product there has been very real achievement.

In-country training, especially in Thailand, is developing very positively. Training at M. S. and Ph.D. level at the lead institution is continuing and in any renewal of the project, the adequacy of this should be reviewed.

4. Adequacy of Science - technical merits of program. **Rating 5.0**

4.1 The program is very forward looking indeed and thoroughly innovative in its research with general awareness, at a very high level, of questions of biodiversity (in the format genetic resources), sustainability and food supply and economic progress.

4.2 Economic implications really center around the seed storage question, while this is not a problem for the breeders, it can and could be a considerable constraint in reaping full benefit from more productive cultivars. Concerns with production of special purpose cultivars (i.e. for boiling) could positively affect increase generation.

4.3 There are some areas where supplementing investigation seems appropriate. Current yield ceilings appear to be very low. ca 2t/ha. What are the factors imposing this? Can they be circumvented? Would some soil science and/or agronomic input be appropriate?

4.4 The only other breeding program comparable to this combined entity is probably that at ICRISAT in India and it can be expected to go from strength to strength.

5. Applicability of Research. **Rating 5.0**

5.1 Overall, the work in this program addresses problems of universal concerns to the peanut producing community world wide and specifically national problems. Cylindrocladium blackrot (CBR) is a serious concern in the southeastern U. S. but not elsewhere. Dorylid ants are a pest in Thailand but absent from the U. S. This program covers both types of problem and so lead and host countries both stand to benefit.

Publication of results is highly satisfactory. Host country scientists in Thailand have expressed appreciation at the help and assistance they have received in preparing and presenting work for publication in English language international journals.

5.2 Relationships with international research programs are good and close. All three institutions were, for example, represented at the last International Groundnut workshop held at ICRISAT in 1991.

5.3 There can be no question that the perception of Peanut CRSP activity in host countries is positive. The whole concept, ideology, and practice is well conceived and the general perception is that it has been fruitful in operation.

6. Observations.

6.1 Strength

a. The program is scientifically sound.
b. The coverage is remarkably comprehensive.
c. The panel of investigators has shown competence of a high order.
d. The program is forward looking and innovative and has covered adequately the major international problems, in addition to those of national and local interest.

6.2 Weakness

a. The somewhat insular attitudes considered need to be reversed. Fortunately, these appear to have been a comparatively recent development and have had no detectable adverse effects on the output of the cooperating institutions. There is a possible role for Dr. Barbara Shew to develop in more closely linking them.
b. As indicated, yield levels in both Thailand and the Philippines which are currently achieved appear to be on the low side. The causes of this need to be identified.
c. The work of cultivar improvement is likely to be compromised by the problems of post harvest seed storage and handling. This question needs to be addressed as a matter of urgency.

7. Recommendations.

This program has already delivered useful results with more in prospect. The potential for future development is enormous. The program should be continued, success should be rewarded. The importance of more frequent contact between institutions at a personal level should be encouraged. It may be difficult for lead country personnel to find the time, but this should be done. This would ensure sustained cross-fertilization in thinking and mutual intellectual stimulation.

The single reservation expressed and discussed previously notwithstanding, this project has been outstanding and can be rated as excellent.

External Evaluation Panel Assessment Rating for Peanut CRSP
Project TX/MM/SG Mycotoxin Management in Peanut by Monitoring and Prevention of Contamination.

In addition to first hand discussion between EEP members and PIs and administrators, the project profile evaluation is based on visits to research laboratories, field plots, and on the oral and written reports and other written materials provided by the host countries and U. S. institutions and by Dr. D. G. Cummins, Program Director.

1. Achievement of Objectives. Rating 4.5

The objectives stated have been achieved in varying degrees of success at the host countries and in the U. S. Long term training of graduate students and short term training of technicians have taken place at the Texas A&M University. Short term training of senior scientists from the host countries have either been carried out in recent years or planned for in the near future.

1.1 Senegal - Under spray-inoculation conditions, some cultivars are more infected with Aspergillus flavus than others. Cultivar susceptibility influenced the soil content of A. flavus propagules. Spraying plants at pegging time resulted in most infection.

Newly developed aflatoxin sorption (clay) methodologies will allow local villages and industry to treat peanut oil to reduce aflatoxin levels to a safe level for consumption.

1.2 Ghana - Two Ghanian Institutes have been officially accepted into the mycotoxin program. The PIs are Dr. Richard Awuah at UST and Ms. Kafui Kpodo at FRI. Their participation has strengthened the research program, according to Texas PIs.

1.3 Texas - Microbial assays using colored aflatoxin mutants in Aspergillus flavus and A. parasiticus have been initiated.

  a. to assess peanut cultivars for relative resistance/susceptibility and Asperiglllus infestations and/or aflatoxin contamination,
  b. to assess plant extracts for their effects on this interaction.

Preliminary results have identified three promising Ghanian plants which may decrease both Aspergillus growth and aflatoxin production.

A cluster of genes have been identified as important in the sterigmatocystin/aflatoxin pathway. Studies are being initiated to study Fusarium mycotoxin in peanuts.

2. Implementation and Management. Rating 4.5

2.1 Administrative Involvement
The administrative involvement of this Peanut CRSP project of Texas A&M and in the two host countries was highly satisfactory and supportive.

2.1.1 Senegal - ISRA and ITA are collaborating agencies for this Peanut CRSP. The Director Generals of both these institutions appreciate the collaboration with the Texas A&M University.

2.1.2 Ghana - Two institutes have become official collaborating agencies of this mycotoxin program. They are UST at Kumasi and FRI at Accra.

2.1.3 Texas - The project funds are managed by the TAMU Research Foundations. The Institutional representatives are the Head of the TAMU's Department of Plant Pathology and Microbiology and the Associate Director of Texas Agricultural Experiment Station.

2.2 Researcher's Involvement

The researchers' involvement on this project by the U. S. PIs and host country-collaborators was highly satisfactory.

2.2.1 Senegal

Dr. Amadou Ba of ISRA at Bambey and Dr. Amadou Kane of ITA at Dakar-Hann are Principal PIs of this project. Dr. Ba is primarily responsible for screening peanut cultivars and genotypes under laboratory and field conditions for tolerance or resistance to aflatoxin producing fungi. Dr. Amadou Kane who took over the responsibilities formerly held by Bashir Sarr at ITA is responsible for detection of aflatoxin in peanut samples collected in Senegal and for initiating the transfer of clay chemi-sorption technologies at a village level.

2.2.2 Ghana

Dr. Richard Awuah of UST will assess Ghanian plants and plant extracts for their ability to decrease Aspergillus growth and aflatoxin production. Ms. Kafui Kpodo at FRI will develop safe, economical and effective methods for the detoxification of aflatoxin-contaminated peanut products.

2.2.3 Texas

Even though Drs. Beremand and Keller have been the PI and Co-PI for only two years, they have made significant contributions toward the microbial assays and molecular understanding of aflatoxin production in peanuts. Dr. Timothy D. Phillips of the TAMU's Department of Veterinary Public Health and his associates were responsible for the development and refinement of clay chemi-sorption technology for removal of aflatoxin in peanut oil to a safe level for consumption. All the PIs at the TAMU are responsible for the maintenance of the long term training programs for graduate students or short term training for technicians and senior scientists.

3. Institutional Development. Rating 5.0

The funding support from the Peanut CRSP has enabled scientists in the host countries to obtain modern equipment and instruments and to upgrade their facilities.

3.1 Senegal - In addition to funding and technical support from Peanut CRSP, peanut research in Senegal also received substantial assistance from CIRAD in terms of monetary help and additional scientific expertise. The PI with ISRA is also coordinating CORAF Peanut Network for eight countries in West Africa.

3.2 Ghana - According to the U. S. PIs and one EEP member who have personally visited the excellent research facilities in Ghana, they believe that collaboration with competent Ghanian scientists will greatly benefit the research outcome of this mycotoxin program.

3.3 Texas - The interdisciplinary collaboration within the TAMU system and the outstanding facilities and technical support have sustained the cutting edge research on microbial assays using colored aflatoxin mutants, the mapping of genes in the aflatoxin pathway and molecular understanding of factors influencing aflatoxin production in peanuts under the leadership of Drs. Beremand and Keller.

4. Adequacy of Science - Technical Merits of Program. Rating 5.0

4.1 This project involves scientifically sound adaptive and basic research on mycotoxin management in peanuts.

4.2 This research will protect not only consumers on the village levels in host countries, but also all consumers of food products throughout the world by removing serious health hazards posed by aflatoxin contamination. I The social/economic impact will be very great indeed.

4.3 The clay or chemi-sorption and disease screening technologies devised and biotechnology protocols produced will have enormous impact not only on monitoring and prevention of aflatoxin contamination but also on assisting breeders in developing genotypes resistant or tolerant to aflatoxin producing fungi.

5. Applicability of Research. Rating 5.0

5.1 This research has tremendous relevance to all countries where peanuts are grown and where peanut products are consumed. Findings from this research could be applied at either village levels or utilized at the well equipped laboratories. Biotechnology protocols developed for peanuts will also be applicable to other legumes or even to non-legumes.

5.2 The mycotoxin research of this Peanut CRSP will attract enormous interest in collaboration from the international research programs.

5.3 USAID/Dakar Mission takes an active interest in this research and considers its impact important, particularly on the village level consumers of peanut products.

6. Observations.

6.1 Strengths

6.1.1 Senegal - The facilities at the Bambey Station are being modernized and expanded. Work on aflatoxin detection and clay chemi-sorption will be continued without interruption at ITA.

6.1.2 Ghana - The addition of two competent Ghanian scientists is definitely a plus for the collaborating mycotoxin research program.

6.1.3 Texas - The PIs and cooperators have contributed greatly to microbial assays and molecular understanding of aflatoxin production in peanuts.

6.2 Weaknesses

6.2.1 Dr. Amadou Ba, PI of this project and Senegalese PI of TX/BCP/WA, is Director of ISRA's Bambey Research Center and coordinator of CORAF Network. He needs more technical assistance for his many research involvements. The equipment at ITA needs to be repaired and updated for effective aflatoxin detection.

6.2.2 Senegal - Unfortunate misunderstanding developed between USAID/Dakar Mission and Peanut CRSP over the issue of Dr. Sarr not returning to Senegal upon completion of his Ph.D. training on aflatoxin research and his acceptance of a post doctoral appointment at the TAMU's Department of Veterinary Public Health.

7. Recommendations.

Recommend another 5-year extension for this highly innovative and productive mycotoxin research program. Short term visits and training by all PIs in the host countries at the Texas A&M University will be highly desirable.

SUMMARY

GA/IM/BF - IPM Strategies for Peanut Insects in SAT Africa

1. Achievement of Objectives **Rating 4.0**

Goals

1. Identify peanut germplasm with resistance to termites, lesser cornstalk borer (LCB), aflatoxin formation, and rosette which is useful in West Africa and the U.S.

This goal has been substantially attained although further research is justified to maintain the level of resistance and yield now available.

2. Identify the major mechanisms and interrelationships between insect damage to peanut pods, A. flavus invasion, and aflatoxin in seed.

With completion of analysis and publication of present data, this goal will have been substantially attained. Further research should concentrate on a new goal of understanding the factors and mechanisms of termite resistance in peanut.

3. Develop IPM strategies . . . for insect control, reduction of peanut losses, and of aflatoxin.

Much of the work toward attainment of this goal remains to be done. It involves both continuation of research on objectives 3 and 4 and research on new objectives, such as understanding the emerging threat of thrips as a vector in TSWV, and work with extension and other organizations in direct contact with farmers to develop effective improvements in pest management strategies.

4. Provide training for host country collaborators.

The training of researchers and technicians has been substantially accomplished. The training of personnel for implementation of IPM strategies is an important next step.

Objectives and accomplishments

1. Identify the major economic pests of peanut in Burkina Faso.

   (1) Research conducted variously in West Africa prior to 1990 had contributed to identification of the following major foliage pests:
   * Aphis craccivora (Koch)
   * Empoasca facialis Jacobi
   * Empoasca dolichi Paoli
   * Thrips (several species)
   * Helicoverpa armigera (Huber)
   * Spodoptera littoralis (Boisduval)

   --and the following root, peg, or pod pests:
   * Microtermes thoracalis Sjostedt
   * Hilda patruelis Stal.
   * Caryedon serratus (Ol.)

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* Whitegrubs (numerous species)
* Peridontopyge sp.
* Elasmolomus sordidus (F.)

(2) Research in Burkina Faso identified aphids and thrips as principal foliage pests as much because they transmit rosette and tomato spotted wilt virus, respectively, as fro the direct damage to peanut, and termites as the major pod pest due to its direct destruction of peanut and to facilitating the entry of A. flavus in damaged pods.

Additional research on this objective is not needed.

2. Determine the relationships between level and type of arthropod injury to peanut pods and aflatoxin contamination of preharvest and postharvest peanut.

(1) Studies have shown that the damage to termite pods varies by harvest date--increasing rapidly after the 100th day--soil moisture level, and in southern Burkina Faso by plant population. the invasion of A. flavus is known to vary by termite pod damage. research data obtained will indicate the variation in aflatoxin level by type of pod damage--no damage, scarified, and penetrated.

Full attainment of this objective has been delayed due to lack of adequate analytical equipment and trained personnel, both of which have now been corrected.

3. Develop economic injury levels for the major arthropods by quantifying pest density or injury level with losses in peanut yields.

To a significant extent, economic injury levels vary by eco-environmental condition.

(1) Research at Gampala indicated that aphid populations and rosette incidence were invariant by increases in plant population while damage due to thrips and lepidopterous larvae declined with increases in plant population. With increases in plant population, termite damage increased while did not vary significantly.

(2) At Farakoba, foliar insect and rosette damage varied with increases in the plant population while both termite damage and yields increased.

(3) Neither the percentages of undamaged, termite scarified, or penetrated pods nor peanut yields was affected by the depth of tillage in Burkina Faso although deep tillage in the U.S. significantly reduces termite infestation and damage to peanuts.

Further research is needed in Burkina Faso to develop reliable information on losses in yields as related to pest densities especially in the Gampala region.

4. Develop reliable sampling procedures to estimate population densities of the major pests.

Satisfactory methods for research purposes have been developed by adapting U.S. methods in the conjunction with research projects in Burkina Faso. These methods, however, have not been evaluated for possible use in IPM on farms in Burkina Faso.

5. Determine arthropod abundance in relation to plant phenology and growing season in Burkina Faso.

(1) Research has shown that damage to peanut plants due to aphids, thrips and leaf hoppers increases from early to midseason and, thereafter is not an important factor.
(2) Damage due to Lepidopterous larvae is a problem primarily in midseason.
(3) Damage due to termites becomes a problem in late season and with relatively high moisture levels.

Research on seasonal variation in pest populations is needed for development of reliable knowledge for development of IPM.

6. Evaluate promising peanut lines from ICRISAT or from the Breeding CRSP for resistance ... to major arthropod pests.

Of the ICRISAT lines evaluated for thrips, jassids, and termites, about a dozen lines were returned to Georgia for multiplication. Evaluation of these lines in Burkina Faso for resistance to termite damage determined that:

(1) At Gampala NCAc 343 yielded more than twice as much as its nearest competitor and termite damage both to plant roots and pods was significantly lower than for check varieties.

(2) At Farakoba, the yield of NCAc 343, although not higher than other varieties at the first harvest, increased more than other varieties, except TS 32-1, by the second harvest and along with NCAc 2240, 2243, and RMP 40 had over 90% undamaged pods at the second harvest.

This constitutes a major accomplishment toward attaining the goal of increasing yields and reducing aflatoxin in peanuts.

7. Evaluate insect control methods.
Although this was not listed as a specific objective, studies in Burkina Faso and Georgia demonstrated:

(1) Neem was not found to be an effective control agent against thrips, jassids, Lepidoptera, or termites.
(2) Lorsban, used as granules or pressure injection, reduced the percentage of damaged peanut pods, but only the use of Lorsban 15G resulted in significantly increased yields.

No research on biological control, which was an early objective, has been conducted.

8. Cooperate with the Texas A&M Breeding CRSP in the evaluation of germplasm for resistance to termite damage and aflatoxin contamination.

(1) Germplasm of the high yielding, termite resistant line NCAc 343 has been transferred to Texas A&M (TX/BCP/WA) for crossing with other lines.

9. Provide training for scientists and students from Burkina Faso.
Six students have received training on on-going research projects in Burkina Faso, and one scientist has received short term training in the U.S. on aflatoxin analysis. One student has completed Ph.D. training during this project period.

The principal training need in the future is for personnel to carry out extension type responsibilities.

2. Implementation and Management of Projects **Rating 4.0**

2.1 Attitude towards, support, and perceived relevancy to the institution.
There has been substantial and effective information flow, at the level of the PIs and Peanut CRSP management. The reporting of research accomplishments in relation to objectives and goals has sometimes not been carried out as systematically as desired. There is a perception, which stems from earlier criticism of lack of sufficient collaboration with Peanut CRSP researchers, that neither the extent of collaboration nor effort to engage in it has been adequately appreciated.

For the most part funding has been adequate in that the progress of research has not been notably handicapped due to the lack of funds.

2.2 Adequacy of planning.
Annual work plans have been developed systematically and in satisfactory detail. The planning has been done largely in the U.S., which although probably necessary in the early years, should be carried out more and more as a joint venture especially in the host country.

3. Institutional Development **Rating 4.8**

3.1 Complementarity to ongoing research efforts.
There has been notable complementarity in the development of reliable pest sampling methods in Burkina Faso, study of pod damage and aflatoxin contamination due to termites and the lesser corn borer, the screening of varieties for termite resistance, and training.

3.2 Strengthening of scientist/equipment/facility.
The analytical capability necessary for the continuation of the research program in Burkina Faso has been put in place.

3.3 Extent of collaborative actions.
While collaboration among project PIs has been effective, they have not taken sufficient initiative to reach out to new clientele and potential collaborators especially in building toward effective IPM strategies.

3.4 Training.
Despite the absence of a formal Peanut CRSP training plan, the training has followed a plan. In this case, USAID had an institution building project in Burkina Faso, which the Peanut CRSP helped implement by training some of the key staff. Students have received high quality training as required to staff the research program in Burkina Faso, and along with others with similar training, constitute the faculty of a research and training center in Burkina Faso of regional importance. The Peanut CRSP has been instrumental in establishing a network of scientists in Burkina Faso, Senegal, Mali, and Nigeria.

4. Adequacy of Science. **Rating 3.7**

4.1 Progressiveness and innovativeness.

4.2 Social science/economic implications.
Little or no socioeconomic assessment has been attempted on this project.

4.3 Appropriateness of research.

There has been satisfactory balance of basic and adaptive research in the work that has been conducted.

5. Applicability of Research. **Rating 4.3**

5.1 Relevancy and transferability ...
While the research has been published as is availability to scientists, the effort to get the results of the research into the actual use of farmers has not been made. Admittedly, in important respects further research is required before such transfer can be effective.

5.2 Relationship to other international research.
There has been notable collaboration with ICRISAT and others engaged in assessing pest damage and aflatoxin contamination.

5.3 USAID/host country perceptions.
There has been a continual, high level of interest by the USAID mission in Burkina Faso in this project.

6. Observations

The project has been largely successful in attainment of the primary research goals. Its strengths has been in:

* Scientific quality
* Research planning and execution
* Reporting research results to other scientists
* Strengthening research centers with trained scientists
* Establishing networks of committed scientists

Its weaknesses have been:

* Developing research planning capability in host country
* Engaging technology transfer groups
* Developing practical IPM

7. Recommendations

New project leadership probably is desirable in re-orienting this project to new research and technology transfer goals.

SUMMARY

NCS/IM/TP - Management of Arthropods on Peanuts in Southeast Asia

1. Achievement of Objectives. **Rating 3.5**

Goals
Effectively manage those arthropod pests that limit peanut production through an effective pest management program based on sound principles of IPM and sustainable agriculture.

Objectives and Accomplishments
(1) Evaluate genetic material for insect tolerance or resistance to single species and arthropod complexes.

(i) Philippines--On the basis of data obtained over several years of screening cultivars for host-plant pest resistance several entries show sufficient resistance for their characteristics to be utilized in a host-plant-resistance package. studies evaluating this package have been expanded to numerous locations.

(ii) Thailand--Screening of germplasm for insect resistance is being carried on by the DOA and Khon ;Kaen U.

Progress is being made on this important objective but more slowly than expected.

(2) Develop damage assessment data for arthropod complexes as related to host plant phenology to determine IPM thresholds.

(i) Philippines--Research has increased the information of insecticide timing, off-target effects, and economic benefits for incorporation of insecticides into improved IPM programs.

(ii) Thailand--Continued research on insecticide timing, host-plant resistance, pest prevalence, and peanut pod fill (economic cost/benefit) has established the data base for improving IPM programs.

This objective has been substantially attained and future work would be phased down.

(3) Study the biology, ecology, and pest abundance and status of the important arthropod pests.

(i) Philippines--an important data base exists for use in biological control techniques with aphids, thrips, and leaf hoppers.

(ii) Thailand--Research has increased understanding of thrips--incidence and migration--which will contribute to the improved management of peanut yellow spot virus.

(iii) United States--Studies have increased information on the relationship between thrips overwintering, migration, and within-field distribution to TSWV in peanut which helps develop improved management strategies for this virus (and complements studies in Thailand).

Work on this objective is on-going and having a demonstrable impact in the development of more sustainable IPM programs. It should be continued, even expanded.

(4) Determine the effects of cultural practices on insect populations and host plant damage.

(i) Philippines--Research is building an information base on the relationships between cropping systems, e.g., intercropped peanuts with corn, bananas, on arthropod complexes and pest control strategies.

(ii) Thailand and United States--Research has produced promising results on the relation between tillage practices and early season insect populations.

This is a broad objective and the work to date is only beginning to provide useful findings. The objective should be more narrowly construed and research more actively pursued.

(5) Utilize monitoring devices to gain a better understanding of insect biology and to predict insect occurrence and abundance.

Such devices have been used in research studies in all three collaborating countries.

These methods are components of other objectives and should not be represented as an independent objective.

(6) Develop an effective IPM program and demonstrate benefits in North Carolina, Thailand, and Philippines.

(i) Philippines--In 1994, a Review and Planning Workshop on Peanut Integrated Pest Management was held at PCAARD to update information on peanut IPM, identify peanut pest problems, to develop plans for short- and long-term solutions, and to prepare recommendations for improving IPM programs.

(ii) Thailand--Studies and demonstrations using improved IPM strategies have been carried out in several locations. Farmer training in improved IPM has led to change and improvement in farmer pest management.

(iii) United States--Through the development of information on the preceding objectives, management strategies for improving the sustainability of peanut production have been strengthened.

Development and improvement of IPM programs is the goal of research on other objectives and must be continued.

(7) Added in 1992: Evaluate the potential for biological control as a realistic approach to arthropod management in peanuts.

(i) Philippines--Biological control of Lepidopterous pests on peanut using <u>Trichogramma</u> sp. and a microbial insecticide <u>Bacillus thuringiensis</u> have been highly successful. Trials to evaluate pest thresholds and the efficacy of alternative pest management strategies in realistic foam settings have been undertaken.

(ii) United States--Complementary studies with promising results have been conducted on controlling two peanut insect pests in North Carolina.

This is an important alternative to conventional chemical control. Testing and incorporation of the alternative in IPM should be continued.

Except for objective 5, which is essential to other substantive objectives and therefore unnecessary, and objective 4 which is too broad, the objectives are sound and should be continued. Although significant progress has been made toward attainment of the objectives, it is slower than expected, especially in the Philippines, due in part to personnel changes, leaves of absence, and to unfortunate accidents in transferring germplasm for screening. Some of the benefits of the research effort are only now beginning to be extended to farmers in Thailand in the form of improved IPM, but in the Philippines the improved IPM is still being evaluated. Clearly, the objectives have been more nearly accomplished in Thailand and should receive at least a "4" rating while in the Philippines the rating would be no more than a "3".

2. Implementation and Management of Projects. **Rating 4.5**

2.1 Administrative involvement

The NCSU administrative is highly supportive of the project, quite responsive to the researchers, and believe that the present PIs have a good research and extension program.

While more could be done with increased funds, the researchers do not perceive funding as a major constraint.

2.2 Research planning

Research and extension planning, especially in Philippines has been weak. It was facilitated by the recent trip of the NCSU PIs to Philippines. This needs to become routine. Overall, the contact between U.S. and host-country scientists has been less frequent than desirable for the most effective collaborative research.

3. Institutional Development **Rating 3.8**

3.1 Complementarity to ongoing research efforts

There is good complementarity in studies of pest ecology, cultural practices, biological control, and the development of overall IPM strategies. Researchers are attuned to developments in other IPM research projects on disease resistance factors.

3.2 Strengthening of scientists and facilities

Facilities are adequate for most types of studies except the most innovative work on biological agents. Scientists occasionally have been supported in attending professional meetings and in making short-term visits. However, networking and professional publications by host country scientists have not been satisfactory, suggesting that the rewards for publication in host countries are not satisfactory.

3.3 Extent of collaborative actions

Collaboration, which was a strong point early in the project, was interrupted when project leadership changed. Direct personal contact between U.S. and host-country PIs has been too limited to establish effective collaboration. Notably absent since 1990 are publications and papers co-authored by U.S. and host country scientists. This is symptomatic of the lack of collaboration despite the complementarity of some of the research.

3.4 Training

This project has not has an explicit training component. However, host country PIs have been well trained, and two students with Peanut CRSP support have been working on advanced degrees in Philippines. Training programs for extension personnel working with IPM have been recently established in Thailand.

IPM training of extension workers should be expanded both in Thailand and the Philippines.

3.5 Comments

In recent years host country PIs have been primarily oriented to building data bases necessary for implementation of IPM programs. These bases have been established sufficiently that the programs in Thailand and Philippines are shifting to IPM recommendations and outreach. The present U.S. PIs are strong in this orientation and the extent of collaboration hopefully will increase the pace of the outreach in the next phase.

4. Adequacy of Science - technical merits of program. Rating 3.7

4.1 Progressiveness and innovativeness of research.
Research on Biological control has been innovative and highly successful, especially in the Philippines. The research on thrips as a vector in TYGV is innovative and promising. Throughout there is attention to minimizing environmental impact of pest control methods. However, despite the interesting results, the project has not yet developed a general control strategy, contributing to a plant protection strategy for the humid tropics, comparable to that developed for dry areas of West Africa.

4.2 Social science/economic implications.
Studies of F"ecomomic thresholds" of prevalence of various pests have been made, which guide the timing of chemical control, and limited assessments have been made of the cost benefit of biological versus conventional pest control. However, socioeconomic analysis of various methods of control have not been made.

4.3 Appropriateness of research (basic/adaptive). Rating 4.0

Studies of the biology, ecology, and pest abundance of arthropod pests, screening of germplasm for pest resistance, studies of thrips as a vector in PYSV, and of arthropod ecology are highly important to the development of improved IPM. There is need for the latter to occur and for it to be extended to farmers, especially in Philippines.

4.4 One E.E.P. member commenting on Philippines noted: "There is no indication of a systematic survey ;of pests and diseases in general, comparing the incidence of arthropods, nematodes, fungal and viral diseases, and aflatoxin contamination, and the interaction of these components of plant protection." Despite interesting results, the project has not yet developed a general control strategy.

5. Applicability of Research Rating 4.0

5.1 Relevancy and transferability of research.
IPM, because of the increased management requirements, is inherently difficult to transfer. Despite this, there is some evidence in Thailand that farmers will accept the new methods. Although farmers are more inclined to accept pest resistant varieties of new seeds than new management practices in Thailand and Philippines the effectiveness of a strategy of breeding pest and distribution. Thus, which approach would most effectively reduce pest damage to peanuts requires a more finely tuned evaluation of the constraints in each host country.

5.2 Relationship to other international research.
Some international networking and national workshops have occurred, more in Thailand than in the Philippines. Much more short courses and workshops in both countries will be required.

5.3 USAID/Host country perceptions of research.

5.4 Comments.
In a region with expanding demand for peanuts, peanut production in the Philippines and to a lesser extent Thailand is lagging. Seed quality and pests are the two most important constraints, and the work thus has high relevance and applicability to helping these countries attain national production targets.

6. Observations.

6.1 Strengths

Principal strengths of the research program are:

* Quality and commitment of scientists
* Development of reliable knowledge base
* Range of the research in addressing pest biology, ecology, peanut disease interactions, pest resistance
* Institutional means for transfer of IPM knowledge to clientele

6.2 Weaknesses

* Lack of overall pest control strategy
* Lack of U.S./Hist country scientist interaction
* In Philippines, weak linkage between researchers and DOA
* Inadequate capacity for seed multiplication and distribution
* Inadequate training capacity for farmers in IPM

7. Recommendations

1. A general pest control strategy for each host country should be developed.

2. Ways of increasing scientist collaboration should by explored as this will be increasingly important as Thailand and Philippines strive to transfer IPM technology to farmers.

3. Study the effect of underground and storage insect pests on seed quality, yield, and A. flavus contamination. While the problem of Aspergillus contamination may be small now because of limited on farm storage, any improvement of on-farm production and storage is likely to increase the problem.

External Evaluation Panel Assessment Rating for Peanut CRSP
Project GA/PV/N,TP. Peanut Viruses: Etiology, Epidemiology and Nature of Resistance.

1. Achievement of Objectives. **Rating 5.0**

1.1 In the course of this project's term, the completion of virus disease surveys means that the first two aspects specified in the project title have been definitively dealt with and that the issue of virus resistance and its nature are the common concern of all partners in the program. The specific viruses concerned vary geographically with rosette (GRV), prevalent in Nigeria, bud necrosis virus (GBNV), predominant in Thailand, with peanut stripe virus (PST.V) and peanut mottle (PMV) also in evidence. The virus of major concern in the United States is tomato spotted wilt (TSWV). TSWV and GBNV appear, though related, to be distinct but have a common vector, thrips.

1.2 Resistance to GRV is established in cultivars but due to shortening of the rainy season, this resistance has to be transferred to earlier maturity lines which is now in hand. Progress is being achieved in Nigeria.

1.3 Selection objectives have been defined in Thailand, which include resistance to infection of all viruses and reduced rates of transmission through seed of seedborne viruses.

1.4 Considerable progress has been achieved at the University of Georgia in developing protein coat mediated resistance to PSTV. Protocols have been devised which enable regeneration of plantlets to occur from cells from seedlings which have been transformed. Work on Agrobacterium mediated transfer is also under way. These procedures when developed shall have general application to other viruses.

1.5 An additional biotechnological approach is through protoplast fusion. This has been achieved and regeneration of cytohybrids obtained. Work is in hand to incorporate resistance from rhizomatous Arachis species into the Arachis hypogaea genomes.

2. Implementation and Management of Projects. **Rating 5.0**
The support for this project can only be described as enthusiastic. There is a free flow of information and materials between institutions which has been enormously assisted by Dr. Demski's active maintenance of personal contacts with colleagues in the host countries. The levels of both activity and enthusiasm are high. The program is one which is clearly defined and the approach is well focused.

In common with all projects, there are financial constraints but work progresses well in spite of them. While any reduction in financial resources could inhibit progress at least to come extent, financial stringency to date has probably increased cost effectiveness.

3. Institutional Development. **Rating 5.0**

There can be no question of the very considerable benefits derived from this project which have accrued to the University of Georgia. The techniques developed for regeneration of plants from culture cells are a significant breakthrough with difficult and recalcitrant material reflecting great credit on all concerned and the parent institution.

Training is being carried out at the graduate student level and excellent work is being accomplished. It is unfortunate that the Nigerian link is under stress for political reasons, hopefully the situation will improve.

Closeness of collaboration is exemplary, in terms of numbers of personnel. The project is relatively small (but productive out of all proportion to its size!), which means that maintenance of close personal contact is comparatively easy. As long as Dr. Demski maintains his present level of activity and productivity, this project has enormous potential for further development.

4. Adequacy of Science - Technical Merits of Program. Rating 5.0

4.1 This program is in the vanguard of legume biotechnology, a notoriously difficult and recalcitrant group. The techniques devised and protocols produced will have enormous impact and relevant, not only to biotechnology of plants, but also that of other legume species.

4.2 The virus protein transformation route to virus resistance could save a very great deal of time and effort in germplasm screening and effect a considerable economy in breeding costs. Resistances once incorporated could be a very significant factor in promoting much needed yield stability in peanut crops in the Third world.

4.3 The major problem with legume biotechnology has been to make standard techniques, routine in other crops, actually work in crops such as peanut. In this sense, the present work could be considered as adaptive research, in a sense.

5. Applicability of Research. Rating 5.0

5.1 This research has immediate relevance to any country where peanuts are grown since viruses are ubiquitous. The economic effects in areas such as Nigeria could be considerable where virus wipe-outs of peanut crops can occur. A very good level of publication of results, mostly collaborative, has been achieved. Research findings are being very widely disseminated. There have been excellent publications produced in Thailand on viruses which clearly have benefited from the project.

5.2 This work would be of the greatest interest to scientists at ICRISAT in the peanut context and at ICARDA,ITTA and CIAT, with respect to potential application in other legumes.

5.3 In common with other Peanut CRSP projects, the reaction to this project has been very positive indeed and there is very real gratitude for the initiation and carrying out of work such as this.

6. Observations.

6.1 Strength
- a. The program is scientifically very sound indeed.
- b. Its objectives are well defined and clearly focused.
- c. Its organization is excellent.
- d. Competence of participants is outstanding.
- e. Leadership is dynamic, one might also say inspirational.
- f. It is innovative, forward looking, and breaking new ground in legume research.

6.2 Weakness
- a. It is difficult to identify any areas of real weakness. The only question is whether it might be possible for more graduate students to be recruited to benefit from Dr. Demski's tutelage.

7. Recommendations.

Overall, the project can be rated as outstanding with consistently excellent performance. The potential for future development is enormous. The EEP strongly recommends another 5-year extension of this program.

External Evaluation Panel Review

Peanut CRSP Code: AAMU/FT/BF

Project Title: An Interdisciplinary Approach to Optimum Food Utility of Peanut in Semi-Arid Tropical Africa

Principal Investigators and Collaborating Institutions: Dr. M. Elena Castell-Perez, Alabama A&M University, U.S.; Dr. Alfred S. Traore, University of Ouagadougou, Burkina Faso; Ms. Kafui Kpodo, Food Research Institute, Council for Science and Industrial Research, Accra, Ghana; and Dr. Richard T. Awuah, University of Science and Technology, Kumasi, Ghana.

Collaborating institutions include the Department of Food Science, Alabama A&M University (AAMU), Normal, Alabama; University of Ouagadougou (OU) and Ministry of Agriculture, L'Institute D'Etudies Et De Recherches Agricoles (INERA), Service Technologie Alimentoire, and Bureau of Extension, Service of Nutrition, Ouagadougou, Burkina Faso; Food Research Institute (FRI), Council for Science and Industrial Research, Ministry of Industries, Science and Technology, Accra, and Department of Crop Science, University of Science and Technology (UST), Kumasi, Ghana.

Project Objectives: Plans are to address the constraints that limit the maximum utilization of peanut for human consumption in Semi-Arid and Tropical Africa. Peanut utilization could be considerably improved via the following efforts: to increase utilization of peanut into more refined-processed form; to improve packaging of peanut and peanut products to increase shelf life; to utilize peanut flour (after oil extraction) to increase protein value of cereal-based foods; and to improve the methods of storage, postharvest handling and inventory management.

One member of the EEP visited the institutions mentioned above in West Africa. This report presents only the findings from visits to the food research and collaborating institutions and industries in Ghana and Burkina Faso.

1. Achievement of Objectives

The project is enhancing the capability of research at OU and FRI and leading to improved utilization of peanut in Burkina Faso and Ghana. Other Semi-Arid and Tropical African countries and the U.S. are similarly benfitting. Specifically, research results are improving methods of storage, packaging, processing and development of a variety of new and improved products. The objectives include collaborative research with plant scientists, microbiologists and entomologists to improve the quality of peanut for human consumption. Applications of results from research conducted in Burkina Faso on the use of solvent/aqueous extracts from selected plants in Africa, e.g., Allium sativum, as inhibitors of aspergilli growth and aflatoxin production on peanut during storage has great potential for helping to resolve health conditions of the people due to these food contaminants; similar studies with other plant sources are being initiated in Ghana. The new project with similar objectives as those for Burkina Faso, has been initiated in Ghana and is showing excellent potential for rapid success as valuable expertise, facilities, instruments and equipment are added to Peanut CRSP in Africa.

An emphasis on technology transfer has increased collaborations between the research institutions and industries - both large and small or entrepreneurial and regulatory agencies in Burkina Faso and Ghana. Another major emphasis is the training component including advanced degrees for graduate level students and short courses for support personnel. Workshops on advances in peanut utilization for industrial personnel and the nutritional well-being of consumers are having an impact on host countries and the U.S.

Ghana

The FRI Director, A. Andals was pleased that Peanut CRSP was supporting peanut programs in Ghana. Many opportunities are in place to utilize peanut ingredients in foods. Peanut ingredients are being added to traditional foods made with maize and cowpeas, the major commodities produced in Ghana. The focus of the research is on target groups, especially an expanding middle income segment of the population. Studies are identifying their tastes, preferences, and snack desires. Advertising is drawing attention to new peanut products and helping to increase purchases. FRI's policy is to use its strong research programs and equipped laboratories to cooperate with universities and the private sector. The government has asked FRI researchers to work toward the commercialization of their food products. Also, the institute must use its facilities, including pilot plants to make commercial products for sale to create income to support the research programs. Plans are to reduce government funding to FRI while the researchers gain monies through national and international grants and from industries. Multidisciplinary teams of researchers are an important part of FRI's programs; food scientists-technologists, microbiologists and engineers work together on team projects to produce food products. Emphasis is on adding peanut meal to enrich protein content of high carbohydrate-based cereal and cassava foods. Defatted peanut cake, after oil extraction, is being planned for studies in extrusion technologies.

A National Agriculture Research Project (NARP) as part of the Council for Scientific and Industrial Research is in place in Ghana with a pool of monetary resources to provide support funding for agricultural research. The project includes high priority commodities, requires multidisciplinary collaborations, and controls duplication of efforts; its primary purpose is to identify areas of research programming not presently covered. Commodities included are soybean, plantain, pineapple, etc., and peanut is included on the highest priority list. Equipment needs are an important component of the project. Also, support for work to fabricate equipment for processing uses and industrial applications are supported. Pilot plants are in place to show new developments to entrepreneurs. Local businesses can pay to use these facilities to demonstrate feasibility of new processing, product and equipment technologies on an industrial scale. These new technologies are also exhibited-advertised at local industrial fairs to attract new business ventures and entrepreneurs. Technology transfer efforts include FRI-sponsored fairs, National Agricultural Fairs and Industrial Technology Fairs.

A National Board for Small Scale Industry in Ghana is making small grants available to help solve industry problems; this granting board works closely with FRI. Industries have little available monies to support research. In fact, to encourage industries to participate in the Peanut CRSP survey presently being conducted by FRI, in Ghana, monetary enticement is required to cooperate throughout the nation.

The Finance Office at UST, Kumasi, Ghana, where collaborative studies on aspergilli-aflatoxin contamination are being conducted with FRI researchers, coordinates grant funds for scientists at no overhead charges. The office assures transfer of funds through the banks and maintains accountability according to the guidelines of the Peanut CRSP contract; protecting the interest of the granting institution is assured. Foreign operations are centralized through the Ghana Commercial Bank in Accra. Noted was that recently a double cabin Datsun truck ($12,000) was purchased from funds of a grant from the Canadian International Development Agency. A request was made for similar support for scientists from U.S. funding sources.

A brief meeting was held with Dr. George Akosa, Minister, Ministry of Science and Technology, Accra, Ghana, who was visiting the Department of Civil Engineering, at the University of Science and Technology, Kumasi. Dr. Akosa was head of this department before becoming Minister. The brief meeting allowed for discussion on the importance of the new Peanut CRSP to utilization research projects in Ghana. In the Civil Engineering Department, work is underway to improve water quality in Ghana, especially in small villages. Another priority is to develop crops endemic to Ghana, e.g., peanut. Noted - Peanut CRSP should transfer technologies on peanut production (agronomic, breeding, entomology, etc.) to Ghana from other African nations. Peanut CRSP is the linkage mechanism to encourage this technology transfer. Peanut CRSP should, and is giving, support to new thrusts in utilization, postharvest technologies in Ghana. This includes natural fungicides to control aspergilli and aflatoxin contamination from active compounds of endemic African plant extracts, and food handling, storage, packaging, processing and marketing technologies. Training of farmers, handlers/traders, industrial personnel and the consumer should be a major part of this endeavor, led by Peanut CRSP.

Burkina Faso

Progress continues for the commitment of research programming and enhancement of international programs at OU. Starting with the president of OU, Dr. Alfred S. Traore, administrative and faculty support for Peanut CRSP and collaboration with AAMU, is clearly evident. Faculty and students greatly benefit from their involvement with international programs. Their efforts have developed a favorable environment for facilitating collaborative studies and training programs in agriculture among OU faculty and U.S. scientists that is greatly benefiting Burkina Faso.

AAMU

The tragic death and the loss of the dedicated efforts of Dr. Bharat Singh, former PI, has impacted progress on Peanut CRSP at AAMU. Dr. Elena Castell-Perez, new PI, a food engineer is fast learning the research needs of Peanut CRSP and is showing her leadership qualities. Special acknowledgment is given to Dr. Onuma Okezie, Director, International Programs, AAMU for guidance given to Peanut CRSP during these trying times at the university. It was his guidance and travel with Dr. Castell-Perez to Ghana, that led to the development of new programs with the FRI, Accra, and UST, Kumasi, Ghana.

Institutional Development - Ghana: The FRI, Accra, Ghana, began operation in 1965 with assistance from the United Nations Development Program (UNDP) and the Food and Agriculture Organization of the United Nations (FAO). The institute is currently administered by the Council for Scientific and Industrial Research (CSIR) which is governed by the Ministry of Industries, Science and Technology. The FRI is led by a Management Board, but the daily administration of the institute is the responsibility of the Director, Deputy Director and Division Heads.

The objectives of FRI are (1) to carry out a coordinated program of applied research in the storage, processing, preservation, marketing and utilization of agricultural commodities with the aim of contributing towards the development and improvement of Ghana's food industries and increasing productivity; (2) to advise the government in planning and implementing its food policy; and (3) to do all such other things as appear to the CSIR to be relevant or conducive to the attainment of all or any of the above objectives. Areas of research and development involve multidisciplinary approaches in cereal processing and preservation; grains and legumes processing and preservation; fish and meat handling, processing and preservation; root crops processing and preservation; oils and oilseed processing and preservation; storage of stable food crops and other perishable commodities; extension of methods for food preservation; and solar energy technology and application. This is an impressive research program that is benefitting Ghana.

In addition to research programs, FRI conducts support or consultant services for industries and national and international government organizations. These include the following areas of food science and technology: (1) meat technology - processing, preservation and product development; (2) fats and oils - deodorization of Shea butter and mayonnaise processing; (3) cereal technology - bread, biscuit processing and machinery development, and cereal grain quality evaluation (including maize, rice, wheat and sorghum); (4) weaning foods - formulation and production of cereal and legume-based foods; (5) fish technology - homemade sardines, fish crackers and kippers, fish salting, drying, smoking and canning processes; (6) cassava processing - preparation of gari, tapioca and glucose syrup from cassava and dehydrated cassava flour; (7) fruits and vegetables processing - drying of okra, garden pepper and ginger, and preparation of fruit juices, jams and marmalades; (8) storage technology - storage of maize, fresh cassava and tomatoes; and (9) solar energy technology and application - design,, construction, installation and operation of various crop dryers and other solar drying devices.

The FRI's technical services link the institute's programs with government and private organizations interested in food science and technology. These activities are "Services to Industries," and "Information Dissemination Services." At the request of the food industries, food samples are examined for their specifications or for assessment as to their suitabilities for human consumption. This includes chemical, microbiological and organoleptic analyses. The results of FRI research activities are disseminated to the public by the Scientific Information Division which has documentation-library services, scientific information and publication-sharing and public relations. Available are a FRI Newsletter, and Annual and Technical Reports, Internal seminars for the food industry and other user agencies, feature articles in newspapers and journals and participation in radio and television discussion programs are presented by FRI. All of these activities communicate research developments, and transfer of technologies to industries, government regulatory agencies and extension services, farmers and consumers.

The FRI library has about 300 books on food science and technology, nutrition, agricultural economics and marketing. There are also a number of periodicals, scientific journals, newspapers and magazines. The library maintains programs with both foreign and local bodies such as FAO, IDRC, CTFRI, UST and the Crops Research Institute. The library serves as a reference center for students, chemists, lecturers, farmers, industrialists and homemakers. The FRI offers a number of training programs and facilities in food science and technology. These include a three month program for personnel in food processing and food quality control organizations; National service training for graduates and diplomats up to one year, and training for undergraduates in food science and technology, nutrition, agriculture and biochemistry are available from the universities for up to three months.

While at FRI, Peanut CRSP and its support of ongoing and future research studies were discussed with Mr. Niels Hauffe, Consultant, World Bank. The facilities and equipment needs of FRI are under study by this world organization for additional funds. The World Bank has done much to support FRI in renovation of laboratories and supplying important equipment-instruments.

The World Bank has funded an upgrade of laboratory facilities for the Microbiological Unit, FRI. Plans are to modernize the analytical laboratory and an under-utilized facility as an expanded information center and library. The Danish International Development Assistance (DANIDA) program and the government of Ghana, supported purchases of a high pressure liquid chromatograph (HPLC) instrument and inoculation room, preparation room, autoclaves and incubators for the modernized microbiological laboratory.

The UST, Kumasi, Ghana, was officially inaugurated in 1961; the original school was opened in 1951, as the Kumasi College of Technology, Ghana. A Department of Agriculture opened in 1953, providing courses for the Ministry of Agriculture. Today, the university has five Faculties, two Schools, three Institutes and one College, all of comparable status headed by Deans/Directors. The Faculty of Agriculture comprises the Departments of Agricultural Economics and Farm Management, Agricultural Engineering, Animal Science, Crop Science and Horticulture. The faculty consists of 42 Lecturers, four Associate Professors and three Technical Instructors; two visiting lecturers are included. Most of the faculty are Ph.D.-degreed. Bachelor's degree (4-year) in Agriculture and Diploma (2-year) programs in Tropical Horticulture are awarded; a Bachelor of Science degree is awarded in Agricultural Engineering in conjunction with the School of Engineering. A Faculty of Science comprises the Departments of Biological Sciences, Biochemistry, Chemistry, Physics, and Mathematics and Computer Science. This Faculty consists of 63 Lecturers. Four-year degree and two-year Master's degree programs are provided. These two Faculty present an impressive array of courses required to receive degrees. Of the total, 4157 (1992/93 year) undergraduate students enrolled at the university, 316 are in Agriculture, 739, Science. The percent of female students is 12%, Agriculture, 16% Science, and 18%, total enrollment. The university Library stocks about 150,000 volumes and subscribes to over 1,500 periodicals. Faculty Libraries add another 47,000 volumes.

The Vice-Chancellor, Professor Amonoo-Neizer, UST, Kumasi, was featured in The Ghanian Chronicle, January 27-30, 1994, accepting an assembly of sophisticated laboratory equipment worth over 280,000 Swiss francs, for UST from Switzerland. The article, headlined "Swiss Govt. Gives Equip. to UST," stated that the equipment benefits the Chemistry, Physics, and Engineering Departments, and the Faculty of Pharmacy. The contribution is from the Swiss government to higher learning in Ghana under a bilateral cooperation between the two countries. The equipment is installed with the assistance of the Societe Generale Surveillance (SGS) and includes rotovaporators, XT-recorders, testers, amplifiers, computerized analyzers, digital balances and pH meters plus accessories. The donation added to the Swiss government's current commitment and assistance to Ghana. The newspaper article stated that the objectives of the Swiss foreign policy in Ghana are preservation and promotion of peace and security, promotion of democracy and social well-being, reduction of social disparities and protection of environment and natural resources.

Recent funding in addition to Peanut CRSP has come from the African Development Foundation (ADF), to develop an integrated plant disease control program, and OPEC Fund for International Development Grant, to assist in establishing a Plant Disease Diagnostic Laboratory at UST. In spite of these grants, equipment needs include light microscopes, growth chambers and incubators and autoclaves. Professor Amonoo-Neizer, Vice-Chancellor, UST, confirmed these observations and expressed the importance of granting agencies, both national and international, like Peanut CRSP, to the university's faculty and programs in support of Ghana's goals. He pointed out that availability of such equipment occurs through collaborative involvements among departments, e.g., Department of Crop Science, Department of Microbiology and Chemistry Department for microbiological and analytical chemistry (for pesticide, insecticide and aflatoxin research) needs. A HPLC and an UV infrared Atomic Absorption Spectrometer are available for mycotoxin analyses and characterization of natural fungicides in the Chemistry Department. Collaborations with the School of Medicinal Science allow for epidemiological studies on aflatoxin effects in body physiology, and with the Pharmacy Department, feeding studies with animals. Plant collections and travel are done with Peanut CRSP funds. It is up to the faculty to take the initiative to search out funding sources and seek out multidisciplinary approaches to research problems and support in the university.

ICRISAT is the main international agricultural institute supporting Ghana's programs. Its regional peanut program in Niamey, Niger, has focussed on diseases and insect pests resistance, drought resistance, plant nutrition, varying maturity periods and breeding of stable high yielding varieties for specific adaptation and consumer preferred characteristics such as high oil content and good table quality (specifically confectionery peanut). Some successes are available to the farmer.

<u>Institutional Development-Burkina Faso</u>: The 1989 EEP noted that Dr. A. S. Traore, PI of Peanut CRSP in Burkina Faso, was the only member of the faculty at OU with experience in food science and technology. Dr. Traore, now President of the university has much responsibility. However, since 1989, the students then identified for graduate programs in food science have gone on to receive degrees and are supporting research at the university. Many of these students are also in high level industry positions and remain dedicated to support of Dr. Traore and his programs at OU. An Assistant Professor, Food Technologist, Laboratory Technician, two cooperating Food Technologists and two Graduate Research Assistants are part of the Peanut CRSP. Collaborative efforts include two Entomologists and a Phytopathologist. These additions, and increased collaborations with the food industry have been greatly strengthened by the Peanut CRSP in Burkina Faso.

Institutional Development-AAMU: Research at AAMU is adequately supported with laboratory facilities, instruments and equipment. Food and nutrition facilities include dairy products, cereals and legumes, breadmaking-bakery, meat processing, taste panel-food preparation and remote sensing laboratories. Other laboratories include a pilot plant to support postharvest research, provide technology transfer capabilities and commercialization of food products; e.g., cottage industry development in the U.S. and entrepreneurs in host countries. Commercial-scale extrusion equipment is allowing development of new foods with unique functional properties and shelf life. Close collaboration is occurring between scientists working on breadmaking properties of grains and legumes and plant breeders. The rapid capillary column technique is being used for detection-quantitation and monitoring of aflatoxins in peanut. The instrumentation laboratory is well equipped with HPLC, GC and gel electrophoretic instruments for compositional analyses. A scanning electron microscope is used for structure-function properties of foods.

A significant portion of Peanut CRSP funds at AAMU is used for training graduate students from host countries and the U.S. A newly approved Ph.D. degree program in the Department of Food Science is now in place. A USDA-supported Capacity Building Grant for educational strengthening is adding new Ph.D. level graduate students and faculty to the department. Faculty and universities (U.S. and host countries) are benefiting from publication of data in dissertations/theses. The PI works closely with the graduate students.

Adequacy of Science-Technology Merits of Program-Ghana: In Ghana, peanut research has been reported since 1926. The first concerted effort on variety development began in 1949, in northern Ghana with the collection and analysis of local and introduced varieties. During the 1960's, newly introduced varieties were screened in northern and southern Ghana in multilocational tests. In 1986, the Ghana Grains Development Project included peanut in its research program. The results have been the following: (1) The presence of large cultivar by location collaborations in field trials. Factors included in these studies are adaptation, stability, yield advantage as important criteria for selecting superior breeding lines. (2) Development of early/maturity lines for areas with short growing seasons or where grown under residual moisture conditions. (3) Noting that foliar diseases, especially early and late leaf spot, are important yield-limiting factors in the relatively humid ecologies in Southern Ghana. (4) Insect pests, especially aphids, are vectors of the virus that causes rosette diseases; and termites cause considerable damage.

Areas of high priority production (agronomic - breeding) research in Ghana include: (1) the influence of environmental factors on disease development; (2) monitoring and assessment of Aspergillus flavus and aflatoxin contamination of peanut seed and products; (3) drought tolerance/resistance screening; (4) biological - nitrogen fixation as affected by agronomic practices; and (5) identification of peanut varieties suitable for intercropping with cereals and root-tuber crops and coconut trees. Goals have been set to have impact from these priorities in the next five years. The major peanut production areas of Upper East and Northern Regions of Ghana and the transition environmental zones of Ashanti, Brong-Ahafo and Volta regions are expected to benefit from these goals.

In Ghana, peanut is predominantly (85%) grown in the northern parts of the country. National production is estimated at 115,000 tons, with an average yield of 0.9 ton/ha. Peanut seed is commonly processed to oil and the rest consumed as food. Among the major constraints to increased production are unreliable rainfall, low inherent soil fertility, low yielding varieties, pests and diseases, and poor socioeconomic conditions.

Multilocational yield testing in Northern Ghana resulted in the release of varieties Spanish 207-3, MK383, No. 146 and Manipinter in 1960. In the 1970's, six more were released including Florispan Runner, Natal Common, Shitaochi, Tirik, Philippine Red and Kumawi. The yields of these cultivars were between 700 and 1900 kg/ha. Maturity occurred in 90 to 130 days. Further advancements have been limited due to a lack of extension and seed producing institutions, poor crop husbandry practices constraining production and a lack of continuity of research programs due to inadequate funding and trained personnel.

Time of planting follows the general cropping seasons which begins in June after establishment of the first rains. In the south, planting is done in early March-April during the major planting season, and early September, a second but smaller cropping period. Although the use of the hoe and cutless for tillage operations is common throughout Ghana, there is considerable demand for bullock plows, tractors and other farm implements among peanut growers farming large acreages.

Socioeconomic constraints include: (1) Lack of agricultural credit facilities for acquiring improved seed, fertilizer and agricultural machinery, etc., by farmers. (2) Small farm size and fragmentation of holdings tend to cause scarcity of land for peanut. (3) Unfavorable land tenure systems retards production. (4) Lack of ability to purchase and maintain farm equipment. (5) Poor transportation and communication facilities. (6) Poor marketing facilities and pricing structure. (7) Poor living conditions of the farmer force them to deter from adopting improved technologies.

Peanut research is mainly conducted at the Crops Research Institute's stations at Kwadaso, the institute's headquarters in the south, and Nyankpala located in the north of the country. The current research activities have been aimed at developing production technologies to raise the productivity of the farmers.

Mature peanut, following harvesting and drying are stored in jute bags and kept in barns built of mud or thatch. The bulk of the peanut crop each season is consumed in six months after harvest. In humid areas, particularly in the forest areas, stored peanut are infected by aspergilli species.

Peanut is marketed locally. The Ghana Food Distribution Corporation (GFDC), a government marketing and distribution organization buys peanut from farmers, then stores and later resells them to consumers. This organization handles a small portion of the peanut. Most farmers depend on middlemen and women for market sales. Like GFDC, these traders buy the peanut, then transport and sell them at urban centers.

The bulk of the peanut is hand labor-processed by local women for vegetable oil. The defatted meal is fried to make a local food called "kuli-kuli." Noted is that not enough peanut is produced to keep oil crushing mills operating continuously, hence, profit margins are narrow. Peanut production needs to be increased to improve continuous processing of peanut oil and meal; one objective is to make Ghana self-sufficient in peanut production. Peanut and maize flours are blended for weaning foods. Peanut paste from roasted kernels is used to thicken stews and soups. In the urban centers, salted peanut are roasted or fried in oil and served at gatherings. Very little of the meal goes into animal feeds. The hulls and empty pods are used as animal feeds.

Extension Services, Ministry of Agriculture, technology transfer efforts on peanut are confined mostly to seed production and supply. Currently, seed of Shitaochi and Manipintar are being multiplied by the Ghana Seed Company for distribution to the farmers. The extension services, however, have not done enough to educate farmers on improved technologies. More efforts are needed to educate farmers in Ghana on how to cultivate peanut efficiently in mixed crop systems.

In further discussions, the management team at FRI, Accra, emphasized a need to strengthen utilization of peanut research in Ghana. Finding of new diversified marketing outlets for peanut oil is needed. This includes expanded use of traditional foods and blending with other commodities to enhance protein composition, especially weaning foods. Agriculture engineering for improved postharvest technologies, extension services and technology transfer need to be strengthened in Ghana.

The peanut industry in Ghana is mostly small household operations, i.e., family shops selling traditional snack foods such as salted and roasted peanut. It is important that research programs improve the quality of peanut meal, after oil extraction, for food use. Products from the meal are mainly "kuli kuli," molded and fried defatted meal, "tunkusa," a partially defatted peanut butter paste, and "dzowe," a finely milled peanut and maize blended flour, seasoned and molded into balls. The planned food research program in Ghana, which is mainly conducted at FRI, is examining ways to improve and expand these technologies for cottage industry development. This includes blended products with high carbohydrate traditional foods made with cereals, maize and cassava. Efforts will strengthen collaborations between Cowpea CRSP and Peanut CRSP for expanded new and traditional foods with cowpea-peanut blended ingredients. These studies, coordinated by the newly instituted Peanut CRSP program in Ghana, further expand similar work initiated in the Philippines and Thailand. This further supports the need for a utilization workshop of Peanut CRSP and other CRSP program countries.

Ghana has a National Council of Women in Development (NCWD) program to assist women in various institutions to further their careers. However, few funds are set aside for this program. The researchers can have their salaries paid while pursuing all three levels of degrees; but unless there are funds for travel, housing and per diem, which are not covered in the support program, opportunities are limited without outside-of-Ghana resources. The FRI does not have a graduate student program. Support technicians are recruited out of secondary schools. If interested, the workers can pursue training opportunities, e.g., in Denmark and the U.S. for college graduates.

A news item in the Daily Graphic, Ghana's Biggest Selling Newspaper, Thursday, February 24, 1994, No. 13448, headlined "Government will assist women." The president of the 31st December Women's Movement gave assurance that the government will continue to assist women in their development efforts. New methods of assistance are being explored. Discussions are ongoing with banks in the country to assist women with loans. The Deputy Minister of Local Government and General Secretary of the movement suggested the formation of mobile banks to cater to women. These actions are helping women expand their businesses. Women are being trained how to save money and invest in businesses.

The FRI is mainly involved in research programs. Peanut CRSP has encouraged increased support for peanut research, which up until now has been a minor component of this institute's research program. In Ghana, peanut production is approximately 150-175,000 ha with yields averaging about 8-900 lbs/ha. Traders-buyers control on-farm production, buying and marketing the peanut crop. There exists on-farm processing by women (wives) entrepreneurs. This is an opportunity waiting to be encouraged and the basis for the FRI Peanut CRSP initiated in 1993 with AAMU.

The Peanut CRSP program outlined for FRI, has as its first phase, three objectives. They are: (1) To determine through a field survey the existing traditional techniques for peanut butter production. A survey questionnaire, first tested in the greater Accra region to determine its applicability. Now proven, it is being applied in the 10 regional capitals and surrounding villages of Ghana to determine the traditional techniques used in peanut butter production; 100 respondents will be accumulated. (2) To modify/standardize identified unit operations in the production of peanut butter to attain uniformity and reduce drudgery. The data obtained from the survey will identify processes used in peanut butter production, efficiency constraints and ways to maximize yields while achieving product uniformity and quality. (3) To evaluate the quality of traditional peanut products. Traditional peanut products (peanut butter, tunkunsa, "kuli-kuli," dzowe, oil, roasted and boiled peanut) will be examined for nutritional-compositional value, including proximates, fat acidity and peroxide values. Microbiological analyses will include total viable counts, mold and yeast, coliforms, staphylococci and Salmonella. Tests for aflatoxins will be included.

In Ghana, small-scale local entrepreneurs are making traditional products such as sugar-coated and caramel-coated peanut and peanut cake, a coarsely ground and molded candy-like bar. Needed are packaging technologies to improve presentation and shelf-life of traditional products. The survey questionnaire will have an objective of identifying all traditional peanut products in Ghana. It will also be used to determine where in the pre- and postharvest system mycotoxin contamination is likely to occur. This work will be used to develop recipe brochures and workshops to train processors in the use of traditional foods. A similar effort is now underway on maize products and finding new outlets for these foods in Ghana. Economic and marketing analyses are being included in these studies and projecting ways to scale up entrepreneurial family scale ventures to businesses employing a significant number of people.

The administrative offices in Ghana have limited support for education-training programs, and some travel monies. A World Bank project, National Agricultural Research Project, assists research programs including education-training monies for researchers. The Peanut CRSP supports research efforts at FRI, Accra, and Crop Science Department, UST, Kumasi, to screen peanut and peanut products throughout Ghana. At FRI, the work is being done by food scientists and microbiologists. In Kumasi, a plant pathologist is collaborating with plant breeders and agronomists. Both research institutions are working closely together. Peanut butter, which in Ghana is a ground whole peanut paste with no additives other than an occasional incorporation of cassava or maize flours to increase yields, boiled peanut, roasted peanut and peanut blends with various cereals are available products being analyzed. The peanut paste is mainly used for soups in the Ghanan home. Major mycotoxins evaluated include aflatoxins, zerealonin, citronin and other related compounds. In 1994, plans are to expand mycotoxin work to precursors of aflatoxins and fumonisins, a Fusaria toxin. A Danish project is examining various foods for aflatoxins. Early developing results show high aflatoxin contamination of peanut pastes. A Ghana National Committee was established to examine how serious the problem may be and determine safe limits. The Ghana government is also being influenced by the Nagouchi Memorial Institute for Medical Research, Japan. The Japanese are funding work on incidence of liver cancer including seriousness and degree of occurrence that may be related to aflatoxin contamination of foods.

At UST, Kumasi, Dr. Richard Awuah has developed five objectives for his attack on mycotoxins. They are: (1) Determine degree of mycotoxin contamination in peanut and peanut products including aflatoxins from Aspergillus parasiticus and A. flavus and fumonisins from Fusarium species. (2) Identify natural biologically active plant compounds, fungicides, that prevent synthesis of aflatoxins by aspergilli species, and/or inhibits growth of these fungi. (3) Prevent or control mycotoxin contamination of foods by understanding regulatory processes of mycotoxin synthesis by fungi and how peanut-fungal interactions are involved in this regulation at the molecular level. (4) Study the molecular biochemistry of aflatoxin synthesis. (5) Develop rapid and simple assays for determination of aflatoxin resistant peanut cultivars or aflatoxin inhibitors degrading compounds from other plants. It is shown that there are a number of African plants with compounds that affect toxin production. A simple test is needed to rapidly identify these compounds and their sources.

Adequacy of Science-Technology Merits of Program - Burkina Faso: Studies in Burkina Faso involve collaborative efforts among food scientists, plant breeders, entomologists, extension and nutrition services and especially, industry. These collaborations have greatly strengthened during the past five years, and will continue to grow in the future programs. Peanut CRSP has played the lead role in these developments.

Adequacy of Science - Technology Merits of Program - AAMU: The research at AAMU is increasing potential for utilization of peanut in new and existing foods. These experiments have been enhanced by the availability of adequate laboratory facilities and equipment in the U.S. that are not always present in the host countries. Efforts are underway to extend these research capabilities to FRI and OU and collaborating institutions for extension to entrepreneurs and farmers. An example is the plan to transfer an extruder from AAMU to FRI. Clearly, high protein peanut products will help to alleviate deficiencies due to limited meat supplies in Ghana and Burkina Faso.

Applicability of Research-Ghana: Work at FRI, Accra, is showing that adding peanut flour/meal to food formulas improves protein content. As FRI develops and sells its own research products and becomes commercially competitive, the private industries re-evaluate their own products and improve them, an interesting concept of technology transfer.

At FRI, sensory evaluations are done on new products for industries. These analyses include aroma, taste, color, consistency, texture and overall sensory quality. These efforts include strong assistance to industry in collaborative development of new food products.

At FRI, newly developed food products from research programs are advertised to the commercial community by the Commercial Unit, Department of Economics and Consumption, FRI. The private industry uses FRI's pilot plant for production of formulated foods. One company, Hagest Foods, LTD, Accra, Ghana, formulates a product HAG-WEANER, A High Protein-Energy Food, with ingredients of maize, cowpea and peanut meals in the FRI pilot plant. The formulation is similar to FRI-WEANER, a product of FRI. FRI researchers help entrepreneurs formulate products, conduct quality control training and design labels.

Food technologies including peanut ingredients developed at FRI are numerous. In the Weanling Food Products Unit, a commercial high protein weaning food, FRI-WEANER is available to consumers. The product's package and label was designed at FRI. Its ingredients are maize, soybean or cowpea and peanut meals plus a small amount of powdered milk. The label contains nutrition information (based on 100 g dry meal) as moisture (g), 4.6, protein (g), 17.5, fat (g), 8.6, calcium (mg), 220, phosphorus (mg), 239.1 and iron (mg), 9.2. Preparation is recommended as follows: Mix one cup of FRI-WEANER with one and one-half cups cold water to prepare a smooth slurry. Stir into one cup boiling water and allow to cook for 5 min. Add sugar and salt to taste.

Another product developed at FRI is MANNA CEREAL FOOD, produced by EEL-Shennaut Co., OTD., Takoradi, Ghana. This is a high protein food that is very nourishing and palatable containing maize and cowpea meals, sugar and salt. Peanut meal is either added or used as a substitute for cowpea meal. The nutrition information (based on 100 g dry meal) is moisture (%), 4.5, protein (%), 13.8, fat (%), 4.8, calcium (mg), 55, phosphorous (mg), 217.6, and iron (mg), 6. Estimated calories is 371.2. Preparation is as follows: Pour MANNA CEREAL FOOD into desired volume of hot or cold water. A little water may be added while continuously stirring to make a porridge. The product can be enjoyed in a cold drink form as well. For infants: always allow to boil for five minutes. Note the food safety statement made on the label when used for feeding to infants.

PEACOMIX, a high-protein instant cereal food (for adults and children) is now produced in Ghana by Lin Food Products, LTD., Tena. This product's ingredients are maize, cowpea, peanut, sugar and salt. Preparation is done by mixing the food with cold or hot water to the desired consistency. Milk may be added especially in the case of children. Nutrition information includes protein (%), 13.2, fat (%), 9.0 ash (%), 1.0, carbohydrates (%), 73, moisture (%), 2.9, calcium (mg; 100 g) 32, phosphorous (mg; 100 g), 122.1, iron (mg; 100 g), 4.3, and calories, 418.2.

Extrusion technology is being examined for use with PEACOMIX. This product is extruded while heat puffed under pressure, then milled into a crumbly textured product with very acceptable food properties. Other extruded products included in future plans are noodles and other macaroni products. Peanut

CRSP should bring together researchers at Kasetsart University, Thailand and UGA for the development of these technologies in Ghana, Africa. Opportunities exist for advancing extrusion technologies to village cooperatives, family entrepreneurs, working together to develop new food businesses. A cooperative could invest in an expeller-extruder for new product development and marketing.

At the Department of Nutrition and Food Science, University of Ghana, a seed oil screwpress expeller was modified and converted to an extruder. This is using technology and equipment endemic to Ghana in cost effective applications for new foods. The modification involves simple closing of the expeller pores to force pressed materials to extrude from the end of the apparatus. Temperature, pressure and time measurements are studied in the formulation of newly structured foods. The work with the converted expeller-extruder is funded by the Cowpea CRSP to expand cowpea utilization. The work is a collaborative study between the University of Ghana, and the Department of Food Science and Technology, University of Georgia. A student earning a M.S. degree in food science is funded by the project. Specialized products include extruded dehulled whole cowpea meal and not cracked whole corn kernel meal; both processes include heating during the extrusion process. Efforts are underway to work with peanut via Peanut CRSP jointly with FRI. Peanut CRSP monies would be used to support a M.S. degree level graduate student in this joint Cowpea CRSP and Peanut CRSP project. One product identified is an extruded meal, ground, and then used in porridge and bread. The time is right for development of extrusion technologies for new foods. Demonstrations are underway to show fabricators how to manufacture the converted expeller-extruder.

An interesting study at the Department of Nutrition and Food Science, University of Ghana, is showing that steam-treated cowpea, when stored on-farm, are insect resistant. Little or no insect damage occurs during storage for three to four months. Evidently, the steam treatment releases biologically active chemicals on the surface of cowpea with insect resistant properties.

The work at the Department of Nutrition and Food Science, University of Ghana, is focused on finding new uses for equipment such as dehullers and mills, endemic to Ghana for cowpea applications. The objective is to utilize locally built equipment via simple inexpensive modification for multiple use purposes by villagers and farmers. It is important to note that there was little interest in sophisticated equipment.

Cowpea CRSP has similar problems as Peanut CRSP in that communication and collaborations among production and utilization researchers could be strengthened. There is need for enhancing utilization and marketing collaborations in the development, technology transfer and sale of new commodities.

The first phase of the Peanut CRSP at FRI, Accra, Ghana, has focused on the survey and collection of peanut products from the growing regions to analyze for mycotoxins. Initially, the analyses were completed by TLC, now they are done by HPLC, via an instrument purchased with funds from the DANIDA program. It was based on the finding that peanut butter samples were high in aflatoxin that instituted the successful effort to obtain funds from Peanut CRSP. The collaborative efforts include Drs. Nancy Keller, Texas A&M University, College Station, Texas, U.S., and Dr. Richard Awuah, mycologist, Department of Crop Science, UST, Ministry of Education, Kumasi. Dr. Awuah was working on plant extracts from selected endemic plants in Africa that behave as natural fungicides. This attracted the interest of Dr. Keller to utilize these extracts to control aspergilli and aflatoxin contamination on peanut and initiate a collaborative program between the two universities.

Dr. R. Awuah, UST, showed that a steam distillate from leaves of West African plants, Cymbopagon citratus completely inhibited the growth of four fungi, Ustilago maydis, Ustilaginoidea virens, Curvulara lunata and Rhizopus sp. Hot water extracts from fresh leaves of Ocimum gratissimum and Chromoleona odorata, and dry fruits of Xylopia aethiopica, reduced radial growth of these fungi by 10-60%. This investigation into plant extracts with activity against phytopathogenic fungi is a first step towards developing potential botanical fungicides from West African plants.

Further studies by Dr. Awuah showed that a crude steam distillate from Ocimum gratissimum sprayed on infections of coca pods moments after inoculation with Phytophthora palmivora completely inhibited the pathogen and blackpod lesion development in 75% of the cases. Disease suppression obtained with the extract was comparable to that obtained with a chemical fungicide, Kocide 101 suspension. In the field, the O. gratissimum extract also suppressed lesion development although to a significantly lower extent in comparison to Kocide 101. Sporangia of P. palmivora from sporilating blackpod lesions on both detached and non-detached pods lost their infectivity within one hour of treatment with O. gratissimum extract on pods. However, this effect was lost within three hours of application. Thus, despite its in vivo effectiveness as an eradicant, the O. gratissimum extract, in its present form, has limited utility as a protectant fungicide. Work is now underway to identify the compound(s) with fungicidal activity.

Dr. R. Awuah, UST, showed that the steam distillate from O. gratissimum inhibited aflatoxin synthesis in A. parasiticus. The inhibition prevents accumulation of the norsolorinic acid intermediate in aflatoxin production. A rapid assay has been developed with mutants that cannot continue synthesis of this intermediate, hence it accumulates and is readily detected by a color change in the culture. Any inhibition that prevents its accumulation can be determined as with the O. gratissimum extract.

With natural fungicides, on-farm treatments would prevent aflatoxin contamination of peanut seed. Varying degrees of applications could be developed since in West African plants, extracts have been shown to be capable of immediate inhibition, while others vary in degree of ability to interfere with aflatoxin biosynthesis. In any case, these studies are taking advantage of endemic plant materials - doing control by nature's way. The concept of using natural fungicides follows that used by pharmaceuticals for medicinal control of human diseases and cancer from plants. The potential of natural compounds in controlling toxin production in foods is limitless.

Dr. R. Awuah, Department of Crop Science, UST, Kumasi, Ghana, is collaborating on the Peanut CRSP with Ms. Kafui Kpodo, FRI, Accra, Ghana, to determine the degree of aspergilli-aflatoxin contamination in peanut and peanut products. Values averaging 5-6000 ppb were being found in peanut products. When farmers separated out quality peanut, aflatoxin levels were less than 20 ppb. There is a need to educate peanut processors and consumers about the aflatoxin problem; they are not aware of the extent of this problem. Food safety is becoming a concern in Ghana, as the news media learns about the issues and headlines them. Except for the monies from Peanut CRSP to study the degree of aflatoxin contamination in peanut products, research grants for this type of work are limited at this time.

The new Peanut CRSP is pinpointing where in the production chain, aflatoxin contamination occurs. Work is following the peanut from the field to the shelf. This funding is opening an entirely new area for work on peanut production and marketing in Ghana. The program enhances peanut research in the same way other support (UNIDO) strengthens efforts with maize, and sorghum for beer fermentation studies to replace malt, a high cost import commodity. These efforts include workshops and support of extension services to expand such technologies in Africa.

The government of Ghana is aware of the aflatoxin problem and has set up a committee to examine this issue. This was initially initiated in maize with support from Denmark. Peanut CRSP is now strengthening this work by extending the studies to include peanut. The Danish studies are focused on helping the farmers, whereas, Peanut CRSP is looking at production, storage, handling and processing. Noted was that processors are not aware of the aflatoxin issue; in fact, they do not understand that aflatoxin is a health issue, and hence a new education program is needed. To get cooperation in sample collection at the various steps, incentives, such as money or special gifts are needed.

Since the Peanut CRSP supported studies began to determine the degree of aspergilli-aflatoxin contamination, an awareness of this problem has been kindled with the housewife entrepreneurs. These businesses have been encouraged to pick out the off-colored, damaged and moldy peanut. However, rather than thrash these peanut, they use them in paste for stew-soup thickener. Obviously, this does not solve the aflatoxin problem in these households.

Applicability of Research-Burkina Faso: A visit to Societe des Huiles et Savons du Burkina Citec Huilerie, a company located in Bobo-Dioulasso that processes oilseeds for oils and soaps proved to be a very valuable meeting. The Directeur d'Exploitation, Mr. Ouedraogo Abdoulaye, and his staff were very informative in highlighting the high priority of the industry processing oilseeds, especially for peanut, in Burkina Faso. Citec Huilerie is a state operated company willing to explore new venture investments. In Burkina Faso, efforts are underway to turn over state operated companies to individual or group investors and move toward a free market society. The reason for meeting with officials at Citec Huilerie was to learn more about the processing of their high protein (20-25%) peanut product, La Pate d'Arachide, trade name, Tigadegue. The company was annually producing and marketing 900 tons of this product, but recently had to suspend production and sales because of higher costs compared to similar products produced by entrepreneurs and sold in the local marketplaces. Tigadegue, a peanut paste produced from the screw-pressed meal after oil extraction, performs and tastes similar to traditional products produced by housewives in the home and used in soups and sauces. The company was emphasizing quality or biological safety (microbiologically-free) and aflatoxin-free in the sale of its product. Also emphasized was that the product had 100% peanut and high protein nutrition. Products sold in marketplaces did not have this quality and contained corn and sorghum meal. The major reason for high cost was the packaging of the product in cans purchased from France. Also, during the discussions, other problems surfaced, packaging size and lack of diverse uses for the peanut product. The containers are too large for the amount used in average households to make soups and sauces, and subsequently waste occurs. If other uses could be found for the product, then the amounts packaged would be completely used by families, and possibly warrant the cost. Hence, ongoing collaborative studies were being expanded with researchers at OU from aflatoxin analyses to new packaging technologies.

The discussions surfaced the observation made by Citec Huilerie workers that children were eating the peanut paste product on bread like peanut butter in the U.S. This observation, along with emphasis on quality and nutrition surfaced during the discussions as an approach that needed further research studies at OU. Presently, emphasis at OU is on finding new packaging technologies and expanding sale of varying packaged quantities to better meet the needs of the consumer in Burkina Faso.

The investigations on packaging have been with a local plastic package-making company, Fasoplast, in Bobo-Dioulasso. One problem is storage of the plastic package in the warm climate of Burkina Faso. Also, to maintain control of microbiological contamination, the processed product would have to be packaged while still at high temperatures. These conditions melt the plastic packaging. Other problems include shelflife, where increasing acidity and lipid oxidation of the peanut paste causes off-flavors during storage in the plastic containers. Ongoing experiments by researchers at OU with Fasoplast and Citec Huilerie are examining thicker plastics that could withstand 90 C temperatures of the peanut paste during packaging.

Another answer to Citec Huilerie's problem is the need to find new uses that would attract sales for Tigadegue. Noted was that the peanut paste was processed to one texture level, a coarse ground

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meal. If children were finding this coarsely-ground product acceptable as a peanut butter-like spread on breads, what would they do with a much more finely ground food? This discussion was explored with much enthusiasm and expanded further at the thought of flavoring the product with fruit marmalades, mangoes, strawberries, papayas, etc. Also, the idea of formulating a product that could be used in weaning foods was discussed. Weaning foods come from France and are expensive. These product ideas were accepted as high priority research approaches to diversify utilization of Citec Huilerie's peanut paste product and should be supported by Peanut CRSP via OU.

A visit was made to Citec Huilerie's peanut paste processing plant. Presently, this plant is shut down because the product is not marketed. However, it is ready for operation as soon as modifications to packaging and expansion of product diversity are developed to increase profitability and sales occurs. The processing plant is a Spanish built ground meat processing facility adapted for peanut paste manufacture. Hence, the diversity of peanut paste texture and product variation is limited only by the capability of the meat grinding step at the end of the process. This last step is where research work should be conducted to diversify the grinding capability for acceptable textures of peanut paste products. Possibly replacing this meat grinding equipment with that having specialized texturing capabilities for producing diversely formulated products can open new market opportunities, once they are identified. The Peanut CRSP project for Western Africa has the properly identified objectives in utilization to overcome the constraints keeping this program from becoming reality.

The project "An Interdisciplinary Approach to Optimum Food Utility of Peanut in SAT Africa, coordinated in West Africa under Dr. Alfred S. Traore, OU, has done much to advance peanut science and technology. Studies have been on the assessment of biological parameters of peanut pastes sold in Burkina Faso; aflatoxin contamination of peanut and peanut products; aflatoxin contamination of stored peanut and the effects on selected physicochemical properties; possible role of aflatoxin-contaminated peanut and peanut products in liver cancer; and isolation-characterization of Aspergillus flavus-aflatoxin contamination and growth inhibiting effects of Allium sativum extracts.

The results of these studies have educated the people (consumers, sellers) of Burkina Faso about the problems of microbial-aflatoxin contamination; Citec Huilerie processed peanut pastes have become the reference of quality (aflatoxin-free) for all products in Burkina Faso; and other microorganisms, bacteria (Coliforms, Staphylococci, Salmonella, Shigella, Clostridia) and yeasts-molds have been identified in peanut products and sellers-manufacturers educated in safe processing procedures as used by Citec Huilerie.

To reinforce the need to carefully handle and process peanut was demonstrated at OU by the finding with thin layer chromatographic analyses of chloroform extracts that aflatoxins B_1, B_2, G_1 and G_2 were present at levels greater than 250 ppb in 14 to 43% of peanut samples from two selected cultivars (Boanga, Wobgo). Peanut samples from these two cultivars were sampled during an 18-month storage period and analyzed for aflatoxins, and changes in seed moisture, aflatoxins, proteins, lipids and sugars. The losses in nutrient composition corresponded with increases in aflatoxins. Data showed that increased water content and lipid metabolism were closely correlated to aflatoxin contamination and growth of aspergilli species. These levels of aflatoxin contamination were assumed to be contributing to the increased presence of liver cancer in Burkina Faso. Allium sativium extracts (20%; crude or steam distilled) inhibited growth of Aspergillus flavus in culture studies at 30 C for 7 days.

Roasted peanut, commonly known as marba-tigue, are widely marketed in Burkina Faso. In Ouagadougou, Burkina Faso, large numbers of women derive the greatest part of their incomes from selling this product. The preparative processing steps, packaging in polyethylene bags, storage and marketing of the product were studied relative to nutritive value, moisture uptake and oxidizing reactions, including peroxidase activities. Nutrient changes noted included losses (digestibility) of water-soluble proteins and lysine during water soaking and roasting. Garlic extracts improved keeping quality of marba-tigue. Soaking peanut in water reduced peroxidase activity. And adding milk and sugar to sweeten peanut, and reduce off-flavors, formed a product enjoyed by children. These studies provided an opportunity to find solutions to improve quality and nutritive value of peanut and peanut products; especially to improve production of marba-tigue.

"Toe," a porridge made from whole sorghum, corn or millet flour is a major food in West Africa, especially Burkina Faso. This food is low in protein composition. Studies were conducted adding defatted peanut flour (source, cultivar Sofivar) to enrich protein content of "Toe." Adding defatted peanut flour increased protein, fat and ash levels and reduced total sugar and energy levels. Sensory evaluation showed a preference for "Toe" fortified with 10 and 20% peanut flour. In 1993, further studies led to the production of an acceptable "Toe" fortified with 20% partially defatted (25%; screw pressed) peanut flour. Similar studies, with comparable results were conducted with the cereal-based weaning food Vitaset. Adding up to 20% defatted peanut flour improved protein composition of infant diets.

Applicability of Research - AAMU: At AAMU, the importance of continuing research on the development of new nutritious, high quality food products based on combinations of cereals (such as rice and sorghum) and peanut was emphasized. A model system, Idli (black grain and rice-based staple food prepared by steaming a fermented batter), a breakfast food consumed in the southern part of the Indian subcontinent and similar to "Toe" and "Kisra," was used as the model system. A new product was developed by using sorghum instead of rice, and supplementing with peanut (up to 30% defatted peanut flour). Adding peanut, decreased moisture content and increased protein levels up to 63%. Textural properties of the peanut supplemented product were similar to those of Idli. Fermentation increased viscosity of batters and also enhanced the degree of pseudoplasticity. A highly nutritious sorghum-based, peanut supplemented fermented food with acceptable organoleptic and textural characteristics, was developed for utilization of sorghum and peanut which are commonly grown in Burkina Faso and Ghana.

Studies on identification of compounds in peanut that contribute to flavor were studied at AAMU. This showed a n-methyl pyrrole was associated with musty off-flavors and found to be high in selected Texas grown cultivars. Data from these studies further reinforce the need for food researchers and plant breeders to work together and screen early developing breeding lines and germplasm accessions for these off-flavor compounds. The objective would be to determine the concentrations of objectionable flavor defects and to select those varieties having desirable flavor profiles.

Observations-Strengths and Recommendations: Note - Weaknesses are not separately defined in this report. Instead, all observations, including strengths are presented with ways to further add to the research studies of an already strong program.

In Africa, Peanut CRSP should emphasize three areas of research programming, which each should be strategically located to reduce duplication of effort. Developments then could be technologically transferred to the other countries by Peanut CRSP. These are: (1) Production-plant breeding, agronomy and entomology. (2) Mycological control-naturally occurring fungi growth suppressants and toxin inhibiting compounds from plants endemic to West Africa. (3) Commercialization-postharvest handling, storage, processing, packaging and marketing. Number (2) is a new emerging thrust for Peanut CRSP to support the research program in West Africa. With emphasis on pharmaceutical companies to find new natural sources of medicines and drugs from plants, this same emphasis should be with natural compounds to control pathogenic microorganisms and improve food quality.

By placing Dr. R. Awuah, UST, Kumasi, Ghana, on the Peanut CRSP, collaborative studies with the plant breeding program at the Agricultural Experiment Station, Nyankpala, have been encouraged. Until this occurred, plant breeders have mainly focused on developing high yielding peanut varieties.

Now they have become aware of the aspergilli-aflatoxin problem. This also links the breeders to the utilization program at FRI, Accra, Ghana. Similar observations can be made with the U.S. institutions, AAMU and Texas A&M University, working on utilization and mycotoxin research programs linked to Peanut CRSP, respectively. Hence, Peanut CRSP, via the new Ghana project has linked research on peanut from the farm to market via efforts to control aspergilli-aflatoxin contamination. This work is also examining Fusarium sp and fumonisin toxins contamination.

Biological control technologies for aspergilli-aflatoxin control may be more appropriate for subtropical-tropical regions of the world where constant rain and humidity make it difficult to maintain controlled and inexpensive storage conditions. Moreover, because of limited financial resources, simple cost-effective technologies can only be realistically afforded. Obviously, the ultimate need is aspergilli-resistant peanut cultivars. This can only be thought of as long range technologies. In the meantime, low cost limited controlled handling-storage facilities are being developed. These developments linked to biological control or spray technologies may be the answer to improving quality of peanut and other commodities including maize, cereals, cowpea, etc. All concepts would be indigenous to developing countries including storage facilities and plant inhibitors-suppressants. Attempting to transfer technologies/concepts from developed countries is not always in the best interest of the developing countries. Let the developing countries find new ways of solving their own problems; sometimes these breakthroughs may be useful in developed countries. A link should be developed among the OU, Ouagadougou, UST, Kumasi, FRI, Accra, AAMU, Normal, AL, and Texas A&M University, College Station, TX, Burkina Faso, Ghana and U.S. institutions, through Peanut CRSP to form a multidisciplinary team of food scientists/technologists, food microbiologists, mycologists and agricultural engineers interrelating biological control, handling and storage technologies for quality-safe peanut and peanut products in West Africa.

Note: Peanut CRSP can extend breeding and agronomic developments in other countries of Africa, including Burkina Faso to Ghana without duplicating those research programs. The emphasis in Ghana can then focus on developing the biological control of fungi and their mycotoxins. Hence, Ghana would focus on improving the utilization of quality peanut and transfer these technologies to the other West African countries.

Regarding workshops and information transfer, Peanut CRSP and ICRISAT should join forces on utilization. There is a new effort to address strengths and weaknesses of ongoing food utilization programs, especially aflatoxin contamination throughout the peanut producing countries. For example, Peanut CRSP has supported efforts to complete surveys on peanut utilization in Africa and Southeast Asia. The reports of these studies should be shared with researchers in Ghana. The background information on design, conduct and data analysis of the surveys would strengthen the approaches taken in Ghana in the conduct of this project. Making the reports available would allow for Ghanan researchers to focus on the objectives and reduce errors made by the other projects.

The Ghana Peanut CRSP team is multidisciplinary including Ms. Kafui Kpodo, PI, Food Technologist with food mycotoxin and extrusion technology expertise (M.S. degreed); Dr. Wisdom Plahar, Co PI, Food Science and Technology with emphasis on weaning foods; Dr. Nana Annan, Food Science and Technology with emphasis on processing and utilization of grains and legume-sorghum, cowpeas and wingbean; Dr. Hodari-Okae, Food Microbiologist; Mr. C.K. Gyato, Agricultural Engineer, design and manufacture of processing machinery--planting, harvesting, shelling, storage, handling and processing of peanut; and Mr. R.K. Adjei, Agricultural Economist, Socioeconomics. Note: Mr. Gyato should link his efforts through Peanut CRSP to work completed on peanut production-utilization machinery in Thailand and Caribbean countries. He should obtain machinery, and training in their use, from these countries and work to adapt them to the needs of the farmers in Ghana.

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Peanut CRSP should play a lead role in organizing a utilization workshop that includes all food scientists and technologists working on CRSPs including cowpea, sorghum-millet, soybean, etc. This would afford an opportunity for all food researchers to share experiences on program planning strategies, problems encountered, ways of overcoming issues and achievements. Equipment and processing technologies could be shared as well as transferred to Ghana and Burkina Faso, as research tools are modified for local applications. Training in these developments would reduce duplication of efforts and speed advances. An excellent example would be the transfer of pre- and postharvest technologies for planting, growing, harvesting, handling and storage of peanut at Khan Khaen University, Thailand. Results of surveys conducted during the start-up phases of Peanut CRSP in Burkina Faso and Sudan to determine product uses for peanut in cities, villages and at the family level should be transferred to Ghana. As the food research program unfolds at FRI, Accra, and the survey of peanut uses is completed, including the degree of aflatoxin contamination in peanut products, efforts will expand to collaborations with breeders and agronomists. These collaborations will examine peanut for flavor, composition, nutritional and functional properties for optimum consumer quality and acceptance.

Plans are to transfer a newly Peanut CRSP-purchased extruder from AAMU to FRI, Accra, Ghana. This is recommended. The availability of this research instrument will allow for carefully designed experiments to formulate extruded foods under controlled pressure temperature and time conditions. The technology developed at FRI would identify the best conditions for quality food products that would be applied with the fabricated expeller-extruder, developed in the Department of Nutrition and Food Science, University of Ghana. Hence, more carefully designed and diverse extruded foods from this collaborative study would be made available to the consumer.

Citec Huilerie in Burkina Faso now has an idle processing plant that is capable of processing defatted peanut meal to paste at 500 kg/hr. The company would be willing to make the processing plant and support personnel available in a research project to diversify peanut paste uses by the OU researchers; the company has only limited funds available for research, hence the project would have to rely on outside monies such as Peanut CRSP. The support from Citec Huilerie would include availability of peanut meal, laborers to run the operations and assistance in modifying equipment and available parts. Peanut CRSP would fund small equipment purchases and OU researchers, including technicians and graduate students. Studies on plastic packaging should also continue between OU and Fasoplast. These efforts should also include studies at AAMU on exploring for new products, especially weaning foods, from screw pressed defatted peanut meal; these studies should include varying textural properties and their effects on functional properties for new food uses. Collaborations between these two universities should include finding the market niche for the new peanut paste (peanut butter-like) products; e.g., packaging size of products that would meet the needs of the consumer.

Near Citec Huilerie, is Savana Unite Agro Industrielle, a fruits and vegetables processing plant making fruit juices, syrups, concentrates and marmalades-jellies. Fruits and vegetables processed include mangos, apples, pineapples, guava, tamarin, papaya, lemon, grenadine, orange, tomatoes, etc. During the visit, the company was processing tons of tomatoes into juice and sauce-paste. Most fruits are from Burkina Faso. At OU, research studies are underway to explore processing of other fruits and vegetables. The technical director of Savana, Mr. Nana Vincent, was very interested in collaborative studies to blend various fruit marmalades with peanut paste; this followed discussions on the topic of diversifying peanut paste made at Citec Huilerie to meet new marketing strategies, specifically fruit flavored peanut butter-like products. Opportunities exist for expanded marketing of fruit flavored peanut products to neighboring West African countries including Nigeria, Tunisia, Libya, Niger, etc. It was agreed that these research ideas should include a collaborative study involving the two industries, Citec Huilerie and Savana, and OU and AAMU as a project funded by Peanut CRSP.

Note: The industry in Burkina Faso relies on marketing studies at OU before entering into management discussions and decisions to commercialize new products. There have been few marketing experiments in Burkina Faso, hence the food industry has identified this area as a high priority research need with the support of Peanut CRSP. The university needs to strengthen programs that survey market potential, determine economics and the capacity for the industry to develop the available process technology for new and improved products. Until this is strongly emphasized by the university, only small advances in peanut products, or any commodity, will occur led by the industries in Burkina Faso.

Technologies have advanced in handling, storage and processing of peanut in Burkina Faso, especially in Ouagodougou. Additionally, new uses and products have been developed. This has increased consumption of peanut and peanut products. Underway are studies to evaluate the socioeconomic impact of peanut in Burkina Faso. They are: (1) To evaluate the acceptability of peanut products from new processes including Marba Tigue, Sugar Nuts and Roasted Peanut with Milk. (2) To develop applications for Allium sativum extracts in the control of aspergilli-aflatoxin contamination. (3) To solve Citec-Huilerie's problems in the sale of their peanut paste product. (4) To provide products of sorghum, millet and maize flours supplemented with peanut flour at Nutrition Centers. Regarding (4), work is underway with Nutrition Centers sponsored by the Health Ministry to nutritionally improve presently available high carbohydrate flours (Missola, Kasona, Den-Mugu and Vitaline) by supplementing them with high protein peanut flour for infants. This is sorely needed in the protein-deficient diets of infants in Western Africa. Roasted and sugar-coated peanut products are processed mainly by women and sold in shops, markets and hotels. Assurance studies and educating these women in the importance of consistent flavor quality and packaging was completed with favorable results. Producers and sellers are willing to try new products and technologies as recommended by Peanut CRSP supported programs at OU. Research programs must continue on quality, price reduction, supply, packaging and markets. Efforts are needed to popularize the new technologies in the news media and via collaborations with non-government organizations, village associations-groups and social services. In the future, Peanut CRSP will continue to play a very important role in the success and expanded growth of these programs.

Peanut CRSP Code: GA/FT/TP
Project Title: Appropriate Technology for Storage and Utilization of Peanut
Principal Investigators and Collaborating Institutions: Dr. L. R. Beuchat, U.S., University of Georgia; Dr. P. Chompreeda, Thailand, Kasetsart University; Dr. V. V. Garcia, Philippines, University of the Philippines at Los Banos, Laguna; Dr. L. S. Palomar, Baybay, Leyte, Visayas State College of Agriculture.
Collaborating institutions include the Center for Food Safety and Quality Enhancement, Department of Food Science and Technology, University of Georgia (UGA); Department of Science and Technology (DOST), Food and Nutrition Research Institute (FNRI), Philippines Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), Institute of Food Science and Technology, Institute of Plant Breeding, Department of Entomology and National Institutes of Biotechnology and Applied Microbiology, University of the Philippines at Los Banos (UPLB), Laguna, Department of Agricultural Chemistry and Food Science, Visayas State University of Agriculture (ViSCA), Baybay, Leyte, and Ministry of Agriculture, Cagayan Valley, Isabela, the Philippines; Department of Product Development, Kasetsart University (KU), Department of Food Science and Technology, Cheingmai University (CU), Department of Food Agricultural Engineering, Khon Kaen University (KKU), and Ministry of Agriculture and Cooperatives, Department of Agriculture (DOA), Thailand.

1. Achievement of objectives

The objectives, conceptually reasonable, realistic and being achieved are to develop and demonstrate procedures to eliminate aflatoxin-contaminated seed from farmer's lots; to prevent growth of aflatoxigenic aspergilli through control of temperature and humidity during storage; to maintain sensory quality of raw and roasted seed; and to develop and adapt technologies to utilize peanut and peanut products in traditional and new food products which would be acceptable in Thailand, the Philippines, other Southeast Asian countries and the U.S. This program's researchers have had the foresight to evolve collaborative linkages among national and international government institutions, experiment stations and universities to form multidisciplinary teams of food scientists and technologists, agricultural engineers, peanut breeders, agronomists and entomologists. As a growing emphasis began for technology transfer, efforts increased in collaborations between the research institutions and industry - both large and small or entrepreneurial, and regulatory agencies. Another major emphasis is the training component including advanced degrees (M.S., Ph.D.) and short courses for support personnel. Workshops on advances in peanut utilization for industrial personnel, and the nutritional well being of consumers are having an impact on host countries and the U.S.

Philippines

(1.1) Research developments have heightened efforts to implement procedures during production and postharvest processes that minimize aspergilli-aflatoxin contamination in peanut and peanut products and consumer awareness that demands safe foods. The Philippines Bureau of Food and Drug (BFAD) surveyed brand-named peanut butter manufactured by metro-Manila firms and regulated removal of products exceeding allowable limits of 20 ppm. The public was warned against purchase of unlabeled peanut butter products sold at unlicensed, not subjected to BFAD tests, local markets.

(1.2) Identification of endemic or traditional food products in the Philippines such as peanut butter, peanut brittle, and a salted-garlic-flavored fried peanut called Adoba, have been completed and recipes made available for entrepreneurs. Workshops to train interested business enthusiasts in product development and continued cooperation are establishing local enterprises and sales of selected peanut products.

(1.3) On-farm trials at Pampanga and Isabela showed that new disease (leafspot, rust) and insect (leafhopper) cultivars UPL Pn_{10} and UPL Pn_2 were preferred by peanut growers because of high yielding traits, and acceptable seed size, shape, color, flavor and nutritional composition. Increased seed production of the two cultivars is ongoing and pilot development at major peanut-growing areas as well as new potential sites will be initiated during the late October-November, 1994, growing season. The work resulted from collaborative efforts of breeders, entomologists and food scientists.

Thailand
(1.4) Acceptable peanut-supplemented Chinese noodles were prepared from blends of durum wheat flour and partially defatted peanut flour. Physical measures, sensory quality, lightness, cutting force and firmness studies showed replacement of up to 15% of wheat flour with peanut flour resulted in noodles judged to have acceptable sensory and nutritional qualities. A Bangkok food company has made products available to consumers.

(1.5) A group of seven entrepreneurial producers was selected, equipped with the necessary equipment to oil and dry roast peanut and trained in the appropriate technology. This effort proved very successful in terms of the ability to produce high quality products, including low to no aflatoxin levels. The producers were chosen from an area where the farming population was poor but the experience of this effort showed that when given the opportunity, local entrepreneurs can produce successful businesses.

(1.6) A nutritious 12% protein snack containing defatted peanut flour, potato granule, pregelatinized potato starch and potato starch was made with a single-screw extruder. Incorporation of peanut tempeh flour increased protein content to 12.9% compared to 5% in the unfortified formula. The sensory evaluation tests with consumers showed acceptance of these two products.

UGA
(1.7) A number of selected new products are available because of breakthrough developments with peanut functionalities to formulate unique food properties at UGA. A protein extract is used as a protein base for coffee whiteners in liquid and dried forms. Peanut flour made from partially defatted and fermented with Rhizoporus microsporus var. oligosporus formed soy sauce and meat-like flavored food ingredients. Unhydrogenated palm oil at levels of 2.0-2.5% effectively stabilizes peanut butter for at least one year at 21-24 C. A low-fat milk-like beverage with typical roasted peanut flour (but without milk) has been developed with little or no chalky mouth feel as a nutritious milk substitute.

(1.8) Studies on Chinese-type noodles were extended to include wheat flour fortified with defatted peanut (7-21%) and cowpea (4-12%) flours. This is an example of collaborative studies of Peanut CRSP and Bean/Cowpea CRSP. Computer-generated analyses revealed that up to 15% peanut flour and 8% cowpea flour supplementations produced Chinese noodles with acceptable physical and sensory qualities while improving protein content. Also demonstrated was that peanut and cowpea are acceptable as ingredients for preparing natto-like products similar to those traditionally fermented from soybean in Japan.

2.1 Administrative involvement
2.1.1. Attitude towards, support and perceived relevancy to the institution.

In the Philippines, PCARRD confirmed full commitment to Peanut CRSP. A National Agricultural Resource Research Network is in place to coordinate research programs at the national, state, experiment station and university levels. Those programs are closely coordinated with the Philippines' industries. Cooperation with the Department of Agriculture through pilot plant research programs and extension services is helping to move research developments to commercialization. A National Commodity Team for each crop, e.g., legumes, including peanut variety improvement at the Department of Agriculture experiment stations, in partnership with PCARRD and UPLB is greatly improving technology transfer of research developments to the farmers and industries. Municipal,

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provincial, regional and local governments are working with national programs to support projects. Extension services support local governments in efforts to meet the research needs of entrepreneurs, small industries and farmers.

The Thailand Ministry of Agriculture, DOA, KU, CU, KKU conduct Thailand's agricultural and food research including Peanut CRSP. Funding for Peanut CRSP is coordinated through DOA's Field Crops Institute. Peanut improvement research is part of the Thailand Coordinated Groundnut Improvement Program. The importance of Thailand being able to process agricultural products to help the national economy is recognized by the country's high level administrators. A close collaborative teaching and research relationship exists among all Peanut CRSP programs including Department of Product Development KU, Department of Food Science and Technology, CU, Department of Food Agricultural Engineering, KKU and DOA. Research programming is commodity oriented and highest among its priorities is quality. The Thailand effort is largely due to Peanut CRSP.

Dr. G. F. Arkin, Associate Director, Georgia Experiment Station, confirmed commitment to peanut research and Peanut CRSP. Recognized were the benefits of Peanut CRSP from international programs, collaborative research and teaching-training within and among Host Country and U.S. institutions, broadening scientists' thinking-creativeness, expertise and recognition, improving faculty promotion potential and investing in the future of the world. There was a clear appreciation for the problems that confront Host Countries and their institutions. It was understood that important to Peanut CRSP's success was that research solve high priority problems, be targeted for technology transfer to the users, improve through teaching-training the knowledge base of faculty and students, and through these educational efforts strengthen the quality-sophistication of science, equipment-instrumentation and facilities of Host Country and U.S. institutions.

2.1.2. Fiscal/logistical assistance

A major benefit noted at Host Country and U.S. institutions was contributions of scientists' expertise, and instruments, equipment, facilities and research programs, at no cost to the Peanut CRSP through collaborative programs; a benefit of research in the university setting. In spite of limited funding, the programs are productive and are accomplishing more than expected.

Scientists from Host Countries being trained in the U.S., and other advanced countries, are developing expertise with modern, sophisticated equipment-instruments, facilities and experimental designs. When they return to their own institutions the newly learned skills are of limited use because equipment, instruments and facilities are partially or not available. This stymies their ability to begin immediate development of programs that will solve the problems confronting the Host Country. Funds from a number of sources should and in selected cases are being identified to complement those of Peanut CRSP, and purchased during the training period.

2.1.3. Resource commitment (faculty/facilities)

During the past 10 years, the number of faculty at UPLB has decreased from 17 to 10. Where positions have been filled, Ph.D's. were hired. Noted was that the best qualified students study outside of the Philippines, in, e.g., Canada, Australia and the U.S. The Philippines has a wealth of educated human resources. Foreign students studying in the Philippines make up 20%, and mainly come from Southeast Asia, Thailand, Indonesia and Malaysia. The graduate program has 22 M.S. and 8 Ph.D. students. Undergraduate thesis and apprenticeship programs whereby students work on industrial-related problems strengthen the department; apprenticeship students work on industrial problems and may be funded while the thesis projects are supported by the University and PCARRD. Women make up 80-85% of the students. Funds for research projects are obtained from UPLB, DOA, PCARRD, Peanut CRSP and the food industry. Industry funds projects of immediate concern on processing.

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2.2. Adequacy of planning

Planned work continues to emphasize development of new and improved foods at Host Countries and U.S. institutions. As further understanding of structure-function of peanut seed components expands, new unique functional and nutritional properties are developed. In Thailand and the Philippines, advances in ways to store seed between seasons to maintain seed viability are being developed. Ways to increase production of viable planting seed is being addressed. Existing agricultural storage systems are being studied to determine their adaptability and cost effective on-farm use. Similarly, cost effective, and efficient drying systems are being examined for their ability to reduce pre- and postharvet aspergillus-aflatoxin contamination. A ViSCA-University of Georgia project at Baybay, Leyte, the Philippines, implemented during 1993, has identified cooperators and completed a socioeconomic baseline survey and its analysis structured to determine products and their market potential. Recipes, processes and training programs in their application, packaging and marketing are ongoing and their further development are well planned. Similar developments are occurring with village scale peanut processors at Huay-Bong-Nua, Phroa District, Cheingmai Province, Thailand. Host Country and US PI's have adequately communicated in a team approach to these plans.

2.1.5 Comments

A workshop on Transfer of Peanut Production and Utilization was held in Thailand at KU during 1993. This highly successful workshop included presentations by researchers representing all Peanut CRSP projects in Thailand. A similar National Peanut Workshop presenting advances in the Philippines' peanut programs occurred at PCARRD in 1994. Similar types of workshops are needed for the entire Southeast Asia, and could include other Peanut CRSP countries, such as West Africa and other USAID CRSP,, to broaden exchanges of experiences to solve problems and do technology transfer, etc.

3. Institutional Development

3.1. Complementarily to ongoing research effort

Many of the faculty that work on Peanut CRSP in the Philippines and Thailand have received advanced degrees and training from U.S. institutions, particularly, UGA, and other countries. These researchers have opportunities to travel to international meetings. These occurrences have greatly increased collaborative involvements among institutions both within Host Countries, the U.S. and worldwide. The opportunities are available for peanut researchers from the various institutes to exchange up-to-date information on programs in progress, and published, and to jointly plan future projects in different disciplines that include cooperative

3.2. Strengthening of scientist/equipment/facility capabilities

The food science programs in Host Country and U.S. institutions are gradually equipping their laboratories with the most modern equipment-instrumentation and facilities. Facilities include teaching, analytical, and microbiological laboratories, pilot plants, kitchens and taste panel rooms. These developments have been a slow tedious process accomplished with the strong support of Peanut CRSP.

3.3. Extent of collaborative actions

A major benefit of collaborations among Host Country and U.S. institutions was contributions of scientist expertise, and instruments, equipment, facilities and research programming. This has especially been true with UGA where researchers have come to be trained and receive advanced degrees while completing experiments that have contributed to the accomplishments. This has improved productivity in spite of limited funding. Moreover, collaborations have occurred among faculty of Peanut CRSP and Bean/Cowpea CRSP. The EEP in 1989, recommended that efforts be strengthened in multidisciplinary teams including breeders, entomologists, food scientists/technologists and agricultural engineers. This has occurred in the development of newly released cultivars, awareness of aspergillus-aflatoxin issues and their control and development of family operated cottage industries in farming communities of Host Countries.

3.4. Training
Faculty and students of Host Countries with bachelor level and advanced degrees have increased via Peanut CRSP. The results have strengthened teaching and research programs at Host Country institutions. New Ph.D. programs have been approved at Host Country universities because of improved faculty strength, and a broadened availability and diversity of course work.

3.5. Comments
A major benefit noted at UGA was contributions of scientist expertise, and instruments, equipment, facilities and research, at no cost to Peanut CRSP through collaborative programs; a benefit of research in the university setting. In spite of limited funding, the programs are productive and are accomplishing more than expected.

4. Adequacy of Science-technical merits of program

4.1. Progress and innovativeness of the science/research
An objective of countries of Southeast Asia is to attain self-sufficiency in peanut production. The Philippines has set the goal for this to happen by the year 2000. The strategies that support this effort are to develop/adopt high yielding, drought-resistant and pest-resistant varieties and improved production technologies; to strengthen postharvest facilities and operations to eliminate aspergilli-aflatoxin contamination; to expand production to agronomically marginal growing areas; and to develop diversified products that create higher demand and enhanced value, especially for small businesses, including cottage industries.

A project in the Philippines entitled "Seed Production and Dissemination of Improved Crop Varieties for Countryside Development in the Second District of Leguna" has the much needed objectives to produce and disseminate seed, including peanut, and planting materials to improve crop varieties; and to provide training to enhance production efficiency of improved crop varieties.

4.2. Social science/economic implications
Pilot studies of women cooperates at Huay-Bong-Nua Village, Phroa District, Cheingmai Province, in collaboration with Cheingmai University, Thailand; and Baybay and Ormoc City, Leyte, working with ViSCA, the Philippines is transferring techniques for processing and marketing selected peanut products by newly formed small businesses. Peanut CRSP is directly contributing to the development (research, training, funds) of these programs.

The advancements of Peanut CRSP countries, Thailand and Caribbean countries, on manual and powered mechanized machinery (tillers, planters, weeders, strippers, threshers, shellers, cleaners, sizers, grinders) for peanut production and postharvest handling need to be transferred to host countries without these technologies, e.g., the Philippines. This equipment has been successfully demonstrated by agricultural engineers to extension personnel and farmers in training workshops with exceptionally positive responses via purchases that are improving on-farm operations and profits. It is through this type of technology transfer where Peanut CRSP is making a strong contribution.

4.3. Appropriateness of research (basic/adaptive)
Studies supported by Peanut CRSP on the use of fungi metabolites to biologically control, inhibit or inactivate aspergilli growth and hence, aflatoxin contamination of peanut seed is being done at the Institute of Food Science and Technology, UPLB. Environmental, farming, and handling conditions in Southeast Asia highly favor aspergilli contamination of harvested and stored peanut seed. Small farming operations with marginal profits limits investment in sophisticated storage technologies that eliminate growing conditions of aspergilli. Hence, these new concepts in biological control technologies may be an answer to controlling aflatoxins in developing countries and should be classified as high priority programs in Peanut CRSP.

4.4. Comments
Research at U.S. institutions, like UGA is developing new and improved technologies for handling, storing and processing food commodities through sophisticated studies on nutritional, functional, fermentation and physicochemical properties, sensory qualities and microbial safety. Postharvest engineering technologies include energy conservation, dehydration, packaging, refrigeration, freezing and computer modeling systems. Important to these programs is consumer oriented product research i.e., factors affecting consumer perceptions/attitudes, food purchase behavior and use. These capabilities are found only in part in Host Countries' research programs. Complementarity of Peanut CRSP to these ongoing research efforts, and in turn, to the development and adaptation of technologies to utilize peanut and peanut products in traditional and new food products are very evident, but better done at U.S. institutions and the technology transferred to the Host Countries.

5. Applicability of Research
5.1. Relevancy and transferability of research to Host Country or U.S. programs
Coordination of food science and technology research with breeding and variety evaluation programs through collaborative studies has improved during the past five years. Similarly, breeding agronomic, entomological and food science studies are increasingly coordinated with post-production handling, storage and processing conditions, and marketing and consumer acceptance factors. Needed strengthening is to produce/disseminate planting seed and demonstration plants of newly released high yielding-insect/disease resistant peanut cultivars.

The Philippines Bureau of Food and Drug regulated removal of peanut products exceeding allowable levels of aflatoxin from stores. The public was warned against purchase of unlabeled peanut butter sold by unlicensed, not subjected to regulator's tests marketplaces. Such occurrences in Southeast Asian countries are putting pressure on farmers, handlers and processors to learn and use advanced technologies being developed by Peanut CRSP supported institutions.

Identification of traditional peanut foods and development of new products in the Philippines and Thailand are completed and recipes are available for businesses. An acceptable peanut-supplemented Chinese noodles product developed by Peanut CRSP programs in Thailand and UGA are being test marketed. Family cooperators in villages of the Philippines and Thailand are being trained in the processing and marketing of peanut-based products; this includes operating small business ventures including overcoming impediments and constraints in the use of new technologies. Small and large businesses are paying attention to marketing interests, especially snack foods popular with the younger generation. These occurrences are encouraging industry to play a greater role in prioritizing research needs of peanut.

The technical know-how for powered mechanized machinery to produce, harvest and handle-store peanut on-farm is available in Thailand. Demonstration workshops and machinery entrepreneurs are encouraging farmers to purchase-use these technologies. The result is reduced farming costs, increased profits and reduction of aspergilli-aflatoxin contamination. Peanut CRSP researchers are initiating transfer of these technologies to the Philippines and other Southeast Asian countries.

5.2. Relationship to other international research programs
Linkages and scientific friendships are in place and will endure long after Peanut CRSP. Numerous national, regional and world organizations with which Peanut CRSP has developed cooperation to solve peanut production and utilization constraints include ICRISAT (India, Niger), Institute for Oilseeds Research (France), CARDI (Caribbean), International Development Centre-Canada, Australian Center for International Agricultural Research, IRRI (the Philippines), PCARRD (the Philippines), FAO United Nations (Italy), African Groundnut Council (Nigeria) and Conference des Responsables Africians et Francais de la Recherche Agronomique (France). Peanut CRSP has sponsored or supported many conferences, workshops and symposia on peanut. An impressive list of publications released or

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supported by Peanut CRSP is available. Technology dissemination programs are self sufficient in Host Countries.

5.3. USAID/host country perceptions of Peanut CRSP
The USAID Mission personnel are very supportive of Peanut CRSP in Thailand and the Philippines. They are impressed with the research accomplishments and efforts to extend technologies to farmers and village food entrepreneurs-processors in the rural provinces. It is here where Peanut CRSP is strengthening its program, especially in postharvest technologies. Training programs are strongly endorsed. Emphasis on research and training programs that build linkages between scientific institutions and users, specifically farmers and industry are applauded. Noted was the dramatic increase in human capital or resources for peanut programs in the Host Countries and the U.S. because of Peanut CRSP. According to the USAID Mission personnel, Thailand is becoming self-sufficient and is now recognized as an Advanced Developing Country.

5.4. Comments
The most important contribution of Peanut CRSP is the establishment of a coordinated, sustainable, national research program on peanut in Southeast Asia. Such a coherent effort has positively and permanently influenced the overall research policy on peanut in this part of the world.

6. Observations

6.1. Strengths:
The impact of Peanut CRSP in food research has far exceeded its actual funding. The funds allocated over the years has brought major successes in developing human capital (training, advanced degrees); increased the knowledge base (research); educated the public in international dimensions of technology; and increased sensitivity of the land grant and sister institutions to the global problems of technology. This modest investment has caused a significantly increased effort in research, extended a network of collaborators and allowed for the actualization of graduate programs at Kasetsart University, Thailand and the University of the Philippines at Los Banos, the Philippines; and is beginning to do the same at Cheingmai University Thailand, and Visayas State University of Agriculture, the Philippines.

A primary strength noted for Peanut CRSP is the knowledge, dedication, leadership and enthusiasm of the Principal Investigators, co-Principal Investigators and the cooperating scientists to attack the constraints of peanut production and utilization. A critical mass of peanut scientists has been built thereby strengthening the national research capabilities of Peanut CRSP Host Countries and the U.S.

The leadership of Peanut CRSP has shown excellent foresight in guiding programs since its start in 1982. Peanut CRSP's priorities have evolved with the needs of the times during the 1980's and developing in the 1990's. This includes research and development, technology transfer, socioeconomic program concepts and informational-educational-sharing publications, the latter three priorities being emphasized in the late 1980's to present. Peanut CRSP is applauded for this progressive programming.

6.2. Weaknesses
Peanut CRSP should strengthen its commitment with start-up funds to Host Country scientists returning home after studies in the U.S. This would assist them in efforts to initiate new programs. These trained scientists with their newly learned expertise are capable of rapidly developing new programs to meet the immediate needs of the Host Country, if more start-up funds were made available.

7. Recommendations

Strengthen newly initiated projects in Southeast Asia that enhance rural community-based and social action programs through marketing of peanut products. This includes uplifting the living conditions of women and youth through the development of ecologically, sound alternative livelihoods via strengthening of existing and new businesses, entrepreneurial ventures, or cottage-scale women processors. Implement technologies that improve post-harvest handling operations and storage facilities that reduce aspergilli-aflatoxin contamination in peanut seed. Scale-up production and distribution of planting peanut seed to farmers through local experiment station programs; educate farmers in the use of newly developed peanut cultivars, maintaining pure planting seed through extension services supported demonstration plots. Hence, support the challenging Peanut CRSP research program outlined for the new five-year (1996-2000) plans, budgets and accompanying justifications with the goal: "Sustainable development of peanut-producing and peanut-consuming countries, particularly those with peanut farmers and consumers with low incomes."

External Evaluation Panel Assessment Rating for Peanut CRSP Project GA/PH/C Postharvest Handling System for the Small-Scale Peanut Producer.

1. Achievement of Objectives **Rating 4.3**

1.1 Belize

CARDI, with technical assistance from Peanut CRSP has made substantial progress in developing satisfactory prototype machines for postharvest handling system.

1.2 Jamaica

There has been some successful attempts to copy and fabricate machinery for threshing, shelling, drying, and storage. Much of what has been developed needs to be tested and refined for study and mechanical durability.

1.3 Georgia

The PI at the University of Georgia and his associates have been successful in developing a global model for evaluating the acceptability and profitability of peanut postharvest systems for Caribbean countries.

2. Implementation and Management of Project. **Rating 5.0**

2.1 Administrative Involvement

2.1.1 Belize

CARDI Research Station of the Ministry of Agriculture and BFAC are host country collaborating institutions.

2.1.2 Jamaica

CARDI, University of West Indies at Kingston, and RADA/Ministry of Agriculture are host country collaborating institutions.

2.1.3 Georgia

University of Georgia system is the U. S. lead institution. In addition to the PI's Department of Food Science and Technology at Griffin, Department of Agricultural Engineering and Department of Agricultural Economics at Griffin and the Department of Agronomy at Tifton are also involved in this project. the project funds are managed by the Business Office for the University of Georgia Research Foundation at Athens.

2.2 Researcher's Involvement

2.2.1 Belize

Mr. A. K. Sinha is the PI. He was very enthusiastic about this project and also worked closely with Mr. E. O. Enriquez, Manager of BFAC.

2.2.2 Jamaica

Dr. Joe Lindsey became PI in 1990 after the change of program direction from GA/BCP/CAR to GA/PH/C in 1988. Mr. Urvan Wilson, Project Engineer who was responsible for the construction of the dryer and storage facility at Newton in 1990 or 1991, resigned from the project in 1992.

2.2.3 Georgia

Dr. Manjeet Chinnan is the PI of this project. He and other researchers at UGA worked closely together, identified needs, equipment, and proceeded to do an outstanding job.

3. Institutional Development **Rating 4.7**

3.1.1 Belize

Through the development and transfer of new postharvest technology and product development, BFAC and CARDI have brought about the commercialization of peanut industry and significant economic benefits to the farmers. The technical support provided by the Peanut CRSP to CARDI representatives has been a notable component of the development of the peanut industry.

3.1.2 Jamaica

CARDI researchers and extension personnel offered technical assistance and training as needed to peanut growers. A three day workshop was held in Mandeville in January, 1993 on improving production and quality of peanuts. About 60 peqple attended the conference out of which more than 50% were peanut producers, handlers, and processors.

3.1.3 Georgia

W. E. Chapman of UGA visited Belize and Jamaica in November, 1992 to provide technical assistance in the use of postharvest equipment. New collaboration has been undertaken at Khon Kaen University, Thailand, in conjunction with the Peanut utilization project (GA/FT/TP) and at Kasetsart University, Bangkok, Thailand, for an improved system of postharvest operations and provide linkage with the production and utilization aspects of peanuts.

4. Adequacy of Science - Technical Merits of Program. **Rating 4.3**

4.1 The scientific principals involved in this project are sound. Technical merits have been beneficially demonstrated in Belize.

4.2 Postharvest technologies are still evolving in Jamaica. A drying/storing facility has been completed at Newton, St. Elizabeth, but suitable arrangement with RADA to manage and operate this facility has not been worked out to date. Several factors have discouraged the full utilization of this facility.

4.3. Georgia - Thanks to the abundance of expertise and dedication to assist developing countries, the scientists at UGA have designed and modified pedal-powered blower for peanut hull/seed separation for acceptance by local farmers, who do not have electric motors or gasoline power engines. They have also developed a portable peanut dryer for CARDI. Other technical development which will benefit host countries are simple, inexpensive equipment, and effective protocol for measuring aflatoxin levels in peanuts and peanut products and the experimental use of palm oil to stabilize peanut butter..

5. Applicability of Research. **Rating 4.7**

5.1 Postharvest handling systems are more readily acceptable in Belize than in Jamaica. Because of its longer growing season, acceptance of new variety CARDI/Payne has been slow by small peanut farmers in Jamaica but its higher yielding potential larger seed size and resistance to shattering in comparison with locally grown Valencia were considered desirable by larger growers and candy and food manufacturers. The blending of CARDI/Payne with the Valencia overcame its less desirable taste and achieved optimal texture and taste in finished food products.

5.2 Collaboration with international research centers such as ICRISAT, with related Peanut CRSP projects in other host countries and industries has taken place and were encouraged.

5.3 Many publications and oral presentations by U. S. and host country scientists have been published in technical journals and scientific meetings and workshops.

6. Observations.

6.1 Strength

6.1.1 The program has highly competent scientists and engineers.

6.1.2 The postharvest handling systems are appropriate for the developing countries.

6.1.3 Good collaboration exists between this project and GA/FT/TP.

6.1.4 High degree of appreciation by government officials of the host countries and USAID Missions.

6.2 Weakness

6.2.1 Some doubt exists whether or not postharvest handling system takes precedence over development of superior new cultivars and cultural practices.

6.2.2 Labor costs and highly fluctuating prices of peanuts influenced the peanut production in Jamaica.

6.2.3 More detailed crop enterprise budgets and data are not readily available at this time.

6.2.4 Pending cooperative type utilization and management arrangements delayed the full effective use of newly completed drying/storing facility at Newton, Jamaica.

7. Recommendations.

7.1 Reassess the exclusive focus on postharvest technology.
7.2 Conduct safety tests on fabricated equipment and evaluate more thoroughly the cost and time savings from increased mechanization, especially in Jamaica.
7.3 More attention should be focused on utilization. Find ways to generate new products which would utilize peanuts.
7.4 Peanut CRSP should be continued. Newer, second generation constraints, will be just as serious and important to continued development, and will require as much, if not more, research and technical assistance by CARDI and the U. S. institutions as have the first generation constraints which are being successfully addressed in Belize and partially successful in Jamaica.
7.5 Explore ways of capitalizing private sector investment in the utilization of peanuts and in refining the appropriate technology so vital to the agriculture and people of Jamaica.

MANAGEMENT

I. Introduction

This summary covers two categories of information:1) a characterization of the CRSP's management based on several indicator and 2) a description of impressions gained from brief visits with administrators in Georgia. There are many angles from which to review and assess management. However, the most logical route is to use the agreed upon and described indicators. In the effort to characterize the Peanut CRSP's management effectiveness, the following are used: 1) scope and effectiveness of panning, 2) the administrative structure, 3) the management('s) strategy, 4) effectiveness of clientele focus, 5) geographic coverage, 6(collaboration in management and research, 7) human resource development strategy and accomplishment, 8) communication and outreach, 9) review and evaluation strategies and 10) forward, focused planning.

II. Overall CRSP Management

A. Scope and Effectiveness of Planning: One of the most evident strengths of the management has been the ability to develop comprehensive and well-thought-out plans. After reviewing the initial global plan, the strategic plan for the 1990's, the yearly project forward plans it was possible to interact with (and listen carefully) CRSP administrators, host country researchers and administrator, U.S. scientist and EEP panel members. Having done so, I conclude that the CRSP's management has put together plans which effectively focused on achievable targets under the broad areas of sustainability, resource management and communication. Choosing to focus planned activities around constraints was a strong feature. Planning for broad-based and realized collaboration (temporally and globally) has added strength to not only to realized accomplishments, but to future potential. The intricacies of the CRSP's planned and planning allow for moving from global the specifics, with reasonable continuity. With careful reading and assessment, it is possible to connect individual project or principal investigator (research) accomplishments back to the global plan. The plans have been logical, respectful of fiscal, human and ecological constraints. They have served as reasonable roadmaps to agreed-upon goals.

B. Administrative Structure: The CRSP's administrative and management structure looks cumbersome, yet it has been effective in supporting the management entity. The Board of Directors has engaged in policy and direction and has been actively committed to the CRSP's success. The other critical components are the technical committee, external evaluation panel(s), the USAID program manager, and the BIFADEC Liaison. While this grouping cannot take credit for success on the part of plant breeders and scientists, the discharge of respective responsibilities have enabled the management entity to effectively service the needs of CRSP project collaborators. Overall, the administrative structure has been an asset to the effective management of this project.

C. The Management(s) Strategy: The overall strategy was straight forward: Specify the geographic focus, set priorities, fund research projects, implement, monitor and evaluate. The strategy has been cognizant of sustainability, equity, role of women, production and the need for information dissemination. The strategy is applauded, especially since it has been crucial to those accomplishments which have been, thus far, realized. The strategy has allowed some flexibility for PI's to be intellectually creative.

Another applaudable aspect of the CRSP's strategy was the decision to focus on constraint mitigation. This approach allowed for keeping the "problem" focused and out front and for associating the expenditure of CRSP resources with efforts to solve problems. Continuity of focus is of "critical" importance; not solely for the PI's but also for the management structure and congressional resource (fiscal) allocators.

D. Identification of Clientele: The management structure originally identified the beneficiaries/clientele as growers, processors and consumers. This broad definition allowed for capturing a wide band of potential benefits expected to result fro the CRSP. In reality the clientele of first order have been the Peanut Research (scientist) community and the institution engaged in implementing the research. Since the CRSP had no extension component or formal technology/transfer structure, claiming consumers as immediate clients might have been somewhat misleading. Once the projects technology breakthroughs are extended to the farming and processing sectors, then the consuming sector might capture the benefits.

E. Geographic Coverage: The project was quite specific in identifying countries and regions of initial focus. As shown in the plan (for example) the Africa regional focus was to encompass Burkina Faso, Mali, Niger (Nigeria) and Senegal. There was to be inclusion of other countries via collaboration. It was not clear from the reports or interactions as to which other countries were effectively involved and subsequently to benefit from the CRSP. Even with the selected primary countries, there was reportedly difficulty in achieving the desired frequency of interactive project site visits by American principal investigators.

F. Collaboration: There was continuous evidence in program reports, plans and publication of collaboration among and between the various actors in the CRSP network. Of course, this is a key aspect of the project. Collaboration was achieved through management meetings, regional and national scientific workshops, local committee group meetings, the annual plan/report development, external reviews and, of course, long distance correspondence (via phone, FAX and computer). All of these are a ploy described in the EEP reports and annual CRSP reports.

The less positive note on "collaboration" was the failure at effective collaboration with clientele users. Those groups would have been consumer groups, small and large food processors, farmers and others. Some forms of collaboration might have spurred the use of some of the technology by beneficiaries.

G. Human Resource Development Strategy: Training has been stated as an integral part of the CRSP. The intent was to upgrade the skills of existing scientists and provide training for young scientists. Over the life of the CRSP and, indeed, during the most recent five-year plan, considerable progress has been made. Graduate (M.S. and Ph.D.) training has occurred and short-term training has been programmed for established personnel. this training, as has occurred, will be a lasting investment.

As important as training is, it has been noted that global and country level training plans are not routinely developed, vetted or implemented. They do not exist. As it stands now, it appears that training has been ad hoc. If the project or some aspect of it is redirected, the training component should be more purposefully planned and pursued.

H. Communication and Outreach: The managerial intent was to stimulate increased communication and outreach to primary clientele groups. That has been achieved through several venues: a) publications, b) sponsoring and participating in workshops, c) the development and dissemination of a newsletter, d) travel and collaborative visit (reciprocal) to the research labs and centers and e) administrative report, planned and communicate development and utilization. The scientific and operational communication has been strong.

The communication down-side has been the failure to achieve good outreach to farmers, processors and users at the village level. This was not really an easy task for the research project.

I. Review and Evaluation: One of the management tools used was the annual evaluation. The earlier evaluations were executed almost exclusively by non-social scientists. The evaluations were useful in taking stock of progress toward reaching project goals. The most recent evaluation was to encompass impact analysis and social science. This component would compliment an already successful series of reviews.

J. Forward Focused Planning has been built into the CRSP at all levels. This element is a part of yearly evaluation and resource allocation. The advantage of forward planning is that is has allowed the PIs and CRSP management to keep a focus on constraint mitigation while being involved in the allocation and use of decreasing support funds from USAID and other sources.

III. Georgia Based Management Visit

During the EEP meeting in Griffin, Georgia, it was made possible for visits with University administrators. Those visits provided a chance for useful interaction through which impressions as to how management worked were sought. Some of the findings are shared below:

A. The Business Office, which handles the fiscal affairs for the CRSP, has been recently reorganized to manage all funds in the College of Agriculture: research, extension, teaching and other sponsored grants. The CRSP funds are managed under the auspices of the Agricultural Experiment Station. Within the business office, one senior person has been assigned to manage the fiscal aspects of the CRSP.

Probably 60 percent of the fiscal officers salary is paid by CRSP and substantial capacity has been created for managing the peculiar aspects of CRSP and AID type projects. The accounting process is governed by a cost reimbursement procedure triggered by monthly and quarterly reports.

No significant problems or delays have been encountered in managing the CRSP's affairs. The Business Office Director was complimentary of the CRSP Coordinator's effort in supplying timely reports and facilitating smooth operation of the project.

B. The Agricultural Administration (Vice President for Research and Services, Dean of the College and Director of the Experiment Station) was very positive about its commitment to the CRSP activity (past and future). It was stressed strongly that the Peanut CRSP fits tightly into the college and university missions. It was also stressed that fiscal support would be focused on peanut breeding and utilization, even if the CRSP were not funded by USAID, in the future. However, the nature of focus might be exclusively on Georgia.

Each of these key administrators felt that the CRSP had enhanced the institution's capacity in the international arena.

C. The Departmental visit revealed that the department head was strongly committed to the work of the CRSP. During the discussion several CRSP advantages were described: 1) access to a worldwide network of peanut researchers, 2) increased ability to attract and train international students, 3) the undergirding of the department's ongoing thrust in virus research (especially the tomato spotted virus) and 4) collaborative help with a crop of crucial importance to the State of Georgia. the Peanut CRSP states (GA, TX and NC) produce 80 percent of the U.S. peanut crop. Departmental capacity was said to be enhanced. Subsequent to the CRSP involvement, the department now has:

- access to a wider variety of peanut germplasm,
- ability to cross wild plants with available varieties,

- experience in perfecting certain genetic transfer techniques,
- experience in working with the tomato spotted virus, and
- built on unusually strong collaboration with Texas, North Carolina and Alabama.

D. The upper administration (Associate Vice President for International Development) demonstrated strong support for the CRSP and stressed a desire for continued support. A recent report by the office reflects a strong level of commitment by University of Georgia faculty for involvement in a broad range of international activity (Report to the President, 1993). The CRSP role along with Title XII initiative in enhancing faculty experience and commitment should not be underestimated.

Overall, the management team in Georgia was committed to the CRSP project. They were pleased with the CRSP Manager and general office operations. The only weakness described was a failure at the game of garnering a strong political footing in Washington, DC.

Management noted a few problems emanating from AID, which contributed to managerial frustrations. They were:

- High turnover among AID professionals who would work with the CRSP Coordinator.
- Discontinuity in program funding priorities.
- Change in project focus.
- Uncertainty about the future of CRSPs.

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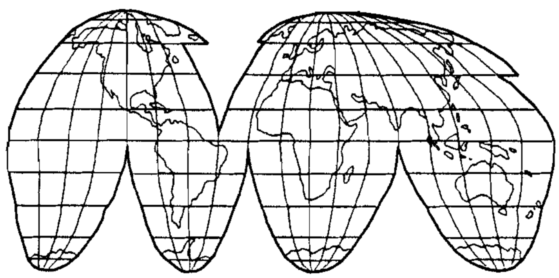
EXTERNAL EVALUATION PANEL

TRIP REPORTS

1993 - 1994



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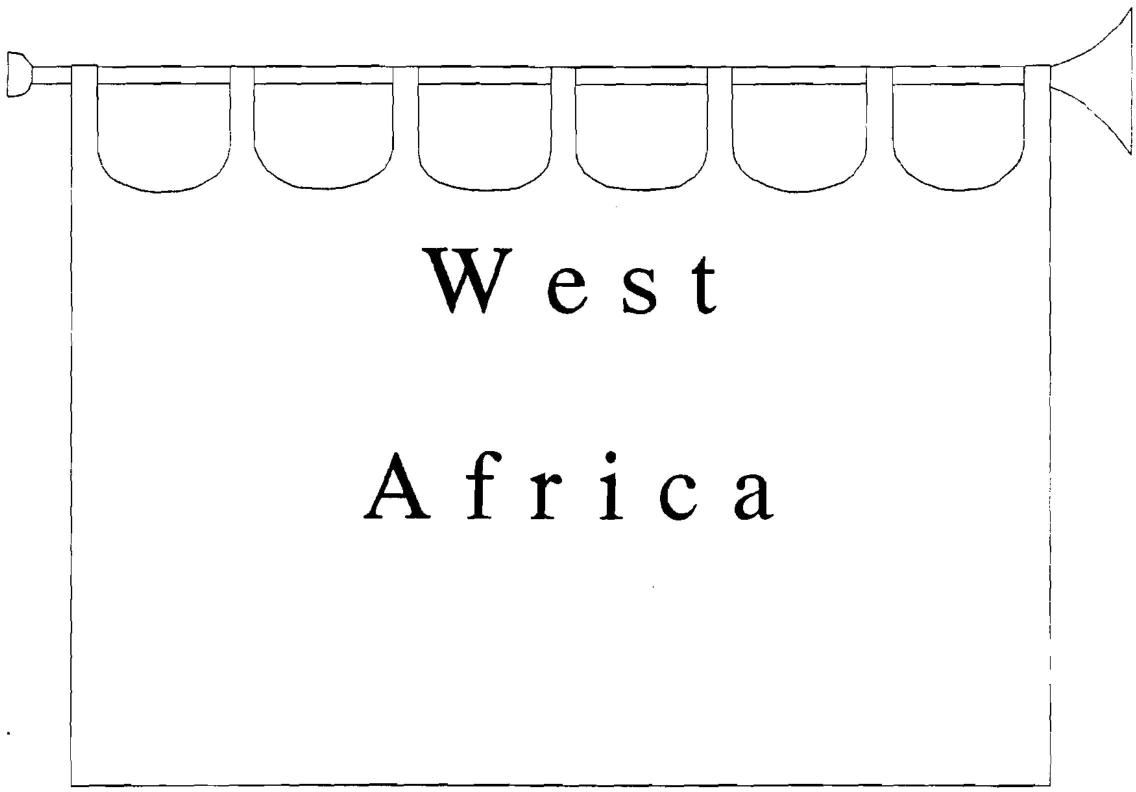
West
Africa

REPORT ON VISIT TO WEST AFRICA

NOVEMBER 1993

David Hsi
Member of EEP

NAAS/AJAS
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Albuquerque, New Mexico

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Preliminary Report on West Africa Visit
by David Hsi, Member of EEP

Peanut CRSP Code: TX/BCP/WA

Project Title: Disease-Resistant Peanut Varieties For Semi-Arid Environments

Principal Investigators and Collaborating Institutions and Countries:

O. D. Smith, Texas A&M University, USA
O. N'Doye, Institut Senegalais de Recherches Agricoles (ISRA), Senegal
M. Sanogo, Institut Economie Rurale (IER), Mali
P. Sankara, Universite de Ouagadougou/Institut Development Rurale (IDR), Burkina Faso
A. Mounkaila, Institut Nationale de Recherches Agronomique du Niger (INRAN)

Introduction

Major constraints to peanut production in West Africa include highly restrictive ecological zones with short growing seasons of annual rainfall, intermittent drought, soils with low moisture holding capacity and fertility, diseases, insects, nematodes and weeds. Production of the crop is relegated to small fields, and growers have very limited financial resources for crop production and protection. The development and utilization of improved varieties is the preferred and most efficient means of improving peanut production.

A previous extensive on-site review was made by EEP members in 1989. This evaluation report resulted from visits to Niger on November 4-6, 1993, by R. Schilling, D. Hsi, accompanied by D. Cummins, Program Director; to Burkina Faso on November 6-10 by H. Williamson, R. Schilling, D. Hsi, and D. Cummins; to Mali on November 10-13 by H. Williamson, R. Schilling, D. Hsi, and D. Cummins; and to Senegal on November 13-19, by H. Williamson, R. Schilling, and D. Hsi. While in Niger, the panel visited the ICRISAT Sahelien Center (ISC) in Sadore, near Niamey, and with two ICRISAT scientists, physiologist, J. H. Williams, and breeder, B. R. N'Tare. In all four countries, the panel visited with USAID Mission officials upon arrival and prior to departure of individual countries, and with institutional administrators of each country. They also visited research laboratories, field plots, and had extensive discussions with principal investigators and cooperators and representatives from various pertinent agencies. They also reviewed reports, contracted articles, and journal reprints provided by the host countries, Dr. Cummins, and USAID Missions.

1. Research Highlights

<u>Niger:</u> The panel, accompanied by A. Mounkaila, Niger Principal Investigator, visited the Bengou Research Station. The Station was recently enlarged with a new office and laboratory building and possesses an irrigation pump. Mr. Mounkaila is now in charge of that station. The station is wired for electricity but has not been connected to the main trunk line. The panel saw the plastic bags of harvested peanut plots laying on the ground because there is no storage facility for them. During the natural drying process, peanut pods from the test plots received unexpected late rain, thus their quality was deteriorating, as well as showing signs of insect infestation. Most of the test plots were advanced breeding lines derived from crosses made by Mr. Mounkaila during his six-month stay in Texas in 1989. The crosses were made to transfer genes for tolerance to drought stress and shorter growing season requirements to adaptable varieties. The advanced generation lines have not encountered severe natural rosette epidemic conditions to enable Mr. Mounkaila to screen them for rosette resistance. The

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panel advised him to send some of his promising materials to places such as Nigeria, for rosette resistance screening under artificially produced epidemics either in the greenhouse or in controlled field plots. With his additional responsibility as station chief, and with the untimely death of a young researcher, a capable technical assistant is urgently needed for the peanut improvement program in Niger. ICRISAT Sahelian Center (ISC) has been conducting their field testing at the Bengou Station for several years. They provided their own equipment and staff and transported the harvested materials back to their Sadore Center for processing and analysis. There were some interactions between ISC scientists and the INRAN investigator, but no apparent close collaboration.

Burkina Faso: The performance and adaptation of U. S. peanut lines and other introductions were evaluated at five test locations representing various ecological zones, primarily amounts of rainfall received. The panel visited the Gampela Station with Dr. Philippe Sankara, principal investigator of the host country. The test plots have already been harvested and stored in a good storage facility and are ready for weighing, processing, and grading analysis. The station is well equipped for research purposes. From the oral and written reports, more than 300 peanut lines have been tested, some of which proved to be good yielding lines adapted to the central and eastern parts of Burkina Faso, as compared to local checks. In the western part of the country, however, all the lines appeared to be very susceptible to foliar diseases (including early and late leaf spots and rusts) and to peanut green rosettes, soil borne diseases, and termites. Upon completion of tests at multiple locations, promising varieties will be subjected to final productivity evaluation under conditions of Benlate (fungicide) control of leaf spots at Bobo and Gampela. Excessive exchangeable aluminum content found in soil at the research site of Farakoba might be responsible for low peanut yield at that location, in addition to leaf diseases. A soil amendment test using three cultivars (RMP12, QH243C, TS32-1) under five treatments (gypsum, phosphate, gypsum plus phosphate, ash and control) showed that application of ash increased yields for two of the three cultivars. A number of lines showing resistance to rust and leaf spot were identified. Some of them were given to the peanut breeding program of INERA. Low prevalence of soil borne pathogens prevented effective screening for resistance to soil borne diseases. Peanut rosette screening is being conducted at Niangoloko and involved 161 F_3 lines. Methods for field scoring used in Nigeria are adapted for field evaluation in Burkina Faso. Dr. Sankara hopes to identify some resistant and early maturing materials in the near future.

Mali: New varieties from Senegal, Burkina Faso, ISC, and Texas A&M were introduced and evaluated at four locations in Mali for resistance to foliar diseases and adaptation to different agro ecological zones. The four test sites are located at Kayes-Same, Kita, Sotuba, and Cinzana, where average annual rainfall measures 700, 1,000, 900, and 600 mm, respectively. In addition, 129 ecotypes or land races from Mali with different maturity periods were also compared and evaluated for tolerance to leaf spots. After having identified the promising materials resistant to Cercospora leaf spot, a crossing program involving these lines and locally adaptable varieties will be initiated and their progenies screened for disease resistance. The panel visited one of the test locations, the Cinzana station, where a varietal trial was conducted, as well as seed of desirable varieties being multiplied and stored. Moussa Daouda Sanogo recently replaced Dielimoussa Soumano and is now in charge of peanut improvement and stationed at Kayes-Same. Sadio Traore, agronomist, remains responsible for agronomic aspects of peanut program. Several technicians are also assisting the peanut research.

Senegal: A number of oil and edible varieties and selections were evaluated in tests at three locations representing different agro-ecological zones. Tests at Bambey Station have already been harvested and stored. The panel, accompanied by host country breeder, Ousmane N'Doye, visited the Nioro Station. While enroute, they saw peanut plants being plowed up for harvesting and peanut pods being threshed from already dried and cured peanut stacks. The peanut plots at Nioro have just been harvested and are being dried in bundles rested on boards raised several feet above ground level to prevent insect and rodent damage. Mr. N'Doye is assisted by an experienced, capable technician who assisted Dr. Robert Schilling, one of the panel members, nearly 20 years ago at a nearby station when Dr. Schilling was conducting peanut research in Senegal. The panel stayed at Bambey Station for two nights and was briefed by the location scientists of several disciplines on their research on physiology, post-harvest technology, agronomy, and plant protection.

2. Research Management

In this Peanut CRSP project, researchers with the Texas A&M University are collaborating with their counterparts who are employed by the government organizations of three of the four host countries and by the University in the only remaining country.

Niger: The panel met and visited with Dr. Mahamadon Ouattara, the new Director General of INRAN. Dr. Ouattara received his advanced training in the U. S. and was very supportive of the Peanut CRSP project and in favor of a possible inter-CRSP linkage and subsequent establishment of a joint project in Niger. Mr. Amadou Mounkaila has been the collaborator since the project's inception. He spent a six-month research and study leave at Texas A&M in 1989 and attended several international conferences. As stated previously, with his additional responsibility as Chief of the Bengou Station, Mr. Mounkaila needs someone to assist him with the peanut research program. There were some interactions between INRAN's researcher and scientists with the ICRISAT Sahelian Center and their research seemed to be complementary to each other, even without formal collaboration.

Burkina Faso: The panel spent considerable time with Dr. Philippe Sankara, the host country collaborator, on this project. In addition to being the Professor of Plant Pathology at the IDR of the University of Ouagadoukou, Dr. Sankara is also the research coordinator for CNRST of the government. He gave an excellent oral and written report about his research and intended to collaborate with Dr. Diolier Balma of INERA (National Program) for breeding and on-farm trials. He also collaborated with researchers in other CRSP supported projects. Dr. Sankara received good support from Dr. Alfred Traore, the new Rector of the University and the Collaborator of AAMU/FT/BF CRSP project. He has a number of students and technicians to assist him with his experiments at five locations.

Mali: In their visit with Dr. Oumar Niangado, Director General of IER and with Dr. Tim Schilling, a U. S. scientist who is the location leader for a large Texas A&M project funded by USAID and an advisor to IER, extensive reorganization of IER is underway in Mali. All projects funded by 23 International Donor Programs, including Peanut CRSP, will be administered by a newly formed National Science Foundation. The basic operation and objectives of TX/BCP/WA will remain essentially the same. The change only affects the host country upper level administration. In recent years, Mali has received considerable funding from outside donors. For instance, the Cinzana Station where the panel visited and stayed overnight, received funding support from USAID, EEC, CIRAD, and Ciba-Geigy, in addition to their own government. Hopefully, the extensive restructuring will improve efficiency in management and thus increase research output. The main peanut research activities will be moved to Kayes-Same, which is located northwest of Niamey and close to the Senegal border. The previous collaborator, Mr. Dielimoussa Soumano, who received extensive training at Texas A&M, has decided to work on cotton research and has left the peanut program. He is replaced by Mr. Moussa Sanogo. Mr. Sadio Traore, an agronomist who previously worked with Mr. Soumano, will now collaborate with Mr. Sanogo. Both of them will now be stationed at Kayes-Same.

Senegal: The panel had an opportunity to visit with Dr. Mahamodou Ly, Director General of ISRA, toward the end of their stay in Senegal. Dr. Ly understood the importance of international collaboration and the contribution made by the CRSP project. He told us that the Banbey Station is being expanded by adding scientists transferred from outlying stations. This includes Mr. Ousmane N'Doye, who has been stationed at the Nioro Station. The Bambey Station is also being extensively remodeled to meet the needs of refined laboratory analysis, physiological studies, disease screening, and plant protection. The administrator for the Bambey Station is Dr. Amadou Ba, co-collaborator on the mycotoxin project (TX/MM/S) and coordinator of the CORAF Peanut Network for eight countries in West Africa. Three senior scientists and two student volunteers at the Bambey Station are from France and their salaries are paid by CIRAD of the French government.

3. Research Accomplishments

Niger: Advanced generation lines from crosses made by Mr. A. Mounkaila at Texas A&M in the U. S. in 1989 are being evaluated for potential new varieties for Niger. The main peanut research of INRAN is now at the Bengou Station where ISC is also conducting their research plots. This will lead to more collaboration and increased research output.

Burkina Faso: Several good yielding lines adaptable to the central and eastern parts of the country have been identified. Application of ash increased yields at the peanut research sites of Farakoba where exchangeable aluminum content was excessive, accompanied by high acidity. A booklet summarizing several years of peanut varietal trials will be completed by the end of 1993. A number of lines showing resistance to rust and leaf spot were identified, some of which were given to INERA for use in their breeding program.

Mali: Several varieties were found to be tolerant to Cercospora leaf spot and to drought. Pure seed of desirable varieties have been multiplied. Main peanut research of IER is now located at Kayes-Same Station.

Senegal: PC 79-79 (oil type) and H75-0 (edible type) have shown considerable yield advantage over the check varieties. Some introduced lines showed lower leaf spot scores than the checks. Fleur 11, a newly released variety derived from a 90-day Chinese peanut line (PI 1174), with assistance from Peanut CRSP, consistently produced about 25% higher pod yields in several locations in Senegal, as compared with the local varieties. The main peanut research activities are now located at the Bambey Station.

4. Training Accomplishments

M. S. degree for Ousmane N'Doye (Senegal) at Texas A&M
M. S. and Ph.D. for Mahama Ouedraogo (Burkina Faso) at Texas A&M
Short term training and international meetings for scientists from all four host countries in WA

5. Observations

High degree of expertise and sound scientific approaches were apparent from the collaborative research programs.

The unsettled national economies, overall annual reduction in rainfall and a shortening of the useful duration of the growing season affected the research outcome and psychological stability of the researchers in the host countries.

Maximum returns from the Peanut CRSP monetary investments appear to be in Burkina Faso and Senegal. However, the potential of greater research accomplishments are possible in Niger and Mali with closer collaboration with ISC and other CRSP projects, and with an expanded/multidisciplinary project.

6. Recommendations

Niger: Addition of a capable researcher for the peanut program. Closer cooperation with ISC and with neighboring countries, especially with Nigeria on rosette screening.

Burkina Faso: Further development of the University of Ouadadougo into a regional training center for students and technicians. Closer cooperation between university scientists of ISP and government scientists of INERA.

Mali: Hoping that the successful outcome of restructuring of IER will result in greater research output. Advanced training of the new collaborator, Mr. M. Sanogo, in the U. S. may be desirable.

Senegal: Ph.D. training program for O. N'Doye.

The panel supports another five-year extension of this CRSP project because breeding is a long term proposition and also because some of the research funding are reaching application stage to be of greatest benefit to the host countries. Expanded, multidisiplinary efforts in Niger and Mali would be desirable to maximize impacts on the peanut industry.

Peanut CRSP Code: TX/MM/S,G

Project Title: Mycotoxin Management in Peanut by Prevention of Contamination and Monitoring

Principal Investigators and Collaborating Institutions and Countries:
M. N. Beremand, Texas A&M University, USA
N. P. Keller, Texas A&M University, USA
T. D. Phillips, Texas A&M University, USA
A. Ba, Institut Senegalais de Recherches Agricoles, Senegal
A. Kane, Institut de Technologie Alimentaire, Senegal
R. T. Awuah, University of Science and Technology, Ghana
K. Kpodo, Food Research Institute, Ghana

Introductions

Mycotoxin contamination of peanut poses a serious health hazard to consumers of peanut products throughout the world. Peanuts contaminated by aflatoxin above certain minute levels cannot be accepted on the international markets. Selecting peanut germplasm with resistance to aflatoxin production, improving agronomic production practices and post-harvest technology are some of the approaches suggested for the host countries to reduce levels of contamination. The development of rapid, practical, and economical monitoring procedures for mycotoxin detection and detoxifying protocols for mycotoxin removal or deactivation within peanut products will also be helpful to alleviate this serious problem for the peanut industry.

While in Senegal, the panel visited with Dr. Amadou Ba of ISRA about his research on mycotoxin management in peanut and with Dr. Amadou Kane of ITA about his plan for research on mycotoxin detection and detoxification. The panel did not visit Ghana on this trip (see Dr. Cherry's report on a later visit to Ghana). The panel also visited the officials at the USAID Mission office, and were accompanied by Dr. Ba at the first visit and by Drs. Ba and Kane at the second and exit visit. The Mission officials were not pleased with the decision by Dr. A. F. Sarr to remain in the U. S. for a post-doctoral appointment in Dr. T. D. Phillips lab at Texas A&M and expressed strongly their displeasure that mycotoxin research in Senegal, especially that on the aflatoxin removal by clay particles devised by Drs. Phillips and Sarr might be affected or even interrupted. Both Drs. Ba and Kane assured the USAID Mission that mycotoxin research will be continued without interruption and that the government of Senegal places a great deal of emphasis on peanut mycotoxin management research.

1. Research Highlights

One series of experiments was conducted from 1990 to 1991 for the purpose of finding an effective method of artificial inoculation of Aspergillus flavus fungal propagules for varietal screening under field plot conditions. The experiments included three varieties and consisted of plant soil spraying with a conidial suspension of A. flavus at 30, 45, 60, and 75 days after sowing.

Cultivar susceptibility influenced the soil content of A. flavus propagules. Artificial row sprayings with A. flavus conidial suspension at 30 and 45 days after sowing resulted in higher contamination levels of pods and seeds than those sprayed at 60 and 75 days after sowing. The pegging period is most likely a decisive stage for peanut susceptibility to preharvest contamination by A. flavus.

Another series of experiments was carried out from 1990 to 1992 in collaboration with ISC for evaluating selected peanut lines with regard to A. flavus infestation in field conditions. The percent of seed colonization was determined by incubating surface sterilized seed of different genotypes in petri dishes on filter paper, moistened daily with 10 ml of sterile distilled water for 7-8 days. There were

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differences in contamination levels between the various lines tested with some lines showing lower levels of infestation by A. flavus.

2. Research Management

Two PIs, Drs. Marian Beremand and Nancy Keller, with the Department of Plant Pathology and Microbiology and one P. I., Dr. Timothy Phillips, with the Department of Veterinary Public Health of Texas A&M University are collaborating with Dr. Amadou Ba of ISRA and Dr. Amadou Kane of ITA in Senegal and recently with Dr. Richard Awuah of the University of Science and Technology and Mrs. Kafui Kpodo of the food Research Institute in Ghana. Drs. Beremand and Keller have replaced Dr. Robert Pettit who has retired from Texas A&M. The revised research proposal includes components of basic molecular biology research.

The panel visited with the Director General of ISRA, Dr. Mohamadouh Ly, and the Deputy Director General of ITA. They also visited the remodeled lab for mycotoxin work at the Bambey Station and the mycotoxin lab at the Institute for Food Research.

3. Research Accomplishments

Cultivar 77-33 appeared to be more infected than cultivars 55-437 and 73-20 under spray-inoculation conditions in the field. Cultivar susceptibility may influence the soil content of A. flavus propagules. Spraying plants at pegging resulted in the most infection. This could be associated with millipede damage which suggests the need for IPM systems in preventing peanut preharvest contamination with A. flavus.

Advanced lines from resistant parents ICGV 87084, ICGV 87094, and ICGV 87110 showed variable contamination levels and the cultivars JL 24, TS 32-1, Var 27 and ICGV 87101 appeared to be the most susceptible to A. flavus contamination. The multilocational test in Senegal, Niger, and Burkina, as proposed by ISC, will make it possible to test the performance of peanut genotypes for several growing conditions and could help improve exchange material between western African research institutions.

4. Training Accomplishments

Ph.D. degree, A. Bachir Sarr (Senegal), Texas A&M University, USA
Ph.D. degree, Julius Fajardo (Philippines), Texas A&M University, USA
Drs. Awuah (Ghana) and Ba (Senegal) visited with scientists in the Peanut CRSP Programs at Texas A&M and attended the APRES meeting in Huntsville, AL.

5. Observations

High degree of expertise and sound scientific approaches were apparent from the collaborative research programs. Oil detoxification techniques developed by this CRSP project will be useful at farmer's level. Socioeconomic studies will be made to assess the oil detoxification process at village level and cost of the process.

Mycotoxin research will be carried on by Drs. Ba and Kane in Senegal even without the return of Dr. Sarr to his native country.

6. Recommendation

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Short term training for Dr. Amadou Kane at Dr. Phillips' Lab at Texas A&M to learn the rapid detection of aflatoxin levels in test samples and to observe fundamental molecular biology research conducted by Drs. Beremand and Keller.

Repair and update laboratory equipment for mycotoxin research at ITA in Senegal.

More interdisciplinary approach in newly equipped laboratories at the expanded Bambey Research Center.

Recommend another five-year extension of this expanded project.

Project CRSP Code: GA/IM/BF

Project Title: IPM Strategies for Peanut Insects in SAT Africa

Principal Investigators and Collaborating Institutions and Countries:
R. E. Lynch, USDA/University of Georgia, USA
P. A. Ouedraogo, University of Ouagadougou, Burkina Faso

Introduction

Attainment of stable, sustainable food production in SAT Africa requires cooperative research aimed at improving cropping procedures, developing better crop varieties, and improved methods for control of insects and diseases. Arthropod pests are a major detriment to stable food production and have been estimated to reduce yield or destroy over 30% of the food produced. Equally important to direct losses caused by arthropod injury are the plant pathogens that they transmit or exacerbate. Rosette transmitted by the peanut aphid and enhanced contamination of peanut seed with Aspergillus flavus and aflatoxin as a result of termite injury are two of the most important insect-pathogen relationships in West Africa.

A coordinated, interdisciplinary approach to research integrating entomology, plant pathology, agronomy, and plant breeding will be required to attain the goal of stabilized good production in West Africa. The research must develop systems of food production that are compatible with the socioeconomic framework of the developing nations and are sustainable. In entomology, plant resistance to insect pests such as termites and aphid-transmitted rosette, control of pests with indigenous products, and reduction of aflatoxin contamination of peanut through cultural practices and plant resistance are compatible with these guidelines.

The panel had an extensive visit with Dr. P. A. Ouedraogo and other host country collaborators. They also visited his field plots at Gampela and his entomology laboratory at the University. They received from host country investigators their extensive research plans of the 1993 experiments and excellent oral and written reports from Dr. Ouedraogo.

1. Research Highlights

Upon the completion of a survey of peanut arthropod pests at six locations in Burkina Faso, experiments on influence of different cultural practices and local varieties on insect damages and evaluation of U. S. germplasm and local varieties for susceptibility to insect damage were conducted and completed from 1984 to 1986. Experiments on chemical control of peanut arthropods and their effects on peanut yield, evaluation of international peanut varieties for pest resistance and control of peanut arthropods with neem-insecticide have been conducted at the Gampela Station from 1985 to 1990.

The experiments which began at different times and which are still in progress include effect of harvest date on termite and millipede damage and aflatoxin contamination, influence of plant population on the relative abundance of peanut insects and associated diseases, evaluation of the most promising peanut lines from ICRISAT for termite resistance, the effect of depth of preplant tillage on termite damage to peanut pods, performance evaluation of insect pest resistant selections developed at ICRISAT under different agroclimatic conditions and production systems, identification of lines with better adaptability and stability for the next cycle of crossing programs, and evaluation of NCAC-343 progenies for resistance to termite and other insects.

2. Research Management

Dr. Robert E. Lynch of the U. S. Department of Agriculture and the University of Georgia has been collaborating with Drs. P. A. Ouedraogo and Idrissa Dicko of the University of Ouagadougou since 1984. The research team at the University of Ouagadougou has been expanded to include Dr. Salido Some, an agronomist, to include agronomic interests and to form a bridge between the entomology and plant pathology projects conducted by the University.

3. Research Accomplishments

The major economic arthropod pests of peanuts have been identified. This project also helped to develop reliable sampling procedures to estimate population density of the major pests and also to determine arthropod abundance as related to peanut developmental phenology and season. Research has shown that preharvest damage to peanut pods by termites exacerbates aflatoxin contamination of peanut seed. Germplasm with resistance to termites has been identified and cooperative research with the Texas A&M Peanut CRSP Breeding Project has been initiated to evaluate progenies from crosses with the resistant germplasm for termite and aflatoxin resistance.

At Gampela, thrips damage and defoliation by lepidopterous larvae to peanut declined with increase in plant population. Control of insects with insecticides increased yield by 900-1550 kg/ha.

Termite damage to peanut pods increased with an increase in days to harvest at both Gampela and Farakoba. Evaluation of the influence of soil moisture on termite damage showed that the percentage of externally damaged pods and penetrated pods increased as soil moisture decreased. The number of termite damaged plants decreased with increase in tillage depth. However, tillage depth did not affect the percentage of undamaged pods, scarified pods, or penetrated pods.

4. Training Accomplishments

Ph.D., Solibo J. A. Some, University of Georgia, USA (Former project collaborator, AID mission supported training, maintained CRSP linkage).

The following students at the University of Ouagadougou work on research conducted by the Peanut CRSP and utilize the data for papers, as required by their curriculum for graduation.

Hubert Bathomo	5th cycle
Hamado Tapsoba	5th cycle
Karim Traore	5th cycle
Hamado Sawadago	5th cycle
Antoine Sanon	3rd cycle
Issoufou Ouedraogo	3rd cycle

Short-term training in the U. S. - Mr. Olle Kam, assistant in the Peanut CRSP entomology Project in Burkina Faso, spent two weeks in the Mycotoxin Laboratory, University of Georgia, Coastal Plain Experiment Station, receiving training in aflatoxin analysis, using the Vicam Elisa aflatoxin analysis system.

Nine-month training was received by the following students at the University of Ouagadougou since 1989, not including those students already mentioned:

Daouda Thiam	1989
Adama Zare	1993

The Peanut CRSP project provided funds for equipping the Entomology Laboratory and miscellaneous supplies used for training students at the University.

5. Observations

This project, like the Peanut CRSP Food Technology Project, has achieved outstanding results in teaching, research, and student training. The collaboration between the scientists and administrators of the University of Georgia and their counterparts at the University of Ouagadougou was excellent and thus responsible for the successful outcome. We can foresee more accomplishments and practical benefits in future years. We also believe that this project will continue to contribute to solving food security problems by improving peanut yield and quality of peanut products and by reducing losses from insect pests.

6. Recommendations

Continued strong support for this Peanut CRSP project and recommend another five year extension.

Continued interdisciplinary approach between this project and other Peanut CRSP projects in West Africa.

Eventual development of the University of Ouagadougou into a Regional Training Center for several important disciplines.

Peanut CRSP Code: AAMU/FT/BF,G

Project Title: An Interdisciplinary approach to Optimum Food Utility of the Peanut SAT (Semi-Arid Tropic) Africa

Principal Investigators and Collaborating Institutions and Countries:

M. E. Castell-Perez, Alabama A&M University, USA
J. L. Anderson, Alabama A&M University, USA
A. S. Traore, University of Ouagadougou, Burkina Faso
K. Kpodo, food Research Institute, Ghana
W. A. Plahar, food Research Institute, Ghana

Introduction

Major constraints to maximum utilization of peanuts and peanut products include short shelf life and quality deterioration, under utilization of peanut flour and aflatoxin contamination resulting from poor storage conditions, improper post harvest handling, and inventory management. This project is designed to increase utilization of peanuts into more refined/processed forms, to improve packaging of peanuts and peanut products for commercial markets and longer shelf life, to utilize peanut flour (after extraction of oil) to increase protein value of cereal-based food and to reduce aflatoxin contamination by improving method of storage, post harvest handling, and inventory management.

The panel visited with Dr. Alfred S. Traore, host country PI of this project and Rector of the University, in addition to being Professor of Biochemistry and food Science. They also received oral and written reports of his excellent research. They have visited his laboratory with the presence of many of his graduate students and saw the displayed samples of food products developed from the utilization research. The panel did not visit Ghana on this trip. (see Dr. Cherry's report on later visit to Ghana)

1. Research Highlights

Significant variations in protein, fats, carbohydrates, free fatty acids content existed in samples of peanuts and peanut products of local peanut cultivars and lines introduced from Texas A&M. Aflatoxin was detected in almost all samples, however, the amount was usually less than 20 ppb. Peanut pastes prepared by traditional methods on the farms or at the village level had more aflatoxins and microbial contaminations than those prepared by industrial methods. A cereal-based staple food (idli) with higher peanut-fortified protein content was developed without drastically affecting its textural properties.

A packaging material suitable for the marketing of peanut paste is being developed and to be manufactured by a local factory (CITEC-HUILERIE) in Burkina Faso.

A research study is conducted on the fortification of staple foods, such as "toe" with peanut proteins. The physical, nutritional, and organoleptic properties of the supplemented flour (sorghum/defatted peanut) were being analyzed.

Encouraging results were obtained from using an extract of Allium sativum for growth inhibition of a strain of Aspergillus flavus. The proper method of application of the extract to the peanuts during storage still needs to be determined. A biocontrol method using local plant extract would could have a wide impact.

2. Research Management

Drs. M. Elena Castell-Perez and John C. Anderson, with the Department of Food Science of the Alabama A&M University, are collaborating with Dr. Alfred Traore, Professor of Biochemistry and Food Science and Rector of the University of Ougadougou. Dr. Castell-Perez has done an outstanding job in taking over the research in 1992, following the tragic and untimely death of Dr. Bharat Singh. The project was recently extended for collaboration with Mrs. Kafui Kpodo and Dr. Wisdom A. Plahar of Ghana's food Research Institute for improvement of post-harvest operations and utilization of peanuts.

Following the APRES meeting in Alabama in July, the three panel members on this host country visit had an opportunity to visit the well equipped food research laboratories at Alabama A&M University and to be informed of their ongoing research. The other four panel members who were not on this trip to West Africa but were in attendance at the APRES meeting, and at the organizational meeting of EEP in July, also had visited this CRSP Project conducted at Alabama A&M University.

3. Research Accomplishments

Results from this project have made local people more aware of the importance of hygiene of peanut-based products. Improved packaging of peanut-based products is now commonly practiced in Burkina Faso. Increased consumption of new peanut products, such as roasted and boiled peanut seed (Marba-tigue), roasted partially defatted peanut paste (Coura-coura), and non-defatted peanut paste (Tigue-tigue). The CITEC-HUILERIE oil factory has been reactivated because of the development of an improved packing process, thus enhancing peanut paste consumption and maintaining employment at a time of economic depression.

4. Training Accomplishments

M. S. Degree in Food Science, Ashok Mishra, Alabama A&M, USA Doctorate in Food Science, Philippe Nikiema, University of Ouagadougou Doctorate in Food Science, Rubin Simdt, University of Ouagadougou Doctorate in Food Science, Simean Nanema, University of Ouagadougou.

Many undergraduate students from neighboring countries are being trained at the University of Ouagadougou.

The equipment to the food science laboratory provided by funds from the Peanut CRSP project has been very useful in training students in food science and technology. There are needs for more trained people in food chemistry, food microbiology, human nutrition, and protein engineering. All the graduates from the University have been placed in suitable employment at various locations in West Africa.

5. Observations

This project has achieved excellent results in teaching, research, and education (extension). This is in a large part due to the outstanding collaboration between the scientists and administrators of the Alabama A&M University and their counterparts at the University of Ouadadougou. The panel admired Dr. Traore for his capable leadership and inspiring dedication to research and education. In spite of his high administrative position, he is still devoting considerable time in biochemistry and food science research. His exemplifying behavior is contagious to his colleagues and young aspiring scientists. We can foresee even greater accomplishments in future years and the University of Ouagadougou assuming the role of a regional training center in several disciplines for countries in West Africa.

6. Recommendations

Continued strong support for this Peanut CRSP project and recommend another five year extension.

Continued interdisciplinary approach between this project and TX/MM/BF,G in the areas of improvement of post-harvest technology and reduction of mycotoxin contamination, particularly the biocontrol methodology.

Closer collaboration between researchers in Burkina Faso and Ghana through the common linkages with AAMU and TAMU.

The University of Ouagadougou has a unique opportunity to impact the country and region in food technology in both development of improved processing, handling, and use and in training of students.

REPORT ON VISIT TO WEST AFRICA

OCTOBER 25 - NOVEMBER 11, 1994

Robert Schilling
Member of EEP

CIRAD-CA
Montpellier, France

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A MAJOR CONSTRAINT TO PEANUT PRODUCTION IN WEST AFRICA:

Seed Production and Distribution

1. Groundnut Multiplication: Basic Biological Data

Availability of sufficient quantities of quality plant material is a basic element in groundnut productivity and production. As shelled yield is 70% and seed yield 50%, 100 to 150 kg (according to variety) of unshelled groundnut is required per hectare for sowing at the densities recommended in West Africa. Yields of traditional cropping are generally less that 1 ton per hectare, groundnut seed multiplication rate is rarely more than 8 and investment in seed is always a serious constraint for farmers, researchers, and development officials.

Groundnut seed is delicate, bulky, sensitive to heat and moisture, exposed to a range of pests and also capable of transmitting certain virus diseases. Seed production, storage, control and transport therefore raises delicate problems at all levels.

From the genetic point of view, practically strict autogamy leads to several favorable features for breeders. Natural populations are made up of a mosaic of stable types. Mother-plants can be used for identical reproduction but no improvement is possible in the progeny. This facilitates the maintaining of pure lines and seed multiplication. In the tried and tested system used in Senegal, research stations produced small quantities of pure seed which the extension services distributed to contracted farmers. The latter multiplied the seed within the framework of a careful schedule managed by a specialized seed department.

2. Varietal Improvement of Groundnut in West Africa: General Situation

Groundnut breading has been carried out for several decades at three main centers: Bambey, Senegal, a dry savannah site, Niangoloko, Burkina Faso, a humid savannah site, and Samaru, Nigeria, which, with its substations, can cover a broad range of pedo-climatic conditions. The ICRISAT regional center in Niamey was opened in 1982. The groundnut network of the Conference for Representatives of Agricultural Research in Africa (CORAF) was formed in 1987, grouping seventeen African research institutes for associated programs with a coordinator based in Bambey, the network center. Peanut CRSP contributed significant support from 1982 onwards.

Ongoing breeding programs are aimed at meeting four types of constraints for development of the crop in West Africa identified at a Groundnut Network workshop on varietal improvement (Dakar, 1988):

a) Nutritional and agrofood constraints, the two main ones being: aflatoxin contamination, market standards for groundnut for direct consumption.
b) Climatic constraints including: drought (lack of rainfall or poor distribution),temperature, a limiting factor in temperate or highland zones and cold or hot off seasons, specific problems in regions with two rainy seasons.
c) Constraints related to fungal and viral diseases (Cercospora, rust, rosette).
d) Constraints affecting soil fertility (aluminum and manganese toxicity, salinity). Several thousand groundnut varieties are held in the collections at the various West African centers. Exchanges between NARS are rare, fortuitous and not usually monitored; there are frequent, undetectable multiple denominations because of lack of reliable genealogical data and a harmonized codification system. The varieties extended to a certain degree in CORAF countries (mainly francophone to date) are listed in Table 1 with their principal characteristics.. Creation in

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countries which are not CORAF members (especially Nigeria) should be added. ICRISAT and Peanut CRSP varieties are still being tested in West Africa.

The genetic capital available is rich and varied, but not always made available to farmers or even researchers. It is likely to meet West African local demand in most situations, even if many problems remain to be solved, especially concerning tolerance to drought, aflatoxin and major diseases. Introductions from other African regions or other continents are performed by ICRISAT, within the frame work of various cooperation projects and also by poorly controlled pathways (private initiative, food aid, NGOs). Recording, sorting and multi-site testing of this material - undertaken separately by various multilateral projects - is encountering problems of logistics and regulation, as well as scientific and technical coordination.

3. Production of Basic Seed and the Role of Researchers

Extremely strict appraisal of varieties may finally lead to a decision to distribute them. Multiplication work is variable and poorly codified in West Africa: roughly the following procedure is used but only satisfactorily in Senegal, the other countries seldom going beyond declarations of intents and general policy with very low levels of implementation.

Any creation with an interesting feature and which is an improvement on existing cultivars must be conserved at research stations level. This is the role of the "live collections" to be managed in parallel with gene banks. Live collections are often very bulky and can be kept in cold stores for several years to avoid having to resow the material every season. Only ICRISAT Sahelian Centre in Niamey disposes of these facilities.

When the local varietal commission has decided to use a variety proposed by researchers, the grower or possibly the research center concerned must provide the breeder seed. The station initially possesses a line or small quantity of homogeneous seed. Successive controlled multiplication operations are performed under conditions providing guarantee of genotype purity to produce foundation seed in two or three stages.:

a) The principle is to maintain a "genetic core" at all times. This consists of a minimum of 100 plants (over 1000 according to requirements) sown in one row per plant chosen for good representation of the variety, state of health, productivity, etc. Purity is strictly monitored during growth and at harvesting, with attention paid to phenotype features. Any dubious element is discarded and fresh choice made to reconstitute the genetic core. This phase of multiplication leads to seed referred to as "foundation" ("souche" or "prebase" in French), and which is rarely distributed except to other research institutes which can ensure rigorous maintenance of purity.
b) Foundation seed is produced from bulk seed according to the requirements of multiplication establishments once the "genetic core" has been set aside. Given the low multiplication capability of groundnut, this is performed in one, two, or three successive phases but still at the research station or farm with all the monitoring facilities required and where crops can be properly maintained, processed and stored under good conditions.

This type of seed is sometimes referred to internationally as elite or registered seed; purity should be over 99%.

4. Organization of Seed Production: The Example of Senegal

Very poor use is made of achievements in groundnut breeding in the region. Effective use by farmers of selected plant material is extremely limited - with the exception of Senegal - for lack of rational organization of the seed sector based on strong links between research and development.

Senegal national seed requirements were met almost completely until recent years by a state organization. This success (whose technical basis can be extrapolated to all African peanut producer countries) is based on the establishment by IRHO in 1972 of a research and development framework which maintained a seed "capital" derived from first generation seed provided in very small quantities by breeders. Senegal is thus the only country in West Africa to have maintained the area planted with peanut in spite of lasting drought and has become on the world's leading peanut oil exporter. It has also exported large amounts of seed to countries whose production has sometimes plummeted dramatically, necessitating large imports of edible oil and the mothballing of extraction industries.

The new agricultural policy which has come into force recently is based on reduction of the state intervention and partial retrocession of seed capital to the private sector and the farmers themselves. This liberalization, supported by USAID, requires the supplying of excellent quality plant material for the seed programs and strict control of a centrally managed "emergency seed capital" to be used in case of shortage and for replacement of seed. Simultaneously, strong research emphases should be given in the field on on-farm (or private) seed production storage or control.

5. Conclusion: A Deadlock Situation

USAID was aware of the problem of peanut seed availability and has financed actions of seed multiplication (including control laboratories) in the past in Burkina Faso. These actions have been interrupted in the early eighties, creating a gap between research activity in charge of foundation seed production and extension services in charge of seed distribution. this gap, which have never been filled, is experienced today as a major constraint to crop development and improvement. A similar situation is met in Niger since the Seed multiplication scheme financed by France ceased activity in 1981; the Senegalese privatization policy has resulted, from 1985 to 1993, in a dramatic reduction of seed release which has not been compensated by the hoped-for intervention of the private sector nor by a significant effort in favor in on-farm production and storage. The present situation of confusion and shortage could end up in a very severe reduction of plantings if a drought spell were to occur again in the region.

TABLE 1

Characteristics of the main groundnut varieties distributed in Francophone West Africa

	Precocity >100 days	Dormancy	Drought tolerance	Rosette tolerance	Shelling >70%	100 seed weight>50g	Edible/ confect.types
55-437	X		X		X		X
73-30		X	X		X		
47-10	X				X		X
Te 3	X		X				
Ts 32-1	X		X				
KH-149 A	X			X			
KH 241 D	X			X			
55-422		X			X	X	X
73-33		X	X		X	X	
28-206		X			X		
69-101		X		X	X		
57-313		X		X	X		
RMP 12		X		X	X	X	
GH119-20		X				X	X
756 A		X				X	X
73-27		X			X	X	X
73-28		X			X	X	X

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Peanut Post Harvest Technology: Situation and Needs in West Africa

1. Position of the Problem

Post harvest technology of peanut, under West African cropping conditions, covers two main fields of application:

- Traditional uses of peanut as a constituent or household on artisanal preparations (nuts and kernels boiled or roasted, peanut paste and butter, flour, candies and diverse food preparations). This sector, of major importance especially in countries where peanut is dominantly a locally consumed food crop, is well addressed by project AAM/FT/BF.
- Technologies which enable both high quality seeds and high-quality edible nuts and kernels to be obtained, especially in countries where peanut is a marketable crop and where seed multiplication and edible nut production are undertaken on a rational bases for the national or sub-regional markets. At present, only Senegal and (to some extent) Burkina Faso have attained this level. The trend in Senegal (with pressure from USAID) being to shift from a State-managed seed multiplication scheme to partial on-farm and private seed production, therefore special attention should be given to these aspects.

2. The Regional Edible Peanut Sector

In Africa, less than half of the production is crushed for oil. The major part goes to self-consumption or is sold on local, national or regional markets under various forms. Only Senegal exports very small quantities on the international market.

Crop techniques present specific aspects as regards varieties, sowing, tillage and harvest, crop protection, fertilization and even irrigation when it can be applied. These aspects are studied by ISRA in Senegal, with support from France and EEC. Post harvest operations at the farm (drying and threshing in particular) have a considerable effect on quality; primary marketing, transport and storage before processing require special organization and numerous checks, so that quality can be maintained. The following operations are carried out in succession, the purpose being to obtain whole kernels with their testa intact, uniform shape, size and color without insect or fungal damage: cleaning, shelling, calibration, sorting, packing, and storing. Quality checks should be carried out at various stages of the process. Manufacture of more sophisticated products such as peanut butter or paste, at a semi-industrial level adapted to local demand, requires more elaborate technology including blanching, removing the embryo and aflatoxin control. The only research program in West Africa besides Peanut CRSP covering some of these aspects is located in Senegal, with insufficient funding and scientific back-up.

3. Improved Seed Technology

3.1 The current situation

The quantities of peanut seeds required for sowing are most considerable: 100 to 150 kg unshelled per hectare, depending on varieties, i.e. 10% of production or over. For a country like Senegal, this represents 120 to 140,000 tons/year and more than 300,000 tons for West Africa. These seeds have to be stocked for about 8 months on farms or at storage centers. Storage in shell offers a certain amount of mechanical protection against insects, molds, heat and humidity, which combine to lower the seed's sowing value; nonetheless, losses can be substantial under current storage conditions. The volume to be stored is most considerable, due to the low density of unshelled groundnut (200 to 330 kg/m^2).

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A short while before sowing, the farmer has to shell the seeds and sort them manually, which takes a considerable time (90 to 150 hours per hectare) and leads to losses of 15 to 20% due to broken seeds and domestic consumption. The farmer then has to treat these seeds with a fungicide-insecticide powder. This operation is very important for crop productivity and is difficult to carry out without special equipment; it also depends on the supplies of treatment products which are subject to distribution uncertainties.

Under ambient storage conditions, peanut seeds cannot retain their germinating capacity more than 8 months, because of high temperatures and humidity prevalent during the rainy season. It is therefore necessary each year to produce the quantities required for all levels of multiplication in the following year, since it is not possible to carry over from one campaign to the next. Such multiplications take 3 to 4 years in succession from foundation stock usually produced by research centers. During the serious drought years experienced by Sahel countries, seed production has often shown a strong deficit, leading to a very serious drop in the areas planted in certain countries. In a drought year, the drop in quality is added to the drop in available seed quantities; the cropping value, which is the quantity of seeds required per hectare, can be increased by 50% or more.

Availability of seeds of good quality in sufficient quantities appear to be the major constraint to peanut production increase and improvement in West Africa.

3.2 Possible research orientations

Distributions to growers of shelled, sorted and coated seeds packed in sealed bags would make it possible to guarantee quality, which leads to a 15 to 30% improvement in productivity depending on the years, which is added to the increased area sown with the same quantity of unshelled seeds.

Guaranteed seed quality and the possibility of building up buffer stocks justifies the development of ready-to-use shelled and coated seed production. The advantages compared to the present traditional system are numerous but should be economically assessed:

- higher yields than with traditional shelling,
- the lower volumes to be stocked and transported,
- valorization of shells and sorting rejects.

The shells represent 30% of the weight of unshelled seeds and have a high energy value: 1 kg of shells equals 1 kwh. Sorting rejects amount to 20% and are valorized in the oil mill, for a sorted sowing seed yield which is 50% for unshelled seeds.

In the traditional system, shells are lost and sorting rejects are consumed, which is a serious health risk for local people as these rejects are often contaminated by aflatoxin. A refrigerated seed store (700 t capacity) has been operating for some years in Senegal and compensated vacuum packaging is currently being experimented by ISRA. Refrigerated storage requires a considerable amount of power, which is expensive in many countries, so that it becomes more expensive than storage in a nitrogen compensated vacuum as soon as the storage period exceeds 6-8 months. This latter method could be more flexible for seed preservation: once they are packed, seeds could be distributed for storage by the actual users without having to take any special precautions. The residual vacuum holds the seeds tightly together, which prevents breaking and skinning by friction during transport and handling. Refrigerated storage could preferably be reserved for mixed seed and edible peanut storage, on mill sites where shells can be used to produce energy.

The privatization of seed production and distribution in West Africa (particularly in Senegal) justifies research impact at two levels:

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- Central management of a limited security seed capital, processed and stored adequately with the best available technology;
- Private production (commercial and on-farm) of stock seed, at low cost, with adapted technology.

A research program of this nature would have to be supported and undertaken in true scale in countries such as Senegal and Burkina Faso where a rational seed multiplication scheme is operating or envisaged (SOFIVAR in Burkina Faso). Professional and scientific back-up from the US would be most valuable; potential economic impact for the whole region is evident; more over, the characteristics of seeds used for sowing and kernels used as edible seeds are to large extent the same, and the same project could cover both aspects.

NARS Peanut Results and Regional Organization In Francophone West Africa

1. The Agroeconomic Context

The programs are primarily drawn up in accordance with the requirements of traditional African small holdings and their production methods, the main characteristics of which are as follows:

- Manual farming, or light animal-drawn implements;
- Low or zero input consumption; and
- A strategy to reduce risks in peanut-cereal-fallow rotation systems.

In this context, which determines the main field of research activity, the most vulnerable points in the producer-consumer chain in the short term are:

- Seed availability for selected varieties with good germinating ability (peanut seeds are fragile and their multiplication rate is low;
- Disease and predator incidence, in the field (leaf diseases), in stocks (insect damage), and in the final product (mycotoxin);
  Organization of product marketing and payment to the producer (guaranteed outlets, pricing, and agricultural credit policies), which govern access to inputs and technical innovation; and, in the long term;
- Fertility conservation in very fragile soils where peanut is usually grown, as it copes relatively better than other crops.

2. Overview of Major Research Results Prior to CRSP

2.1 Agronomy

2.1.1 Rotation-soil-fertility studies. Successive peanut millet or peanut-sorghum cropping, which is typical of the Sudan-Sahelian Zone, provides knowledge of how soils and yields evolve depending on the rotation patterns and cropping techniques used; it is therefore possible to determine conditions for cost-effective and sustainable intensification. It became clear that organic matter availability was an essential prerequisite for maintaining a continuous cropping system (especially for cereal production) and that the systems that generate the most income, while conserving the fertility level, were those that combined continuous cropping with annual organic fertilizer applications, a slight mineral supplement, and adapted farming operations accessible to African small holders. These trials (the oldest still under way was set up in Burkina Faso in 1960) make it possible to measure the effects of rotations and techniques on several parameters (soil, plants, parasite pressure and productivity) under very stable conditions representative of the real environment.

2.1.2 Mineral nutrition and fertilization. The leaf analysis technique, adapted to peanut, is used in all the research programs monitored in collaboration with CIRAD. The element contents, determined by leaf sample analysis, provide useful indication on plant mineral nutrition. Critical levels (deficiency thresholds) have been determined for N, P, K, Da, Mg, and S, along with their interactions, and a standardized sampling, analysis, and interpretation method has been developed. It can be used to monitor plant nutrition in relation to the treatments studied (rotations, fertilizers, soil tillage, varieties, etc.) and to effectively reduce the impact of any deficits on production.

Plant fertilizer requirements vary according to climatic conditions, the acceleration of rotations, and the varieties grown. The most effective rates and forms and the area of application for each formula vary, depending on the natural environment and the policies followed in the different producer countries. It is necessary to develop low-cost fertilizer formulas (combinations of mineral fertilizers-organic restitution) and make the most of local resources (by the use of natural raw phosphates or by transformation into basic or annual fertilizer). This work is under way in Senegal, Burkina Faso and other locations.

2.1.3 Intervention strategy: the economic constraint. Peanut research has included studies of the socio-economic environment of production, which is a basic constraint on the application of research results. Prices and price fluctuations are a determining factor: purchase price, harvest prices, price paid for inputs, and expected relative income govern the farm's technical decisions and market opportunities. Peanut, which is a "driving" crop in the Sudan-Sahelian Zone, proves the suggestion that pricing policies are not usually in accordance with official declarations of intention and do not make the most of the technical and financial resources that are available for development. There is no other way of explaining the erratic use of fertilizers in West Africa and the dramatic decline in their use over the past decades; the oft-proclaimed intensification policies sometimes saw the denial of credit and a tripling of fertilizer prices, which resulted in the almost total removal of fertilizers from peanut and other rotation crops.

This situation makes it logical to recommend the methodical and widespread use of so-called light techniques in the small-holder environment, in preference to inevitably sporadic and expensive heavy practices, limited to a few farmers who can afford them, e.g., the plowing/deep phosphate application/high annual fertilizer rate combination, which is no longer being applied in Senegal. this realistic move should be continued.

2.1.4 Recommended technical practices. Research organizations in various countries have made precise recommendations on the techniques developed to improve the main rainfed crops (peanut and millet-sorghum). These recommendations are:

- Use of selected varieties;
- Seed fungicide treatment;
- Sowing in rows, at the right time, right density and right depth
- Light mechanization using animal traction (sowing, hoeing, lifting);
- Light mineral fertilizer application, spread and dug in at the right time;
- Weeding at the right time; and
- Harvesting at the right stage of maturity.

The wide-scale application of these techniques in Senegal during the 1960s led to a general shift from manual to mechanized agriculture, both for peanut (which funded the shift) and for cereals grown in rotation with it. Although some of these recommendations have been adopted in other West African countries, albeit poorly, mechanization is not as wide-spread as in Senegal where animal traction practices have been developed and where equipment is available.

The strategy that was adopted needed to take the minimum number of risks in a drought-prone area. It required:

- Rustic varieties, capable of withstanding difficult soils and climatic conditions;
- Low-cost, multipurpose equipment and hitched tools;
- Light fertilizer rates, based on short-term cost effectiveness; and
- Effective integration of traditional cropping practices and farming calendar.

2.2 Breeding

Basic research (varietal creation and development of physiological tests and screening techniques for peanut) is carried out in Senegal for dry zones, where the main constraint is drought, and in Burkina Faso for humid zones, where the main constraint is diseases. More limited variety improvement programs based on local and introduced material are being conducted in the multidisciplinary peanut programs in other countries. These projects produce and multiply peanut foundation seed wherever local seed services are operating.

2.2.1 Productivity improvement. This topic covers agronomical capabilities and the quality of the products obtained. Breeding criteria taken into account are yield (with its main components being pods, haulm, emergence, and shelling); ecological adaptation (cycle length, dormancy, drought and disease tolerance); adaptation to cropping techniques (response to fertilizers and mechanized farming).

2.2.2 Drought tolerance. This dual topic (physiology breeding) sets out to develop tolerant varieties through selection based on physiological criteria:

- Short-cycle varieties with dormant seeds (variety 73-30 extended in Senegal); and
- Variable-cycle varieties capable of tolerating periods of water stress during vegetative development. Selection is carried out in Bambey (Senegal) from a basic population created by intercrossing eight varieties chosen for their complementary qualities.
- Alternation of generations between Senegal and Botswana makes it possible to speed up the program and subject sowing material, once it is grown in the field, to different drought conditions in North and South hemispheres.

2.2.3 Tolerance to leaf diseases. Rosette-resistant material has been obtained and very widely distributed. The aim of the programs under way in Burkina Faso is to develop varieties that are resistant to both rosette and to the cryptogamic diseases that are often rife at the same time as rosette: rust and cercospora leaf spot diseases. Artificial inoculations tests have been developed and hybrid progenies are being screened in Burkina Faso, along with families currently undergoing selection for other research topics and intended for zones exposed to these diseases. The ICRISAT Sahelian Centre in Niamey is a major participant to this and the following sub-program.

2.2.4 Tolerance to Aspergillus flavus. The difference in the degree of contamination of seeds by A. flavus is the soil prior to harvesting has been shown. Crosses are currently being carried out between extended varieties and parents with known resistance, and the progenies are being screened in artificial inoculation tests, with CRSP participation.

2.2.5 Edible peanut. Selection of edible peanut that can be marketed in shell or seed form is currently under way in Senegal and Burkina Faso, with CRSP participation. Satisfactory varieties have been obtained and the current programs are directed towards producing higher yielding varieties resistant to diseases, and to improving seed shape and size. These programs are of interest to numerous producer countries to meet the requirements of the domestic market.

2.3 CROP PROTECTION

Phytosanitary problems with peanut in Africa are becoming more acute as cropping rotations become shorter, double annual cropping becomes widespread and international seed exchanges develop. Research into these problems has been done with regard to cropping methods, variety improvement, and chemical control.

2.3.1 Protection from diseases and pests on emergence. Many fungi are responsible for emergence losses that may reach 50%. Seeds therefore need protection and effective formulas have been developed and made widely available. As fungal flora and pest action vary in time and space, and sowing material susceptibility is different, these studies need to be continued in different situations, and the repulsive effect on termite and millipede attacks needs to be assessed.

2.3.2 Millipede control. Millipedes attack plants and young pods as they form. Poisoned baits have been developed and used in Senegal. Biological and epidemiological research has been conducted with ORSTOM and the Natural History Museum in Paris. This work should be continued, determining the most vulnerable stages of the julid's biological cycle and developing new products through experimentation. Biological control should be considered.

2.3.3 Aflatoxin control. Studies have been carried out, although sporadically before CRSP, at all stages of the peanut producer-consumer chain-genetics, agronomy (prevention of contamination in the field), and technology (elimination of contaminated pods and seeds and detoxification). An artificial inoculation test has been developed to determine a reference susceptibility scale. An additional test, based on seed coat permeability, is being investigated and the correlation with actual contamination in the field is being measured. Field prevention techniques (and checking techniques at the time of harvest) have been developed (threshing before drying, rapid drying, and purchasing based on quality). Future studies should concentrate on assessing and controlling preharvest contamination in various ecological zones, and on determining critical susceptibility phases.

2.3.4 Nematode control. The results obtained led to the implementation of a nematode treatment project in North-central Senegal. The technique has now been perfected, but trials are necessary to reduce doses, test other products, and determine optimum application date. Much still remains to be done in the field of adaptive agricultural research, particularly to determine the sowing density and fertilizer level that will best optimize the treatment and conserve soil fertility with sustainable increased yields. Tolerant varieties are needed. The problem of residues remains unsolved.

2.3.5 Leaf disease control. The impact of rust, combined with that of cercospora leaf spot diseases, is increasing in West Africa. Effective treatments exist, but they are too costly in extensive crops. The research under way in concentrating on selection tests on cross progenies based on resistance to rust both in the laboratory and in the field. Theses programs are backed up by contamination trials that cannot be conducted in producer countries and are therefore carried out in Montpellier (France) with infesting strains from various places inoculated into different varieties ranging from the most tolerant to the most susceptible. this work is carried out in collaboration with CIRAD and the University College (London) with financial support from the European Community (EEC) and scientific support from ICRISAT.

2.4 Technology

Major results in technology have been obtained in the field of small, animal drawn equipment which has been available in Senegal since the sixties. The only program under way is still located in Senegal and consists of two parts: one devoted to technology proper and t he other covering the conditions under which aflatoxin appear, along with control methods.

2.4.1 Improvement of technological and seed qualities. The criteria for assessing the technological quality of edible peanut have been defined and assessment tests and analytical methods have been developed. Several varieties have been chosen and proposed for dissemination. The effects of various agronomical treatments have been measured and corresponding research recommendations are made and adapted to the destination of the product (effect of Ca on exportable seed yields and germination capacity, effect on B in germinating capacity, effect of growth regulators on seed value, etc.).

2.4.2 Study of shelled peanut conservation and storage procedures. A method of insect eradication in stocks has been developed (fumigation and dusting). Refrigerated storage has been used, but the gradual return of the seed stock to ambient temperature upon removal from storage deserves further research. Packaging in sealed packs in a modified atmosphere (nitrogen compensated vacuum) could give good results and ensure good preservation conditions at lowest price. The technique should be further improved with a view to using it on the seed capital and possibly on cereal stocks.

2.4.3 Control of Aspergillus flavus contamination. This aspect of the program is conducted in part with breeding operations (screening of hybrid progenies); it also covers industrial processes for eliminating contaminated pods and seeds, selective skinning with hydrogen peroxide, and chemical detoxification of press-cakes, in cooperation with the oil industry in Senegal.

2.4.4 Improvement of seed processing. Production of top quality seeds for sowing or for export onto the confectionery market is studied at several stages of the industrial process: shelling, electronic sorting, skinning and production of ready-to-use seeds, the ultimate aim being to mechanize the entire sequence of operations (shelling, sorting, coating, and packaging). Moving from the experimental stage to industrial pilot-plant level remains problematical and would require external support. These processes are extremely important in Senegal, since the reduction in the seed capital distributed by the state, under pressure of external donors, means that more efforts have to be made in maintaining and improving the seed quality. At the same time, greater attention needs to be paid to problems that occur when small holders produce and store seed, as is generally the case in most countries.

3. Elements of Regional Coordination

All west-African countries conduct peanut research programs under their NARS, adapted to their national policies and resulting from the diverse impulse of national scientists very often isolated and uncoordinated. The risk of dispersion and duplication is very great, especially in breeding, where the trend is to select "national" varieties rather than join efforts and share results. Consequences can be paradoxical, such as refusing to screen in another country the progeny of a rosette-resistance program although the facilities for this are not available locally . . . The historic and linguistic barrier between anglophones and francophones, more over, remains a major hindrance.

The four Peanut CRSP programs fit well with the needs and priorities of peanut research in the region, and contribute towards better integration. Positive elements, or attempts, towards this goal can be listed chronologically as follows.

- The traditional concentration of basic research on three locations, two covering the francophone sector: Bambey in Senegal (major constraint: drought) and Niangoloko in Burkina Faso (major constraint: diseases) and one covering the anglophone sector: Samaru in Nigeria.

It should be kept in mind that a very important amount of useful results have been obtained over time on these locations, at a period and under a system which did not favor publication of scientific data through the academic channel inspired by the modern, and especially American, University-based model. Most of the information is available in the form of unpublished reports, proceedings or miscellaneous papers of which no data base will give record. This situation makes very difficult the exploitation of these results for investigators working outside Africa, reading English only and relying solely on computerized bibliographical sources . . .

- The establishment of ICRISAT Sahelian Centre in Sadore, Niger: founded in 1984, ISC serves as a relay in Western and Central-Western Africa for the research potential, and especially the germplasm, available in Hyderabad ICRISAT Centre. ISC, through its mandate and the excellent

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facilities it operates in Sadore, is a position to play a major role in the regional and inter-African coordination of peanut research. This is undertaken through regional meetings, multinational network trials, training sessions and direct scientific support (including documentation) to NARS, besides the research work that is carried out in Sadore and its substations.

- The Conference of the African Authorities in charge of Agronomic Research (CORAF) was founded in 1987, initially by francophone African countries, with the objective of reinforcing and coordinating national programs working on a number of crops, among which peanuts, the "groundnut network" includes to date seventeen member institutions and runs a number of projects with financial support from the European Community (EEC). A "base center" has been established in Bambey, with support from France, the network organizes workshops, publishes a bulletin, organizes multinational trials and facilitates communication and scientific exchange between the members.

The major problem remains intermittent and insufficient funding, as well as the very low participation on non-francophone members, which deprives CORAF of the African representatively which it claims. CORAF would certainly welcome more diversified partnerships.

4. General Recommendations

Peanut CRSP programs should fit as closely as possible with the existing lineaments of regional integration, and contribute to better coordination between the various operators of peanut research in West Africa, focusing on the locations and structures where significant progress can be accomplished. Training will have limited impact as long as trained scientists will not have proper facilities in strong institutions to work in; isolated researchers should be linked to a base-center within a networking system.

Peanut CRSP, who has associative links with ISC on one hand and with CIRAD on the other, should help coordinate the three operators and reinforce ties in the form of a memorandum of understanding; the African NARS partners should develop a regional network associated with CORAF, or any form of association that could bring together the francophone and anglophone components within or without CORAF. The next Regional groundnut workshop cosponsored by ICRISAT and Peanut CRSP, to be held in Niamey in 1994, could be the occasion to discuss this problem.

Logistics and expenditures should not be dispersed but concentrated on locations of regional interest, which could in time acquire a regional status autonomous from the host country, as is already the case with CERAAS in Senegal. Bambey is obviously in this situation, and is hosting a number of CORAF regional projects with substantial contributions from France and EEC.

The situation in Burkina Faso should be clarified, considering the sharing of tasks between University (in charge of teaching and basic research) and INERA (in charge of applied research and transfer of technology to extensions services and the production sector). Peanut CRSP should reconsider its partnerships on this basis and relocate all breeding work, varietal testing and soil improvement research with INERA, and collaborate with University/IDR in the specialized field of nutrition, entomology and the more basic aspects of plant pathology and toxicology. The Director of IDR and CRSP host country investigator being Scientific Director of the National Centre of Scientific and Technological Research (CNRST) supervising INERA, this should not bring about great difficulties, and would soothe the legitimate resentment of INERA and prevent the redundancies that could result from two varietal testing programs operating separately in the same areas.

Breeding work in Mali and Niger does not address any particular thematic demand that is not already covered elsewhere in the region: the CRSP should therefore encourage the breeders in these countries to establish links with Senegal, Burkina, ICRISAT and Nigeria depending on their needs, and help them screen segregating material or bulks imported from external breeding centers, rather than start "national" breeding programs.

TX/BCP/WA

DISEASE RESISTANT PEANUT VARIETIES FOR SEMI-ARID ENVIRONMENTS

1. Retrospective Overview of Peanut Breeding Results in Francophone West Africa (F.W.A.)

Peanut selection started as early as 1924 in Bambey (Senegal) which still is today the major breeding center in F.W.A. along with Niangoloko (Burkina Faso) where all the rosette-resistant lines still in use today have been bred. These two centers, before ICRISAT and Peanut CRSP started their activity in the area, provided the totality of selected germplasm to the other countries of F.W.A. and most (if not all) varieties presently is use in these countries have the same origin.

Breeding goals in Bambey have changed over time, due to changes in cropping techniques (shifting from manual to animal-drawn tillage in Senegal), to climatic changes (rainfall decrease), to increasing disease incidence (rosette), to market demand (diversification). Two major periods prior to CRSP can be considered:

- From 1924 to 1960, selection work for yield increase was done on local populations and imported varieties enriching the central collection for the Federation of French West African territories.
- From 1960 to 1982, hybridizations were undertaken, based on more qualitative criteria. During this period, major changes have occurred in the varietal pattern: erect replaced runner types; edible varieties were introduced or created; early maturing types were introduced and early dormant types were created; a drought tolerant variety was introduced in the sub-Sahelian area and a rosette-resistant variety was introduced in the South (Casamance).

The following varieties, rapidly distributed in Senegal through an efficient seed multiplication service, have been progressively adopted over the entire area:

1936: 28-206, productive, erect, 120 days.
1958: 47-16, productive, runner, 120 days.
1967: 55-437, drought tolerant, erect, 90 days.
1970: GH 119-20, edible, 115 days.
1972: 69-101, erect, rosette resistant, 120 days.
1978: 73-30, erect, dormant, 95 days.
73-33, erect, dormant, 105 days.

When Peanut CRSP participation began, all the traditional, low-yielding local varieties in use in Senegal had been replaced by new improved varieties. Further goals well be technically more difficult to reach; this will require time, funds and international cooperation. Orientations of the breeding goals for the future as determined by ISRA in 1986, can be summarized as follows, from North to South of the country:

Zone	Present Variety	Objectives
North	55-437 -- 90 days	<90 days, dormancy, A. flavus tolerance
North-Central	73-30 -- 95 days	drought tolerance, A. flavus tolerance Confectionery
South-Central	73-33 -- 105 days	A. flavus tolerance Leafspot resistance Confectionery
	GH 119-20 -- 115 days	id + edible. Improved germination and productivity
South/East	69-101 -- 120 days	A. flavus tolerance Leafspot resistance Rust resistance edible

The Peanut CRSP breeding program fits adequately into this pattern, which can be extended eastward to the other countries within the same latitudes. It should be considered that these goals are very ambitious, that they meet with the major problems of peanut breeding worldwide, and that no spectacular breakthrough can be expected in West Africa in the very near future: the easy part of the work was already done when Peanut CRSP stepped in.

2. Further Developments of the Program

Breeding of improved varieties should be ranked first among the sectors where research can respond to production constraints. These can be listed briefly as follows:

Breeding for:	**Associated with:**
Drought tolerance	Physiology
Aflatoxin control	Phytopathology/physiology
Foliar disease resistance	Phytopathology
Rosette	Virology
Edible market requisites	Nutrition/commercial sector

Nematodes have been identified as a major pest in the northern Senegalese peanut basin, where impressive results have been obtained through chemical control by an eradication operation conducted in the Thies-Diourbel area during the 1984-89 period. The geographic extent of nematode infestation should be assessed, as well as the economic impact in other areas.

Drought tolerance should be given more emphasis through closer collaboration with ICRISAT and the EEC-CORAF project operating within ISRA. These two operators use different approaches to the problem: analytical, resorting to physiological tests, in Senegal; global, assessing direct response to water stress, in ISC. Peanut CRSP could contribute usefully to establishing links and developing a common strategy that could be extended to other crops, possibly through an interdisciplinary, inter-CRSP organization that would collaborate with CERAAS in Bambey (Regional Research Centre for the Improvement of Adaptation to Drought). Over fifty scientists from thirty-one countries working on eighteen plants have used CERAAS facilities and undergone training in the Centre managed in collaboration with CORAF and co-funded by EEC. Many countries, though, are reluctant to join

CORAF because of its "francophone" image and close ties with France. CORAF is aware of this problem and would welcome opportunities to diversify its partnership by establishing links with the CRSP.

Management of aflatoxin (including breeding) has given way to a number of intermittent projects on the area over the last three decades; all attempts towards better coordination of this work either by the African Groundnut Council or by the commodity group of FAO have not been very successful. The Senegalese breeding program is a major component of aflatoxin research in the region. It benefits from direct and indirect, continuous or intermittent support from different sources: France, EEC through CORAF, ICRISAT, CIRAD, and Peanut CRSP. The American contribution, although limited financially, has an important impact and it links African research with the country where aflatoxin research is the most performant and where the problem, at production level, is under control to an extent that has not been reached anywhere else. This contribution, more over, is concentrated on the two weak points of the Senegalese system: training and scientific back-up on one hand, direct support to expenditure budgets, where the work is being done, on the other hand.

The breeder in Bambey collaborates with a chemist-pathologist in charge of screening the lines by artificial inoculation, and measuring aflatoxin contents using different methods. These two scientists are not full-time on this work and the abundance of other tasks, especially administration, is a growing constraint. ISRA should therefore consider strengthening the team through direct participation of the plant protection sub-program, until recently located in Kaolack and now in Bambey, in support of the chemistry/pathology component.

Breeding for foliar disease resistance is taking place in at least three locations in F.W.A.: ISRA with CRSP support; ICRISAT; Niangoloko-Bobo Dioulasso where an EEC-funded project has been operating since 1984 with several European and African associates, including IDR Ouagadougou, a CRSP partner, thus operating on the two sides! There is no formal link, except indirectly through CORAF, between ISRA and the Burkina Faso project managed by the Institution officially in charge of applied agricultural research in the country, INERA, who has no participative action with the Peanut CRSP.

It should be acknowledged that the CRSP intervention in this sector, although justified and scientifically sound, has not contributed to better coordination of efforts on a regional basis; in Burkina Faso, two separate breeding programs are now operating, nevertheless without any duplication from a strictly scientific standpoint. The problem has not been examined in detail, due to the absence of the Director of INERA and of the Chief of Legumes program during the EEP visit, but the possibility of establishing closer links between IDR-ISRA-CRSP and INERA-EEC should be considered attentively.

The "edible" breeding activity operating in Senegal and (to a lesser extent) in Burkina Faso with IDR addresses a very important demand all over the region, where varieties in the past have been selected generally for characters interesting to the milling industry with little consideration given to the local and regional needs for direct consumption or transformation. It was only in the sixties that crosses between local varieties and large-seeded American varieties were made in Senegal; a collection is conserved in Nioro with CRSP support. Many edible varieties tested in West Africa, such as EH 310-9 and 78-28 at pre-extension level in Mali, proceed for that collection. It is therefore surprising that the edible project operating in Senegal very successfully (Project arachide do bouche, 30,000 ha) is still using an obsolete American variety, GH 119-20, directly imported in 1963, in spite of problems of poor germinative capacity and of an unexplained reduction of pod size. NOVASEN, the Company in charge of this operation, has tried without success other importations (NC 7 lately). This situation reflects the importance of CRSP support, and probably the necessity of close links with the institutions in charge of development and with the private production sector. From a logistic standpoint, the recent transfer of the HC investigator from Nioro where the trials and collection are located, to Bambey 200 km away,

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outside the edible peanut growing area, poses problems of follow-up in spite of the presence on Nioro of an excellent technical team working with good facilities.

An effort should be made in Bambey to improve facilities, and particularly procure good land, for breeding activities, large parts of the station are contaminated with peanut clump; no cold storage is available , making it necessary to replant collections every two years; plantations are not well protected from wandering animals and occasional thefts. Priceless information, and material, can thus be lost. Peanut CRSP should insist upon obtaining permanent allocation of uncontaminated land, putting it under homogenous cultivation and crop rotation, and contribute to the expense of a fence and of day and night watchers when the crops are ripe and drying in open air. It should be noted that the situation is much better, and the general agricultural and climatic environment much for favorable, in Nioro than in Bambey where the peanut research team is not concentrated.

3. Summary of Recommendations

1. Consider the possibility of initiating a breeding program for nematode resistance in Senegal, and develop links with CORAF in the fields of drought tolerance in Senegal (CERAAS) and foliar disease resistance in Burkina Faso (INERA/EEC).

2. Multi-locational variety testing should compare, for a given type of situation, varieties presenting the required characteristics, rather than large numbers of very different varieties with a very low probability to select locally adapted material. For instance, it is no longer necessary, in Burkina Faso to include early maturing, non rosette-resistance varieties in the rainy, south west area, and late maturing varieties such as RMP 12 in the dry central area where they have no chance of ever being produced. The exploratory phase should now be considered closed and future trials should be more selective in view of extension in the short term.

3. Reinforce the aflatoxin team in Senegal Through direct participation of the ISRA plant protection sub-program now located in Bambey; improve field quality and security in Bambey station.

4. Concentrate and coordinate operations in Senegal and Burkina Faso where all the hybridization work should be done, with consideration to location - specific particularities and capabilities (drought, aflatoxin and edible sub-programs in Senegal; foliar disease dominantly in Burkina Faso).

5. Reconsider local partnership in Burkina Faso, where breeding and varietal testing activities, in the national program, is under the responsibility of INERA and not of University/IDR.

6. Limit interventions in Mali and Niger to training of scientists and breeding activities from improved populations (bulks) received from the US, ICRISAT, Senegal or Burkina Faso.

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GA/IM/BF
IPM STRATEGIES FOR PEANUT INSECTS IN SAT AFRICA

1. Situation of the Problem in West Africa

Entomology is certainly a weak point in the peanut research system in FWA: no full-time entomologist is working on the crop in ISC, nor in any NARS, except those supported by CRSP in Burkina Faso. Interesting work has nevertheless been done, prior to CRSP, although intermittently and without much insight into basic biological aspects. There again, much of the relevant information lies in the form of unpublished documentation, project reports, communications in local workshops, etc.

Two types of situations can be considered:

a) Areas where peanut holds an important position in the cropping systems and therefore plays a role in the ecological balance, and where large quantities of peanuts are or have been handled, stored and distributed over wide distances: this is particularly the case in Central-Northern Nigeria and in the Senegalese peanut basin. These situations are met to a lesser degree in Niger (Zinder-Maradi-Dosso areas), in Southwest Burkina Faso and in some areas of Mali. Under these conditions, specific insect damage arises:

   During storage either on-farm or on marketing and primary storage points, regional stores where the product can be kept for months ("seccos" in Senegal) or in seed stores where leftover batches, residues and uncleaned equipment maintain year-round contamination. Bruchids, often sheltered on perennial host plants as well, are then by far the most detrimental insect pests of the crop.

   In the field, where millipedes can cause serious damage during germination (up to 50% damaged plantlets on large-seeded varieties in South-Central Senegal) and at pod formation (15 to 30% damaged pods in the same area). Proliferation of these pests started during the dry spells of the early seventies in areas where peanut acreage was important, for unknown reasons linked probably to the biology and population dynamics of these arthropods on which little information is available.

b) Areas where peanut is a minor crop very often interplanted with cereals and seldom stored in large quantities: insect attacks are then diversified and episodic, with occasional large-scale epidemics when the acreage reaches a certain extent and when favorable climatic conditions occur (aphid invasions in Niger). The preceding pests can cause intermittent losses, and others, among which thrips and jassids, can have important effects as well.

   Termites are a ubiquitous pest during maturation, before and after harvest, especially when the crop is drying in the field, when the rains stop early, when harvest is delayed and when stacks are left unprotected for long periods. Proper monitoring is the best preventive method. Oil-sucking bugs (Aphanus sp., "wangs" in Senegal), although inconspicuous, can cause severe damage resulting in shrivelled kernels with increased susceptibility to A. flavus and low germinative capacity.

   Nematodes deserve a special mention; the peanut basin in Senegal is infested to a large extent. Chemical control has given excellent results: +550 kg/ha^{-1} (control: 795 kg/ha^{-1}) on treated peanuts and + 365 kg/ha^{-1} (control: 490 kg/ha^{-1}) carry over effect on the following sorghum in farmers' fields. These pests this appear as an important bottleneck to crop intensification in Senegal. It is therefore surprising that the problem has not received more attention from research, that the Senegalese project has been limited to large-scale use of chemicals (over

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10,000 ha treated in 6 years) without adequate scientific back-up and that the extent of this infestation has not been assessed in West Africa, where, to our knowledge, no peanut nematologist is operating.

2. Adequation of Peanut CRSP Project to Production Constraints

Peanut CRSP project in Burkina Faso addresses only partially the peanut invertebrate pest problems in the area. Major gaps at regional level can be identified as follows:

- storage pests (particularly bruchids);
- other arthropod pests (millipedes);
- non arthropod pests (nematodes).

Concentration of efforts on the termite problem, with special consideration to the incidence of termite damage on aflatoxin contamination, is justified by the very ubiquitous occurrence of this pest and by the qualitative as well as quantitative consequences of termite damage, as well as by financial constraints probably precluding any wider field of action. How did the project fulfill its purpose?

The global achievements of the project, as compared with the initial objectives, can be estimated as follows:

Objectives:

A. Identify the major economic pests of peanut in Burkina Faso.
The major insect pests have been identified, but Burkina Faso is not representative of the entire area, and no economic assessment has yet been made.

B. Determine the relationships between level and type of arthropod injury to groundnut pods and aflatoxin contamination of preharvest and postharvest peanut.
This point, to be complete, should include millipede damage. The objective as far as concerns termites can be considered achieved except for postharvest damage still under trial.

C. Develop economic injury levels for the major arthropods by quantifying pest density or injury level with losses in peanut yield.
This point has not yet been undertaken.

D. Develop reliable sampling procedures to estimate population densities of the major pests.

E. Determine arthropod abundance in relation to plant phenology and growing season in Burkina Faso.

F. Provide training for scientists and students from Burkina Faso.
Achieved.

G. Develop bait attractants or other control strategies for the major insect pests.
Not achieved.

H. Evaluate promising peanut lines from ICRISAT or lines developed by the Breeding CRSP for resistance/susceptibility to major arthropod pests.
Under way.

3. Suggestions for Further Developments of Research

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The major goals of the project are in good progress, except the evaluation of breeding lines which is a long and exacting task. Further developments will involve other disciplines and a broader geographic operation zone in order to cover different cropping situations. Objectives A and H should be given priority, in conjunction with breeders and economists:

Undertake a global agro-economic survey of invertebrate pests (including millipedes and myriapodes) all over the unimodal rainfall area of West Africa, in collaboration with ICRISAT.

Carry on the evaluation of promising lines from ICRISAT and other origins. The possibility of including nematode tolerance should be considered, with regard to breeding programs under way in other countries in collaboration with other US Universities. The priority given to this action would perhaps justify, at present stage of operations, to bring it under a breeding program with entomologist support, rather than the reverse.

AAMU/FT/BF
OPTIMUM FOOD UTILITY OF THE PEANUT IN SAT AFRICA

1. Project Justification

Peanut development in West Africa was originally undertaken in order to answer the oil demand, and the protein component is still considered as a by-product either to be disposed of locally or to be exported for animal feed whenever possible. Little effort, prior to Peanut CRSP, was conceded to develop peanut and promote peanut products as an alternative source of food protein in countries (including important peanut producers such as Senegal and Nigeria) where severe protein deficiency is endemic.

Attempts to develop soybean in order to meet with this deficiency have failed, as could have been expected, in countries such as Senegal, Cote d'Ivoire, and Burkina Faso because no accompanying effort has been made to develop the necessary food technology, whereas traditional peanut food products were in widespread use and could have been encouraged and improved for the same purpose.

From an economic standpoint, it should be noted that peanut in more developed countries is processed in priority for the protein component and refuse is crushed for oil, whereas oil production, although less profitable, is given priority in West Africa mainly because the appropriate technology for improved marketable food products is not available. Peanut products, however, are of daily use in West African traditional food habits, albeit in a crude form and with no consideration for aflatoxin content. The scope for potential improvement is considerable.

2. Project Accomplishments and Future Developments

Peanut supplementation of cereal-based staple food and promotion of new products are consistent with the general CRSP goal of optimizing the food utility of the peanut for peanut producing and consuming populations of the SAT regions of Africa. They will require, when ready for extension, a considerable effort of publicizing, education, marketing as well as cultural innovation. The use of soybean milk recently processed in Burkina Faso has failed because these problems had been under-evaluated. The only popular use of soybean today, unexpected by its promoters, is in the preparation of a local condiment, soumbala, to which no official attention has been paid . . .

The improvement of existing peanut products will probably find direct applications as it meets immediately the consumer demand: improved consistency, taste, packaging, and conservation of peanut paste, improvement of traditional roasting and packaging of sweet or salted peanuts, come under this category. Improvement of the sanitary quality of products will be more difficult to pass through, as no efficient regulation is yet applicable on the traditional market and the consumers are generally not aware of the problem posed by aflatoxin contamination. This problem, nevertheless, is given great attention by the project, rightly; it should remain the first priority in the future.

The project, at least for some products, should be entering an application phase where marketing aspects well command acceptability and success. Contacts will have to be made or reinforced with economic operators, inside or outside Burkina Faso: i.e., the packaging problems met by a local factory (CITEC in Bobo-Dioulasso) processing peanut butter have apparently been solved in Senegal by a local firm, AGRIFA. This same firm uses chromatic electronic sorting with CIRAD/ISRA support, for aflatoxin control, and is supplying the domestic urban market efficiently; more efforts are needed to meet demand in rural areas, where monetary income is much lower. Collaboration or exchange of information through Peanut CRSP, in this case, could be fruitful and avoid redundancies.

In Burkina Faso itself, the society in charge of peanut extension and marketing, SOFIVAR, is planning to develop edible peanut for the domestic and regional market. A processing plant is scheduled in Ouagadougou, an American variety has been imported directly (with no regard for local research) and technical expertise--not available in the country--is requested.

Different fields of cooperation should be explored by the project, upstream with INERA and SOFIVAR, downstream with SOFIVAR as well as with public and private operators inside and outside Burkina Faso.

REPORT ON VISIT TO WEST AFRICA

FEBRUARY 17 - 22, 1994

John P. Cherry
Member of EEP

Eastern Regional Research Center
Philadelphia, PA

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External Evaluation Panel Review

Peanut CRSP Code: AAMU/FT/BF

Project Title: An Interdisciplinary Approach to Optimum Food Utility of Peanut in Semi-Arid Tropical Africa

Principal Investigators and Collaborating Institutions: Dr. M. Elena Castell-Perez, Alabama A&M University, U.S.; Dr. Alfred S. Traore, University of Ouagadougou, Burkina Faso; Ms. Kafui Kpodo, Food Research Institute, Council for Science and Industrial Research, Accra, Ghana; and Dr. Richard T. Awuah, University of Science and Technology, Kumasi, Ghana.

> Collaborating institutions include the Department of Food Science, Alabama A&M University (AAMU), Normal, Alabama; University of Ouagadougou (UO) and Ministry of Agriculture, L'Institute D'Etudies Et De Recherches Agricoles (INERA), Service Technologie Alimentoire, and Bureau of Extension, Service of Nutrition, Ouagadougou, Burkina Faso; Food Research Institute (FRI), Council for Science and Industrial Research, Ministry of Industries, Science and Technology, Accra, and Department of Crop Science, University of Science and Technology (UST), Kumasi, Ghana.

Project Objectives: Plans are to address the constraints that limit the maximum utilization of peanut for human consumption in Semi-Arid and Tropical Africa. Peanut utilization could be considerably improved via the following efforts: to increase utilization of peanut into more refined-processed form; to improve packaging of peanut and peanut products to increase shelf life; to utilize peanut flour (after oil extraction) to increase protein value of cereal-based foods; and to improve the methods of storage, postharvest handling and inventory management.

One member of the EEP, Dr. Cherry, visited the institutions mentioned above in West Africa for an intensive review. (Drs. Hsi, Schilling, and Williamson in an earlier visit reviewed project to a lesser degree). <u>This report presents only the findings from visits to the food research and collaborating institutions and industries in **Ghana** and **Burkina Faso.**</u>

Achievement of Objectives: The project is enhancing the capability of research at UO and FRI and leading to improved utilization of peanut in Burkina Faso and Ghana. Other Semi-Arid and Tropical African countries and the U.S. are similarly benefitting. Specifically, research results are improving methods of storage, packaging, processing and development of a variety of new and improved products. The objectives include collaborative research with plant scientists, microbiologists and entomologists to improve the quality of peanut for human consumption. Applications of results from research conducted in Burkina Faso on the use of solvent/aqueous extracts from selected plants in Africa, e.g., <u>Allium</u> <u>sativum</u>, as inhibitors of aspergilli growth and aflatoxin production on peanut during storage has great potential for helping to resolve health conditions of the people due to these food contaminants; similar studies with other plant sources are being initiated in Ghana. The new project with similar objectives as those for Burkina Faso, has been initiated in Ghana and is showing excellent potential for rapid success as valuable expertise, facilities, instruments and equipment are added to Peanut CRSP in Africa.

An emphasis on technology transfer has increased collaborations between the research institutions and industries - both large and small or entrepreneurial and regulatory agencies in Burkina Faso and Ghana. Another major emphasis is the training component including advanced degrees for graduate level students and short courses for support personnel. Workshops on advances in peanut utilization for industrial personnel and the nutritional well-being of consumers are having an impact on host countries and the U.S.

Implementation and Management of Projects - Ghana: The FRI Director, A. Andals was pleased that Peanut CRSP was supporting peanut programs in Ghana. Many opportunities are in place to utilize peanut ingredients in foods. Peanut ingredients are being added to traditional foods made with maize and cowpeas, the major commodities produced in Ghana. The focus of the research is on target groups, especially an expanding middle income segment of the population. Studies are identifying their tastes, preferences, and snack desires. Advertising is drawing attention to new peanut products and helping to increase purchases. FRI's policy is to use its strong research programs and equipped laboratories to cooperate with universities and the private sector. The government has asked FRI researchers to work toward the commercialization of their food products. Also, the institute must use its facilities, including pilot plants to make commercial products for sale to create income to support the research programs. Plans are to reduce government funding to FRI while the researchers gain monies through national and international grants and from industries. Multidisciplinary teams of researchers are an important part of FRI's programs; food scientists-technologists, microbiologists and engineers work together on team projects to produce food products. Emphasis is on adding peanut meal to enrich protein content of high carbohydrate-based cereal and cassava foods. Defatted peanut cake, after oil extraction, is being planned for studies in extrusion technologies.

A National Agriculture Research Project (NARP) as part of the Council for Scientific and Industrial Research is in place in Ghana with a pool of monetary resources to provide support funding for agricultural research. The project includes high priority commodities, requires multidisciplinary collaborations, and controls duplication of efforts; its primary purpose is to identify areas of research programming not presently covered. Commodities included are soybean, plantain, pineapple, etc.; and peanut is included on the highest priority list. Equipment needs are an important component of the project. Also, support for work to fabricate equipment for processing uses and industrial applications are supported. Pilot plants are in place to show new developments to entrepreneurs. Local businesses can pay to use these facilities to demonstrate feasibility of new processing, product and equipment technologies on an industrial scale. These new technologies are also exhibited-advertised at local industrial fairs to attract new business ventures and entrepreneurs. Technology transfer efforts include FRI-sponsored fairs, National Agricultural Fairs and Industrial Technology Fairs.

A National Board for Small Scale Industry in Ghana is making small grants available to help solve industry problems; this granting board works closely with FRI. Industries have little available monies to support research. In fact, to encourage industries to participate in the Peanut CRSP, a survey is presently being conducted by FRI. In Ghana, monetary enticement is required to develop cooperation throughout the nation.

The Finance Office at UST, Kumasi, Ghana, where collaborative studies on aspergilli-aflatoxin contamination are being conducted with FRI researchers, coordinates grant funds for scientists at no overhead charges. The office assures transfer of funds through the banks and maintains accountability according to the guidelines of the Peanut CRSP contract; protecting the interest of the granting institution is assured. Foreign operations are centralized through the Ghana Commercial Bank in Accra. Noted was that recently a double cabin Datsun truck ($12,000) was purchased from funds of a grant from the Canadian International Development Agency. A request was made for similar support for scientists from U.S. funding sources.

A brief meeting was held with Dr. George Akosa, Minister, Ministry of Science and Technology, Accra, Ghana, who was visiting the Department of Civil Engineering, at the University of Science and Technology, Kumasi. Dr. Akosa was head of this department before becoming Minister. The brief meeting allowed for discussion on the importance of the new Peanut CRSP to utilization research projects in Ghana. In the Civil Engineering Department, work is underway to improve water quality in Ghana, especially in small villages. Another priority is to develop crops endemic to Ghana, e.g., peanut. Noted - Peanut CRSP should transfer technologies on peanut production (agronomic, breeding, entomology, etc.) to Ghana from other African nations. Peanut CRSP is the linkage mechanism to encourage this technology transfer. Peanut CRSP should, and is giving, support to new thrusts in utilization, postharvest technologies in Ghana. This includes natural fungicides to control aspergilli and aflatoxin contamination from active compounds of endemic African plant extracts, and food handling, storage, packaging, processing and marketing technologies. Training of farmers, handlers/traders, industrial personnel and the consumer should be a major part of this endeavor, led by Peanut CRSP.

Implementation and Management of Projects - Burkina Faso: Progress continues for the commitment of research programming and enhancement of international programs at UO. Starting with the president of UO, Dr. Alfred S. Traore, administrative and faculty support for Peanut CRSP and collaboration with AAMU, is clearly evident. Faculty and students greatly benefit from their involvement with international programs. Their efforts have developed a favorable environment for facilitating collaborative studies and training programs in agriculture among UO faculty and U.S. scientists that is greatly benefiting Burkina Faso.

Implementation and Management of Projects - AAMU: The tragic death and the loss of the dedicated efforts of Dr. Bharat Singh, former PI, has impacted progress on Peanut CRSP at AAMU. Dr. Elena Castell-Perez, new PI, a food engineer is fast learning the research needs of Peanut CRSP and is showing her leadership qualities. Special acknowledgment is given to Dr. Onuma Okezie, Director, International Programs, AAMU for guidance given to Peanut CRSP during these trying times at the university. It was his guidance and travel with Drs. Castell-Perez and David Cummins, Program Director to Ghana, that led to the development of new programs with the FRI, Accra, and UST, Kumasi, Ghana.

Institutional Development - Ghana: The FRI, Accra, Ghana, began operation in 1965 with assistance from the United Nations Development Program (UNDP) and the Food and Agriculture Organization of the United Nations (FAO). The institute is currently administered by the Council for Scientific and Industrial Research (CSIR) which is governed by the Ministry of Industries, Science and Technology. The FRI is led by a Management Board, but the daily administration of the institute is the responsibility of the Director, Deputy Director and Division Heads.

The objectives of FRI are

(1) to carry out a coordinated program of applied research in the storage, processing, preservation, marketing and utilization of agricultural commodities with the aim of contributing towards the development and improvement of Ghana's food industries and increasing productivity;
(2) to advise the government in planning and implementing its food policy; and
(3) to do all such other things as appear to the CSIR to be relevant or conducive to the attainment of all or any of the above objectives.

Areas of research and development involve multidisciplinary approaches in cereal processing and preservation; grains and legumes processing and preservation; fish and meat handling, processing and preservation; root crops processing and preservation; oils and oilseed processing and preservation; storage of stable food crops and other perishable commodities; extension of methods for food preservation; and solar energy technology and application. This is an impressive research program that is benefitting Ghana.

In addition to research programs, FRI conducts support or consultant services for industries and national and international government organizations. These include the following areas of food science and technology:

(1) meat technology - processing, preservation and product development;
(2) fats and oils - deodorization of Shea butter and mayonnaise processing;
(3) cereal technology - bread, biscuit processing and machinery development, and cereal grain quality evaluation (including maize, rice, wheat and sorghum);
(4) weaning foods - formulation and production of cereal and legume-based foods;
(5) fish technology - homemade sardines, fish crackers and kippers, fish salting, drying, smoking and canning processes;
(6) cassava processing - preparation of gari, tapioca and glucose syrup from cassava and dehydrated cassava flour;
(7) fruits and vegetables processing - drying of okra, garden pepper and ginger, and preparation of fruit juices, jams and marmalades;
(8) storage technology - storage of maize, fresh cassava and tomatoes; and
(9) solar energy technology and application - design,, construction, installation and operation of various crop dryers and other solar drying devices.

The FRI's technical services link the institute's programs with government and private organizations interested in food science and technology. These activities are "Services to Industries," and "Information Dissemination Services." At the request of the food industries, food samples are examined for their specifications or for assessment as to their suitabilities for human consumption. This includes chemical, microbiological and organoleptic analyses. The results of FRI research activities are disseminated to the public by the Scientific Information Division which has documentation-library services, scientific information and publication-sharing and public relations. Available are a FRI Newsletter, and Annual and Technical Reports,

Internal seminars for the food industry and other user agencies, feature articles in newspapers and journals and participation in radio and television discussion programs are presented by FRI. All of these activities communicate research developments, and transfer of technologies to industries, government regulatory agencies and extension services, farmers and consumers.

The FRI library has about 300 books on food science and technology, nutrition, agricultural economics and marketing. There are also a number of periodicals, scientific journals, newspapers and magazines. The library maintains programs with both foreign and local bodies such as FAO, IDRC, CTFRI, UST and the Crops Research Institute. The library serves as a reference center for students, chemists, lecturers, farmers, industrialists and homemakers. The FRI offers a number of training programs and facilities in food science and technology. These include a three month program for personnel in food processing and food quality control organizations; National service training for graduates and diplomats up to one year, and training for undergraduates in food science and technology, nutrition, agriculture and biochemistry are available from the universities for up to three months.

While at FRI, Peanut CRSP and its support of ongoing and future research studies were discussed with Mr. Niels Hauffe, Consultant, World Bank. The facilities and equipment needs of FRI are under study by this world organization for additional funds. The World Bank has done much to support FRI in renovation of laboratories and supplying important equipment-instruments.

The World Bank has funded an upgrade of laboratory facilities for the Microbiological Unit, FRI. Plans are to modernize the analytical laboratory and an under-utilized facility as an expanded information center and library. The Danish International Development Assistance (DANIDA) program and the government of Ghana, supported purchases of a high pressure liquid chromatograph (HPLC)

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instrument and inoculation room, preparation room, autoclaves and incubators for the modernized microbiological laboratory.

The UST, Kumasi, Ghana, was officially inaugurated in 1961; the original school was opened in 1951, as the Kumasi College of Technology, Ghana. A Department of Agriculture opened in 1953, providing courses for the Ministry of Agriculture. Today, the university has five Faculties, two Schools, three Institutes and one College, all of comparable status headed by Deans/Directors. The Faculty of Agriculture comprises the Departments of Agricultural Economics and Farm Management, Agricultural Engineering, Animal Science, Crop Science and Horticulture. The faculty consists of 42 Lecturers, four Associate Professors and three Technical Instructors; two visiting lecturers are included. Most of the faculty are Ph.D.-degree. Bachelor's degree (4-year) in Agriculture and Diploma (2-year) programs in Tropical Horticulture are awarded; a Bachelor of Science degree is awarded in Agricultural Engineering in conjunction with the School of Engineering. A Faculty of Science comprises the Departments of Biological Sciences, Biochemistry, Chemistry, Physics, and Mathematics and Computer Science. This Faculty consists of 63 Lecturers. Four-year degree and two-year Master's degree programs are provided. These two Faculty present an impressive array of courses required to receive degrees. Of the total, 4157 (1992/93 year) undergraduate students enrolled at the university, 316 are in Agriculture, 739, Science. The percent of female students is 12% Agriculture, 16% Science, and 18% total enrollment. The university Library stocks about 150,000 volumes and subscribes to over 1,500 periodicals. Faculty Libraries add another 47,000 volumes.

The Vice-Chancellor, Professor Amonoo-Neizer, UST, Kumasi, was featured in The Ghanian Chronicle, January 27-30, 1994, accepting an assembly of sophisticated laboratory equipment worth over 280,000 Swiss francs, for UST from Switzerland. The article, headlined "Swiss Govt. Gives Equip. to UST," stated that the equipment benefits the Chemistry, Physics, and Engineering Departments, and the Faculty of Pharmacy. The contribution is from the Swiss government to higher learning in Ghana under a bilateral cooperation between the two countries. The equipment is installed with the assistance of the Societe Generale Surveillance (SGS) and includes rotovaporators, XT-recorders, testers, amplifiers, computerized analyzers, digital balances and pH meters plus accessories. The donation added to the Swiss government's current commitment and assistance to Ghana. The newspaper article stated that the objectives of the Swiss foreign policy in Ghana are preservation and promotion of peace and security, promotion of democracy and social well-being, reduction of social disparities and protection of environment and natural resources.

Recent funding in addition to Peanut CRSP has come from the African Development Foundation (ADF), to develop an integrated plant disease control program, and OPEC Fund for International Development Grant, to assist in establishing a Plant Disease Diagnostic Laboratory at UST. In spite of these grants, equipment needs include light microscopes, growth chambers and incubators and autoclaves. Professor Amonoo-Neizer, Vice-Chancellor, UST, confirmed these observations and expressed the importance of granting agencies, both national and international, like Peanut CRSP, to the university's faculty and programs in support of Ghana's goals. He pointed out that availability of such equipment occurs through collaborative involvements among departments, e.g., Department of Crop Science, Department of Microbiology and Chemistry Department for microbiological and analytical chemistry (for pesticide, insecticide and aflatoxin research) needs. A HPLC and an UV infrared Atomic Absorption Spectrometer are available for mycotoxin analyses and characterization of natural fungicides in the Chemistry Department. Collaborations with the School of Medicinal Science allow for epidemiological studies on aflatoxin effects in body physiology, and with the Pharmacy Department, feeding studies with animals. Plant collections and travel are done with Peanut CRSP funds. It is up to the faculty to take the initiative to search out funding sources and seek out multidisciplinary approaches to research problems and support in the university.

ICRISAT is the main international agricultural institute supporting Ghana's programs. Its regional peanut program in Niamey, Niger, has focussed on diseases and insect pests resistance, drought resistance, plant nutrition, varying maturity periods and breeding of stable high yielding varieties for specific adaptation and consumer preferred characteristics such as high oil content and good table quality (specifically confectionery peanut). Some successes are available to the farmer.

Institutional Development-Burkina Faso: The 1989 EEP noted that Dr. A. S. Traore, PI of Peanut CRSP in Burkina Faso, was the only member of the faculty at UO with experience in food science and technology. Dr. Traore, now President of the university has much responsibility. However, since 1989, the students then identified for graduate programs in food science have gone on to receive degrees and are supporting research at the university. Many of these students are also in high level industry positions and remain dedicated to support of Dr. Traore and his programs at UO. An Assistant Professor, Food Technologist, Laboratory Technician, two cooperating Food Technologists and two Graduate Research Assistants are part of the Peanut CRSP. Collaborative efforts include two Entomologists and a Phytopathologist. These additions, and increased collaborations with the food industry have been greatly strengthened by the Peanut CRSP in Burkina Faso.

Institutional Development-AAMU: Research at AAMU is adequately supported with laboratory facilities, instruments and equipment. Food and nutrition facilities include dairy products, cereals and legumes, breadmaking-bakery, meat processing, taste panel-food preparation and remote sensing laboratories. Other laboratories include a pilot plant to support postharvest research, provide technology transfer capabilities and commercialization of food products; e.g., cottage industry development in the U.S. and entrepreneurs in host countries. Commercial-scale extrusion equipment is allowing development of new foods with unique functional properties and shelf life. Close collaboration is occurring between scientists working on breadmaking properties of grains and legumes and plant breeders. The rapid capillary column technique is being used for detection-quantitation and monitoring of aflatoxins in peanut. The instrumentation laboratory is well equipped with HPLC, GC and gel electrophoretic instruments for compositional analyses. A scanning electron microscope is used for structure-function properties of foods.

A significant portion of Peanut CRSP funds at AAMU is used for training graduate students from host countries and the U.S. A newly approved Ph.D. degree program in the Department of Food Science is now in place. A USDA-supported Capacity Building Grant for educational strengthening is adding new Ph.D. level graduate students and faculty to the department. Faculty and universities (U.S. and host countries) are benefiting from publication of data in dissertations/theses. The PI works closely with the graduate students.

Adequacy of Science-Technology Merits of Program-Ghana: In Ghana, peanut research has been reported since 1926. The first concerted effort on variety development began in 1949, in northern Ghana with the collection and analysis of local and introduced varieties. During the 1960's, newly introduced varieties were screened in northern and southern Ghana in multilocational tests. In 1986, the Ghana Grains Development Project included peanut in its research program. The results have been the following:

(1) The presence of large cultivar by location collaborations in field trials. Factors included in these studies are adaptation, stability, yield advantage as important criteria for selecting superior breeding lines.
(2) Development of early/maturity lines for areas with short growing seasons or where grown under residual moisture conditions.
(3) Noting that foliar diseases, especially early and late leaf spot, are important yield-limiting factors in the relatively humid ecologies in Southern Ghana.

(4) Insect pests, especially aphids, are vectors of the virus that causes rosette diseases; and termites cause considerable damage.

Areas of high priority production (agronomic - breeding) research in Ghana include:

(1) the influence of environmental factors on disease development;
(2) monitoring and assessment of Aspergillus flavus and aflatoxin contamination of peanut seed and products;
(3) drought tolerance/resistance screening;
(4) biological - nitrogen fixation as affected by agronomic practices; and
(5) identification of peanut varieties suitable for intercropping with cereals and root-tuber crops and coconut trees.

Goals have been set to have impact from these priorities in the next five years. The major peanut production areas of Upper East and Northern Regions of Ghana and the transition environmental zones of Ashanti, Brong-Ahafo and Volta regions are expected to benefit from these goals.

In Ghana, peanut is predominantly (85%) grown in the northern parts of the country. National production is estimated at 115,000 tons, with an average yield of 0.9 ton/ha. Peanut seed is commonly processed to oil and the rest consumed as food. Among the major constraints to increased production are unreliable rainfall, low inherent soil fertility, low yielding varieties, pests and diseases, and poor socioeconomic conditions.

Multilocational yield testing in Northern Ghana resulted in the release of varieties Spanish 207-3, MK383, No. 146 and Manipintar in 1960. In the 1970's, six more were released including Florispan Runner, Natal Common, Shitaochi, Tirik, Philippine Red and Kumawi. The yields of these cultivars were between 700 and 1900 kg/ha. Maturity occurred in 90 to 130 days. Further advancements have been limited due to a lack of extension and seed producing institutions, poor crop husbandry practices constraining production and a lack of continuity of research programs due to inadequate funding and trained personnel.

Time of planting follows the general cropping seasons which begins in June after establishment of the first rains. In the south, planting is done in early March-April during the major planting season, and early September, a second but smaller cropping period. Although the use of the hoe and cutlass for tillage operations is common throughout Ghana, there is considerable demand for bullock plows, tractors and other farm implements among peanut growers farming large acreage.

Socioeconomic constraints include:

(1) Lack of agricultural credit facilities for acquiring improved seed, fertilizer and agricultural machinery, etc., by farmers.
(2) Small farm size and fragmentation of holdings tend to cause scarcity of land for peanut.
(3) Unfavorable land tenure systems retards production.
(4) Lack of ability to purchase and maintain farm equipment.
(5) Poor transportation and communication facilities.
(6) Poor marketing facilities and pricing structure.
(7) Poor living conditions of the farmer force them to deter from adopting improved technologies.

Peanut research is mainly conducted at the Crops Research Institute's stations at Kwadaso, the institute's headquarters in the south, and Nyankpala located in the north of the country. The current research activities have been aimed at developing production technologies to raise the productivity of the farmers.

Mature peanut, following harvesting and drying are stored in jute bags and kept in barns built of mud or thatch. The bulk of the peanut crop each season is consumed in six months after harvest. In humid areas, particularly in the forest areas, stored peanut are infected by aspergilli species.

Peanut is marketed locally. The Ghana Food Distribution Corporation (GFDC), a government marketing and distribution organization buys peanut from farmers, then stores and later resells them to consumers. This organization handles a small portion of the peanut. Most farmers depend on middlemen and women for market sales. Like GFDC, these traders buy the peanut, then transport and sell them at urban centers.

The bulk of the peanut is hand labor-processed by local women for vegetable oil. The defatted meal is fried to make a local food called "kuli-kuli." <u>Noted</u> is that <u>not</u> enough peanut is produced to keep oil crushing mills operating continuously, hence, profit margins are narrow. Peanut production needs to be increased to improve continuous processing of peanut oil and meal; one objective is to make Ghana self-sufficient in peanut production. Peanut and maize flours are blended for weaning foods. Peanut paste from roasted kernels is used to thicken stews and soups. In the urban centers, salted peanut are roasted or fried in oil and served at gatherings. Very little of the meal goes into animal feeds. The hulls and empty pods are used as animal feeds.

Extension Services, Ministry of Agriculture, technology transfer efforts on peanut are confined mostly to seed production and supply. Currently, seed of Shitaochi and Manipintar are being multiplied by the Ghana Seed Company for distribution to the farmers. The extension services, however, have not done enough to educate farmers on improved technologies. More efforts are needed to educate farmers in Ghana on how to cultivate peanut efficiently in mixed crop systems.

In further discussions, the management team at FRI, Accra, emphasized a need to strengthen utilization of peanut research in Ghana. Finding of new diversified marketing outlets for peanut oil is needed. This includes expanded use of traditional foods and blending with other commodities to enhance protein composition, especially weaning foods. Agriculture engineering for improved postharvest technologies, extension services and technology transfer need to be strengthened in Ghana.

The peanut industry in Ghana is mostly small household operations, i.e., family shops selling traditional snack foods such as salted and roasted peanut. It is important that research programs improve the quality of peanut meal, after oil extraction, for food use. Products from the meal are mainly "kuli kuli," molded and fried defatted meal, "tunkusa," a partially defatted peanut butter paste, and "dzowe," a finely milled peanut and maize blended flour, seasoned and molded into balls. The planned food research program in Ghana, which is mainly conducted at FRI, is examining ways to improve and expand these technologies for cottage industry development. This includes blended products with high carbohydrate traditional foods made with cereals, maize and cassava. Efforts will strengthen collaborations between Cowpea CRSP and Peanut CRSP for expanded new and traditional foods with cowpea-peanut blended ingredients. These studies, coordinated by the newly instituted Peanut CRSP program in Ghana, further expand similar work initiated in the Philippines and Thailand. This further supports the need for a <u>utilization workshop</u> of Peanut CRSP and other CRSP program countries.

Ghana has a National Council of Women in Development (NCWD) program to assist women in various institutions to further their careers. However, few funds are set aside for this program. The researchers can have their salaries paid while pursuing all three levels of degrees; but unless there are funds for travel, housing and per diem, which are not covered in the support program, opportunities are limited without outside-of-Ghana resources. The FRI does not have a graduate student program. Support technicians are recruited out of secondary schools. If interested, the workers can pursue training opportunities, e.g., in Denmark and the U.S. for college graduates.

A news item in the Daily Graphic, Ghana's Biggest Selling Newspaper, Thursday, February 24, 1994, No. 13448, headlined "Government will assist women." The president of the 31st December Women's Movement gave assurance that the government will continue to assist women in their development efforts. New methods of assistance are being explored. Discussions are ongoing with banks in the country to assist women with loans. The Deputy Minister of Local Government and General Secretary of the movement suggested the formation of mobile banks to cater to women. These actions are helping women expand their businesses. Women are being trained how to save money and invest in businesses.

The FRI is mainly involved in research programs. Peanut CRSP has encouraged increased support for peanut research, which up until now has been a minor component of this institute's research program. In Ghana, peanut production is approximately 150-175,000 ha with yields averaging about 8-900 lbs/ha. Traders-buyers control on-farm production, buying and marketing the peanut crop. There exists on-farm processing by women (wives) entrepreneurs. This is an opportunity waiting to be encouraged and the basis for the FRI Peanut CRSP initiated in 1993 with AAMU.

The Peanut CRSP program outlined for FRI, has as its first phase, three objectives. They are:

(1) To determine through a field survey the existing traditional techniques for peanut butter production. A survey questionnaire, first tested in the greater Accra region to determine its applicability. Now proven, it is being applied in the 10 regional capitals and surrounding villages of Ghana to determine the traditional techniques used in peanut butter production; 100 respondents will be accumulated.

(2) To modify/standardize identified unit operations in the production of peanut butter to attain uniformity and reduce drudgery. The data obtained from the survey will identify processes used in peanut butter production, efficiency constraints and ways to maximize yields while achieving product uniformity and quality.

(3) To evaluate the quality of traditional peanut products. Traditional peanut products (peanut butter, tunkunsa, "kuli-kuli," dzowe, oil, roasted and boiled peanut) will be examined for nutritional-compositional value, including proximates, fat acidity and peroxide values. Microbiological analyses will include total viable counts, mold and yeast, coliforms, staphylococci and Salmonella. Tests for aflatoxins will be included.

In Ghana, small-scale local entrepreneurs are making traditional products such as sugar-coated and caramel-coated peanut and peanut cake, a coarsely ground and molded candy-like bar. Needed are packaging technologies to improve presentation and shelf-life of traditional products. The survey questionnaire will have an objective of identifying all traditional peanut products in Ghana. It will also be used to determine where in the pre- and postharvest system mycotoxin contamination is likely to occur. This work will be used to develop recipe brochures and workshops to train processors in the use of traditional foods. A similar effort is now underway on maize products and finding new outlets for these foods in Ghana. Economic and marketing analyses are being included in these studies and projecting ways to scale up entrepreneurial family scale ventures to businesses employing a significant number of people.

The administrative offices in Ghana have limited support for education-training programs, and some travel monies. A World Bank project, National Agricultural Research Project, assists research programs including education-training monies for researchers. The Peanut CRSP supports research efforts at FRI, Accra, and Crop Science Department, UST, Kumasi, to screen peanut and peanut products throughout Ghana. At FRI, the work is being done by food scientists and microbiologists. In Kumasi, a plant pathologist is collaborating with plant breeders and agronomists. Both research institutions are working closely together. Peanut butter, which in Ghana is a ground whole peanut paste with no additives other than an occasional incorporation of cassava or maize flours to increase yields, boiled peanut, roasted peanut and peanut blends with various cereals are available products being analyzed.

The peanut paste is mainly used for soups in the Ghanan home. Major mycotoxins evaluated include aflatoxins, zerealonin, citronin and other related compounds. In 1994, plans are to expand mycotoxin work to precursors of aflatoxins and fumonisins, a Fusaria toxin. A Danish project is examining various foods for aflatoxins. Early developing results show high aflatoxin contamination of peanut pastes. A Ghana National Committee was established to examine how serious the problem may be and determine safe limits. The Ghana government is also being influenced by the Nagouchi Memorial Institute for Medical Research, Japan. The Japanese are funding work on incidence of liver cancer including seriousness and degree of occurrence that may be related to aflatoxin contamination of foods.

At UST, Kumasi, Dr. Richard Awuah has developed five objectives for his attack on mycotoxins. (1) Determine degree of mycotoxin contamination in peanut and peanut products including aflatoxins from Aspergillus parasiticus and A. flavus and fumonisins from Fusarium species.

(2) Identify natural biologically active plant compounds, fungicides, that prevent synthesis of aflatoxins by aspergilli species, and/or inhibits growth of these fungi.
(3) Prevent or control mycotoxin contamination of foods by understanding regulatory processes of mycotoxin synthesis by fungi and how peanut-fungal interactions are involved in this regulation at the molecular level.
(4) Study the molecular biochemistry of aflatoxin synthesis.
(5) Develop rapid and simple assays for determination of aflatoxin resistant peanut cultivars or aflatoxin inhibitors degrading compounds from other plants.

It is shown that there are a number of African plants with compounds that affect toxin production. A simple test is needed to rapidly identify these compounds and their sources.

Adequacy of Science-Technology Merits of Program - Burkina Faso: Studies in Burkina Faso involve collaborative efforts among food scientists, plant breeders, entomologists, extension and nutrition services and especially, industry. These collaborations have greatly strengthened during the past five years, and will continue to grow in the future programs. Peanut CRSP has played the lead role in these developments.

Adequacy of Science - Technology Merits of Program - AAMU: The research at AAMU is increasing potential for utilization of peanut in new and existing foods. These experiments have been enhanced by the availability of adequate laboratory facilities and equipment in the U.S. that are not always present in the host countries. Efforts are underway to extend these research capabilities to FRI and UO and collaborating institutions for extension to entrepreneurs and farmers. An example is the plan to transfer an extruder from AAMU to FRI. Clearly, high protein peanut products will help to alleviate deficiencies due to limited meat supplies in Ghana and Burkina Faso.

Applicability of Research-Ghana: Work at FRI, Accra, is showing that adding peanut flour/meal to food formulas improves protein content. As FRI develops and sells its own research products and becomes commercially competitive, the private industries re-evaluate their own products and improve them, an interesting concept of technology transfer.

At FRI, sensory evaluations are done on new products for industries. These analyses include aroma, taste, color, consistency, texture and overall sensory quality. These efforts include strong assistance to industry in collaborative development of new food products.

At FRI, newly developed food products from research programs are advertised to the commercial community by the Commercial Unit, Department of Economics and Consumption, FRI. The private industry uses FRI's pilot plant for production of formulated foods. One company, Hagest Foods, LTD, Accra, Ghana, formulates a product HAG-WEANER, A High Protein-Energy Food, with ingredients of maize, cowpea and peanut meals in the FRI pilot plant. The formulation is similar to FRI-WEANER, a product of FRI. FRI researchers help entrepreneurs formulate products, conduct quality control training and design labels.

Food technologies including peanut ingredients developed at FRI are numerous. In the Weanling Food Products Unit, a commercial high protein weaning food, FRI-WEANER is available to consumers. The product's package and label was designed at FRI. Its ingredients are maize, soybean or cowpea and peanut meals plus a small amount of powdered milk. The label contains nutrition information (based on 100 g dry meal) as moisture (g), 4.6, protein (g), 17.5, fat (g), 8.6, calcium (mg), 220, phosphorus (mg), 239.1 and iron (mg), 9.2. Preparation is recommended as follows: Mix one cup of FRI-WEANER with one and one-half cups cold water to prepare a smooth slurry. Stir into one cup boiling water and allow to cook for 5 min. Add sugar and salt to taste.

Another product developed at FRI is MANNA CEREAL FOOD, produced by EEL-Shennaut Co., OTD., Takoradi, Ghana. This is a high protein food that is very nourishing and palatable containing maize and cowpea meals, sugar and salt. Peanut meal is either added or used as a substitute for cowpea meal. The nutrition information (based on 100 g dry meal) is moisture (%), 4.5, protein (%), 13.8, fat (%), 4.8, calcium (mg), 55, phosphorous (mg), 217.6, and iron (mg), 6. Estimated calories is 371.2. Preparation is as follows: Pour MANNA CEREAL FOOD into desired volume of hot or cold water. A little water may be added while continuously stirring to make a porridge. The product can be enjoyed in a cold drink form as well. For infants: always allow to boil for five minutes. Note the food safety statement made on the label when used for feeding to infants.

PEACOMIX, a high-protein instant cereal food (for adults and children) is now produced in Ghana by Lin Food Products, LTD., Tena. This product's ingredients are maize, cowpea, peanut, sugar and salt. Preparation is done by mixing the food with cold or hot water to the desired consistency. Milk may be added especially in the case of children. Nutrition information includes protein (%), 13.2, fat (%), 9.0 ash (%), 1.0, carbohydrates (%), 73, moisture (%), 2.9, calcium (mg; 100 g) 32, phosphorous (mg; 100 g), 122.1, iron (mg; 100 g), 4.3, and calories, 418.2.

Extrusion technology is being examined for use with PEACOMIX. This product is extruded while heat puffed under pressure, then milled into a crumbly textured product with very acceptable food properties. Other extruded products included in future plans are noodles and other macaroni products. Peanut CRSP should bring together researchers at Kasetsart University, Thailand and UGA for the development of these technologies in Ghana, Africa. Opportunities exist for advancing extrusion technologies to village cooperatives, family entrepreneurs, working together to develop new food businesses. A cooperative could invest in an expeller-extruder for new product development and marketing.

At the Department of Nutrition and Food Science, University of Ghana, a seed oil screwpress expeller was modified and converted to an extruder. This is using technology and equipment endemic to Ghana in cost effective applications for new foods. The modification involves simple closing of the expeller pores to force pressed materials to extrude from the end of the apparatus. Temperature, pressure and time measurements are studied in the formulation of newly structured foods. The work with the converted expeller-extruder is funded by the Cowpea CRSP to expand cowpea utilization. The work is a collaborative study between the University of Ghana, and the Department of Food Science and Technology, University of Georgia. A student earning a M.S. degree in food science is funded by the project. Specialized products include extruded dehulled whole cowpea meal and not cracked whole corn kernel meal; both processes include heating during the extrusion process. Efforts are underway to work with peanut via Peanut CRSP jointly with FRI. Peanut CRSP monies would be used to support a M.S. degree level graduate student in this joint Cowpea CRSP and Peanut CRSP project. One product identified is an extruded meal, ground, and then used in porridge and bread. The time is right for development of extrusion technologies for new foods. Demonstrations are underway to show fabricators how to manufacture the converted expeller-extruder.

An interesting study at the Department of Nutrition and Food Science, University of Ghana, is showing that steam-treated cowpea, when stored on-farm, are insect resistant. Little or no insect damage occurs during storage for three to four months. Evidently, the steam treatment releases biologically active chemicals on the surface of cowpea with insect resistant properties.

The work at the Department of Nutrition and Food Science, University of Ghana, is focused on finding new uses for equipment such as dehullers and mills, endemic to Ghana for cowpea applications. The objective is to utilize locally built equipment via simple inexpensive modification for multiple use purposes by villagers and farmers. It is important to note that there was little interest in sophisticated equipment.

Cowpea CRSP has similar problems as Peanut CRSP in that communication and collaborations among production and utilization researchers could be strengthened. There is need for enhancing utilization and marketing collaborations in the development, technology transfer and sale of new commodities.

The first phase of the Peanut CRSP at FRI, Accra, Ghana, has focused on the survey and collection of peanut products from the growing regions to analyze for mycotoxins. Initially, the analyses were completed by TLC, now they are done by HPLC, via an instrument purchased with funds from the DANIDA program. It was based on the finding that peanut butter samples were high in aflatoxin that instituted the successful effort to obtain funds from Peanut CRSP. The collaborative efforts include Drs. Nancy Keller, Texas A&M University, College Station, Texas, U.S., and Dr. Richard Awuah, mycologist, Department of Crop Science, UST, Ministry of Education, Kumasi. Dr. Awuah was working on plant extracts from selected endemic plants in Africa that behave as natural fungicides. This attracted the interest of Dr. Keller to utilize these extracts to control aspergilli and aflatoxin contamination on peanut and initiate a collaborative program between the two universities.

Dr. R. Awuah, UST, showed that a steam distillate from leaves of West African plants, Cymbopagon citratus completely inhibited the growth of four fungi, Ustilago maydis, Ustilaginoidea virens, Curvulara lunata and Rhizopus sp. Hot water extracts from fresh leaves of Ocimum gratissimum and Chromoleona odorata, and dry fruits of Xylopia aethiopica, reduced radial growth of these fungi by 10-60%. This investigation into plant extracts with activity against phytopathogenic fungi is a first step towards developing potential botanical fungicides from West African plants.

Further studies by Dr. Awuah showed that a crude steam distillate from Ocimum gratissimum sprayed on infections of coca pods moments after inoculation with Phytophthora palmivora completely inhibited the pathogen and blackpod lesion development in 75% of the cases. Disease suppression obtained with the extract was comparable to that obtained with a chemical fungicide, Kocide 101 suspension. In the field, the O. gratissimum extract also suppressed lesion development although to a significantly lower extent in comparison to Kocide 101. Sporangia of P. palmivora from sporilating blackpod lesions on both detached and non-detached pods lost their infectivity within one hour of treatment with O. gratissimum extract on pods. However, this effect was lost within three hours of application. Thus, despite its in vivo effectiveness as an eradicant, the O. gratissimum extract, in its present form, has limited utility as a protectant fungicide. Work is now underway to identify the compound(s) with fungicidal activity.

Dr. R. Awuah, UST, showed that the steam distillate from O. gratissimum inhibited aflatoxin synthesis in A. parasiticus. The inhibition prevents accumulation of the norsolorinic acid intermediate in aflatoxin production. A rapid assay has been developed with mutants that cannot continue synthesis of this intermediate, hence it accumulates and is readily detected by a color change in the culture. Any inhibition that prevents its accumulation can be determined as with the O. gratissimum extract.

With natural fungicides, on-farm treatments would prevent aflatoxin contamination of peanut seed. Varying degrees of applications could be developed since in West African plants, extracts have been shown to be capable of immediate inhibition, while others vary in degree of ability to interfere with aflatoxin biosynthesis. In any case, these studies are taking advantage of endemic plant materials - doing control by nature's way. The concept of using natural fungicides follows that used by pharmaceuticals for medicinal control of human diseases and cancer from plants. The potential of natural compounds in controlling toxin production in foods is limitless.

Dr. R. Awuah, Department of Crop Science, UST, Kumasi, Ghana, is collaborating on the Peanut CRSP with Ms. Kafui Kpodo, FRI, Accra, Ghana, to determine the degree of aspergilli-aflatoxin contamination in peanut and peanut products. Values averaging 5-6000 ppb were being found in peanut products. When farmers separated out quality peanut, aflatoxin levels were less than 20 ppb. There is a need to educate peanut processors and consumers about the aflatoxin problem; they are not aware of the extent of this problem. Food safety is becoming a concern in Ghana, as the news media learns about the issues and headlines them. Except for the monies from Peanut CRSP to study the degree of aflatoxin contamination in peanut products, research grants for this type of work are limited at this time.

The new Peanut CRSP is pinpointing where in the production chain, aflatoxin contamination occurs. Work is following the peanut from the field to the shelf. This funding is opening an entirely new area for work on peanut production and marketing in Ghana. The program enhances peanut research in the same way other support (UNIDO) strengthens efforts with maize, and sorghum for beer fermentation studies to replace malt, a high cost import commodity. These efforts include workshops and support of extension services to expand such technologies in Africa.

The government of Ghana is aware of the aflatoxin problem and has set up a committee to examine this issue. This was initially initiated in maize with support from Denmark. Peanut CRSP is now strengthening this work by extending the studies to include peanut. The Danish studies are focused on helping the farmers, whereas, Peanut CRSP is looking at production, storage, handling and processing. Noted was that processors are not aware of the aflatoxin issue; in fact, they do not understand that aflatoxin is a health issue, and hence a new education program is needed. To get cooperation in sample collection at the various steps, incentives, such as money or special gifts are needed.

Since the Peanut CRSP supported studies began to determine the degree of aspergilli-aflatoxin contamination, an awareness of this problem has been kindled with the housewife entrepreneurs. These businesses have been encouraged to pick out the off-colored, damaged and moldy peanut. However, rather than thrash these peanut, they use them in paste for stew-soup thickener. Obviously, this does not solve the aflatoxin problem in these households.

Applicability of Research-Burkina Faso: A visit to Societe des Huiles et Savons du Burkina Citec Huilerie, a company located in Bobo-Dioulasso that processes oilseeds for oils and soaps proved to be a very valuable meeting. The Directeur d'Exploitation, Mr. Ouedraogo Abdoulaye, and his staff were very informative in highlighting the high priority of the industry processing oilseeds, especially for peanut, in Burkina Faso. Citec Huilerie is a state operated company willing to explore new venture investments. In Burkina Faso, efforts are underway to turn over state operated companies to individual or group investors and move toward a free market society. The reason for meeting with officials at Citec Huilerie was to learn more about the processing of their high protein (20-25%) peanut product, La Pate d'Arachide, trade name, Tigadegue. The company was annually producing and marketing 900 tons of this product, but recently had to suspend production and sales because of higher costs compared to similar products produced by entrepreneurs and sold in the local marketplaces. Tigadegue, a peanut paste produced from the screw-pressed meal after oil extraction, performs and tastes similar to traditional products produced by housewives in the home and used in soups and sauces. The company was emphasizing quality or biological safety (microbiologically-free) and aflatoxin-free in the sale of its product. Also emphasized was that the product had 100% peanut and high protein nutrition. Products sold in marketplaces did not have this quality and contained corn and sorghum meal. The major reason for high cost was the packaging of the product in cans purchased from France. Also, during the discussions, other problems surfaced, packaging size and lack of diverse uses for the peanut product. The containers are too large for the amount used in average households to make soups and sauces, and subsequently waste occurs. If other uses could be found for the product, then the amounts packaged would be completely used by families, and possibly warrant the cost. Hence, ongoing collaborative studies were being expanded with researchers at UO from aflatoxin analyses to new packaging technologies.

The discussions surfaced the observation made by Citec Huilerie workers that children were eating the peanut paste product on bread like peanut butter in the U.S. This observation, along with emphasis on quality and nutrition surfaced during the discussions as an approach that needed further research studies at UO. Presently, emphasis at UO is on finding new packaging technologies and expanding sale of varying packaged quantities to better meet the needs of the consumer in Burkina Faso.

The investigations on packaging have been with a local plastic package-making company, Fasoplast, in Bobo-Dioulasso. One problem is storage of the plastic package in the warm climate of Burkina Faso. Also, to maintain control of microbiological contamination, the processed product would have to be packaged while still at high temperatures. These conditions melt the plastic packaging. Other problems include shelflife, where increasing acidity and lipid oxidation of the peanut paste causes off-flavors during storage in the plastic containers. Ongoing experiments by researchers at UO with Fasoplast and Citec Huilerie are examining thicker plastics that could withstand 90 C temperatures of the peanut paste during packaging.

Another answer to Citec Huilerie's problem is the need to find new uses that would attract sales for Tigadegue. Noted was that the peanut paste was processed to one texture level, a coarse ground meal. If children were finding this coarsely-ground product acceptable as a peanut butter-like spread on breads, what would they do with a much more finely ground food? This discussion was explored with much enthusiasm and expanded further at the thought of flavoring the product with fruit marmalades, mangoes, strawberries, papayas, etc. Also, the idea of formulating a product that could be used in weaning foods was discussed. Weaning foods come from France and are expensive. These product ideas were accepted as high priority research approaches to diversify utilization of Citec Huilerie's peanut paste product and should be supported by Peanut CRSP via UO.

A visit was made to Citec Huilerie's peanut paste processing plant. Presently, this plant is shut down because the product is not marketed. However, it is ready for operation as soon as modifications to packaging and expansion of product diversity are developed to increase profitability and sales occurs. The processing plant is a Spanish built ground meat processing facility adapted for peanut paste manufacture. Hence, the diversity of peanut paste texture and product variation is limited only by the capability of the meat grinding step at the end of the process. This last step is where research work should be conducted to diversify the grinding capability for acceptable textures of peanut paste products. Possibly replacing this meat grinding equipment with that having specialized texturing capabilities for producing diversely formulated products can open new market opportunities, once they are identified. The Peanut CRSP project for Western Africa has the properly identified objectives in utilization to overcome the constraints keeping this program from becoming reality.

The project "An Interdisciplinary Approach to Optimum Food Utility of Peanut in SAT Africa, coordinated in West Africa under Dr. Alfred S. Traore, UO, has done much to advance peanut science and technology. Studies have been on the assessment of biological parameters of peanut pastes sold in Burkina Faso; aflatoxin contamination of peanut and peanut products; aflatoxin contamination of stored peanut and the effects on selected physicochemical properties; possible role of aflatoxin-contaminated peanut and peanut products in liver cancer; and isolation-characterization of Aspergillus flavus-aflatoxin contamination and growth inhibiting effects of Allium sativum extracts.

The results of these studies have educated the people (consumers, sellers) of Burkina Faso about the problems of microbial-aflatoxin contamination; Citec Huilerie processed peanut pastes have become the reference of quality (aflatoxin-free) for all products in Burkina Faso; and other microorganisms, bacteria (Coliforms, Staphylococci, Salmonella, Shigella, Clostridia) and yeasts-molds have been identified in peanut products and sellers-manufacturers educated in safe processing procedures as used by Citec Huilerie.

To reinforce the need to carefully handle and process peanut was demonstrated at UO by the finding with thin layer chromatographic analyses of chloroform extracts that aflatoxins B_1, B_2, G_1 and G_2 were present at levels greater than 250 ppb in 14 to 43% of peanut samples from two selected cultivars (Boanga, Wobgo). Peanut samples from these two cultivars were sampled during an 18-month storage period and analyzed for aflatoxins, and changes in seed moisture, aflatoxins, proteins, lipids and sugars. The losses in nutrient composition corresponded with increases in aflatoxins. Data showed that increased water content and lipid metabolism were closely correlated to aflatoxin contamination and growth of aspergilli species. These levels of aflatoxin contamination were assumed to be contributing to the increased presence of liver cancer in Burkina Faso. Allium sativium extracts (20%; crude or steam distilled) inhibited growth of Aspergillus flavus in culture studies at 30 C for 7 days.

Roasted peanut, commonly known as marba-tigue, are widely marketed in Burkina Faso. In Ouagadougou, Burkina Faso, large numbers of women derive the greatest part of their incomes from selling this product. The preparative processing steps, packaging in polyethylene bags, storage and marketing of the product were studied relative to nutritive value, moisture uptake and oxidizing reactions, including peroxidase activities. Nutrient changes noted included losses (digestibility) of water-soluble proteins and lysine during water soaking and roasting. Garlic extracts improved keeping quality of marba-tigue. Soaking peanut in water reduced peroxidase activity. And adding milk and sugar to sweeten peanut, and reduce off-flavors, formed a product enjoyed by children. These studies provided an opportunity to find solutions to improve quality and nutritive value of peanut and peanut products; especially to improve production of marba-tigue.

"Toe," a porridge made from whole sorghum, corn or millet flour is a major food in West Africa, especially Burkina Faso. This food is low in protein composition. Studies were conducted adding defatted peanut flour (source, cultivar Sofivar) to enrich protein content of "Toe." Adding defatted peanut flour increased protein, fat and ash levels and reduced total sugar and energy levels. Sensory evaluation showed a preference for "Toe" fortified with 10 and 20% peanut flour. In 1993, further studies led to the production of an acceptable "Toe" fortified with 20% partially defatted (25%; screw pressed) peanut flour. Similar studies, with comparable results were conducted with the cereal-based weaning food Vitaset. Adding up to 20% defatted peanut flour improved protein composition of infant diets.

Applicability of Research - AAMU: At AAMU, the importance of continuing research on the development of new nutritious, high quality food products based on combinations of cereals (such as rice and sorghum) and peanut was emphasized. A model system, Idli (black grain and rice-based staple food prepared by steaming a fermented batter), a breakfast food consumed in the southern part of the Indian subcontinent and similar to "Toe" and "Kisra," was used as the model system. A new product was developed by using sorghum instead of rice, and supplementing with peanut (up to 30% defatted peanut flour). Adding peanut, decreased moisture content and increased protein levels up to 63%. Textural properties of the peanut supplemented product were similar to those of Idli. Fermentation increased viscosity of batters and also enhanced the degree of pseudoplasticity. A highly nutritious sorghum-based, peanut supplemented fermented food with acceptable organoleptic and textural characteristics, was developed for utilization of sorghum and peanut which are commonly grown in Burkina Faso and Ghana.

Studies on identification of compounds in peanut that contribute to flavor were studied at AAMU. This showed a n-methyl pyrrole was associated with musty off-flavors and found to be high in selected Texas grown cultivars. Data from these studies further reinforce the need for food researchers and plant breeders to work together and screen early developing breeding lines and germplasm accessions for these off-flavor compounds. The objective would be to determine the concentrations of objectionable flavor defects and to select those varieties having desirable flavor profiles.

Observations-Strengths and Recommendations: Note - Weaknesses are not separately defined in this report. Instead, all observations, including strengths are presented with ways to further add to the research studies of an already strong program.

In Africa, Peanut CRSP should emphasize three areas of research programming, which each should be strategically located to reduce duplication of effort. Developments then could be technologically transferred to the other countries by Peanut CRSP. These are:

(1) Production-plant breeding, agronomy and entomology.
(2) Mycological control-naturally occurring fungi growth suppressants and toxin inhibiting compounds from plants endemic to West Africa.
(3) Commercialization-postharvest handling, storage, processing, packaging and marketing.

Number (2) is a new emerging thrust for Peanut CRSP to support the research program in West Africa. With emphasis on pharmaceutical companies to find new natural sources of medicines and drugs from plants, this same emphasis should be with natural compounds to control pathogenic microorganisms and improve food quality.

By placing Dr. R. Awuah, UST, Kumasi, Ghana, on the Peanut CRSP, collaborative studies with the plant breeding program at the Agricultural Experiment Station, Nyankpala, have been encouraged. Until this occurred, plant breeders have mainly focused on developing high yielding peanut varieties. Now they have become aware of the aspergilli-aflatoxin problem. This also links the breeders to the utilization program at FRI, Accra, Ghana. Similar observations can be made with the U.S. institutions, AAMU and Texas A&M University, working on utilization and mycotoxin research programs linked to Peanut CRSP, respectively. Hence, Peanut CRSP, via the new Ghana project has linked research on peanut from the farm to market via efforts to control aspergilli-aflatoxin contamination. This work is also examining Fusarium sp and fumonisin toxins contamination.

Biological control technologies for aspergilli-aflatoxin control may be more appropriate for subtropical-tropical regions of the world where constant rain and humidity make it difficult to maintain controlled and inexpensive storage conditions. Moreover, because of limited financial resources, only simple cost-effective technologies can be realistically afforded. Obviously, the ultimate need is aspergilli-resistant peanut cultivars. This can only be thought of as long range technologies. In the meantime, low cost limited controlled handling-storage facilities are being developed. These developments linked to biological control or spray technologies may be the answer to improving quality of peanut and other commodities including maize, cereals, cowpea, etc. All concepts would be indigenous to developing countries including storage facilities and plant inhibitors-suppressants. Attempting to transfer technologies/concepts from developed countries is not always in the best interest of the developing countries. Let the developing countries find new ways of solving their own problems; sometimes these breakthroughs may be useful in developed countries. A link should be developed among the UO, Ouagadougou, UST, Kumasi; FRI, Accra; AAMU, Normal, AL; and Texas A&M University, College Station, TX (Burkina Faso, Ghana and U.S. institutions) through Peanut CRSP to form a multidisciplinary team of food scientists/technologists, food microbiologists, mycologists and agricultural engineers interrelating biological control, handling and storage technologies for quality-safe peanut and peanut products in West Africa.

Note: Peanut CRSP can extend breeding and agronomic developments in other countries of Africa, including Burkina Faso to Ghana without duplicating those research programs. The emphasis in Ghana can then focus on developing the biological control of fungi and their mycotoxins. Hence, Ghana would focus on improving the utilization of quality peanut and transfer these technologies to the other West African countries.

Regarding workshops and information transfer, Peanut CRSP and ICRISAT should join forces on utilization. There is a new effort to address strengths and weaknesses of ongoing food utilization programs, especially aflatoxin contamination throughout the peanut producing countries. For example, Peanut CRSP has supported efforts to complete surveys on peanut utilization in Africa and Southeast Asia. The reports of these studies should be shared with researchers in Ghana. The background information on design, conduct and data analysis of the surveys would strengthen the approaches taken in Ghana in the conduct of this project. Making the reports available would allow for Ghanan researchers to focus on the objectives and reduce errors made by the other projects.

The Ghana Peanut CRSP team is multidisciplinary including Ms. Kafui Kpodo, PI, Food Technologist with food mycotoxin and extrusion technology expertise (M.S. degree); Dr. Wisdom Plahar, Co PI, Food Science and Technology with emphasis on weaning foods; Dr. Nana Annan, Food Science and Technology with emphasis on processing and utilization of grains and legume-sorghum, cowpeas and wingbean; Dr. Hodari-Okae, Food Microbiologist; Mr. C.K. Gyato, Agricultural Engineer, design and manufacture of processing machinery--planting, harvesting, shelling, storage, handling and processing of peanut; and Mr. R.K. Adjei, Agricultural Economist, Socioeconomics. Note: Mr. Gyato should link his efforts through Peanut CRSP to work completed on peanut production-utilization machinery in Thailand and Caribbean countries. He should obtain machinery, and training in their use, from these countries and work to adapt them to the needs of the farmers in Ghana.

Peanut CRSP should play a lead role in organizing a utilization workshop that includes all food scientists and technologists working on CRSPs including cowpea, sorghum-millet, soybean, etc. This would afford an opportunity for all food researchers to share experiences on program planning strategies, problems encountered, ways of overcoming issues and achievements. Equipment and processing technologies could be shared as well as transferred to Ghana and Burkina Faso, as research tools are modified for local applications. Training in these developments would reduce duplication of efforts and speed advances. An excellent example would be the transfer of pre- and postharvest technologies for planting, growing, harvesting, handling and storage of peanut at Khan Kaen University, Thailand. Results of surveys conducted during the start-up phases of Peanut CRSP in Burkina Faso and Sudan to determine product uses for peanut in cities, villages and at the family level should be transferred to Ghana. As the food research program unfolds at FRI, Accra, and the survey of peanut uses is completed, including the degree of aflatoxin contamination in peanut products, efforts will expand to collaborations with breeders and agronomists. These collaborations will examine peanut for flavor, composition, nutritional and functional properties for optimum consumer quality and acceptance.

Plans are to transfer a newly Peanut CRSP-purchased extruder from AAMU to FRI, Accra, Ghana. This is recommended. The availability of this research instrument will allow for carefully designed experiments to formulate extruded foods under controlled pressure temperature and time conditions. The technology developed at FRI would identify the best conditions for quality food products that would be applied with the fabricated expeller-extruder, developed in the Department of Nutrition and Food Science, University of Ghana. Hence, more carefully designed and diverse extruded foods from this collaborative study would be made available to the consumer.

Citec Huilerie in Burkina Faso now has an idle processing plant that is capable of processing defatted peanut meal to paste at 500 kg/hr. The company would be willing to make the processing plant and support personnel available in a research project to diversify peanut paste uses by the UO researchers; the company has only limited funds available for research, hence the project would have to rely on outside monies such as Peanut CRSP. The support from Citec Huilerie would include availability of peanut meal, laborers to run the operations and assistance in modifying equipment and available parts. Peanut CRSP would fund small equipment purchases and UO researchers, including technicians and graduate students. Studies on plastic packaging should also continue between UO and Fasoplast. These efforts should also include studies at AAMU on exploring for new products, especially weaning foods, from screw pressed defatted peanut meal; these studies should include varying textural properties and their effects on functional properties for new food uses. Collaborations between these two universities should include finding the market niche for the new peanut paste (peanut butter-like) products; e.g., packaging size of products that would meet the needs of the consumer.

Near Citec Huilerie, is Savana Unite Agro Industrielle, a fruits and vegetables processing plant making fruit juices, syrups, concentrates and marmalades-jellies. Fruits and vegetables processed include mangos, apples, pineapples, guava, tamarin, papaya, lemon, grenadine, orange, tomatoes, etc. During the visit, the company was processing tons of tomatoes into juice and sauce-paste. Most fruits are from Burkina Faso. At UO, research studies are underway to explore processing of other fruits and vegetables. The technical director of Savana, Mr. Nana Vincent, was very interested in collaborative studies to blend various fruit marmalades with peanut paste; this followed discussions on the topic of diversifying peanut paste made at Citec Huilerie to meet new marketing strategies, specifically fruit flavored peanut butter-like products. Opportunities exist for expanded marketing of fruit flavored peanut products to neighboring West African countries including Nigeria, Tunisia, Libya, Niger, etc. It was agreed that these research ideas should include a collaborative study involving the two industries, Citec Huilerie and Savana, and UO and AAMU as a project funded by Peanut CRSP.

Note: The industry in Burkina Faso relies on marketing studies at UO before entering into management discussions and decisions to commercialize new products. There have been few marketing experiments in Burkina Faso, hence the food industry has identified this area as a high priority research need with the support of Peanut CRSP. The university needs to strengthen programs that survey market potential, determine economics and the capacity for the industry to develop the available process technology for new and improved products. Until this is strongly emphasized by the university, only small advances in peanut products, or any commodity, will occur led by the industries in Burkina Faso.

Technologies have advanced in handling, storage and processing of peanut in Burkina Faso, especially in Ouagodougou. Additionally, new uses and products have been developed. This has increased consumption of peanut and peanut products. Underway are studies to evaluate the socioeconomic impact of peanut in Burkina Faso.

(1) To evaluate the acceptability of peanut products from new processes including Marba Tigue, Sugar Nuts and Roasted Peanut with Milk.
(2) To develop applications for Allium sativum extracts in the control of aspergilli-aflatoxin contamination.
(3) To solve Citec-Huilerie's problems in the sale of their peanut paste product.
(4) To provide products of sorghum, millet and maize flours supplemented with peanut flour at Nutrition Centers.

Regarding (4), work is underway with Nutrition Centers sponsored by the Health Ministry to nutritionally improve presently available high carbohydrate flours (Missola, Kasona, Den-Mugu and Vitaline) by supplementing them with high protein peanut flour for infants. This is sorely needed in the protein-deficient diets of infants in Western Africa. Roasted and sugar-coated peanut products are processed mainly by women and sold in shops, markets and hotels. Assurance studies and educating these women in the importance of consistent flavor quality and packaging was completed with favorable results. Producers and sellers are willing to try new products and technologies as recommended by Peanut CRSP supported programs at UO. Research programs must continue on quality, price reduction, supply, packaging and markets. Efforts are needed to popularize the new technologies in the news media and via collaborations with non-government organizations, village associations-groups and social services. In the future, Peanut CRSP will continue to play a very important role in the success and expanded growth of these programs.

PEANUT CRSP EVALUATION REPORT: SOCIOECONOMIC IMPACT ASSESSMENT OF THE FIVE-YEAR EXTENSION 1990-1995

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PART I

Scope and Objectives of the External Evaluation Panel Review

A. Introduction

The External Evaluation Panel (EEP) is mandated component of the Peanut Collaborative Research Support Program (CRSP). The panel concept was agreed upon by the United States Agency for International Development (USAID) and the CRSP performing organizations' management entity--The University of Georgia. Historically, panels have been organized and have systemically evaluated the CRSP's performance. Those evaluations have been effectively executed. While prior evaluations have been effective, they were said to have fallen short of conducting relevant sociological and economic impact assessments. This EEP and final report were to be different. The socio-economic impacts were to be assessed.

The current external evaluation comes at a critical time, when AID's support base and budgetary capacities are bordering on being anemic. It also is conducted at a critical transition for the Peanut CRSP and for other CRSPs. Ten years have passed since the Peanut CRSP was initially funded and considerable support has been expended in hopes of capturing results from many years of promise(s). Therefore, this team tasks turned on not only evaluating impacts, but also as making critical recommendations about future directions.

B. Structure of the External Evaluation Panel

To achieve a comprehensive evaluation, and respond to earlier recommendations, it was decided that the panel (EEP) should have members who were practicing sociologists and agricultural economists. They would work in colleagueship with the technical scientists to "round out" the evaluation. The management entity achieved that milestone by building a panel of the following individuals:

- Dr. John Cherry, USDA/ARS, Food Technology
- Dr. Bo Bengtsson, Swedish University of Agricultural Sciences, Research Management
- Dr. Milt Coughenour, University of Kentucky, Rural Sociology
- Dr. David Hsi, New Mexico State University, Plant Pathology
- Dr. Robert Schilling, CIRAD-CA, Montpellier, France, Agronomy/Research Management
- Dr. Joe Smartt, University of Southhampton, UK, Genetics/Breeding
- Dr. Handy Williamson, Jr., The University of Tennessee, Knoxville, Agricultural Economics

The collective expertise of these panelists would allow for proper subject matter coverage and for encompassing the desired socio-economic impact analysis. Additionally, the group represents a tremendous body of experience in terms of years and geographic coverage. From the perspective of U.S. university involvement, the panel would also foster the perspective of the 1890 and 1862 land-grant institutions. Careful planning also permitted the team composition to adequately address the diverse interests of the several governments involved in the CRSP enterprise.

C. Scope of Work for the External Evaluation Panel

The evaluation task was to collect and evaluate data on Peanut CRSP:

(1) inputs,
(2) system and human capital development,
(3) research output-communication, and
(4) utilization of technology by clientele. The Peanut CRSP <u>inputs</u> include information (e.g., constraints, concepts, theories, etc.), financial and human resources. <u>System and human capital development</u> includes net-working and research capacity building of the Peanut CRSP itself as well as

networking (i.e., building relationships, not merely with other scientists and CRSPs) with various clientele (user) groups. On the human side this included the training of scientists and technicians. Research output-communication included publications, workshops, conferences, seminars, etc., for Peanut CRSP and/or other scientists and clientele. Technology utilization included information, technology prototypes (e.g., varieties released) and trained personnel obtained from the Peanut CRSP by clientele or other research systems, and the use of these "products."

A more detailed delineation of the EEP's scope of work as reflected in specific question sets, is included in Appendix. The foregoing merely served to provide the general boundaries of expectation faced by the EEP.

D. Scope and Limitation of the Socio-economic Inquiry

The Peanut CRSP is viewed as an information development and disseminating system. The major goal is enhancing "the potential of the peanut as a crop for human food and animal feed in development countries and the United States. While doing so it must contribute to increasing rural incomes and sustaining agricultural land" (Strategic Plan for the 1990's: 2-3). As a socio-economic system, the CRSP mobilized human resources and knowledge generating and communication activities to facilitate this goal. Information generated by the CRSP system has social and economic value as it can be used to enhance the capacity of (1) material objects, (2) humans, and (3) socio-economic organizations.

The goal of the Peanut-CRSP indicates that its effectiveness is to be measured by both the direct and indirect increase in material, human, and social values. Directly, the Peanut-CRSP builds host-country human, material, and social capacity in doing research, i.e., in cloning itself. More over, through the supply of information and/or prototypes, it directly increases the capital values, for example, of seed reproducers and of manufacturers of peanut products. Indirectly, through new technology and/or information provided by intermediate users, the Peanut CRSP aims to increase the capital values of farmer producers and others in the food sector. Moreover, indirectly, the Peanut CRSP aims to enhance the Sustainability of land resources as well as the well-being of consumers.

The evaluation task was to collect and evaluate data on research output-communication and utilization. The sources of data were: (1) project PIs, (2) research managers--U.S. and host country, (3) other researchers, and (4) extension agents or surrogates, media, seed reproducers, marketing agents, governmental agencies, etc. The data relate to all forms of research informed activity of CRSP scientists and CRSP programs: (1) goals and types of research activity including research publications, reports, news releases, workshops, seminars, conferences, training programs, etc., (2) target audiences, clientele, trainers, etc., and how and why selected, (3) relationships with client groups, organizations, colleagues, etc., and purposes, (4) kinds and types of information received from target audiences, clientele, trainees, etc., (5) role such information has played in research communication, and/or training decisions and output, and (6) difficulties, constraints encountered in attaining goals.

The structure of Peanut CRSP would be assessed by pursing a line of leading questions, related to (1) has it been conducive to promoting collaboration among scientists; (2) which factors may have constrained collaboration, (factors include resource sharing, decision-making processes); and (3) effectiveness of the Technical Committee in setting a research/funding agenda. These are merely examples and are not meant to be all inclusive.

The knowledge production and dissemination would be assessed by another set of questions related to 1) the role of the peanut within local food systems and within the Peanut CRSP research system; 2) linkage of the peanut's traditional role to the Peanut CRSP's knowledge production and dissemination goals; and 3) harmony between the knowledge production goals, (e.g., varietal testing and breeding, mycotoxin management, etc.), and the traditional role for the peanut and overall regional or country-wide priorities? These approaches would aid in understanding whether the CRSP had generated new knowledge and propagated conditions where knowledge production and dissemination priorities would have been negotiated and pursued.

The organizational links to clientele could be identified by pursuing a line of questioning which encompassed the following: 1) what was the nature of the research context (e.g., research station or farming system); 2) were there links to farmers, extension agents and other local resource people; 3) what was the informational purpose of the linkages; and 4) regarding particular client groups, what information or products have been received, how were they tried, were they useful. Responses to these types of questions are reflected in the project documents and in the trip notes. They are relevant questions. Some answers are more direct and obvious than others.

E. Scope and Limitation of the Impact Assessment

The impact assessment for West African CRSP countries has a defined and finite scope. First, the geographic scope is confined to those specific countries visited or targeted. They are Burkina Faso, Mali, Niger and Senegal. To some extent other countries in the region are referred to and embraced because the CRSP Plan projected expectations that they would become involved and might be impacted. Prominent among the spread affect countries would be Nigeria and the Gambia and the Ivory Coast, to name a few.

The geographic focus, while directed toward targeted countries, has a round of limitations induced by within-country disuniformity of soil types and climatological conditions and governmental regulations. Therefore, it would be difficult to extrapolate, with high confidence, regarding the "real" impact of technology on peanut yield, utilization and distribution within a given sub-region in a specific country. Moreover, it would become difficult to extrapolate, with confidence to multi-country regions of West Africa. Therefore, the assessment of impact is not without some real limitations.

From a temporal perspective, there are some limitations as well. The new varieties which have shown yield enhancing properties and which have been partially released, have not been tested in the real world environment (uncontrolled). Therefore, the results obtained under research conditions may not be sustainable. Over time, these new releases will undergo evaluation under "farmer field" and village level management conditions. Such conditions would allow for factors such as variability in: 1) fertilizer availability, 2) pest control conditions, 3) soil types, 4) rainfall and irrigation moisture availability, 4) length of growing season, 5) disease control, 6) cultivation technology, 7) cultural practices, 8) utilization patterns, 9) consumption preferences and 10) socio-cultural norms to be addressed. Until that time comes, assessment must be done with less than desirable temporal observations. Likewise, the assessment would be conducted using marginally tenable assumptions. For convenience, time series yield data have been analyzed, reflecting impact of yield enhancing technology on total production. This is a crude approach, but it provides an initial jumping-off point for impact analysis.

The final limiting factor comes from a flawed initial design in the CRSPs methodology. Put another way, the limitation emerges because the CRSP proposers did not design the project to allow for continuous monitoring of social and economic impact indicators. Therefore, what is known about the economy and social settings has not been gathered in a CRSP project context. To add to the difficulty, is nearly impossible to gather consistent, completely relevant and reliable social and economic data, in just a three-day period. Especially, when trying to evaluate a ten-year-old project. At best, the economist and sociologist could do quick and dirty monitoring and set the stage for sound social and economic assessment in future periods. That is precisely what has been attempted. All is or was not lost.

In spite of the above limitations and disclaimers, it was possible to gather a sense of the CRSP's economic impact. Hopefully, that will become clear in the impact assessment section of this report.

F. Organization of this Report

This report's conclusions represent the thoughts, understandings and opinion of one team member - the Agricultural Economist. The basic findings and data are the intellectual property of others. The report is a temporarily, stand-along document which is intended to fulfill obligation for the socio-economic impact analysis. Hopefully, the information contained herein will be blended into the overall "team report." Such would facilitate the task of communicating comprehensive evaluation results to final audiences.

This report is organized into seven (7) sections: Part I covers the scope and objectives of the evaluation. It encompasses background structure of External Evaluation Panel (EEP), the scope of work of the EEP and limitations of the impact assessment methodology and results.

Part II covers background on the region, commodity (Peanut) and on the CRSP. The evaluator anticipated that the CRSP personnel would find this part redundant. However, important decision makers in AID and elsewhere might find it convenient to have backgrounding and an immediate sense of context. All too often, assessments and conclusions are misinterpreted due to varying contextual frames of reference.

Part III was developed after careful review of the five-year extension plan (1990-1995) and other CRSP documents. It carries the title of "Promises/Planned Activities: 1990 through 1995." Each of the major expectations were categorically examined and stated to insure that the evaluation and assessment covered those items which the CRSP personnel committed to pursue during the extension. This would avoid unfair conclusions. This proved to be a daunting task and also revealed a highly ambitious undertaking by the CRSP team. Sections of this part encompass the global plan, the regional plan, promises/planned accomplishments (by country) and a summary.

Part IV is direct. It categorically describes the many accomplishments reported by CRSP personnel. It is intended to give the reader a frontal picture of the results obtained to date. Accomplishments realized in each country are discussed. To a limited extent, the evaluator tried to provide extrapolative commentary on selected (key) accomplishments. A companion segment to Part IV is to be found in the Appendices (Appendix A). It contains the narrative of trip notes for each host country visited by the evaluator (economist).

Part V represents the impact assessment. It contains data, graphics, analysis and interpretations. Collectively, they should depict the partial economic impact of the Peanut CRSP. Limitation on certain data and the time constraint precluded assessing impacts in all zones: 1) disease and pest control impacts, 2) yield enhancement impact from new cultural and management practices; 4) yield enhancement impacts from "new variety" (cultivar) technology; and 5) food supply enhancement impact from improved utilization technologies and policies. Realistically, the CRSPs impact could be felt in may ways and in fact will be for years to come. This segment of the report reflects analytical impact assessment based on "new variety" technology. Modest attempts were made to extrapolate, in spite of acknowledged limitations.

Parts VI and VII contain a summary and the appendix, respectively. The brief summary if followed by a delineation of issues and some reasoned recommendations.

The Appendix, Part VII, contains trip note narratives, tables, references, redelineation of acronyms, the detailed scope of work, the travel itinerary and consultant bio-data. Hopefully, all the parts and sub-

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components will add to the reader's ability to use, interpret and value this impact assessment. This is not necessarily the "best" report to be completed. However, it does represent a labor of commitment, born out of a high regard for the work of the U.S. Agency for International Development.

PART II
Background and Overview

Introduction

Virtually all of the information in the section came from review reports and documents developed by other researchers. The review, under mandate of the CRSP has dutifully re-organized existing facts to help elucidate the background and outcome of the EEP's evaluation effort.

A. The Place of Peanuts in CRSP Countries

West Africa--Peanut in West Africa was promoted by the French during the colonial period as a source of vegetable oil for France (Fletcher, 1992). Similar activities were supported by the British in the Anglophone countries of the Region. Following the independence of the West African countries in the early 1960's, a general decline in the production occurred due to the loss of the oil market in Europe. Other oil crops produced in Europe have replaced the imported oil, and most of the export market for peanut oil has disappeared except for part of the Senegal production. These countries have traditionally never been exporters of edible peanut. West Africa is a vegetable oil deficit region and imports palm and other oils to satisfy these needs. The imported oils are lower in price than the locally produced peanut oil, depressing demand that could be satisfied with locally produced peanut. Peanut is an important food crop in the Sahelian region of West Africa with most of the oil and edible production consumed domestically, and the primary goal of the Peanut CRSP is to enhance the food use of peanut because of the high protein and energy content of peanut. Peanut is an important small-holder, subsistence farmer crop because of its importance as a food item for the farmer, as a cash crop on the local-urban market, a valuable forage for livestock especially in West Africa, and as a nitrogen supplying legume for sustainable production systems.

Burkina Faso--Annual peanut production in Burkina Faso is about 155,000 metric tons per year. There is some peanut oil export, but the country is a net importer of vegetable oil. There is both commercial and village-level traditional oil production for domestic use. Food use is in pastes for soups and as snack and confectionery foods. Peanut CRSP research is underway to enhance the use of peanut flour in composite flours with cereals and in weaning foods.

Mali--Annual peanut production in Mali is about 95,000 metric tons annually. Similar to Burkina Faso, peanut oil production for export declined in the 1970's. There is commercial and village-level oil production for domestic use, and as a domestic food crop in the form of pastes for soups and as snack and confectionery foods.

Niger--Niger follows much the same pattern as Burkina Faso and Mali with peak peanut production in the 1970's. Rosette virus, drought, and prices has reduced production and export of peanut oil.

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[1]Peanut production and use data for the CRSP host countries presented in this report, were compiled by Dr. Stanley Fletcher, Department of Agricultural Economics, The University of Georgia, Georgia Station. Dr. Fletcher is a part of a team that maintains a data base on the world peanut supply and movement in support of the U.S. peanut industry. The data is based on U.S. Department of Agriculture, Foreign Agricultural Service information. Another source of information, especially descriptive information on the West African peanut industry was "Peanut Production, Marketing and Export: Senegal, Gambia, Mali, Burkina Faso, and Niger" by W.H.M. Morris and published by the Peanut CRSP.

Present production is about 60,000 metric tons per year. Domestic oil production from commercial and artisanal producers, peanut paste for soups, peanut cake for a fried cake called kulikuli, and snack peanut accounts for much of the production.

Nigeria--Nigeria is the most populated country in Africa. The need for vegetable oil and export to Europe during the British Colonial period stimulated a large production of peanut. During the early 1970's, drought, rosette virus, and urban migrations following the development of the petroleum industry caused a decline in peanut production. Hence, peanut has changed from a commercially important export oil crop to a domestic crop. The 400,000 metric tons of peanut produced is used for commercial and village-level domestic oil production, pastes for use in soups and other dishes, and other local food and snack items.

Senegal--Senegal is an exporter of peanut oil, but not edible peanut. In 1984-1985, 83,000 metric tons of oil was produced in Senegal and only about 33 percent was exported with the remaining 55,000 metric tons consumed locally. Additionally, considerable amounts of peanut is consumed as condiment in stews, soups, and as snack food. This puts Senegalese domestic consumption in the range of 75 percent of production.

Production and Use Benefits

The peanut crop has been viewed by many as an environmental enhancement crop. As such, the peanut crop canopy provides nearly full ground cover. Whether grown alone or in sequence with other crops, peanut cultivation reduces exposure of soil to erosion from rainfall of wind (see Table II.1). The closed peanut canopy also suppresses weeds to reduce weed pressure, especially when peanut is intercropped with a grain crop. In either case, reduced weed pressure reduces need for environmentally-harmful chemical weed control.

The peanut contributes to economic growth as it provides a source of cash income for small-holder farmers and rural and urban processors in developing countries. Certain properties make it economically attractive, such as, biological nitrogen fixation. Biological nitrogen fixation by peanut reduces dependence on purchased nitrogen fertilizers. Often, the peanut crop is processed within the village or country that produces the crop. Thus, peanut production stimulates local food processing industries and adds value to the crop. As a versatile crop,

TABLE II.1. Categorical Benefits Expected from Peanut Production in the Selected Host Countries During the Five Year Extension (1990-1995)

Category	Description of Benefits
Source of Protein	The peanut provides a readily consumable and desirable source of protein and food energy for humans and animals. The seed for humans and the fodder and hulls for livestock.
Expandable Capital	The peanut and its products provide expandable capital for small resource farmers. It also augments sustainability through capital for farm implements, fertilizer and labor.
Source of Vegetable Oils	The peanut contributes, significantly to meeting needs in Africa in the world market.
Contributor to Conserving the Soil	As a legume, peanut fixes nitrogen for its own use and leaves a positive nitrogen balance in the soil for other crops.
Helps Make Cropping Systems Work	The short season peanut cultivars fit into various cropping systems of SAT environments. Most notably: a) mono-crop, b) intercropping, and c) under-story planting in tree crops.
Tolerates Drought	The peanut has inherent drought tolerance and is highly suited to SAT conditions. The short season varieties also escape drought.
Combats Soil Erosion	The near closed canopy plant structure during growing seasons shields the soil from rain erosion.
Abates Wind Erosion	Late rainy season planting with maturity well into the dry season, helps the peanut absorb available moisture for plant growth and extends cover for dry soil when subject to wind erosion.
Suppression of Weeds	When inter-cropped with grains, the peanut suppresses weeds. It, therefore, helps reduce labor.

SOURCE: Task Force Report. Environment and Natural Resources: Strategies for Sustainable Agriculture. AID, February, 1988.

peanut provides growers with many options to spread risk. With a short growing season, peanut fits well as a cash crop within a large range of cropping systems. It may be grown as monoculture where the rainy season is short, in sequence with grain crops, or beneath a long-lived orchard crop such as banana or coconut.

Improved human health and nutrition status are connected to the peanut. Peanut has special potential as a famine prevention crop. It may be planted late in a rainy season if the previous crop has failed. At 25 percent protein and 45 percent oil, peanut provides an inexpensive, high-protein, high-energy food for humans and livestock. It is one of the most nutritive crops available as a complement to cereal

[2]The CRSP Annual Progress Report--1993.

grain. Peanut supplies a high-quality, healthy vegetable oil for cooking. Supply of cooking oils is often inadequate in developing countries.

B. The Peanut CRSP: General Background

The context for the evaluation panel's work was set by a scope of work and during discussion at the EEP meeting in Huntsville, Alabama. The unfamiliar reader of the evaluation report should be spared from having to read through the voluminous reports and documents to understand the CRSP's goals and related issues. With this premise in mind, several CRSP documents were reviewed to develop generalized context and understanding of the goals and approaches.

1. Impetus for the Peanut CRSP

The initial impetus goes back to the Title XII legislation and initiatives which flowed therefrom. One of the many CRSP documents (CRSP-1993) gave the following description:

The Collaborative Research Support Program (CRSP) was created to implement Title XII of the United States Foreign Assistance Act of 1975. The goal of Title XII is to prevent famine and to establish freedom from hunger through land-grant university involvement in international development. To help attain these goals, the Peanut CRSP was established in 1982 to enhance the research capability of developing countries through training and research support, and to support research at U.S. land-grant institutions.

2. The Constraints

Initial constraints to the Peanut CRSP were numerous and not well understood, initially. Over the ten years of experience, the constraints have been examined and challenged. In spite of past success, many initial constraints remain and are yet to be addressed. The 1993 Annual Report carried a section which delineated the current constraints. The report carried the following description:

The Peanut CRSP was started in 1982 to address a set of global constraints to sustainable peanut production and use. Those constraints served as the initial basis for planning and organizing the Peanut CRSP in 1980 to 1982. Based on past Peanut CRSP accomplishments and the assessment of the External Evaluation Panel in 1989, the following constraints associated with peanut production were confirmed to be valid for the current 1990 to 1995 phase of the program.

Environmental constraints are generated by several forces. Three of the constraints are:
1) Dependent on chemical to control insect pests and diseases;
2) the southward expansion of the Sahara Desert cultivation in the Sahel region of West Africa may adversely affect peanut cultivation in the Sahel region of West Africa; and
3) inadequate diversity in cultivated peanut germplasm grown in developing countries and the U.S.

Socioeconomic constraints are more prolific in number and may be those difficult to address. The Annual Report for 1993 carried the following:
1) low productivity or yield loss from disease, drought, insects and nematodes;
2) local resource management situations may prevent efficient production and use;

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[3]Ibid.

[4]Ibid.

[5]The CRSP Annual Progress Report--1993.

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3) insufficient local food supply or inadequate food technology prevents growers, processors, or consumers from exploiting the full potential of peanut because it is not considered as a primary food source;
4) information not available to potential beneficiaries of new peanut production and use technologies; and
5) economic losses resulting from mycotoxin contamination.

Health and nutrition constraints are more immediately of deadly consequence. The need to address these remain urgent and they remain important to the CRSP. The two main constraints are:
1) health hazard from mycotoxin in contaminated peanut;
2) methods needed to incorporate peanut and peanut and peanut products into safe and nutritious processed foods.

Research capacity and tools are identified as the human resource related constraints. They are made manifest in:
1) inadequate numbers of trained research and support personnel in host countries; and
2) research tools used in molecular biology which are not readily applicable to peanut. These tools enable efficient and effective germplasm improvement with respect to resistance to pests and diseases, tolerance to abiotic stresses, seed quality and quantity, and adaption of growing season.

Removing the constraints would "enhance the potential of peanut as a cash crop for human food and animal feed in developing countries and the United States. The Peanut CRSP contributes to increasing rural incomes, sustained productivity of agricultural land, and improved health and nutrition of peanut consumers. Furthermore, the Peanut CRSP contributes to enhancing the research capacity of developing country institutions. Collaborative research on peanut is producing new and improved technology that improves the well-being of people in developing countries and the United States. (CRSP/AR-1993).

3. The Peanut CRSP Goals
The broadest expression of goals has been labelled the "global thrusts." Reviewing these thrusts, frequently, provides continued context for the CRSP evaluators and others. As expressed in the 1993 Annual Report and vernacular of one reviewer, the "goals" are: a) to develop sustainable agricultural production and food delivery systems that are profitable, environmentally-sound and relieve important constraints to peanut production and use; b) to resolve resource management situations that restrict appropriate research or diminish efficiency of systems for peanut production and use; and c) to communicate research outputs to beneficiaries in developing and industrialized countries.

Attainment of the above goals would require massive cooperation by countries and organizations. Ultimately, such cooperation would lead to an expected stream of benefits. The CRSP practice have clearly noted that the beneficiaries would be: farmers and peanut growers; food processors; food exporters and marketers and consumers in both rural and urban locations. To some extent, companies involved in developing and sale of mechanical and scientific technology would benefit.

Finally, the goals encompassed expectation that cooperation would occur not only among host and donor governments, but also with ICRISAT, ISC, CIRAD-CA, IDRC and ACIAR (see Page for specifications).

C. Country Profile Information

1. Burkina Faso: Some Pertinent Facts

The history of Burkina Faso (BF) was dominated by the empire-building Mussi people who came from the Central or Eastern Africa in the 11th Century. Burkina's population of 8.7 million people (Voltaic and Mande) who subsist on 106,000 square miles of land, in an economy which is notably agricultural. Better than 36 percent of the Gross National Product (GNP) comes from the agricultural sector (USDS: 1990). Some Pertinent facts are as follows:

- Geographically BF's terrain is savanna, brushy plains and scattered hills. The climate is sahelian and marked by pronounced wet and dry spells. Annual rainfall varies from 40 inches in the South to 10 inches in the north. The country is land locked and shares boundaries with six nations.
- The economy showed a GDP of more than $4.6 billion in the late 1980s - early 1990s, with a growth rate of 4.3 percent. Per capita income is low at $147.00 (1989) and the economy's dominant sector is agriculture.
- The U.S. Development assistance to Burkina Faso grew out of the U.S. response to drought that plagued the Sahel from 1968 through 1974. In 1981 $9.5 million in food aid and $2.9 million in project aid were provided.

2. Mali: Some Pertinent Facts

Mali is the cultural heir to the succession of ancient African empires. Ghana, Malinke and Saheal--that occupied the West African savanna (USDS: 1990). Mali's population of 8.3 million people, experiencing a growth rate of 2.9 percent, subsists on 474,764 square miles of land, an area about the size of Texas and California combined. The economy is notably agricultural, with 40 percent of the $2.8 billion Gross Domestic Product (GDP) coming from the agricultural sector (USDS: 1990). Some other pertinent facts are as follows:

- Geographically, Mali's terrain is savanna and desert. The climate is semitropical in the south and arid in the north, with markedly variable rainfall patterns (north to south). It is land-locked and shares common borders with at least five other neighbors.
- The economy posted a 3 percent growth rate from 1989 - 1991 and per capita income stood at $300. Inflation rate has been held to 1.7 percent while the average millet worker's annual salary was $1,680 (1991). Agriculture is the dominant economic sector, with industry trailing at less than 20 percent of DGP. Agriculture occupies 75 percent of the work force.
- The principal agricultural commodities are millet, sorghum, corn, rice, livestock, sugar, cotton, peanuts (ground nuts) and tobacco. Mali exports to Europe and the United States. Cotton and livestock represent up to 85 percent of the exports.
- Mali receives a considerable mass of foreign aid from the World Bank, France, United States, China and Arab donors. U.S. assistance to Mali reached $51 million in 1991, which included some $34 million in support through USAID. USAID was Mali's fourth largest donor.

3. Niger: Some Pertinent Facts

Niger was an important economic crossroads and the empire of Songhai, Mali, Gao, Kanem and Bornu. Two of the largest ethnic groups in Mali today are the Hausa and Dierma-Songhai. Mali's population of 6.2 million inhabit 490,000 square miles of land (an area three times the size of California) and grows at a rate of 3.1 percent, annually (USDS: 1990). The economy is boosted by a larger agricultural sector, claiming 44 percent of the yearly Gross Domestic Product (GDP). Some pertinent facts are as follows:

- Geographically, the terrain is about two thirds mountain and desert and one third savanna. The climate is hot, dry and dusty and the rainy season stretches from June to September. Annual

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[6] U.S. Department of State, Bureau of Public Affairs, 'Background Notes,' June, 1990.

rainfall ranges from 4 to 32 inches. With the north being mountainous and desert, most of Niger's people live along the southern border.

- The economy posted an annual growth rate of 3 percent during 1984-85 period. Only 10 percent of GDP comes from industry. Exports of $251 million in 1985 were smaller than the $354 million in imports. Petroleum, food stuffs and industrial products are the key imports. Roughly 90 percent of the country's work force is engaged in some type of agricultural enterprise. The main cash crops are peanuts, cotton and cowpeas.
- Mali receives concessionary and grant assistance from several donors. The United States, France, Germany, Canada and Saudi Arabia are the key donors. The World Bank, UNDP and the EC are heavy contributors.

4. Senegal: Some Pertinent Facts

Senegal was inhabited in prehistoric times. It came under the influence of the Mandingo empire in the 13th and 14th Centuries (USDS: 1990). French commercialism in Senegal dates back to the 17th Century. About 70 percent of Senegal's 7 million people are rural and they inhabit 76,000 square miles of land. With a growth rate of nearly 3 percent, the population is made up of Peulh, Serer, Touculear, Diola and Mandingo. Some other pertinent facts are as follows (USDS: 1990):

- Geographically, Senegal is located on the western-most tip of Africa with terrain either flat or moving to the foothills. The climate is tropical and Sahelian and supportive of desert and grassland in the north. The south and southeast have heavy vegetation.
- The economy is more industrialized than some neighboring countries. Industry's 24 percent annual contribution to Gross Domestic Product (GDP) outpaced agriculture's 22 percent (1986). The agriculture sector relies heavily on the commodities of peanut, millet, sorghum, rice and cotton. Senegal's imports of $705 million exceeded the $493 million in exports, causing it to be a "net" importer. Seventy-five percent of the population lives in rural areas.
- The U.S. has provided capital and technical assistance to Senegal since 1946 and it remains as an importer of U.S. goods. Other assistance from the U.S. includes loans and donations under PL 480. USAID has implemented programs in agriculture production support, reforestation, irrigation, water management, community enterprise management and health. Bilateral assistance from the U.S. to Senegal in 1986 totalled more than $65 million.

5. Senegal: Some Policy Facts (USDA/FAS, 1993)

- Gross Domestic Product Growth (GDP) growth (1985-1988) was driven by a strong agriculture sector performance, favorable price incentives especially for peanuts and years of good rainfall.
- During the 1980s Senegal's government liberalized the economy, enhanced production incentives (ag and industry), reduced the deficit, improved public investment, initiated public enterprise reform and abated the expansion of credit.

External Evaluation Panels have been designed and called upon to given unbiased views of how the CRSP progressed toward meeting its objectives. At least three External Evaluation Panels (EEPs) have been engaged to date. They have reviewed and provided the Management Entity with evaluation reports of CRSP activities from the beginning up through 1992-1993. The reviews were done through reports and published information and site travels. Some reviews have been conducted without the benefits of site visits.

5. Historical Accomplishments

During the first eight years of operation, the CRSP met with successes, in spite of evolving understanding of constraints faced and difficulty of the task. To add perspective, vis-a-vis accomplishments, reported for the five-year extension, the historical (pre-1990) accomplishments are revisited. According to the CRSP report, "major accomplishments and benefits. . . . were made by the CRSP during its first eight years. They were/are:

a) Benefits to the host countries:

- Development and release of seven peanut cultivars with a potential to increase incomes over U.S. $20,000,000 per year.
- Integrated pest management (IMP) strategies were developed to reduce insect damage. Reduction in insect damage reduced aflatoxin development caused by Aspergillus sp. invasion through insect damaged pods. Also, IPM strategies decreased losses to rosette virus in West Africa with subsequent annual yield increases up to 25 percent.
- A highly adsorbent clay identified to bind and remove aflatoxin from village processed peanut oil and peanut meal fed to animals (with potential as a food additive) has incalculable potential benefits in control of this carcinogenic compound.
- Nutritionally enriched "kisra" (thin bread) produced by blending sorghum and peanut flour in Sudan can reduce the sorghum induced niacin and protein deficiency and result in a ten-fold increase in the value of peanut oil meal compared to its use as a fertilizer.
- Peanut based cheese spread in the Philippines and peanut enriched noodles in Thailand were developed and are being pilot tested with potential to increase protein intake and economic benefits of U.S. $4,000,000 annually.
- Better understanding of food needs and role of peanut to provide these needs through food consumption surveys in Africa, Southeast Asia and the Caribbean.
- Trained 15 M.S. and 12 Ph.D. students in U.S. universities, 17 M.S. students in host country universities, and 74 host country staff by short-term activities.
- Research equipment valued at U.S. $269,000.

b) Benefits to the United States.

- Development and release of six peanut cultivars that will reduce chemical use in North Carolina through disease resistance and an initial annual return of U.S. $1,000,000 to Texas farmers.
- IPM strategies introduced in North Carolina can save U.S. $1,500,000 annually in chemical and application costs.
- Peanut stripe virus research in the U.S. thwarted a potential virus epidemic and resulted in the elimination of restrictions on interstate movement of peanut seed and increasing annual seed sales U.S. $100,000.
- Highly adsorbent clay has potential of reducing aflatoxin problems in contaminated feeds with a reduction in carcinogenic effects of aflatoxin.
- A new peanut line scheduled for 1990 release in Texas has resistance to aflatoxin accumulation in the seed which results in 15 percent lower aflatoxin levels and could increase gross returns by U.S. $1,000,000 per year through increased quality.
- Peanut based cheese spread has potential of providing U.S. consumers an alternative, high protein, cholesterol free product.
- Trained 19 M.S. and 17 Ph.D. students and broadened perspective of U.S. scientists.
- Provided U.S. $176,600 in equipment.

c) Technology Transfer was Stimulated through:

- Numerous publications
- Over 35 workshops and conferences and in annual in-country planning sessions
- Publication of International Arachis Newsletter
- On-farm pilot programs

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[7] These accomplishments were taken directly from the Peanut CRSP Global Plant and Extension Proposal for 1990-1995, pp. iii-v.

PART III

Promises, Planned Accomplishments, 1990-1995

A. Introduction

The idea of providing a segment covering promises, planned accomplishments or activities resulted from the study of numerous documents related to the Peanut CRSP.

The initial proposals, subsequent plans of work and annual reports outlined many objectives in many sub-parts. To a large degree the outlining of those multi-level objectives could become confusing, especially when one looks at the several levels which the project ideas and activities are communicated. For example, there is the overall CRSP global thrust which is inclusive of all regions and all countries and all projects. Secondly, there is the regional thrust in which, for example, Africa alone could be included. Those projects pertaining to Africa are outlined, showing their goals, plans, accomplishments and final activities. Thirdly, there are the country's specific plans which outline the projects and activities of that country. The country level activities are pursued locally and yet they are part of the regional and global thrusts.

Finally, the program's specific consideration is pursued in a context in which research projects and numerous other development goals are outlined. Given these four levels of consideration, it is quite possible to lose continuity when one moves through the report and plans, moving from level to level. It is possible to confuse the plans and even the expectations. Therefore, it was decided in this particular document to outline the set of planned activities or accomplishments against which the CRSP would be evaluated.

With this structure in mind, it would be easier to study and evaluate the accomplishments and the impact of the Peanut CRSP during the period of 1990-1995. It would also be possible to isolate already achieved accomplishments from 1980-1990, given that CRSP does have some historical activities and achievements. It would be difficult to determine the "flow-through" impact of pre-1990 accomplishments as they may materialize during the 1990-1995 period. That is a concern that must be addressed by the agency because it is not possible to be as precise in dissecting or isolating time zones of impact. However, it might be possible to get some sense of how much the CRSP has enhanced the production yield and consumption of peanuts during 1990-1993.

To achieve the goal of bringing forth a set of commonly-understood assumptions or expectations, the remainder of this section was developed in three parts. Part B deals with the global plan for the Peanut CRSP. It isolates the planned activities and accomplishments in several areas: geographic coverage, region-impact generation, evaluation plans, management strategy, constraints and intentions, resource management, training and communication and knowledge.

Part C focuses on the regional plan for West Africa. It is broken down into sub-parts: rationale, the research strategy, resource management, international cooperation and constraints addressed.

Part D covers planned activities and accomplishments at the country level. In this particular instance the following countries are covered: Burkina Faso, Mali, Niger, Senegal and Nigeria. An attempt has been made to identify and dissect the planned achievements of specific projects within each country. Hopefully, this approach would allow for clarity in terms of specific research, project goals and would allow the reader and other evaluators to have a common set of understanding in terms of what were to be the specific project level activities.

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The use of this segment should be undertaken with some amount of caution. First of all, it has drawn heavily upon a series of documents that were labeled as CRSP Plans and Annual Reports. To the extent that the expectations and goals have been consistent over the years, then it may be found that the planned activities identified in this segment are consistent. However, the reviewer acknowledges that there has been some leeway in interpretation. Subsequently, any error in continuity or judgement should be lodged with this reviewer.

B. The Global Plan for the Peanut CRSP

The Peanut CRSP operated under a set of global expectations (see Table III.1.) which we used to guide research in each country location. In reality, the degree of emphasis on targets depended on resources and needs of a specific location. This document focuses primarily on West Africa.

1. Geographic Coverage--The five-year extension promised to continue operation in semi-arid tropical Africa with emphasis on West Africa. The same host countries were to be the continued focus and sites of operation. They are: Senegal, Burkina Faso, Niger, Mali, and Nigeria. It was also proposed that during the five-year extension that linkages in West Africa would be promogated and initialized with Benin, Cameroon, Chad, Gambia, Ghana, Guinea and Togo. These linkages were to have been effectuated with the cooperation of ISC.

2. Regional Impact Generation--Regional impacts were to have been realized and enhanced through: a) networks, b) linkages to non-host countries, c) conferences, d) workshops, e) USAID Mission "buy-ins" and f) inter-CRSP activities. Cooperation with groups such as ICRISAT, ISC, IRHO, IDRC, and ACIAR was to have been expedited, and it was to have enhanced the regional impacts.

3. Evaluation--External evaluation specialists were to serve on a panel to provide continuous periodic evaluation feedback. The specific role of the External Evaluation Panel (EEP) would be to monitor and evaluate program direction and accomplishments, evaluate future research needs, and make appropriate recommendations for future program plans or adjustments. The panel would be required to make extensive and intensive evaluations at the time of program extensions. General evaluations were slated to be conducted on an annual basis. The expertise on the EEP was to have been expanded to include representation from more disciplines, especially socio-economics.

TABLE III.1. **Summary of Expected Global Accomplishments During the Five-Year Extension of the Peanut CRSP (1990 through 1995)**

TARGET AREAS	TARGET RESULTS
Low-Yielding Cultivars	Fifteen new cultivars will be developed. They will have resistance to: rosette, virus, leafspot, aflatoxin accumulation, and insects. They will be tolerant of: shade, acid soils and drought and early maturing. They will: double farm yield, lower production cost and increase profit.
Yield Loss Due to Pests	Improved IPM strategies will decrease chemical requirements. Biological control agents will eliminate some chemical use. They will decrease farm production cost and increase profit.
Health Hazard from Mycotoxins	Highly resistant cultivars to reduce aflatoxin by 15%. New block to metabolic production of aflatoxin by Aspergillus flavus. Sorbent clays to speed aflatoxin removal. Bacterial decontamination during fermentation.
Inadequate Food	Pilot programs for production and distribution will establish peanut as a major food source. New food products should double peanut consumption in host countries.
Resource Management	Socio-economic evaluations to ensure fit of new technology into sociological framework of farmers and consumers. More efficient means of production and utilization to be transferred. Will result in increased production, utilization and profitability.
Inadequate Number of Trained Researchers	Doubled number of trained scientists.
Unavailability of Information	Enhanced communications and outreach component. A communications specialist will be hired.

4. Management Strategy--The overall management strategy was to be concise: set priorities, fund research projects, implement, monitor and evaluate outputs.

5. Constraint Level Projection of Intentions--

- Increase Yields: Remove the constraint of low yields because of unadapted cultivars and lack of cultivar resistance to disease, insects and drought. Remove the constraint of yield loss due to infestations of weed, insects, diseases and nematodes.
- Mitigate Health Hazards: Remove the constraint of economic loss and health threat due to mycotoxin contamination.
- Increase the Food Supply: Develop appropriate food technologies to exploit a relatively well-adapted peanut crop. The peanut could be increasingly seen as a primary food source.
- Enhance the Soil: Remove physiological and soil micro-biological barriers to higher yields.
- Maximize Resource Utilization: Mitigate poor resource management situations (agronomic, engineering, economic and socio-economic) which prevent efficient production and utilization of the peanut.

- Improve Human Resources: Remove the constraint of too few and poorly-trained personnel by increasing the numbers of highly-trained researchers and support personnel.
- Upgrade Equipment: Remove constraints which have led to situations marked by lack of adequate equipment to conduct research.
- Enhance Information Sharing: Remove the constraint of information not being available to beneficiaries who need it to support production and utilization efforts.

6. Resource Management--The rationale in the proposed extension was that research would be conducted to evaluate new technology in the context of sound and efficient management systems.

- Intra-CRSP activities were to have been implemented to: evaluate consumer acceptability of new cultivars and of new peanut food products; and to develop pest resistant cultivars and IPM systems (via cooperation between the breeding, mycotoxin, insect management, and virus projects).
- Inter-CRSP activities were to have been initiated whereby: soil surveys would be conducted jointly by the topsoils and Peanut CRSPs, and integrated food research for West Africa would be conducted by the Bean/Cowpea, Sorghum/Millet and Peanut CRSPs, cooperatively.

7. Training--More and better trained researchers and support staff. The optimal budget proposed to double support for training which would provide for graduate and short-term training in critical areas.
8. Communication and Outreach--Better communication was to have been achieved through an expanded outreach/communication thrust. Better dissemination of information and communication were to result from:

- Hiring a communications specialist.
- Production and distribution of brochures, publications, leaflets, videos and slides.
- Increasing the number of workshops.
- Enhanced international cooperator networks.
- Expanded on-farm pilot programs.
- Expanded cottage industry pilot programs.
- An international newsletter published jointly with ICRISAT.

C. The Regional Plan and Expectations for West Africa (CRSP/1990-1995)

1. Rationale--The Peanut CRSP concentrated in the Sahelian Region of West Africa to combat severe constraints to crop production, characterized by: a short, rainy season; intermittent drought; disease; insect pressure; mold and aflatoxin contamination. Hence, it is difficult for the host countries to sustain production and ensure stable food supplies for growing populations. Constraints in the host countries (Table III.2.) vary in the degree of intensity and are addressed at different levels by the proposed research projects.

2. Research--The CRSP's research thrust, under the extension, would address the constraints through the resources available and through coordination with ISC and IRHO. Resulting from the research would be: new cultivars, IPM practices, acceptable new food products, and enhanced resource management systems. It was expressed that this new technology would be extended into linkage countries of the Sahelian Region.

TABLE III.2. Constraints to Food Production and Delivery in West Africa: Those Selected for Researchability Under the Peanut CRSP Extension (1990-1995)

TARGET AREAS	CASUAL FACTORS/CONSTRAINT DEFINED
Low Yields	The cultivars are not adapted to short rainy seasons, and hence do not possess desired level of resistance to diseases, insects or drought.
Yield Losses	Insects diseases and nematodes directly impact upon and debilitate the plants ability to achieve maximum agronomic performance. Weed infestations compete with the peanut for available nutrients, moisture and growing space.
Mycotoxin Hazards	Metabolic production of aflatoxin by Aspergillus flavus (fungal infection) causes severe health threats to human and animal consumption.
Inadequate Food Supplies	Due to lack of appropriate food technologies with which to exploit the peanut--a well adapted crop. In spite of the peanut's adaptability and suitability, it is not considered a primary food source.
Resource Management	Inadequate understanding of the agronomic, economic, and sociological situations, apart or in combination, prevent efficient production and optimal utilization of the peanut.

SOURCE: The Peanut CRSP Global Plan and Extension Proposal for 1990-1995.

- Project One: Peanut Cultivar Improvement. The goal was to develop new peanut cultivars; identify breeding lines with resistance to leafspot, rust, rosette, aflatoxin and drought. Expectations were also to blend these taints with early maturation (short season). (TX/BCP/B,M,N,S).
- Project Two: IPM in SAT Africa. The goal was to develop resistant cultivars and IPM procedures applicable to West Africa. These cultivars would help reduce losses associated with: arthropod damage, virus diseases and aflatoxin production. (GA/IM/BF)
- Project Three: Peanut Virus Resistance. The goal was to support a Nigerian peanut breeder (CRSP and rosette trained) in developing rosette resistant cultivars with short season and drought tolerant traits. Coordination expected with ISC, TX/BCP and GA/IM/BF. Senegal, Niger and Burkina Faso were to be involved. (GA/PV/N)
- Project Four: Mycotoxin Management. The goal was to develop and apply techniques for reducing mycotoxin's severity. Specific expected accomplishments were: a) prevention through improved management practices, reduced levels of preharvest contamination and b) reduction through improved detection, diversion, cleanup and detoxification. (TX/MM/S).
- Project Five: Food technology. Goals were to optimize the food utility of peanut through promoting the role of peanut as food items in diets, improving existing products and developing new products.

3. Resource Management--

- Agronomy: It was proposed that technology having an agronomic or biological nature would be elevated in the resource management context. Three thrusts were to have prevailed. First, the Intra-peanut CRSP activities were to have encompassed: breeding/mycotoxin, breeding/food technology and breeding/insect management. Second, cooperation was to have occurred in country, regional and international programs. Third, inter-CRSP activities were to have involved multidisciplinary research.
- Intra-Peanut CRSP Activities: Breeding and food technology projects in West Africa and Southeast Asia were to have cooperated to determine those qualities in promising lines which are most acceptable to consumers. Projects in breeding, mycotoxin, insect management and virus were to cooperate and develop pest resistant cultivars and IPM systems.
- Cooperative Activities: Plans were for Peanut CRSP and ISC to initiate a regional Germplasm Treating Program (GTP) in 1990 and extend it to twelve (12) West African countries by 1991. Programs to test improved cultivars, selected management and production practices in cooperating countries were to have been cooperatively planned, supported and implemented.
- Inter-CRSP Activities: For Burkina Faso, peanut CRSP and topsoil scientists at Texas A&M University were to have cooperated with University of Ouagadougou scientists to survey the major peanut soils in Burkina Faso. For Burkina Faso/Mali/Nigeria, the peanut, bean cowpea and sorghum millet CRSPs were to have collaborated on developing a system to better utilize food resources in the respective countries.
- Socio-economics: While the structure of the program was yet being planned, it was expected that a team of social scientists, economists, and food scientists would collaborate to determine: a)social implications of new technology, b) economic benefits of new technology, c) need and acceptability of new or improved food products, d) socio-economic acceptability of a newly introduced product, and e) the extent to which market developments and government policies affect peanuts.
- Food Technology: Specific improved and new peanut products were to have been evaluated with regard to their socio-economic impact and consumer acceptability.
- Market and Policy Considerations: The primary expected accomplishment in this area was the study of the influence of markets, market types, and government policies on the adoption of new technology.

4. International Cooperation--Research planning and implementation was to be coordinated with the French Oilseed Research Institute (IRHO) and a new French-supported agronomic research group, CORAF.

D. Promises/planned Accomplishments by Country During the CRSP's Five-year Extension (1990-1995)

1. Burkina Faso: Expected Accomplishments
   a. Synopsized Expectations
      - Cultivar improvement efforts would <u>continue</u> and superior germplasm would be <u>infused</u> into selected lines, adapted to local conditions.
      - The Burkina Faso cultivar improvement activity would be <u>linked</u> to efforts in Senegal.
      - Integrated pest management research would <u>continue</u> and solutions would be found to problems caused by <u>insect damage</u> and pest damage to the peanut.
      - Food Technology research would be <u>directed toward</u> better use of peanut as a primary food and <u>delivery</u> of that product to the population.

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- Principal involvement in the above efforts would come from within the following universities: Texas A&M, University of Georgia, Alabama A&M and University of Ouagadougou.

b. Research Project Level Expectations/Burkina Faso: Cultivar Improvement (Code: TX/BCP/B,M,N,S). Develop cultivars and identify breeding lines that are adaptable to ecological areas of Burkina Faso and West Africa, resistant to leafspot, drought tolerant and short season (90 days plant to harvest), cultivars would be developed.

c. Research Project Level Expectations/Burkina Faso: Integrated Pest Management (Code: GA/IM/BF). Develop technology in the form of IPM procedures and new cultivars that will reduce arthropod damage, virus disease transmission and aflatoxin production.

d. Research Project Level Expectations/Burkina Faso: Food Utility (Code: AAM/FT/BF)
- Promote peanut's role as a food item in diets.
- Improve and fortify existing cereal-based food products with peanuts.
- Develop new peanut food products.
- Coordination between breeders and food scientists would optimize nutrition and agronomic goals.
- Improved control of aflatoxin through breeding, management and decontamination.

2. Mali: Expected Accomplishments

a. Synopsized Expectations
- The germplasm improvement project in Mali will be linked with the cultivar improvement program in Senegal.
- Leadership would be coordinated between Texas A&M, Alabama A&M, and the Institute for Economic Research (IER).

b. Research Project Level Expectations/Mali: Cultivar Improvement (Code: TX/BCP/B,M,N,S). Develop cultivars and identify breeding lines. These materials would have resistance to pathogens and be drought tolerant.

3. Niger: Expected Accomplishments

a. Synopsized Expectations
- The cultivar improvement program in Senegal will be linked with the germplasm improvement program in Niger.
- Leadership would be coordinated between Texas A&M and INRAN (Nigerian National Institute for Agricultural Research).

b. Research Project Level Expectations/Niger: Cultivar Improvement (Code: TX/BCP/B,M,N,S). Develop cultivars and identify breeding lines. These materials would have resistance to pathogens, insects and be drought tolerant.

4. Senegal: Expected Accomplishments

a. Synopsized Expectations
- Continue research to develop cultivars with resistance to disease and stress.
- Develop technology for managing aflatoxin which would involve removal via use of absorptive clays and better detection and resistance.
- Leadership would be given to this effort by Texas A&M, ISRA and ITA.

b. Research Project Level Expectations/Senegal: Cultivar Improvement (Code: TX/BCP/B,M,N,S). Develop cultivars and identify breeding lines. These materials would have resistance to pathogens, insects and be drought tolerant.

c. Research Project Level Expectations/Senegal: Mycotoxin Management (Code: TX/MM/S)
- Arrest invasion by <u>Aspergillus flavus</u> through improved harvesting, drying and storage practices.
- Develop resistant cultivars to prevent preharvest invasion.
- Develop management practices to prevent pre-harvest contamination.
- Develop improved detection and diversion procedures.
- Develop clean-up and detoxification procedures.

- Refine the use of "high-affinity clays to bind and neutralize the harmful affect of aflatoxin in peanuts consumed by man and animals.

5. Nigeria: Expected Accomplishments
   a. Synopsized Expectations
      - Research would be conducted to control the rosette virus through development of resistant cultivars.
      - This work would be led by the University of Georgia and Amadou Bello University and linked to work in Senegal and Burkina Faso.
   b. Research Project Level Expectations/Nigeria Peanut Viruses (Rosette) (Code: GA/PV/N, TP)
      - Support the CRSP-trained peanut breeder in Nigeria who has rosette training with desirable cultivars.
      - Coordinated efforts between ISC and the peanut CRSP's West Africa breeding project.
      - Provide support to the rosette resistance breeding effort in Senegal, Burkina Faso and Niger.

E. Summary

In this segment of the report, considerable effort was taken to dissect and clarify the planned activities and planned accomplishments of the Peanut CRSP during the period: 1990-1995. While there may be some elements of redundancy, it was determined that continuity and specificity of expectation would be crucial in conducting a fair and equitable evaluation of the CRSP project, for the specific time frame at hand.

Hopefully, the reader will, upon concluding the review of the evaluation document, discover likewise that the dissecting of specific accomplishments, activities and expectations is of importance. The outlining of planned accomplishments and activities should serve as a useful backdrop as the reader engages in reviewing the section of the overall CRSP report that relates to the actual impact assessment. The central impact assessment part of this document will not cover all variables outlined in the project plan. Rather the socio-economic impact assessment section will focus primarily on those goals which would yield information pertaining to how successful the Peanut CRSP has been in generating stimuli to expanded peanut yield utilization and acceptability.

PART IV
Accomplishments: 1990-1995

A. Global Accomplishments: West Africa

The West Africa project had several goals which were to guide scientific research and training over the five-year period (1990-1995). They encompassed: 1) developing peanut lines adapted to the ecological condition in Sahelian West Africa that utilize available moisture, resist pathogens and are more economical, b) improve the potential of peanut production in the region via better cultural practices, and c) encouraging training in peanut research to bolster the peanut improvement programs. The accomplishments realized, in pursuit of those goals are recorded below, as extracted from project documents, including annual reports.

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1. **Major Accomplishments: West Africa (AR-1992/p.2)**

- Approval for release of Fleur 11 as a peanut cultivar in Senegal was given based upon documentation of pod yield increase in excess of 30 percent during five years of on- and off-station research.
- In response to grower concerns regarding relative performance of Tamspan 90 and Starr under non-irrigated production, replicated tests were conducted at eight locations in Central and Southeast Texas. Pod yields for the two cultivars in Central Texas were equal while in the Southeast Texas tests Tamspan 90 yielded significantly more. Earlier results have shown its superiority over Starr under irrigated production, especially in soils infested with Sclerotinia minor, Pythium Myriotylum, and Rhizoctonia solani.
- A multi-year soil amendment x variety study was initiated at the Farakoba Research Station in Southwest Burkina Faso where yields consistently have been low compared to other sites within the country where rainfall is much lower. The study, in collaboration with TROPSOILS, follows collaborative research in which it was determined that soil acidity and aluminum toxicity might be constraints to the performance of some of all cultivars.
- Significant differences in response to water applications were found among breeding lines and cultivars grown under a source line gradient irrigation system at Yoakum, TX. Such interpretation was made after construction of a variety performance indices (VPI) comprised of normalized values for yield and coefficients of regression.
- Decision was made in Mali to increase seed of four breeding lines (73-28, M 13, HYQ (CG)S-49, EH 310-9) for on-farm tests in prospect of release to farmers as a result of good performance in three years of variety tests.
- Another 250 peanut accessions, bringing to a total of 2260, were field-screened for leafspot reaction at Yoakum, TX. About 1 percent of the 2260 accessions have been considered worthy of further testing.

More than 1800 populations were field-screened for reaction to Sclerotinia minor at Stephenville. The populations derived from crosses of Tamspan 90 and select runner cultivars and breeding lines made for the purpose of developing adapted and acceptable runner cultivars with resistance to the pathogen.

- Populations with selected parentage were developed and are under agronomic selection and generation advance for selection for resistance to rosette virus or termites in Africa, and sclerotinia blight, spotted wilt virus, leafspot, rust, and/or Aspergillus flavus in Texas.

Refereed journal articles, book chapters, and miscellaneous publication were published.

2. **Major Cooperation and Coordination Accomplishments (WA)**

While the Peanut CRSP is the only international program that focuses solely on peanut, there are other research organizations that conduct some peanut research. Since its inception, the Peanut CRSP has enhanced research and technology transfer through cooperative relationship with other international organizations. These relationships enhance cooperative research planning to avoid redundancy across programs, and joint conduct of workshops and symposia to communicate research results. Some organizations with which the Peanut CRSP cooperates are:

- ICRISAT the International Crops Research Institute for the Semi-Arid Tropics
- ISC the ICRISAT Sahelian Center (ISC)
- CIRAD-CA the French Center for International Agricultural Research and Development, Annual Crops Program
- IDRC the Canadian International Development and Research Centre
- ACIAR Australian Centre for International Agricultural Research

[8]TX/BCP/WA, "Disease-Resistant Peanut Varieties for Semi-Arid Environments."

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3. **Major Environmental Enhancement Accomplishments (WA)**

- Two breeding lines were released in Texas with resistance to rootknot nematode.
- North Carolina released 'Robut 33-1 x NC 2214' and 'J11 x (M13 x NC 3083)', two hybrids with excellent resistance to leafhopper and have application in WA.
- Four interspecific hybrids were released in North Carolina as germplasm sources for resistance to early leafspot, the most important peanut disease worldwide. This germplasm has great potential for reducing fungicide use in the U.S. and for increasing yields in developing countries in all Regions.
- Insect ecology studies have shown that thrips, the vector for tomato spotted wilt virus disease, overwinter in maize fields, not in peanut fields. Thus, control of this important disease vector must include fields surrounding peanut fields, not only the peanut fields.

4. **Major Economic Growth Accomplishments (WA)**

- In Burkina Faso, ash application increased peanut yields by 221 percent to improve profitability.
- Two medium-duration varieties with resistance to rosette and one high-yield short-duration variety without resistance were identified and seed increased for release to farmers in Nigeria.
- Data sets have been developed in Texas to test and apply PeanutGro, a crop simulation model. This model will allow efficient environmental characterization and risk analysis.
- 'Musty' flavor is associated with n-methyl pyrrole. Research in Alabama showed that the compound varies across peanut genotypes. Thus, germplasm evaluation and selection against n-methyl pyrrole can improve peanut flavor and seed quality.

5. **Major Human Health and Nutrition Accomplishments (WA)**

Mycotoxin reduction:

- Methods were developed in Texas to screen for norosolenic acid, an aflatoxin precursor. Screening for norosolenic acid will allow easier evaluation of germplasm for resistance to Aspergillis flavus infection or aflatoxin production.
- A strong relationship was shown between termite damage to pods and aflatoxin levels. Termite damage increases with delay in harvest and with decreased soil moisture. Three termite-resistant peanut lines have been identified, NCAc343, a high-yielding cultivar, and lesser yielding NCAc2240 and NCAc2243.

6. **Major Manpower Development Accomplishments (WA)**

- Two institutes in Ghana became partners in the mycotoxin management project: the University of Science and Technology in Kumasi and the Food Research Institute in Accra.
- Four students completed Ph.D. degree programs in U.S. universities. Seven students with full Peanut CRSP support and three with partial Peanut CRSP support are continuing Ph.D. programs in U.S. universities, and one student is continuing a Ph.D. program in a host-country university.
- Two students completed M.S. degree programs in U.S. and two in host-country universities. Three students are continuing M.S. programs in U.S. and seven in host-country universities with full Peanut CRSP support. Three students are continuing M.S. programs in host-country universities with partial support.
- Ten B.S. students are conducting research in Peanut CRSP activities in host-country institutions.
- Three collaborators have come to the U.S. for short-term training and 17 have participated in short-term training in various host-country institutions.

7. **Major Workshop Accomplishments (WA)**

- The Third West Africa Regional Peanut Workshop was held in cooperation with the ICRISAT Sahelian Center September 14-17, 1992, in Ouagadougou, Burkina Faso. Peanut CRSP participants included: Olin Smith, Mike Schubert, Bharat Singh, Robert Lynch, and James Demski from the United States; Ousmane Ndoye and Amadou Ba, Senegal; S. Boye-Goni and O. Aladi,

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Nigeria; Idrissa Dicko and Phillipe Sankara, Burkina Faso; Amadou Mounkalia, Niger; and guest Ms. Kafui Kpodo, Ghana. The major output of the Workshop was a review of on-going research and recommendations for future priority research in the Region.

8. Publications (Global)

Smith, O.D., C.E. Simpson, W.J. Grichar and H.A. Melouk. 1991. Registration of Tamspan 90 peanut. Crop Sci. 31:1711.

Grichar, W.J. and O.D. Smith. 1992. Variation in yield and resistance to southern stem rot among peanut (Arachis hypogaea L.) lines selected for pythium pod rot resistance. Peanut Sci. 19:55-58.

Ndoye, O. and O.D. Smith. 1992. Flowering pattern and fruiting characteristics of five short growth duration peanut lines. Oleagineux 47(5): 235-240.

Aken, C.N., H.A. Melouk, and O.D. Smith. 1992. Field evaluation of peanut genotypes for resistance to sclerotinia blight. Crop Protection: 11:345-348.

Wildman, L.G., O.D. Smith, C.E. Simpson, and R.A. Taber. 1992. Inheritance of resistance to Sclerotinia minor in selected spanish peanut crosses. Peanut Sci. 19:31-35.

Smith, O.D. and C.E. Simpson. Selection of peanut varieties. Book Chapter. APS publication. (accepted).

Simpson, C.E. 1991. Global collaborations find and conserve the irreplaceable genetic resources of wild peanut in South America. Diversity 7: 59-61.

Simpson, C.E., D. L. Higgins, G.D. Thomas, and E.R. Howard. 1992. Catalog of passport data and minimum descriptors of Arachis hypogaea L. germplasm collected in South America. 1977-1986. Texas Agric. Exp. Stn. Texas A&M Univ. System. College Station, TX 77843. Misc. Publ. #1737.

Subrahmanyam, P., J.P. Bosc, Hama Hassane, D.H. Smith, A. Mounkaila, B.J. Ndunguru, and P. Sankara. 1992. Groundnut diseases in Niger and Burkina Faso. Oleagineu 47: 119-133.

Subrahmanyam, P., and D.H. Smith. 1991. Variability in pathogenicity and symptomatology of Leptosphaerulina crassiasca on peanut. Plant Disease 75: 1266-1269.

Smith, D.H., G.D.C. Pauer, and F.M. Shokes. 1992. Cercosporidium and Cercospora leafspots of peanut (groundnut). p. 285-304. In: H.S. Chaube, J. Kumar, A.N. Mukhopadhay, and U.S. Singh (eds.) Diseases of Vegetables and Oil Seed Crops; Plant Diseases of International Importance. Prentice Hall, Englewood Cliffs, New Jersey 07632.

9. Travel--Overseas (Global)

Mahama Ouedraogo conferred with faculty at the University of Ouagadougou and USAID Mission officials, visited peanut research plots in Burkina Faso, and reviewed Texas/Burkina Faso collaborative research with HC collaborators.

10. Presentation and Conference Participation (Global)

Schubert, A.M. and O.D. Smith. 1991. Field screening of peanut resistant germplasm for drought resistance using and irrigation gradient system. APRES.

Woodard, K.E., and C.E. Simpson. 1991. Characterization of Sclerotinia minor isolates from four peanut production areas of Texas. APRES.

Ouedraogo, M., O.D. Smith, E. E. Simpson, and D.H. Smith. 1991. Laboratory and field assessments of resistance to peanut leafspots. APRES.

Wells, M.A., W.J. Grichar, and O.D. Smith. 1991. Reaction of selected peanut (Arachis hypogaea L.) lines to southern blight disease. APRES.

Singh, U., B. Singh, and O.D. Smith. 1991. Effects of variety and processing methods on phytic acid and in vitro protein digestibility of peanuts. APRES.

Wilding, L.P., A. Manu, L.R. Drees, P. Sankara and O.D. Smith. 1991. Soil resource evaluation of Peanut CRSP sites in Burkina Faso, West Africa. Annual Meeting Amer. Soc. Agron.

Philippe Sankara participated in the Annual Meeting of APRES, Suffolk, VA, and the International Congress on Crop Science, Ames, IA.

Mahama Ouedraogo participated in the Annual Meeting of APRES, Suffolk, VA, and the International Congress on Crop Science, Ames, IA.

B. Burkina Faso Based Accomplishments

1. Cultivar Improvement

a. ACCOMPLISHMENT: Variety Testing (BF)
More than 300 hundred varieties have been tested. Some proved to be good yielding lines adapted to the agroecological conditions of Burkina Faso, particularly in the central and eastern parts of the country. These varieties appeared to be very susceptible to foliar diseases (early and late leaf spots and rust) as well as to Peanut Green Rosette, soilborne diseases and termites in the western part of Burkina Faso. The varieties were subjected to final productivity evaluation under condition of Benlate Control of leaf spots at Bobo and Gampela.

b. ACCOMPLISHMENT: Variety and Soils Analysis (BF)
Soil analysis in the Farakoba site peanut research near Bobo-Dioulasso revealed excessive exchangeable aluminum content (2.0 $cmol.kg^{-1}$) and high acidity (Table 1), which may explain the low peanut yield at this location in addition to leaf diseases. A soil amendment test using three local cultivars (RMP 12, QH243 C, TS32-1) under five treatments (gypsum, phosphate, gypsum plus phosphate, ash, and control) was initiated in 1990. Preliminary data obtained in 1992 indicated that the application of ash increased yields for the cultivars TS32-1 and QH243C. While no significant yield response was obtained with gypsum or phosphorus alone, their combined use produced somewhat higher yields.

c. ACCOMPLISHMENT: Yield Trials at Locations (BF)
In a five-location yield trial, peanut yields were relatively low at the Bobo Dioulasso and Niangoloko locations despite high rainfall at these locations. Recent collaboration between the Peanut and Soil Management CRSPs has shown a low soil pH and high aluminum content at Bobo. The first-year of a multiple-year experiment to study the effect of soil amendments on soil pH and peanut yields was completed. Treatments included lime, phosphorus, lime + phosphorus, ash, and a control with three locally grown peanut cultivars. First year results showed a cultivar x soil amendment interaction.

2. Integrated Pest Management (BF)

a. ACCOMPLISHMENTS: IPM Strategies (BF)

Research in Burkina Faso was conducted at two location, Gampala and Farakoba, in 1991. Four major objectives were addressed in this research to: 1) evaluate the influence of peanut plant population on insect damage, rosette, yield and aflatoxin contamination; 2) determine the effect of harvest date on termite damage to plants and pods, yield and aflatoxin; 3) evaluate peanut lines from ICRISAT with reported resistance to termites for resistance to this insect and aflatoxin contamination in Burkina Faso, and 4) evaluate need for control of insect injury on peanut.

At Gampala, thrips and jassid damage to peanut declined with increase in plant population. However, this trend was not evident at Farakoba. Aphids, rosette, and termite damage were more prevalent at Farakoba. No differences were detected in aphid abundance or incidence of rosette that could be attributed to plant population. Conversely, as trend was evident for an increase in both plant and pod damaged by termites as plant population increased. No differences in yield due to plant population were noted at Gampala. However, at Farakoba peanut yield increased with each increase in plant population.

Termite injury to peanut pods increased linearly with an increase in days to harvest at Gampala. This increase in pod injury was directly related to a decrease in soil moisture from an average of 6.8 percent at 90 days to 1.4 percent at 120 days. Maximum yield in both untreated and insecticide-treated plots was recorded at 100 days after planting and then declined with each delay in harvest.

b. ACCOMPLISHMENTS: Termite Resistance Evaluated

Evaluation of peanut cultivars for termite resistance at Gampala produced significant differences in pod damage and yield as a result of both peanut variety and harvest date. Termite damage increased significantly with a delay in harvest. RMP 12, NCAc 2240, NCAc 2243, NCAc2242, and NCAc 343 sustained the least damage, significantly less than the susceptible Robut 33-1. Yield of M13, MCAc 343, RMP 40, and RMP 12 were among the highest, even with a delay in harvest. At Farakoba, an interaction in termite damage was between peanut cultivar and harvest date. Termite damage to pods averaged less than ` percent for NCAc 2243, NCAc 2242, NCAc 2240, NCAc 2230, and NCAc 343.

c. ACCOMPLISHMENTS: Other Insects/Pests Evaluated

Treatment with need produced no meaningful significant differences for reduced damage by thrips, jassids, Lepidoptera, or termites. No consistent trends for reduced damage to plants or pods were noted with the use of need for insect control at either Gampala or Farakoba. Likewise, no significant differences in yield were noted at Gampala in the evaluation of need for insect control. At Farakoba, several neem treatments resulted in yields that were comparable with that for the insecticide treatment, but none of the treatments produced yields significantly higher than the yield of the untreated control.

Evaluation of recommended peanut cultivars in the U.S. for insect damage showed significant differences among cultivars in thrips damage and in laboratory bioassays against the fall armyworm and velvetbean caterpillar. However, no differences were noted in potato leafhopper or velvetbean caterpillar damage ratings in the field. Significant yield and grade differences were also noted among cultivars.

Laboratory evaluation of 14 plant introductions against the velvetbean caterpillar produced significant differences in their level of susceptibility. Evaluation of another group of plant

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[9]GA/IM/BF, "Integrated Pest Management (IPM) Strategies for Peanut Insects in SAT Africa.

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introductions in the field resulted in significant differences in thrips, leafhopper, and velvetbean caterpillar damage ratings. Similarly, evaluation of selected peanut genotypes (from the NC/IM insect project) and cultivars in the field produced significant differences in thrips, leafhopper, and velvetbean caterpillar damage ratings.

d. ACCOMPLISHMENT: Insect Management (BF)

- Plot work was initiated to investigate resistance to thrips, leafhoppers, defoliating insects, and soil inhabiting insects. Several genotypes underwent laboratory evaluation for resistance to the fall army worm, corn earworm, and vegetable caterpillar.
- Movable rain exclusion shelters were used to study aflatoxin accumulation, germplasm resistance to termites, and germplasm resistance to sweet potato whitefly.

e. ACCOMPLISHMENT: Sweetpotato Whitefly on Peanut Studied (BF)

Studies on the sweetpotato whitefly as a pest of peanut showed that there were four instars for the insect on Florunner peanut with mean length and width (μm) as follows: 1st instar 207.8 $\pm$ 5.4, 120.9 $\pm$ 4.4; 2nd instar 314.9 $\pm$ 8.8

3. Food Technology (BF)

a. ACCOMPLISHMENT: Burkina Research Project Shows Success

- An initiative was undertaken to select the most suitable materials for use in packaging, distributing, and marketing peanut paste. The paste is produced by CIETET-HUILERIE (a local factory) in Bobo-Dipulaso, Burkina Faso.
- Peanut paste storage stability tests were initiated at the University of Ouagadougou.
- A market survey was initiated to determine the status of peanut products (aflatoxin contamination) Ouagadougou.
- A study to ascertain the best methods for utilizing Allium sativum in inhibiting aflatoxins continued.
- Research was initiated to investigate changes in sensory characteristics of cereal-based foods when fortified with peanut product.
- Dialogue between Ghanain and US scientists resulted in a preliminary research plan of work to be conducted at the Food Research Institute (FRI) in Accra, Ghana.

The CRSP document (p-CRSP, QPR No. 13, -1993), shared significant accomplishments

b. ACCOMPLISHMENT: Alabama A&M University shows success

- Researchers developed a cereal-based staple food which has a higher protein content (63 percent) and yet, no drastic changes in textural properties. This new food product, with its acceptable sensory characteristics, was created with combinations of defatted peanut flower, rice and sorghum.
- Oil Extraction Technology (procedures) was advanced by AAMU researchers who investigated the procedure with the Spanish and Virginia peanuts. By applying a pressure of 10,000 psi to 400g of peanut that netted an oil extraction level of 20 percent (by weight).
- Reduced fat peanuts were investigated as a product source for producing reduced fat peanut butter and reduced fat roasted peanuts. This could possibly be a healthful outlet for those nuts subjected to increased oil extraction.
- Use of micro wave oven, instead of wok pan, led to reducing the cooking time down to 2.5 minutes from the conventional oven 45 minutes. Standardization of the alternative method is to be pursued, along with work on sensory, texture and chemical analyses.
- Necessary steps for final set up and installation of facilities for the Sorghum-peanut extruded snack snack-bar project have been completed. Initial trials were planned for October 1993).
- Weaning food developed at the University of Ouagaudou was in the process of being analyzed to determine proximate composition. Results were inconclusive at the time of the progress report.

c. ACCOMPLISHMENT: Food Extrusion Advanced (BF)
In Alabama, food extrusion research using different blends of full fat peanut and sorghum showed that peanut should be less than 20% of the mixture for optimum processing. These results will assist in the formulation of peanut-cereal food products acceptable to West Africa consumers.

d. ACCOMPLISHMENT: Peanut Butter Sampled (BF)
In Burkina Fasop, peanut paste/butter samples were collected from industrial and traditional, small-scale manufacturers. Aflatoxin levels were higher in the paste from traditional sources. Since the major portion of the paste used is from traditional sources, methods to help these producers reduce aflatoxin content of pastes are needed.

e. ACCOMPLISHMENT: Processor Assisted (BF)
Food scientists in Burkina Faso continue to assist a peanut butter processor in assessing the product market ability. The product had good quality (consistency, shelf-life, acceptability), but appropriate packaging is needed that is both economical and protective of the product.

f. ACCOMPLISHMENT: Breeders and Food Scientist Cooperate (BF)
Breeding and food technology projects cooperated to determine possible differences in aflatoxin contamination in seed from different breeding lines of peanut. Although no line was aflatoxin free, comparatively less contamination was apparent in some lines than in others at all three locations. Evaluation of lines for aflatoxin production to avoid release of cultivars highly susceptible to aflatoxin production might be an important aspect in cultivar development.

4. Aflatoxin Control (BF)

a. ACCOMPLISHMENT: Poor Drying Studied
The CRSP document (P-CRSP, QRP No. 13, -1993), shared significant accomplishments in correcting protocol for drying. Because of drying conditions during early harvest, the 1992 aflatoxin data and subsequent analysis were erroneous. Poor drying conditions were created because plants with pods were not placed under protective shelter. Hence, extremely high levels of aflatoxin contamination were detected in early harvests, regardless of plant population, harvest date, or tillage depth. Corrective protocol of proper facilities for drying were called for.

5. Virus and Disease Control

a. ACCOMPLISHMENT: Peanut Virus Control (BF)
Breeding for resistance to the rosette virus in Southern and West Africa was reported on before the Groundnut Virus Diseases Working Group (GVDWG) in Dundee Scotland (Trip Report/P. Olorunju and S.M. Misari/ CRSP / Aug. 1993). Evident in reports is the extent of collaboration. Scientists from USA, UK and France shared results of their work on Vectors of groundnut viruses, research on the rosette virus at SCRI, CIRAD/ORSTOM and CRSP locations.

The West and Southern Africa virus research on rosette virus had made some progress:

- Malawin scientists with ICRISAT reported their discovery on an Argentine line that is early maturing and rosette resistant.
- West African scientists reported success in breeding for resistance in late/medium maturing varieties. This group vied for conducting more trials, using non-conventional methods to obtain rosette resistance in early maturing lines adapted to their region.

b. ACCOMPLISHMENT: Disease Control
Soil samples were taken before harvest to assess infestation by soil mycoflora. For foliar diseases, scores were given to lines using the ICRISAT 9-point-scale every two weeks from the time symptoms were first observed. Data were also collected on percent defoliation due to leaf

spots. Field screening sites for rust and leafspots were at located at Bobo-Dioulasso and Niangoloko where natural high pressure exists for both diseases.

A number of lines showing resistance to rust and leaf spot were identified. Some were given to the peanut breeding program of INERA. Low prevalence of soilborne pathogens such as Pythium, Rhizoctonia, and Sclerotium prevented effective screening for resistance.

c. ACCOMPLISHMENT: Rosette Virus Control (BF)
Research was initiated in 1993 to address the problems related to peanut green rosette in Western Burkina Faso. Peanut Rosette screening which was conducted at Niangoloko and involved 161 F_3 lines. A trip was made to Nigeria in September to learn about methods for field scoring. Evaluation is on-going and the Principal Investigators hope to identify some resistant and early maturing materials in the near future.

6. Training

a. ACCOMPLISHMENT: Training in Virology of Peanuts (BF)
Dr. Phindile E. Olorunju received training in Georgia, with the CRSP associates. From August 20 - September 7, 1993, Dr. Olorunju was in Griffin, Georgia with the joint support of the Peanut CRSP and IAR. While there she visited with scientists and worked in laboratories of diverse expertise but with common interest in virology. she visited and worked with personnel in: virology laboratories, virus greenhouses, cultured wild peanuts, plant transformation, plant introduction, meristem culture work, seed tests, inter-country seed movement, plant pathology, plant agronomy.

She became acquainted with laboratory equipment, such as the aseptic hood, critical centrifuge (table top), retraction collector, shaker and chambers. She also observed use of the gene gun, western blot protocol and the DNA mini kit. Dr. Olorunju also spent considerable time in library research.

She returned to Kano, Nigeria to resume work on September 8, 1993.

b. ACCOMPLISHMENT: Training in Virology of Peanuts (BF)
Dr. S. M. Misari received experience in library research and visited with research professionals in the UK. The activity was supported by the Peanut CRSP and NRI. The training was less technical. The training began on August 23, 1993, and completed on September 1, 1993. Dr. Misari departed for Kano, Nigeria on the latter date.

c. ACCOMPLISHMENT: Training (BF)

- A student, Mr. Ashok Minshra, completed requirements for the M.S. degree in Food Science at Alabama A&M University.
- A researcher, Dr. Alfred S. Traore, Principal Investigator of the Peanut CRSP Food Technology Project (BF), was trained at Alabama A&M University on August 22 - September 2, 1993.
- A researcher, Dr. Phindile Oloronju (Nigeria) traveled to the University of Georgia on August 20 - September 8, 1993 for training.
- The EEP (External Evaluation Panel) travelled to Huntsville, Alabama on July 16-17, 1993, where they received familiarization training on the Peanut CRSP. They also attended a management orientation meeting and the APRES Annual Meetings.

d. ACCOMPLISHMENT: Training for Key Personnel (BF)
The project has provided financial support which allowed personnel to participate in peanut research meetings (international workshops in India, Niger, Burkina Faso and the APRES meetings). The project sponsored M.S. and Ph.D. training at Texas A&M University for Mr.

Mahama Ouedraogo. The following people received training at the University of Ouagadougou: Thio Boma, Yamwemba Justin, Keita Famoudou, Djiguimede Lambert, Wininga Bernadette, Kabore Samuel and Yanogo Philippe. A non-degree oriented training on peanut rosette screening was given to the project technician, Mr. Belem Lassane at Ahmadu Bello University in Nigeria.

7. Collaboration

a. ACCOMPLISHMENT: Meetings/Collaboration (BF)

- IFT Meeting in Chicago, Illinois on July 10-14, 1993 was attended by Alabama A&M University scientists.
- Annual Peanut CRSP Meeting, in Huntsville, Alabama on July 13-16, 1993 was attended by CRSP participants who also met with the APRES Annual Meeting.
- EEP (External Evaluation Panel) Meeting, in Huntsville, Alabama on July 16-17, 1993 was attended by the EEP and the CRSP Management Team.
- GVDWG (Groundnut Virus Diseases Working Groups) Meeting, in Dundee, Scotland, on August 15-19, 1993, was attended by David Cummins and James Demski and representatives from ICRISAT; SCRI; CRSP, Nigeria (P. Olorunju and S. Misari), Thailand (S. Wongaew) and Philippines.

b. ACCOMPLISHMENT: Visits

- Dr. Alfred Traore, University of Ouagadougou, Burkina Faso visited Alabama A&M University, Huntsville, Alabama on September 2-3, 1993.
- Drs. Rashad Abo-Elenien and Ibrahim El-Fangary, the Agricultural Research Center, Giza, Egypt visited the Georgia Experiment Station and the Peanut CRSP on August 18-21, 1993.

8. Scientific Knowledge Dissemination

a. ACCOMPLISHMENT: Transfer of Technology (BF)

During research activities in Tenkodogo area, the best varieties were made available to farmers and extension workers (CRPA) for testing under their own cultural practices. Farmers were pleased with these materials. Mainly, because of earlier maturity and higher yields, compared to local cultivars. The only problem with newer varieties appeared to be their susceptibility to both types of leaf spots.

b. ACCOMPLISHMENT: Scientific Knowledge (BF)

Research work in Burkina Faso through the CRSP-Entomology project has permitted the project staff to gather basic information about the dynamic of groundnut anthropod populations throughout the growing season across the country. The major groundnut insect pests are (2) the trips (thysanopterans), (2) the jassids (Homopterans), and (3) subterranean termites (Isopterans). The jassid and trip populations fluctuate during the growing season following the plant phenology. However, they seem to be higher in the southern part of the country where they thrive longer because of the longer rainfall season. Termites invade the field by the end of the growing season when the pods mature and the soil becomes drier.

The CRSP project has allowed the project staff to know more about the effect of termite and millipede damage on peanut contamination by aflatoxin. Amounts of aflatoxin in peanut correlate well with termite and millipede damage to the pods and both increase as harvest is delayed. The project also helped them to know that growing groundnut on ridges is more yield enhancing than flat planting. Because of the project they were able to identify high yielding U.S. varieties with more resistance to termite damage than local varieties.

9. Publications

a. ACCOMPLISHMENT: Publication (BF)

Data from current projects are being compiled and collected to produce the books. A book summarizing peanut research progress in Burkina Faso is being developed. This book will be available to national programs and other partners for consultation and use. It is expected to be completed by the end of 1993 and made available shortly thereafter.

P. Sankara, O. D. Smith, and M. Ouedrago. 1993. Evaluation of US Peanut Varieties in Burkina Faso. ICRISAT Groundnut Regional Meeting.

Wilding, L. P., A. Manu, L. R. Drees, P. Sankara and O. D. Smith. 1991. Soil Resources Evaluation of Peanut CRSP sites in Burkina Faso, West Africa. Annual Meeting American Soci. Agron.

Subrahamanyam, P. J. P. Bosc, Hama Hassane, D. H. Smith, A. Mounkaila, B. J. Ndunguru, and P. Sankara. 1992. Groundnut Diseases in Niger and Burkina Faso. Oleagineux 47: 199-133.

C. Mali Based Accomplishments

1. Cultivar Improvement

a. ACCOMPLISHMENT: Seed Increase (Mali)
In Mali, the decision was made to increase seed of four breeding lines (73-28) M 13, HYQ (CG) S-49, and EH 310-9) for on farm tests in prospect of release to farmers based on performance in three years of on-station tests.

b. ACCOMPLISHMENT: Early Maturing Lines (Mali)
Four short season (early maturing) lines and cultivars were again compared with check cultivars in Mali. This was the third consecutive year in which the four lines performed satisfactorily and seed will be increased in 1992 for on-farm trials in prospect of future release to farmers.

c. ACCOMPLISHMENT: Short Season and Drought Evaluated (Mali)
Short-cycle entries were compared at Katibougou, Cinzanan, and Same for adaptation and performance. Several periods of drought occurred at all locations. Yields were satisfactory at all locations. They were particularly good at some locations where all entries tended to yield in excess of 2000 kg/ha. Again, JL-24 had the highest yield with 2,844 kg/ha. It was followed by two lines with 260 kg/ha of pods.

d. ACCOMPLISHMENT: Germplasm Collection (Mali)
Seven collections of cultivated peanuts were made in 1992 as a joint effort by the IER CO-PI and ICRISAT collaborators. The regional focus was primarily in the South and Southwest. Seed collection would be used for multiplication and observing for breeding traits useful to the program.

e. ACCOMPLISHMENT: Variety Testing (Mali)
The 1993 Annual Report (CRSP, 1993) carried findings which conclude that a total of seven (7) tests of three varieties (short duration) were conducted in on-farm situations. These were conducted in sites having the same agroclimatic conditions as that of the area station. Local varieties were compared to two new varieties: JL-24 and QH 243-C. The new variety (JL-24) out performed the local variety (47-10) in average pod yield, seed and vine yield by 57, 80, and 22 percent, respectively. The other new variety (QH-243-C) turned in a similar performance. The local farmers seemed to be satisfied with JL-24.

D. Niger Based Accomplishments

1. Varietal Selection

a. ACCOMPLISHMENT:

T31-89, selected in Niger from Texas line Tx874737, has produced larger seed and higher yields than the check variety RMP-12 under both low and high rainfall sites and is being evaluated in farmer's fields in 1993.

E. Nigeria Based Accomplishments

1. Virus and Disease Control

a. ACCOMPLISHMENT: Rosette Virus Research (Nigeria)

In Texas, populations with selected parentage were developed and are under agronomic selection and generation advance to select for resistance to rosette virus (and termite) in Africa (Nigeria), and sclerotinia blight, spotted wilt virus, leafspot, rust, and/or Aspergillus flavus in Texas.

b. ACCOMPLISHMENT: New Lines Resist Rosette

In Nigeria, 57 lines (selected from 260) having less than 10% rosette virus infection in 1991 were planted in 1992. Thirty-three of these lines were free of rosette virus infection and show promise of some being acceptable to growers. promising lines that yield from 2.5 to 3.0 metric tons per hectare are being multiplied for state trials.

2. Training/Human Resource Development

a. Tunde Koleosho, Nigeria, completed the M.S. Degree at Alabama A&M University in Huntsville, Alabama (1991-1992).

b. Dr. Phindile Olorunju, Nigeria, P.I. virus project, to Malawi for Regional Groundnut (Peanut) Workshop.

F. Senegal Based Accomplishments

1. Cultivar Improvement

a. ACCOMPLISHMENT: Variety Release (SEN)

Approval for release of Fluer 11 in Senegal was given based upon documentation of pod yield increase in excess of 30% compared to 55-437 (a common cultivar) during five-years of on-and off- station research. Seed are being increased for farmer use.

2. Aflatoxin Control

a. ACCOMPLISHMENT: Village Oil Sampled (SEN)

Fifty samples of unrefined village-produced peanut oil from the Kaolack district were analyzed for aflatoxin B_1. Ninety-six percent of the samples contained levels from 5-254 ppb with an average value of 54 ppb. Twenty oil cake samples from the same locations contained aflatoxin levels from 40-160 ppb with an average of 67 ppb. Twenty samples of hand-picked roasted peanuts from markets did not contain detectable levels of aflatoxin.

b. ACCOMPLISHMENT: Absorbent Clays Investigated (SEN)

Previous studies in Texas (Senegal connected) have shown that highly absorbent clays in the diets of farm animals prevented the deleterious effects of aflatoxins. Studies with rats showed similar protection from aflatoxins, and more importantly no new metabolites were found in rats fed the clay-treated diets containing aflatoxin.

c. ACCOMPLISHMENT: Spraying to Test Contamination (SEN)

Studies in Senegal used row-spraying of conidial suspensions of Aspergillus flavus at different times in the growing season to increase aflatoxin contamination in peanut. Soil inoculation at pegging time resulted in higher aflatoxin levels in seed at harvest. Thus, the pegging-period is a decisive stage for peanut preharvest infection by A. flavus and subsequent aflatoxin contamination in the seed.

d. ACCOMPLISHMENT: Other Mycotoxins Evaluated (SEN)

Studies have been initiated to evaluate the role of other mycotoxins and mycotoxigenic fungi in peanut. Assays for the detection of fumonisins (a newly recognized group of carcinogenic Fusarium mycotoxins), have been added to the program and progress towards the development of a new rapid fumonisin assay is promising.

e. ACCOMPLISHMENT: Molecular Analysis Employed (SEN)

Molecular and genetic analysis of mycotoxin production has also been incorporated as an important aspect of the project. The Aspergillus nidulans ver-1 gene homologue, which encodes a reductase activity postulated to convert versicolorin A into sterigmatocystin in the aflatoxin pathway, has been cloned. Analysis of A.nidulans developmental mutants showed delayed or absent production of sterigmatocystin. DNA fingerprints of Aspergillus spp. have been established. Novel trichothecene producing Fusarium strains have been developed by genetic crosses and utilized to obtain potential new UV-induced toxin biosynthetic mutants.

3. Training/Human Resources Development

a. Two Ph.D. students have successfully defended their thesis work. Dr. A Bachir Sarr (a student from Senegal) received his degree from the Department of Veterinary Public Health in Jan. 1992 and is currently conducting a research project through a cooperative effort between Dr. Phillips' laboratory at Texas A&M and ITA in Dakar, Senegal. Mr. Julius Fajardo (a student from the Philippines) will be awarded his degree from the Department of Plant Pathology and Microbiology in Aug. 1992.

b. Bachir Sarr, Senegal, completed Ph.D. Degree in 1992-1992 at Texas A&M - Veterinary Public Health (Aflatoxins).

4. Collaboration

a. ACCOMPLISHMENT: Cooperation Enhanced

Change in US-PI project management and approval of a revised research proposal has been completed. In developing and planning new projects activities, Drs. Beremand and Kelelr visited locations in West Africa (ITA, Dakar, Senegal; ISRA, Bambey, Senegal; University of Science and Technology (UST), Kumasi, Ghana; Food Research Institute (FRI), Accra, Ghana; and the IITA Biological Control Center (BBC) for Africa, Cotonou, Benin. As a result, programs in Senegal were reviewed and additional collaborators/cooperators were identified in Ghana (Dr. Richard Awuah from the Department of Crop Sciences at UST and Mrs. Kafui Kpodo from the FRI) and in Benin (Dr. Kitty Cardwell at the IITA, BCC). Arrangements are underway to incorporate Dr. Awuah and Mrs. Kpodo into the program and establish linkages with the IITA, BCC. Dr. Awuah's expertise in fungal identification (especially Fusarium species) and pathogenicity will be instrumental in developing new objectives based on microbial assays while Mrs. Kpodo's current skills (HPLC and TLC identification of aflatoxins) and proposed future training in Dr. Timothy Phillips's laboratory on the identification of other key mycotoxins including Fusarium mycotoxins will provide complementary chemical support.

5. Publications (SEN)

a. ACCOMPLISHMENTS: Publications/Presentations Generated

Fajardo, J.E., Cuero, R.G., Waniska, R.D., and Pettit, R.E. Effects of Chitosan and Aspergillus flavus on Isozymes Related to Phenolic Compound Synthesis and Protein Profiles of Peanut Seeds. Manuscript in preparation.

Fajardo, J.E., Cuero, R.G., Waniska, R.D., and Pettit, R.E. Phenolic Compounds in Peanut Seeds: Enhanced Elicitation by Chitosan and Effects on Growth and Aflatoxin B_1 Production by Aspergillus flavus. Manuscript in preparation.

Keller, N.P., Owen, J., Bhatnagar, D., Cleveland, T.E. 1992. Utility of PCR for Diagnosis of Aspergillus Species. APS 1992 Annual Meeting, Phytopathology, abstract.

Pettit, R.E., Ba, A., Kane, A., and Sarr, A.B. 1991. "Information Bulletin Dealing with Prevention of Peanut Infestation by A. flavus." Moisissures de l'arachide et contamination par l''aflatoxine.

Phillips, T.D., Sarr, A.B., Clement, B.A., Kubena, L.F., and Harvey, R.B. 1991. Prevention of Aflatoxicosis in Farm Animals via Selective Chemisorption of Aflatoxin. In Mycotoxins, Cancer, and Health, Vol. 1. Pennington Center Nutrition Series, Louisiana State University Press, Baton Rouge.

Sarr, Ahmedoul Bachir. 1992. Evaluation of Innovative Methods for the Detection and Detoxification of Aflatoxins. Ph.D. Dissertation.

PART V

Economic Impact of the Peanut CRSP

A. Overall Assessment for West Africa (M. Coughenour-1993)

Fletcher, et al. (1992:19) reported that "while world groundnut production has increased [during the 1980s],...the increase ... is primarily in Asia with east Asia being the major contributor ... In contrast, Africa had 17% decrease in production from the 1970s to the 1980s with eastern and southern Africa being the main subregions contributing to this loss... Africa's share [of world production] dropped from 27% to 19% while Asia's share increased from 56% to 67%."

"These shifts in production are due to changes in harvested area and yield." While the harvested area in Asia increased by 12%, Africa's decreased 13%. Meanwhile, yields per ha. in Asia also increased 26%, and African yields declined marginally overall although W. African groundnut yields increased by 4% from the 1970s to 1980s.

The conclusion is that (p. 28) groundnuts have lost ground to rape seed (canola) and sunflower seed as oil producers. "This change in ranking may be attributable to the emergence of health concerns in the industrial countries... Thus, groundnut oil properties need to be reexamined in light of the current health concerns. Also, groundnut oil is not as price competitive on the world market. This was seen in the decline of the African countries in the world groundnut oil export market and the EEC in the groundnut oil import market..."

"Two (p. 29) key factors exist that may change the groundnut environment in the 1990s and beyond. One of the factors is aflatoxin. This factor is a key item in the edible trade as well as the domestic market. The USA, the EEC, and other developed countries are lowering the limits allowed for aflatoxin in edible groundnuts. Aflatoxin is a key problem of African countries wishing to enter the edible trade market on a large scale."

The second factor is GATT, which, if consummated, would change world trading and production patterns due to preferential developing country trading relations.

[10] Much of the referenced narrative for this section was developed by Dr. Milt Coughenour, University of Kentucky.

Badiane (1992) argues for African countries to reorient their exports to the African regional market as a way of compensating for the loss of the EEC market.

Schilling (1992:98): "Fundamental research ... is mostly carried out in Nigeria (Samaru), Senegal (Bambey), and Burkina Faso (Niangoloko). The last two of these stations cover problems in the Sudan-Sahelian Zone (where the major constraint is drought) and the Sudan-Guinean Zone (where the major constraint is disease). The programs have changed considerably in terms of goals and the methods used to achieve them. The changes were reflected in the complete renewal of the seed on offer to growers in W. Africa, shifting from low-yielding creeping varieties with small seeds and a 120-day cycle, to a range of high-yielding erect varieties, better adapted to drought, tolerant of certain diseases, or with characteristics making it possible to sell the seeds to more lucrative markets as edible groundnut. Varieties distributed in Senegal vary depending on the evolution of climatic conditions. The effective production and distribution of seeds each year is determined by the results of research and by government policy.

B. Burkina Faso

1. General Trends in Production and Use

Peanut production (overall output) in Burkina Faso has been variable since 1980 (Figure V-1a and Appendix Table V-1.) Areas planted to peanut (100 ha) was recorded at a constant 140,000 hectares per year, from 1980 through 1984. There was a sharp climb to 250,000 hectares by 1988 and a gradual settling back to 225,000 ha by 1991. Projections through 1994 do not show area planted to increase.

Yield per hectare showed improvement and stability during the 1980-1994 period (92-94 projected). Beginning in 1980 per hectare yield was recorded at .50 MT/ha (Figure V-1b). By 1991 yield had climbed to a high of .72 MT/ha (1988) and settled back to .68 MT/ha by 1991. Projection of yield for 1991 through 1994 showed no significant yield increases with constant technologies. Total production followed similar trends shown for area planted and yield.

Utilization of peanut for food, crushing and feed and seed (depicted in Appendix Table V-1 and Figure V-1d) showed some variability over the 1980-1991 period. However, there was no significant change in utilization patterns between the three use categories.

Professor Milt Coughenour (1993) researched the peanut situation in Burkina Faso and posited the following:

> "(1) Badiane (1992:Table 2) shows that from 1961-1988 the harvested area in groundnuts increased at a 2.02% average annual rate and yields increased at an average rate of .55% annually. (2) Annual Report 1992 (p. xxiii): "Annual peanut production in Burkina Faso is about 155,000 metric tons... There is some peanut oil export, but the country is a net importer of vegetable oil. There is both commercial and village-level traditional oil production for domestic use. Food use is in pastes for soups and as snack and confectionery foods. Peanut CRSP research is underway to enhance the use of peanut flour in composite flours with cereals and in weaning foods."figure 1a,1b

2. Impact Estimation Scenario (BF)

The annual report and interview notes reported that new cultivars (Fleur 11 as an example) had demonstrated sustained yield increases from 17 to 20%. For the impact analysis scenario, a more conservative yield increase of 15.3% was used for 1980-1990 and projected for 1991-1994.

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Under the scenario, it is assumed that if the new variety had been available in 1990, the yield would have been .78 MT/ha as opposed to only .68 MT/ha (Figure V-1c). Correspondingly, production would have jumped from the 150 thousand (MT) to 172.4 thousand MT. Projected figures (estimated) show expected production through 1994 would be sustained at levels above 179 thousand MT annually. The respective annual valuation of this increased production would be as projected below:

Table A. Valuation of Peanut Yield Increase in Burkina Faso

Year	Production Increase (000 MT)	Price in $US/MT (Current)	Value of Increased Production
1990	22,490	200	$ 4,498,000
1991	24,000	185	4,444,000
1992	23,750	151	3,586,250
1993	24,180	153	3,699,540
1994	23,300	153	3,564,900
Total	117,720		$19,788,690

The yield enhancing technology induced by the CRSP, in the form of improved variety, produced a change in production valued at $19.7 million over the five year period (projections).
figure 1c, 1d

C. Mali

1. General Trends in Production and Use

Peanut production and utilization in Mail has been unstable over the 1980-1991 period. Area planted remained fixed at 97,000 Ha for seven years (1980-1986), rose to 115,000 ha (1988) and settled back at 100,000 ha in 1991 (Appendix Table V-2). Yield per ha and total production were also volatile. The trends grew more stable between 1989 and 1994 (Figures V-2a and V-2b).

Total use of peanut and its product increased over the period (1980-1994) while the relative shares between feed, seed, crush and food remained about balanced. Overall, the crush component was more changeable over time (see Figure V-2d).

Professor Milt Coughenour (1993) researched the peanut situation in Mail and posited the following:

> "(1) Badiane (1992:Table 2) indicates that the groundnut harvested area declined at a 2.26% average annual rate from 1961 to 1988 while yields grew slowly, i.e., annual rate of .05%. Production (Table 6) declined at an average annual rate of 2.21%, and Mail lost ground in world export trade (Table 8).
>
> (2) Annual Report 1992 (p. xxiii): 'Annual peanut production ... is about 95,000 metric tons ... Similar to Burkina Faso, peanut oil production for export declined in the 1970's. There is commercial and village-level oil production for domestic use, and as a domestic food crop in the form of pastes for soups and as snack and confectionery foods."

2. Impact Estimate Scenario (Mali)

Using the same scenario conditions and assumptions as for Burkina Faso, the Malian increase in production would have been $13,062,730 as projected below (Table B). **figure 2a, 2b, 2c, 2d**

Table B. Valuation of Peanut Yield Increase In Mali

Year	Production Increase (000 MT)	Price in $US (Current)	Value of Increased Production
1990	15,960	200	$ 3,192,000
1991	15,060	185	2,786,100
1992	15,700	151	2,370,700
1993	15,260	153	2,334,780
1994	15,550	153	2,379,150
Total	77,530		$13,062,730

D. Niger

1. General Trends in Production and Use

Area planted to peanut plummeted from 169,000 ha (1980) to a low of 110,000 ha in 1991 (Appendix Table V-3). Projection to 1994 does not depict upward change (Figure V-3a). Yield per hectare and total production showed significant decreases. The utilization pattern for feed and seed was constant at 3,000 MT. Utilization for food and crushing each declined by greater than 50% over the 1980-1991 period. Trends in use are depicted in Figure V-3d.

Professor Milt Coughenour (1993) researched the West Africa peanut situation and posited the following:

> "(1) Badiane (1992: Table 2) indicates that the groundnut harvested area declined at a 4.47% average annual rate from 1961 to 1988 and yields declined at an average annual rate of 7.03%, and Niger's competitiveness in world exports dropped precipitously (Table 8).
>
> (2) Annual Report 1992 (p. xxiii): "Niger follows much the same pattern as Burkina Faso and Mali with peak peanut production in the 1970's. Rosette virus, drought, and prices has reduced production and export of peanut oil. Present production is about 60,000 MT per year. Domestic oil production from commercial and artisanal producers, peanut paste for soups, peanut cake for a fried cake called kulkuli, and snack peanut accounts for much of the production."

2. Impact Estimate Scenario (Niger)

Again, the same conditions and assumptions as used for Burkina Faso apply for Niger (Table C). The valuation of yearly yield increase would have been in excess of $1.5 million.

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Table C. Valuation of Peanut Yield Increase in Niger.

Year	Production Increase (000 mt)	Price in $US/Constant	Value of Increased Production
1990	9,760	200	$ 1,952,000
1991	9,860	185	1,805,600
1992	10,250	151	1,557,750
1993	10,140	153	1,551,420
1994	10,110	153	1,546,830
Total	50,020		$ 8,403,600

fig 3a, 3b, 3c, 3d

E. Nigeria

1. General Trends in Production and Use

Total area harvested (900 ha) has been on an upward trend (Appendix Table V-4 and Figure V-4a) since 1980. The largest annual area harvested figure was recorded at 80,000 ha in 1987. By 1991, the area had settled at about 750 ha, with projections to 1994 being level. Yield per ha has been disappointing. Beginning in 1981, it was .80 MT/ha and by 1990 it had fallen .50 MT/ha. Of course, these are yields using conventional varieties.

The distribution of available stock between the food, crushing and fee/seed categories has been changeable (Figure V-4d). Food use started out at 200 MT in 1980, increased to 324 MT in 1987 and had settled back to 304 MT in 1991. The data would suggest that peanut is catching on as a food crop in Nigeria. Feed use declined by 50% and formal exports are nearly nonexistent.

2. Impact Estimate Scenario (Nigeria)

In the foregoing scenarios, a yield increase less than that obtainable from the newly released cultivar was used. That same rate of increase (15.3%) and the same assumptions are used for Nigeria were a higher yielding variety to be planted and sustained the production and value would be as depicted below (Table D). Over the five-year period, $48.5 million would have been generated.

Table D. Valuation of Peanut Yield Increase in Niger.

Year	Production Increase (000 MT)	Price in Current $US/MT	Value of Increased Production
1990	56,610	200	$11,322,000
1991	61,200	185	11,322,000
1992	55,960	151	8,449,960
1993	56,630	153	8,664,390
1994	57,510	153	8,799,030
Total	287,910		$48,557,380

figure 4a, 4b, 4c, 4d

F. Senegal

1. General Trends in Production and Use

Senegal has been the preeminent producer and consumer of peanuts, among the CRSP host countries. Area planted was highest in 1980 and 81 with 106 and 108 thousand ha planted, respectively. Yield doubled between 1980 and 1987, increasing by over 100%. While total production rose to 1.1 million MT in 1982, it had receded to 695 by 1991. Senegal showed imports in excess of 25,000 MT in six of twelve years. Food use showed increase over time. Feed and seed usage tended toward decline (Figure V-5d). Peanuts used for crushing showed the greatest share of the market and exhibited strong variation.

Professor Milt Coughenour's research (1993) in this area yielded the following:

> "(1) Fletcher et al. (1992: Tables 12-14) show Senegal as one of the top ten producing countries, but the '80s production declined by 16.2%, harvested area declined by 20.1%, and domestic consumption declined by 11.1%. One the plus side, yields per ha increased by 8.29%.
>
> (2) Badiane (1992: Table 2) shows that the average annual rate of decline from 1961 to 1988 in the area harvested was .94% and in yields was .20%. Production (Table 6) declined at an average annual rate of 1.14%, and its competitiveness in trade also declined (Table 8). Although there was an overall decline in yields from 1961 to 1988, there was some recovery during recent years.
>
> (3) Annual Report 1992 (p. xxiii): 'Senegal is an exporter of peanut oil, but not edible peanut. In 1984-1985, 83,000 MT of oil was produced... and only about 33% was exported with the remaining 55,000 MT consumed locally. Additionally, considerable amounts of peanut is consumed as condiment in stews, soups, and as snack food. This puts Senegalese domestic consumption in the range of 75% of production."

2. Impact Estimate Scenario (Senegal)

Senegal had, by far, the most active market in terms of peanut export, import and domestic consumption. Based on a deflated yield increase projected to stem from newly released variety, Senegal would reap benefits in excess of $94 million during 1990-94 (Table E). Value of the real impact could be greater granted that diseases, insects and losses may have been contained.

\a\

Table E. Valuation of Peanut Yield Increase in Senegal.

Year	Production Increase (000 MT)	Constant Price in $US/MT	Value of Increased Production
1990	104,000	200	20,800,000
1991	108,000	185	19,980,000
*1992	119,260	151	18,008,260
*1993	122,170	153	18,693,010
*1994	114,220	153	17,475,660
Total	567,750		$ 94,955,930

G. Summary: All Countries Combined

Clearly Senegal and Nigeria lead the rest of the countries in the harvested area planted and produced tonnage categories (Figures V-6 and V-7). Overall, food usage has risen in Nigeria (Figure V-8). Peanut feed and seed usage have declined, especially for Nigeria and Senegal. While Burkina Faso had the strong food technology research focus, it has shown the weaker increase in food utilization. fig 5a, 5b fig 5c, 5d fig v6, v7, v8, v9

The combined value of increased yield to new variety in all countries is calculated below (Table F).

Table F. Valuation of Increased Peanut Yield for all Countries.

Projected Value of Increased Production						
Year	Burkina Faso (Mil. $US)	Mali (Mil. $US)	Niger (Mil. $US)	Nigeria (Mil. $US)	Senegal (Mil. $US)	All (Mil. $US)
1990	4,498	3,192	1,952	11,322	20,800	41,764
1991	4,440	2,786	1,805	11,322	19,980	40,333
1992	3,586	2,370	1,548	8,449	18,008	33,961
1993	3,699	2,334	1,551	8,664	18,692	34,940
1994	3,565	2,379	1,547	8,799	17,476	33,766
Total	19,788,690	13,062,730	8,403,600	48,557,380	94,955,930	

Over the five-year period, approximately $184,764,000 would have been generated from the adoption of new cultivar technology. This represents a substantial value when compared to cost outlays.

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PART VI
Summary, Impact Issues and Recommendations

Summarizing this report is a broad sweeping and daunting task. Nonetheless, the summary attempts to return to focus after having pushed through a maze of information foci and documentation.

A. Summary

This evaluation report represents the results of activities and interpretations which partially characterize the Peanut CRSP's progress. It is a partial characterization because: a) it focused mainly on West African host countries, b) it focused primarily on the time period of 1990 through 1993, c) it focused mainly on economic impact, procedural matters and accomplishments; and d) the quantitative impact assessment focused on yield as a proxy for all impactors. Also, this evaluation represents an earnest attempt to conduct an economic impact assessment under extremely difficult constraints.

Many aspects of this evaluation and the CRSP are summarized as follows:

1. The scope of work (SOW) which guided the process was simply to collect and analyze data on CRSP: (1) inputs, (2) systems and human capital development, (3) research and output communication, and (4) utilization of technology by clientele.
2. Several limitations to the impact assessment are discussed elsewhere in this report. However, the major limitation was felt to be the absence of a social science component in the project. Failure to contain a social science component lead to a failure to plan for and collect data useful to a socioeconomic impact assessment.
3. The place of peanuts as an export commodity, in the host country economies (formal) appeared to be shifting toward a weakened position. According to Fletcher (Groundnuts: Production, Utilization, and Trade in the 1980s, In Groundnut, A Global Perspective - Proceedings of the 2nd International Groundnut Workshop, Hyderabad, India 1991, pp. 17-32.), a general decline of peanuts in West African countries began in the early 1960's, following independence. The loss of the European oil market contributed to the decline. Other crops produced in Europe have replaced imported oil.
4. Environmental enhancement attributes of the peanut and its increasing role as a food crop argue for a more sustained place in the regional economy and in cropping systems. There may be basis for arguing for a strengthened role for peanuts, even in the face of international trade politics.
5. Factors which gave rise to the Title XII legislation and subsequently the Peanut CRSP are of looming importance today. The peanut is an almost ideal crop for use in "preventing famine" and establishing "freedom from hunger" and simultaneously "building a sustainable agriculture."
6. The Peanut CRSP practitioners chose well when deciding to let "mitigation of constraints" drive approaches, project design and CRSP resource allocation. The constraints are thoroughly defined in this report and in several CRSP documents. They have been categorized as: (a) environmental, (b) socioeconomic, and (c) human nutrition and health constraints.
7. The CRSP goals evolved around mitigating constraints. They are: (a) to develop sustainable agricultural production and food delivery systems that are profitable and environmentally sound, (b) to resolve resource management situations that restrict appropriate research, and (c) to communicate research output to beneficiaries. Goal attainment would require the sustained, massive collaborative as planned for in the CRSP.
8. The global plan called for initial geographic coverage to encompass Senegal, Burkina Faso, Niger, and Mail and later expand to: Benin, Cameroon, Chad, Gambia, Ghana, Guinea, and Togo. It called for several other important elements: regional impact generation, external evaluation, concise management strategy, constraint mitigation, enhanced resource management,

enhanced training outcomes, and communication and outreach. Appreciable progress was reported on these elements.

9. The country level, project specializations brought identity to achievable tasks and expectations. They varied by country, but collectively called for the following: (a) cultivar improvement, (b) integrated pest management, (c) improved food products, (d) enhanced disease control, (e) control of aflatoxin, (f) control of the rosette virus, (g) improved processing technology, and (h) enhanced supply of peanut for human food and livestock feed. Remarkable progress has been documented in each case.
10. Accomplishments have been numerous, well recorded and vented through reports. Some of the most striking accomplishments have occurred in the arena of cultivar improvement. For example, the approval and release of Fleur II, in Senegal, will lead to significantly increased peanut yield. High yielding varieties with resistance to rosette virus are emerging on the food technology side. Burkina Faso is making strides in new uses for peanut in traditional flour and in new products.
11. Economic impact was given initialization with this review. This review measured change in yield due to new varieties and measured the value of that yield in world market pries during the applicable years. That crude analysis along suggests benefits which outweighed cases in the short run. The value of a projected increased yield was estimated at $184,764,000 for five countries, over the 1990-94 time frame. Subsequent reviews should have data to measure impact at: (a) the input stage, (b) the cultivar stage, (c) the harvest and storage stage, (d) the processing and marketing stages, and (e) the consumption stage. It is suspected that analysis will show the CRSP to have met with success at each stage.

B. Impact Issues

There are several issues which could be raised with regard to the Peanut CRSP's design, approach and impact assessment. The multifaceted issues would be given rise to due to the sheer complexity of the CRSP project. Moreover, the issues could be taken at any point of intervention on the constraints or focused at any point when research or related action could impact peanut growth, yield, viability, processing or consumption.

Since this is not an exercise in issues raising, this evaluator felt compelled to focus only on issues that could influence impact and capacity to assess the economic impact. They are shared below.

1. <u>Design</u>: The CRSP project is felt to have started out with a design flaw. That flaw is related to the lack of a social science component or a plan for engaging social science (SS) personnel. Not only would SS personnel have been able to enhance project acceptance and technology transfer, they would have been positioned to develop socioeconomic impact criteria and methodologies. With their inputs, the sequence of evaluations might have been more holistic and informative.
2. <u>Uniformly comparable database</u>. The lack of continuity in available time series data on peanut production yield and <u>processing</u>, in each counting makes it difficult to conduct economic impact analysis. Moreover, the lack of parallel and availability of social science field surveys made it difficult to assess the social impact of the CRSP.
3. <u>Lack of fully reliable data on peanut production and marketing in each country</u>. To conduct the ideal type of assessment, certain critical data is a must. There are often gaping holes in available data. For example, it was said that in Senegal, a large proportion of the peanuts are sold in the informal market. Official government data are only kept on the formal market. Therefore, information on home consumption, small holder marketing, and livestock feed utilization is limited. Unavailability of such data precludes thorough impact assessment.
4. <u>Consensus on social impact indicators.</u> In measuring social impact or social soundness, any number of variables could be used. When considering roles, needs and expectations of significant groups (e.g., input suppliers, cultivators, equipment distributors, small farmers, harvesters, processors, distributors, consumers and regulators) the complexity of variable selection and measurement become more apparent. It is important that the CRSP management

entity, funding agency and practitioners agree on social impact indicators and how the impact assessment would be approached in the future.

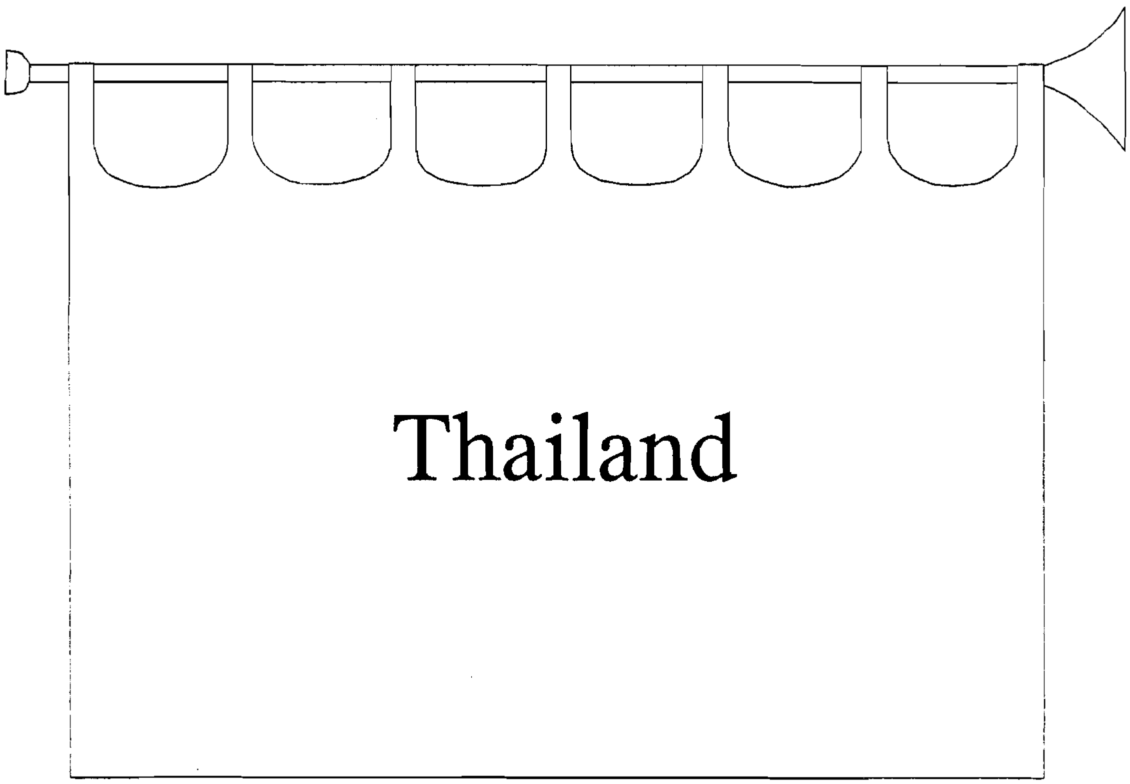
5. Price determination and disuniform variability across countries (of the region) poses another problem. It is difficult to ascribe absolute and comparative values to peanut harvests if the prices are artificially set in ways that bear no relation to supply and demand signals. It was suggested that in at least two countries, the government set prices purely based on how many tons of peanuts it could absorb into the oil extraction and export market. This approach ignored the value of peanut as a "food crop."
6. Lack of an understanding as to how the peanut market could or should work in the selected countries. It would be helpful to have studies conducted on the structure and functioning of the peanut markets (formal and informal) in the CRSP countries. Sub-studies on consumer acceptance on preferences for product, containers and means of conveyance would be helpful; especially if they are conducted with some degree of uniformity across the region.
7. Past GATT negotiation strategies and "new" concerns for safety will impact the capacity of African nations to sell peanut oil and other peanut products to EC countries and the United States. Thus, even increases in yield and marketable product might be met with closed marketing options. Such would be a tragic waste.
8. Availability of seed and fertilizers. It was mentioned on not one but several occasions that seed multiplication and distribution systems (both regional and national) had become disfunctional. Therefore, it would be difficult to multiply and make available to farmers, the new seed and conventional fertilizers. These constraints could well put a damper on immediate utilization of the newly available technology.
9. Utilization of trained personnel. The CRSP has made progress in working with host countries to train research personnel. More could have been done had the desired level of funding been available. Even with many who have been trained, the perennial problems of underemployment, mis-employment (temporary), or lack of research support seem to persist. Several specialists suggested problems in this area.
10. Coordination with extension. One of the problems which emerged during interaction was the less than desirable linkages between research, extension and other critical actors who would help transfer research technology to the users. Improvement on the linkages and on support for technology transfer will be critical to future progress on the CRSP.

C. Recommendations

1. The peanut CRSP has been successful. The peanut crop is an excellent vehicle for helping to prevent famine, provide freedom from hunger and conserve the agricultural resources. In light of these it is recommended that the CRSP be approved for continuance and that the social and economic components be added.
2. Under the extension, it should be required that the cooperators develop and maintain data based on selected indicators, which would facilitate monitoring progress and measuring impact. Social scientists and physical scientists should be synergistically involved in mapping out data requirements.
3. Future work on the CRSP should encompass a more aggressive thrust in food technology, with scientists working in concert with industry personnel. The purpose should be to develop new products and processes to increase the availability of peanut and related products to the people while positively impacting host country private sectors.
4. The U.S. and EC countries should re-evaluate their own protectionist stances and find ways to actively encourage the expanded use and export of peanuts by the developing host countries.
5. Systematic research should be conducted to assess the structure and effectiveness of the agricultural input supply sector, especially where peanut and field crops are concerned. Availability of chemical and non-chemical inputs needs to be known. Utilization levels and practices need to be understood.

6. Continued emphasis should be put on providing more and better trained research personnel. However, the CRSP should explore ways to help in maintaining constructive and useful employment of researchers when they return home.
7. Ways must be discussed to enhance and broaden collaborative activities between research and extension. Agency, regional and cultural barriers should be sought out and removed.
8. Incentives for adopting new varieties should be studied and ways should be found to rapidly enhance and multiply the seed, once selected. The CRSP should seek ways to help remove the constraint of poor seed multiplication infrastructures.

The Agency for International Development and the CRSP universities should critically re-examine and reverse the recent decline in agricultural development assistance. The present trend is socially untenable and in the long run, will prove more costly to the U.S. than the dollars saved by cutting back technical assistance programs.


Thailand

EXECUTIVE SUMMARY OF VISIT TO THAILAND

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Executive Summary
of External Evaluation Panel's Visit to Thailand

1.0. Introduction

Three members, accompanied by Dr. David Cummins, Program Director of Peanut CRSP, visited Thailand from January 22 to January 30, 1994. The three EEP members are:

Dr. Bo Bengtsson, Swedish University of Agricultural Sciences, Sweden
Dr. Joe Smartt, University of Southampton, England
Dr. David Hsi, New Mexico State University, USA

The EEP members visited the Department of Agriculture and Kasetsart University. They were welcomed by the Director of Field Crop Research Institute and director of DOA's Field Crop Research Institute at Khon Kaen. They received written and oral reports from the DOA's collaborators in Bangkok on the latter's pathology and entomology research. The EEP members also visited the facilities of the Department of Product Development at the Kasetsart University, reviewed and discussed their research, and also sampled the various peanuts or peanut flour fortified food products such as dry snacks and cooked wet noodles, and fresh or canned roasted peanuts. The next day, the panel visited Huay-Bong-Nu a village northwest of Chiang Mai where processing technology outreach and technology transfer were taking place. Subsequently, the EEP and Dr. Cummins were joined on 27 February by Dr. Dianne Janczewski, USAID Program Manager for Peanut CRSP, and the group visited with and received oral and written reports from Khon Kaen University and DOA collaborators. They also visited farmers' fields near Khon Kaen where contracted multiplication of foundation seed was in progress, a large sheller-processor factory, a cottage industry of peanut processing operated by a single family unit, and a DOA Extension Seed Center.

All the visits were well organized and useful for giving the EEP members a good overview of the Thailand Coordinated Peanut Improvement Program and ongoing research supported by Peanut CRSP

At the end of their on-site visit, the three members of the EEP held an internal meeting to discuss individual observations and impressions. Their findings and recommendations were later shared with the Director of Peanut CRSP and they sought his clarification on some of the questions raised by them previously.

2.0. Research Accomplishments and Impact

2.1. Appropriate Technology for Storage and Utilization of Peanut

2.1.1 Handling, Sorting, Packaging, and Storing Techniques

By instructing Thai peanut processors in terms of proper post harvest storing and sorting procedures supported by research, substantial progress has been made toward the elimination of the presence of aflatoxin in peanuts and peanut products.

2.1.2 Product Development

Many peanut products have been developed through the collaborative effort of U. S. and Thai food scientists. They are being developed for the purpose of increasing market value of peanuts, the use of defatted peanut flour in extending food products such as Chinese-type noodles and snack foods, and the improvement of nutritional value from eating more peanut products by the Thai consumers.

2.1.3 Technology Transfer

Researchers involved in the project have been advising and assisting peanut handlers, processors, and marketers throughout Thailand. The EEP members visited near Kalasin, in the vicinity of Khon Kaen, one commercial sheller and processor, and one family cottage industry enterprise processing roasted and ground roasted peanuts. The technology transfer of peanut processing of oil roasted and ground roasted peanuts and of marketing management involving seven women farmers in Huay-Bong-Nua village northeast of Chiang Mai was successful and economically promising in the first two years of pilot study. Peanut processing was suspended at the time of the EEP visit due to the shortage of raw peanut supply this year, consequently the resulting high price of raw materials would make processing unprofitable. Even though from a technical standpoint, such village type of enterprise might not be justified, however, there exists some value in extending the project for a few more years to assess the full social-economic impact over a longer period and the costs of maintenance and depreciation of machinery invested by the researchers for such type of small village enterprise.

2.2 Varietal Improvement and Breeding

Well coordinated programs between DOA and KKU are making good progress in developing peanut cultivars suitable for different regions and possessing desirable agronomic traits and host plant resistance to major diseases and insects. Breeding is a long term process because of changing consumer and market demands and constant appearance of new isolates or biotypes of disease pathogens and damaging insects.

The EEP members were impressed with the scope and depth of research conducted by the well trained and dedicated scientists in Thailand. The objectives sometimes seemed to be overly ambitious but could be accomplished with dedication and hard work and continued funding support for retaining competent personnel. Several cultivars have been released, and new cultivars and promising lines are being evaluated and are ready for future release.

2.3 Peanut Viruses

In addition to being part of the breeding program for screening for host plant resistance, many excellent studies were made on the etiology and epidemiology of the viruses. Also, the plant pathologists are cooperating closely with the entomologists in the management and control of those insects which serve as important vectors of viral pathogens.

2.4 Management of Arthropods

Major insect pests on peanuts are leaf miner, leafhoppers, thrips, and subterranean ants. Yield losses caused by three pests have been studied. Various studies on chemical control, natural control, and plant resistance evaluation have been and are being made. The broad-spectrum research program is directed toward effective integrated pest management programs and toward the goal of a sustainable production system for peanut production.

3.0. Observations and Recommendations

Thailand Coordinated Peanut Improvement Program has significantly enhanced research output and training. Annual planning and reviews by Thai scientists are useful in overall research programs and its practice application. Technology transfer of product development and market management is promising but still needs time to fully assess its socio-economic impact. The Thai government is committed to support peanut research and training. Information flow and use at farmers level will be enhanced by continued Peanut CRSP support.

The investment of USAID and Peanut CRSP has produced maximum return and practical research benefits in Thailand. With the wealth of well trained peanut scientists and food technologists, Thailand is in a favorable situation to assume the regional role in assisting neighboring countries in Southeast Asia through research collaboration and advanced training.

The EEP recommends another five-year extension of this Peanut CRSP in Thailand to fully realize the benefits of ten-years of financial investment in research and training toward technology transfer, sustainable agriculture, and economical development of the Southeast Asian region.

REPORT ON VISIT TO THAILAND

JANUARY 22 - 30, 1994

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PEANUT CRSP EXTERNAL EVALUATION PANEL VISIT TO THAILAND

J. Smartt

The operation of the Peanut CRSP in Thailand over the past twelve years can be justly considered an unqualified success. It is very impressive indeed to see the progress which has been made in all the projects which are currently in operation and how previous works (such as those initiated by IDRC) have been made use of in furthering development. Excellent work has been carried out on all active fronts which will be considered in some detail later under individual projects. What come across most strongly to the visitor is the very real and active spirit of cooperation which exists between the scientific staff not only of different universities but also between these and members of the Thai Ministry of Agriculture and its various departments.

It is worthwhile to consider the reasons for this success and the foremost of these is that they appear to have taken a leaf out of the book of the Land Grant Universities of the United States and the way they work. My own experience as a graduate student at such an institution in the United States has made a lasting impression on me. My work was to involve studies of interspecific hybridization and cytogenetics in the genus Arachis, a specialized area rather remote from the practicalities of peanut production in the field. Yet among the first members of the peanut community of North Carolina that I was to meet within a few weeks of my arrival were members of the extension service and the peanut industry. I also found it impressive that members of the University and USDA worked side by side and it was often necessary to refer to staff lists to determine the actual affiliations of specific individuals. This led to very effective and continual cooperation between specialists from different ages and remarkably rapid progress. It is good to see that this model is being followed rather than what is unfortunately more common in the Developing World where all too often there is antagonism between Universities and Departments of Agriculture and far too much energy is dissipated in institutional rivalry. To my mind this indicates overall leadership and direction of a very high standard indeed.

1. Utilization

The problem which above all others stimulates interest in utilization of peanuts is that of improving farmers' incomes without increasing production to a point where the market is oversupplied and the price paid to the producer is depressed. Fortunately, the peanut is a crop not often subject to this economic hazard. More often than not demand tends to exceed supply rather than the reverse and price fluctuations are not a serious difficulty. Compared with other grain crops on world markets peanut of satisfactory quality command a good price in addition to which they have enormous capacity to generate added value. The uses of the crop are legion. In Africa, for example, it can generally be said that whenever the crop can be produced it is produced even if only for subsistence use. The utilization of the crop there is relatively unsophisticated, the green mature (uncured) seed can be consumed boiled, the mature seed can be eaten fresh, parched, roasted and used in soups and relishes. Apart from local expression of oil and production of presscake the opportunities for exploiting potential for adding value have not as yet been exploited seriously. As a consequence of the aflatoxin problem and the market difficulties this raises, production trends in Africa have been drifting gently downward. This is in contrast to the greater part of Asia (except Japan) where there is increasing interest in the crop and the outlook is much more buoyant.

The actual and potential uses of the crop in Asia tend to be rather different from those in the Western World. Not the least exciting area for development is the production of peanut analogues of the soybean fermentation products. The prospect of developing a similar cottage industry to that based on soybean fermentation in Indonesia or elsewhere is S.E. Asia using the peanut is an extremely attractive one. The work on the development of these analogues carried out at the Department of Food Science and Technology (University of Georgia) under the leadership of Dr. Larry R. Beuchat has established a very firm foundation upon which further development in Asian countries could be based.

This is clearly a path of development which could absorb an enormous amount of time and energy in its furtherance and wisely two pilot studies have been selected for further study, field and market testing in Thailand. The results of these are encouraging and a number of important points have already been established. It is an opportune time therefore to take stock of the situation, evaluate the achievement of these pilot studies and to formulate appropriate plans for their future development.

We have been able to sample materials such as the noodles which incorporate defatted peanut meal in their formulation. These are perfectly acceptable (as judged by my own reaction and those of the population samples tested), the question that remains to be answered is whether the Thai public is prepared to pay a premium price for the enhance nutritional value of peanut protein enriched products such as noodles and snack foods which have been developed. There seem to be no serious difficulties of an organoleptic nature. It is possible that it might be necessary if the nutritional situation warranted to encourage use of peanut protein supplements by judicious use of subsidies, not a popular course of action at the present time in the eyes of many political/social economists. A possibility which perhaps might be worth exploring is that of encouraging substitution of plant protein for animal. This is in accordance with Buddhist culture, some popular movement such as is developing in the West to reduce and control consumption of saturated fats, cholesterol and red meats could favor higher use of plant protein-rich products. In the past pulses were considered as "poor man's meat" but now that they are increasingly in favor in the West is a point which could be used in promoting legumes and other protein rich materials. Enhancement of the social status of plant protein rich food could be a useful psychological ploy. One of the contributing if not major causes of failure of efforts to encourage soybean production and consumption in Africa was the fact that the expatriates who were vigorously promoting the crop consumed none of its products themselves. In contrast Africans took readily to consumption of wheaten bread which in their eyes had the status of a prestige food because it was a staple food of the dominant expatriate population.

Before the wide range of products new to the market can be expected to have any impact, note a great deal more market research will be necessary and the private sector must become interested in their promotion. In our visit to the Kalasin province we saw a very large and impressive peanut mill which was also producing oil and meal (Nam Heng Huad Co. Ltd.). We certainly were given the impression that further commercial enterprises would be entertained on their merits by this company which was looking out for opportunities for expansion. At the level of the family cottage industry enterprise we saw an excellent example of a small and apparently flourishing family business which was producing roasted and ground roasted peanuts to supply local needs. The paterfamilias had apparently invested his earnings from working in the Libyan oil industry in his processing equipment and had graduated from producer and processor to processor exclusively. The motivation for this enterprise was self-generated, this is in some contrast to the Technology Transfer exercise carried out in Huay-Bong-Nua Village in the Chiang Mai Province through collaboration of departments of Kasetart University, Chiang Mai University with the cooperation of the local district Home Economist.

In this project the objective was for selected local peanut growers to improve their income by processing their own crop and benefiting from the value thereby added. The products targeted were oil roasted peanuts and ground roasted peanuts for which there were satisfactory local markets. Although the profit margin for oil roasted peanuts was greater (84.16% of cost) than for ground roasted peanuts (39.53% of cost), the greater demand for the latter favored its production. A group of seven producers was selected who were equipped with the necessary equipment and trained in the appropriate technology. This proved to have been very successful in terms of the ability to produce the product and its high quality. The latter represented an improvement in quality (principally low aflatoxin levels) on what was currently offered for sale. The producers chosen were from an area where the farming population was poor but the experience of this project shows that there is nothing wrong with the human resource in this area. The producers and their local mentor did all that could have been expected of them. What does seem to have been a problem is that whereas both the local market and the far larger potential market in Chiang Mai were the targets, in fact only the local market was readily accessible. There have obviously been additional problems in that the processing equipment has been under utilized, one day per week in the processing season. Clearly for this project to serve as a model for further development the equipment would need to be used closer to its capacity. This would entail securing a greater quantity of raw materials and a capacity to store them to maintain production over a longer period. It would also entail eventual specialization in processing on the part of current producers perhaps under some kind of producer-processor cooperative arrangement.

There are some very positive achievements of this project, it has demonstrated the feasibility of generating added value locally on crops produced in the area and increasing income levels. More thought and exploration is required on how best to exploit the potential of both human and material sources to this very desirable end.

2. Post Harvest Handling and Storage

The production of any grain or seed crop in a humid tropical environment presents difficulties especially in relation to spoilage in general and mycotoxin production in particular. The difficulty is compounded in the case of an oilseed crop in that high temperatures and high humidity promote rancidity with loss of viability in seed crops and loss of quality for the processor. The problem is made more complex by the fact that the crop can with irrigation when necessary be produced at any time of the year. The timing of the cropping pattern, should as far as possible, be such that crops mature at times when minimal rainfall is expected. However unseasonal rainfall could raise problems which cannot be ignored. There are three times of year when peanuts can be grown:

a) before the rice crop is taken on paddy land,
b) during the wet season on land not producing rice, and
c) after the rice crop on residual moisture.

Peanut production is a very labor intensive activity especially at harvest time and post harvest. When animal draught is available digging the crop need not present undue difficulty by stripping pods from the vines and shelling them can be excessively time consuming and tedious operations if they have to be done manually. Mechanization of these operations by appropriate technology can do a very great deal to relieve a very important constraint in producing the peanut crop. Shelling is a particularly delicate operation and must be carefully controlled to preserve quality and avoiding, as far as possible, splitting kernels. Suitable equipment has been developed and it is very much a question of developing and refining designs of equipment so that they are robust, durable, and inexpensive. Very good progress is being achieved at Khon Kaen University in this regard.

The major problem relates to curing the crop and reducing water content to a level which permits safe storage most cost effectively. It is desirable to use direct solar energy as far as possible by use of drying floors. There is no reason why driers used for other crops should not be pressed into service subject to availability (i.e. if they are in use for rice, corn etc.). The cost of using artificial drying could seriously impair the economic attractiveness of the crop but may be justified on occasions to maintain both quality and production levels.

In this area of investigation the problems are being effectively addressed, the right questions are being asked and effective means have been adopted to secure appropriate answers.

3. Peanut Viruses: Etiology, Epidemiology and Nature of Resistance and Management of Arthropods

It is sensible to consider these two aspects together because in the case of virus diseases it is necessary to consider both the disease and the vector in conjunction and also there are parallels in the effects of the foliar diseases of the crop (rust and the leafspots) and those of defoliating insects such as the caterpillars of Heliothis. Similarities do not end here as there are distinctly different profiles of both pests and pathogens in the wet season as compared with the dry.

As regards diseases those which predominate in the wet season are the foliar pathogens, rust and late leafspot followed by stem blight and Aspergillus seedling blight. There are characteristic diseases of the growing season wherever the crop is grown. The inoculum of the foliar pathogens is produced abundantly in the prevailing humid conditions and it is effectively spread in the driving rain of the wet season. These conditions equally favor the soil pathogens which attack seedlings (Aspergillus niger), the growing plant (Sclerotium rolfsii), and the maturing pod (Pythium, Fusarium, Sclerotium). The dry season profile is characterized by the predominance of virus disease principally bud necrosis (GBNV) and peanut stripe virus (PStV) with some incidence of Aspergillus seedling blight. This difference is not unexpected, in the semi-arid tropics where much research has been carried out on dissemination of virus diseases, spread is favored by dry/drought periods during the growing season which favors aphid development and depresses the activities of natural agents of biological control. The seedling pathogens can maintain their activity on soil moisture levels which maintain growth of the crop.

In the past most research on peanut viruses has focused on those which are aphid transmitted. Bud necrosis virus (GBNV) is however thrips transmitted and the role of this group of insects as virus vectors has only been appreciated comparatively recently. Not all thrips are virus vectors and it is clearly necessary that those species implicated are accurately identified and their biology understood. This will necessitate further study in cooperation of pathologists and entomologists of the epidemiology in particular of this disease. It is not an area in which the experience of others elsewhere can be drawn upon to any extent since this is relatively sparse.

The control of virus diseases can be tackled in several ways, at the present time none of which can be neglected. First of all, the best possible husbandry practices should be followed. The sooner a complete (or near complete) ground cover can be established, the better since this not only tends to reduce the period of vulnerability to attack, but incidentally produces an environment more favorable to agents of biological control. A closed canopy not only produces an environment favorable for growth and development of entomophagous fungi, but also gives predators more ready access to their prey. This has been effective against Aphis craccivora in Africa and may also be helpful in the case of thrips.

It has also been observed that peanut genotypes differ in their performance as hosts to insects such as aphids which feed upon them. The effect is often expressed in a reduction of fecundity of the pest as well as a lack of initial attraction. This was noted in the African landrace Asiriya Mwitunde whose reputed rosette resistance (GRV) was actually resistance to the vector, not the virus itself. In the case of thrips, it has been observed that Spanish cultivars are less favorable hosts for thrips than at least some other groups of cultivars.

Genetically determined virus resistance is clearly the ultimate resistance mechanism. Sources of resistance can be found in germplasm collections of Arachis hypogaea as well as wild related species in the genus Arachis. The identification of resistance within the cultigen itself can be a rather protracted business. The collections are large and their systematic evaluation for pest and disease resistance is a tack which may never ever be completed, but they represent a pool which can be sampled and which could yield positive results. The wild gene pool is easier to evaluate in terms of number of accessions but once identified, actual transfer of resistance may not be easy. The induction of virus resistance through biotechnology at present appears to be a realistic goal using the technique of incorporating virus coat protein coding genes in the peanut genome. Refinements in genetic transformation techniques which can be expected in the near future should bring forward the day when this can be achieved. As far as Thailand is concerned resistance to bud necrosis (GBNV) is the prime concern. It might well be that the initiative for this would have to come from Thailand (and perhaps neighboring countries in S.E. Asia), but this possible development should be considered seriously. This is because this particular virus (GBNV) is not as serious a problem elsewhere.

By comparison the other viruses seem to pose little problem at the present time, although this situation needs to be kept under constant review. The situation regarding peanut stripe virus (PStV) is of interest. Its occurrence in research stations and their proximity clearly implicated infected seed as the source. Strict quarantine of new stocks is indicated and selection of genotypes with low rates of seed transmission of this and other viruses should be followed up vigorously.

In the wet season the disease problems experienced in Thailand are shared with those of the whole peanut producing world. It can be expected that success achieved elsewhere in improving resistance to foliar and other pathogens could be exploited readily in Thailand. The development of lines resistant to leafspots and rust in the United States and at ICRISAT in India could be very rapidly exploited.

Further studies of soil inhabiting fungi such as sclerotium rolfsii, Pythium spp, Fusarium ssp, and Aspergillus spp should be given serious consideration and involve ecological studies of competitive relationships between these and non pathogenic fungi which could reduce their incidence and help control loss of stand (seedings and mature plants) and crop (developing pods) and perhaps even more importantly reduce incidence of the aflatoxin producers Aspergillus flavus and A. parasiticus as part of an aflatoxin control program.

As far as pest incidence is concerned, the chief contrast between wet and dry seasons is the greater abundance and effect of virus vectors in the dry than in the wet season. While thrips are well in evidence in both, aphids are much less abundant in the wet season. Leaf feeding pests (leaf-miners and leaf hoppers) are less evident in the dry season. Characteristically soil-inhabiting pests are more damaging during the rains than in the dry season. White grubs are a universal pest but the subterranean ant (Dorylus orientalis) is endemic to Thailand (and neighboring countries?) and perhaps merits further detailed investigation in areas where it is a persistent problem.

The value and the urgent necessity to develop and utilize Integrated Pest Management (I.P.M.) practices cannot be over-emphasized. Experience in Thailand and elsewhere has shown that solving one problem (e.g. thrips incidence) by pesticide application can bring about another (e.g. defoliation by Heliothis). An important component of such systems is full use and exploitation of genetically determined pest resistance. In particular, attention should be paid to generalized pest resistance where resistance occurs to complexes of pests rather than single species. This type is, if the genetical control is simple, readily incorporated by straightforward backcross programs into acceptable cultivars.

Some interesting studies have been carried out on the simulation of the effects of defoliation by insect attack by removal of leaves from the canopy. These clearly establish that appreciable canopy loss can occur before a measurable yield loss results. As a result of such experimentation it is possible to equate particular levels of yield loss with degrees of defoliation produced not only by leaf feeding arthropods but also foliar pathogens such as rust and leafspots. It should also assit breeders, were they so inclined to design an ideotype (in terms of the canopy produced) with a maximum harvest index.

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The work carried out by the plant pathologists and entomologists is very closely and effectively linked with that of the breeders, who in their breeding goals are vitally concerned with the incorporation of genetically determined pest and disease resistance into their breeding lines. It is now appropriate to consider the breeding program and its achievements.

4. Peanut Varietal Improvement

In addition to the standard problems of improving pest and pathogens resistance the peanut breeding objectives for Thailand include some distinctly novel objectives which are held in common with breeding programs in other S.E. Asian programs. In many areas where the crop is produced it can be harvested and boiled fresh. The seeds are almost mature and should fill the pods well at the appropriate stage. In contrast with other areas of production this is a major use, not surprisingly in a humid tropical area where storage of a dry mature seed crop may present difficulty. The standards for selection of good boiling types might with advantage be defined as far as possible in terms of quantifiable characteristics. This would be desirable to back up the more subjective and idiosyncratic tasting tests.

The major breeding concerns relate to the unusually varied conditions in which peanut cultivation is possible. On average the effectively rainless period is only 2-3 months which means that for most of the year rainfed peanut production is a possibility. In rice producing areas the crop could be produced either before or after the rice crop without irrigation, in other areas both rainfed and irrigated production is being developed. In the latter case the crop could be maintained in continuous production (not necessarily on the same land). This could create problems in the management of pests and pathogens. In the former system there could be an effective close season for peanuts when the paddy rice crop is taken. The overall situation is clearly one of some complexity and considerable thought and experimentation will be required (in addition to that already invested!) to produce optimal systems.

In essence problem relates to the differing pest/disease profiles of the rainy and dry seasons. The alternately branched (Virginia) forms have higher leafspot tolerance and short term seed dormancy which are advantageous in the wet season while the sequentially branched (Spanish-Valencia) group have early maturity and some thrips resistance which are advantageous in the dry season. The problem with using Virginia cultivars in the rainy season is that they would not be able to exploit its whole duration. Although a less than ideal solution two crops of early maturing varieties are taken during this season. It is interesting to note that comparisons of the released varieties Khon Kaen 60-1, 60-2, and 60-3 the latter (a Virginia type) is the most exacting in its cultural requirements and 60-1 is the most widely adapted. As a result, 60-1 finds use as a standard variety which can cope with the wide range of climate and environmental conditions the crop has to contend with. Nevertheless, the program rightly concerns itself with the search for higher levels of productivity under the defined systems of production (before rice, after rice, etc.). This project is breaking new ground as the production problems of peanuts in the humid tropics have only received serious attention during the currency of the Peanut CRSP campaign. To achieve a definitive solution might necessitate the evaluation of a systematic sampling of landrace peanuts collected from areas in or close to the Amazon basin where similar environments to those of S. E. Asia can be found.

A major concern of breeders is still the establishment of varieties which have the ability to resist infection by aflatoxin producing species of Aspergillus of if infected to suppress production of the mycotoxin. The work now being conducted at North Carolina S.U. will, when it comes to fruition, have considerable relevance to Thailand.

In conclusion, the breeding objectives for the peanut crop in Thailand are very complex. They are breaking new ground and the problems are being tackled in an effectively coordinated and business-like way. However, further investment of energy and resources will be needed before they are finally resolved.

5. Conclusions on Peanut CRSP EEP Visit to Thailand 22-30 January 1994

The operation of the projects supported by USAID through Peanut CRSP has been an unqualified success. This overall success reflects considerable credit on those who have provided leadership as well as those who have carried out the research projects. The impression which is very strongly given is cooperation of the highest order between the universities involved and the relevant government agencies. To me, this is reminiscent of the operation of research, development, and extension activities in the Land Grant Universities of the United States at its very best. The Thai leadership have obviously appreciated the relevance of this model to their own situation and have applied it most effectively. All concerned at all levels are to be congratulated on this success.

6. Technology Transfer

Since the field based research is best considered in its economic environment, conclusions and observations relating to projects concerning the fate of the harvested crop and its products will be considered first. The potential for adding value to the peanut crop has been well appreciated as have the possibilities of the producers increasing their incomes by engaging in some processing themselves. The studies carried out show that this is in fact feasible and in the pilot study carried out not only were the selected products produced satisfactorily, but than an excellent standard of quality control was achieved and that the ground roasted peanut product has excellent market acceptability. However, on our visit some problems came to light which need to be addressed. The village Huay-bong-Nua is in fact too remote from the large Chiang Mai market for it to be an effective outlet for the producers' products. Local market demands have been satisfied by a single day's operation per week during the processing season which arguably does not make effective use of the equipment which is idle for the greater part of the working week. Some means must be found to ensure a more continuous system of operation to justify the capital investment necessary in any extension of the scheme. It would be necessary ultimately for the producers to generate sufficient surplus income to repay the capital costs of equipment. Finance of such ventures on a revolving capital fund could be considered.

Not the least impressive outcome of this project has been the increased awareness among producers of the operation of the market. So much so that due to the lower harvested crop in the past season there was little actual point in processing the crop since the level for added value was low due to the increased value of the unprocessed crop on the one hand and the absence of any increase in the value of the product which presumably could be brought in from elsewhere at an unchanged price. This point was not lost on the producer/processors!

Further development of this line of technology transfer clearly requires further detailed study of economic factors which operate at the level of producers. If this line of study is to be continued and this is well worth considering new horizons will have to be visualized and new goals set.

Other areas of technology transfer offer possibilities for real development at the cottage industry and higher levels, the processing developments in the Kalasin area show clear evidence of significant development potential. Further product development work and market research would obviously be worthwhile, underscoring the need for continuing collaboration between the food scientists at the University of Georgia and those in Thailand.

7. Crop Production Studies

As far as conclusions are concerned it is necessary to consider the pest and disease control projects in conjunction with the varietal improvement program. The three areas are so closely inter-related that it makes little sense to disentangle them in all their ramifications.

Although the peanut crop has been produced for centuries in the humid tropics, it is primarily in the semi-arid tropics and warm temperate regions that research has been carried out with a view to the intensification of production. In semi-arid tropical and warm temperate areas a single crop per annum is customary which has implications in variety selection and the management control of pests and diseases. It can reasonably be expected that a single adapted variety could cope with the normal range of growing conditions and the expected incidence of pests and diseases. In the humid tropics while it may be possible to produce the crop at any time of the year, the crop itself will be subjected to different environmental conditions at different times of the year. While the temperature and rainfall range may be (for the most part) within the range that the crop as a whole may tolerate, it may be expecting too much to believe that a single variety may be able to perform effectively over the full range of prevailing environmental conditions over the whole annual cycle. There are in fact genotypes which, genetically speaking, are so well buffered that they can cope with a broad range of conditions but the majority probably have more closely defined optima. The same considerations apply to pests and diseases and their incidence over the yearly climatic cycle. It is no surprise therefore to find that in Thailand the biotic pressures under which the crop grows in the wet season on the one hand and the dry on the other are different. The wet season profile of both pests and diseases differs markedly from that of the dry season and this poses a problem for the breeder, should the attempt be made to incorporate all relevant resistances into single genotypes or to produce selections with dry season or wet season adaptation but not both? It would be simplest if a basic variety (or a small group a varieties) could be established to cope with the annual range of conditions rather than to have to select varieties selected for specific wet or dry season adaptation. The general purpose strategy might well entail some kind of yield penalty.

The level of yields recorded to date is not unduly impressive, but it is commonplace in the implementation of peanut research programs for there to be considerable inertia in the significant improvement of yields initially on the research station and then in the farmers' fields. The requisite time frame must be born in mind, to develop a new variety fro a crossing program takes 10-15 years. Prior to this some years efforts (2-5 years) are needed to select parents for crosses. When satisfactory genotypes have been established by selection seed multiplication can take a few more years. Concurrently with this it well possibly be necessary to develop an agronomic package to make the best possible use of productive new cultivars. This has been the strategy at the root of the development and exploitation of the Green Revolution rice and wheat cultivars. Closer to home and quite independently this was the strategy which resulted in the development and release in Central Africa of the variety Makulu Red and an accompanying agronomic package in 1961. This led subsequently to the development of a high input system which produced yields in excess of 9 Mt ha^{-1} in 1972-4 in Rhodesia (Now Zimbabwe).

The present strategy of variety development is soundly conceived and is being very competently executed however the complexity of the task is such that the period of 12 years in which it has been operating is not fully adequate to ensure a successful conclusion. Continued collaboration on lines already established is indicated and the very satisfactory progress achieved to date inspires confidence in the abilities of the present team to achieve these objectives. It is I believe an important strategy in research to support strength which has clearly been demonstrated and to reinforce the considerable success already achieved.

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REPORT ON VISIT TO THAILAND

MARCH 1994

David Hsi
Member of EEP

NAAS/AJAS
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Albuquerque, New Mexico

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Report on Visit to Thailand
by David Hsi, Member of EEP

Peanut CRSP Code: GA/FT/TP

Project Title: Appropriate Technology for Storage/Utilization of Peanut

Principal Co-Investigators and Cooperators and Collaborating Institutions:

Principal Investigator: Larry R. Beuchat, University of Georgia, USA
Co-Investigators: Robert E. Brackett, Tommy Nakayama, Anna V. A. Resurreccion, University of Georgia
Principal Investigator: Penkwan Chompreeda, Kasetsart University, Thailand
Co-Investigators: Vichai Haruthaithanasan, Chintana Oupadissakoon, KU
Cooperator: Winit Chinsuwan, Khon Kaen University

Introduction

Early discussions in 1981 revealed that storage and utilization of peanuts appeared to be constraints which existed in the delivery system. This project was initiated in 1983 to investigate low cost methods of storage and their attendant consequences. During the initial years of the project, procedures of handling, sorting, packaging, and storing of peanuts were evaluated. With the development of procedures which minimize or eliminate aflatoxin from peanuts and peanut products, and with the completion of the surveys in obtaining baseline consumption data, the next phase of this project was to concentrate on developing and adapting technologies to utilize peanut and peanut products in traditional and new foods on the basis of consumer surveys. In the late 1980's and continuing to the present, concerted efforts were made to transfer technologies to the commercial arena. A previous extensive on-site review was made by former EEP members in 1989. This evaluation report resulted from visits to Kasetsart University, Department of Agriculture in Bangkok, and Huay-Bong-Nua village (90 km northeast of Chiang Mai) by Joe Smartt, Bo Bengtsson, and David Hsi, accompanied by David Cummins, Program Director of Peanut CRSP. The three EEP members visited research facilities at the University, had extensive discussions with the host country PI's, heard their presentation, and tasted the various food products developed from the project research.

1. Research Highlights

Consumption Survey (1983-85): Results from 807 returned questionnaires revealed that the average quantity consumed and expenditure were highest for boiled peanuts, followed in descending order by roasted peanuts, raw peanuts, and fried peanuts. Use of other forms of peanut products was of less importance; for example, peanut butter was reported as being used only at home. There were regional differences. Households in the North Central region consumed more boiled peanuts and peanut candy than households in the South. The level of peanut product usage is influenced by the level of household income. The usage of boiled peanuts increased with increased income to the middle income class and then a decline as the income level increases. The consumption of fried peanut increases as income increases from low to high levels. The survey revealed the importance (or lack of importance) of the various peanut products available to their consumer.

Handling, Sorting, and Packaging Techniques: A survey of Thai products indicated that the mycotoxin was indeed a problem. By instructing peanut processors in terms of proper storage and sorting procedures, substantial progress has been made toward controlling or eliminating the aflatoxin

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presence in peanuts and peanut products. Thai researchers working with Peanut CRSP and U. S. collaborators have played a major role in achieving this progress.

The roasting and storing qualities of various peanut cultivars grown in Thailand can differ considerably. In addition to high yield potential, the acceptable cultivar for use in processed products must possess desirable sensory and storing qualities.

Product Development and Improvement (1985-present): To increase the utilization of peanut and peanut products and to increase the incomes realized by producers and processors, a variety of traditional and new food products have been improved or developed by the Thai and U. S. researchers funded by Peanut CRSP. Several food items appear to be highly acceptable by the consumer and to have excellent potential for marketing in Thailand and the southeast Asian region. Some of the products and uses of peanut products from Thai-grown peanuts are listed as follows: peanut flour, Thai sausage, sommanut cookie and noodle supplemented with flour, chicken patties extended with flour, infant food containing roasted peanut flour, supplemental food and snacks for pre-school and school-age children, extruded snacks containing peanut flour, tube feeding product containing peanut, peanut butter spread, peanut butter bar, peanut tofu spread, durian-flavored ice cream fortified with peanut protein, chocolate flavored peanut beverage, peanut tempeh flavoring (seasoning) sauce from peanut press cake, improved tuub taab, animal food containing peanut, and vacuum packed boiled peanuts or other peanut products.

Chinese-type noodles are an important staple food in Asia and are growing in popularity world wide. Research from this project indicated that supplementation of Chinese type noodles with as much as 15% defatted peanut flour and 8% cowpea flour would effectively increase protein content in the noodles to 21%, without significantly sacrificing color and textural quality attributes. Because of the very promising results from studies on peanut supplemented noodles prepared in the laboratory, they were being produced at the Thai Preserved Food factory on an industrial scale. Results from consumer tests showed that all groups of consumers accepted the peanut supplemented noodles. The U. S. consumers liked this kind of noodle more than the Thai consumers did. This may be due to the soft texture of the noodle. Thai and U. S. consumers recognized the nutritive value of the peanut supplemented noodles as a factor for buying and eating more needles in the future, if they were more readily available commercially.

2. Research Management

In this Peanut CRSP project, researchers with the University of Georgia are collaborating with their counterparts who are employed by the Kasetsart University. In the initial stage, researchers from Chiang Mai University were also involved.

The panel visited with Dr. Penkwan Chompreeda, Vichai Haruthaithansan, and Dr. Chintana Oupadissakoon and also heard their illustrated presentation of their research and management practices. Dr. Chintana was the host country Principal Investigator for this project until she became the Department Head of Product Development. Mr. Vichai is Director of the Agricultural and Agro-Industrial Product Improvement Institute. Dr. Penkwan is the Assistant Professor in the Faculty of Agro-Industry. All three investigators have their major responsibility in the administration and teaching of undergraduate and supervisory research of graduate students at the Kasetsart University. They received strong support from the Dean of the Faculty of Agriculture and the University Administration.

3. Research Accomplishments

Technology Transfer (1982-present): Researchers supported by Peanut CRSP have been advising and assisting peanut handlers, processors, and marketers throughout Thailand over the life of the project. The scale-up of peanut supplemented Chinese type noodles represented a significant step toward transferring technologies developed in the project to a commercial operation. The most visible effort in technology transfer, however, has been the establishment of a village-scale facility for processing, packing, and marketing ground roasted peanuts in Chiangmai Province.

A pilot group of seven women farmers was formed to process peanut products for the downtown Chiangmai and Prao district markets. All necessary equipment and materials were purchased by the researchers and set up at the project site in Huay-Beng-Nua village, 70 km north of Chiangmai. The women were trained by the extension personnel in the techniques for processing and quality control of both oil roasted and ground roasted peanut, as well as in business management and product marketing. The processed peanut products contained no aflatoxin, no defects, and low microbial contamination. Consumer acceptability of both products was high, especially of the ground roasted peanuts which had better quality than others already available in the markets. Although the profitability of ground roasted peanuts was much less than that of the oil roasted peanuts, researchers have recommended that the women farmers and housewives put more effort in processing ground roasted peanuts. It has a more rapid turnover rate due to constant demand and over three times the processing output, as compared to oil roasted peanuts (100 kg/day vs 30 kg/day). After two years of pilot study, the socio-economic status of households involved in the project is improving. However, since the project has been in place for only a short time, permanent change in socio-economic status is uncertain.

The EEP team and Dr. Cummins were accompanied by the host researchers to make an on-site visit to the Huay-Bong-Nua village. They visited with the women farmers and saw the equipment used for processing roasted peanuts. Due to the exceedingly high price, profitability, and short supply of raw peanuts due to drought, no roasted peanuts were processed in 1994. However, the EEP members were impressed by the participating women for having learned techniques for processing quality peanut products, for business management, and for marketing management, all of which will help them and their households improve their quality of living. [Peanut processing will increase the incomes of farmer-processors in times of plentiful supply of lowly priced raw peanuts due to good farm yield under favorable conditions. Thus, this kind of technology transfer will offer an alternative to stabilize and improve the socio-economic status of the village farmers.]

Publications: A list of publications containing research results by Peanut CRSP researchers and their cooperators was very impressive. The research activities have been reported in over 120 publications. About 40% of these publications resulted from student research projects or graduate thesis.

4. Training Accomplishments

Many undergraduate and graduate students are presently enrolled in the Department of Product Development. The Department has moved to a newly constructed building. Good facilities existed in the Department for student training and research. All of the graduates from the institution found employment in either private industries, government institutions, or state supported universities.

In the past year, two students finished their M. S. degrees at KU and three students were making good progress toward meeting the requirements of the M. S. degrees at the KU's Department of Product Development. In commemorating the 10th anniversary of Peanut CRSP in Thailand and the 50th anniversary of KU, a workshop on Transfer of Peanut Production and Utilization Technologies was held at KU in March, 1993. Summaries of accomplishments by all projects supported by Peanut CRSP were given. The workshop was attended by more than 70 people, about half from the food industry. With the planned additions of two more Ph.D. faculty members, the Department of Product Development is making plans to offer Ph.Ds in the next several years.

5. Observations

A high degree of expertise and sound scientific approaches were apparent from the collaborative research programs.

The success of technological transfer is greatly influenced by the fluctuation of market prices of raw peanuts and by the level of incomes of the consuming public.

The main emphasis of KU researchers is on student training and on supervision of graduate students' research.

6. Recommendation

Another five-year extension of this CRSP project is highly recommended. This will allow more time to assess the full socio-economic impact of the transfer of several promising technologies to small or large processors, on a village level or on a large urban factory level.

Because of outstanding faculty and facilities at KU, the Department of Product Development with the support of continued good research has the capability of developing into a Regional Training Center for students in the Southeastern Asian countries.

Peanut CRSP Code: NCS/BSP/TP

Project Title: Peanut Varietal Improvement for Thailand and the Philippines

Principal Co-Investigators and Cooperators and Collaborating Institutions:
Principal Investigator: Thomas G. Isleib, NC State University, USA
Co-Principal Investigators: Marvin Beute, Thomas Stalker, and Arthur Weissinger, NC State University
Principal Investigator: Aran Patanothai, Khon Kaen University, Thailand
Co-Principal Investigators: Surapong Charoenrath, Duangchai Choopanya, Sopone Kittison, Preecha Surin, Soomjintana Toomsan, Dept. ofAgric., - Sanun Jogley, Sopone Wongkaew, Khon Kaen University; Thammasak Sommartaya, Kasetsart Univ., Thailand

Introduction

Peanut is the major food legume and oil crop of Thailand. The crop is grown by small farmers mainly in the north, northeast, and central regions of the country. It provides a significant source of cash income and is an important source of protein for rural people. Over 100,000 ha (or 625,000 rai) are planted to peanut annually. Yield average about 1,250 kg/ha, but are lower in drought years.

The peanut crop is generally grown in the upland area in the rainy season (rainfed) and in the paddy field following rice in the dry season (residual soil moisture and irrigated). The rainfed acreage is much greater than the irrigated area. More and more peanut is grown in the low fertility upland area, as their irrigated, more fertile acreage is being replaced by more profitable crops, such as sugar cane and pepper. The major constraints in production in Thailand are erratic rainfall (for rainfed area), low soil fertility, improper management, insects, diseases, and weeds. Integrated pest management and host plant resistance to economically important pests are most practical and desirable for growers in Thailand.

1. Research Highlights

Well coordinated programs between the Department of Agriculture (DOA) and Khon Kaen University (KKU) are making good progress in developing peanut cultivars with (a) desirable agronomic traits or high yield, early maturity, and drought tolerance; (b) resistance to foliage and soil-borne diseases, Aspergillus flavus, and insects; and (c) large seed size and traits suitable for boiling purposes and increased ability for biological nitrogen fixation.

The EEP members were presented with many useful publications and materials documenting the various phases of the peanut varietal improvement at the Khon Kaen DOA. They were also presented with illustrated talks by principal and co-principal investigators on the progress of the following research projects: varietal improvement (including breeding for high yield potential, earliness, resistance to rust, leafspots, Aspergillus flavus, large seeded-type, insect resistance, increasing nitrogen fixation, before-rice and after-rice unirrigated growing conditions, and drought tolerance), plant pathology, and entomology.

The EEP members were impressed with the scope and depth of research conducted by the well trained and dedicated scientists with DOA and KKU. They were also told that many agronomic research projects were conducted by DOA outside of the Peanut CRSP project but all the pertinent programs were mutually supportive and well coordinated. Annual research planning sessions were participated in by all peanut investigators.

2. Research Management

In this Peanut CRSP project, researchers with the North Carolina State University are collaborating with their counterparts who are employed by the Department of Agriculture and the Khon Kaen University.

Upon arrival at Bangkok, Thailand, the EEP members were welcomed by Mr. Sophon Sinthuprama, Director of Field Crops Research Institutes of the Department of Agriculture and by Dr. Montien Somabhi, Director of Khon Kaen Field Crops Research Center and were briefed on the Thailand Coordinated Peanut Improvement Program and its collaboration with the Peanut CRSP. The EEP was impressed with the research management and the excellent coordination between the Department of Agriculture and Kasetsart University and Khon Kaen University. During the life of this project, the major thrust has shifted to KKU because of availability of sufficient field plot land and large number (20) of professional staff in various disciplines (breeding, entomology, plant pathology, agronomy, microbiology, agricultural engineering, and seed technology). Also, Khon Kaen is in the Northeast Region of Thailand, selected by the government for expanded peanut production.

There appears to be smooth fund transfers from North Carolina State University to Peanut CRSP researchers in Thailand. Excellent collaboration existed between all institutions involved in the project. The Peanut CRSP fund in Thailand is administered by DOA.

3. Research Accomplishments

A number of high yielding varieties which have good pod and seed characteristics have been recommended to the farmers over the last 10 years. Three types of peanut variety are introduced to farmers, which are boiling type (Lampany, S. K. 3 and Khon Kaen 60-2), medium seed type (Tainan 9 and Khon Kaen 60-1), and large-seed Virginia type (Khon Kaen 60-3). If not for the release of these new varieties, Thai peanut production will be considerably reduced because sizable acreage of peanuts has been moved from fertile paddy fields (irrigated) to the low fertility highland area (rainfed) in recent years.

(Taiwan 2 x UF 71513-1) was released as 'Khon Kaen 4', a high yielding boiling type peanut. It performed better than the check cultivar, Khon Kaen 60-2, and gave 10% higher pod yield. Several promising lines of varying yielding objectives in different yield testing stages were identified by DOA and KKU researchers.

4. Training Accomplishments

Two B. S. students and three M. S. students at Khon Kaen University received partial support from Peanut CRSP.
Ph.D. in Plant Pathology at NC State Univ. for Anan Hirunsalee

5. Observations

High degree of expertise and sound scientific approaches were apparent from the collaborating research programs.

The EEP visited the seed center near Khon Kaen where peanut foundation seed was stored and distributed. This is one of eight such seed centers throughout Thailand for peanut seed increase. The EEP members also visited irrigated farm area where contracted farmers were producing foundation seed from Khon Kaen 4 breeder seed supplied and supervised by scientists with DOA.

Peanut CRSP monetary investments are receiving maximum returns in Thailand because of excellent collaboration and support from other government financed research and extension projects under the national coordinated peanut improvement program.

6. Recommendations

The EEP agreed with the Thai scientists that another five-year extension of Peanut CRSP not only is justified but also highly desirable in order to accomplish the following objectives:

Technology Transfer: Training of extension personnel and production of pamphlets on recommended practices is a continuing process. More training of extension personnel is needed on production practices for the large-seeded cultivars which require more care than the regular small-seeded cultivars. A pilot program is being initiated to fit Khon Kaen 60-2(boiling-type cultivar) and Khon Kaen 60-3 (large-seeded cultivar) into the seed distribution of the extension for specific production areas and also to establish the linkage between production areas and market/utilization of the large-seed cultivars.

Regional Role: The excellent peanut research and teaching system serves as a model for neighboring countries. The Thai government is supporting a policy in assisting the other developing countries in the region. Several training programs have been held for personnel from these countries, particularly in Viet Nam. In 1993, KKU conducted a training program on seed production of peanut for personnel from Myahmar. In collaboration with ICRISAT, FAO/UNDP, Peanut CRSP could greatly assist the further development of regional training for research and extension personnel of countries in Indo-China and neighboring countries, such as Indonesia.

On-going Research and Sustainability: Peanut varietal improvement is a long term project. New varieties need to be developed for new destructive strains of insects and diseases. Research has been initiated on the distribution of peanut residues in maintaining the maintenance of soil fertility. This type of research and developing varieties with more capabilities of fixing nitrogen are important in maintaining the sustainability of peanut production and overall economy in Thailand.

Peanut CRSP Code: NCS/IM/TP

Project Title: Management of Arthropods on Peanuts in Southeast Asia

Principal Co-Investigators and Cooperators and Collaborating Institutions:

Principal Investigator: Rick Brandenburg, North Carolina State University, USA
Co-Investigator: Mary Barbercheck, NC State Univ., USA
Principal Investigator: Manochai Keerati-Kasikom, Khon Khan Univ., Thailand
Principal Investigator: Turnjit Satayavirut, Department of Agriculture, Thailand

Introduction

Insect damages have been a major constraint on peanut production and storage throughout the world and Thailand is no exception. Prior to 1982 and the advent of Peanut CRSP, research on peanut was planned and conducted separately by the DOA, KKU, KU, and Chiang Mai University. The Coordinated Peanut Improvement Program was formed in 1982 and annual meetings are now held for all researchers to report research results and to plan and coordinate the next year's program, a major contribution of the Peanut CRSP.

To effectively manage the damaging insect pests in an economically and environmentally sound approach lending itself toward sustainable agriculture, a sound biological base must be established. Since its inception in 1982, this project has conducted ecological studies, surveys of pest populations, damage assessments and thresholds, population monitoring and scouting techniques, off-target impact of pesticide use and potential interactions, and also has developed and implemented alternative control strategies, including host-plant resistance and cultural and biological control. The broad-spectrum research program is directed toward building effective integrated pest management programs and progressing toward the goal of a sustainable production system for peanut production.

1. Research Highlights

Three major insects found at high incidence were leaf miner, leafhopper, and thrips in the rainy season. Aphids were usually more abundant during the dry season. The population of leaf miner varied from year to year. Leafhoppers were observed all year round and the population increased in April to July. Thrips were present in high numbers during April to August. Aphids scarcely killed the plants but they transmitted virus diseases. Subterranean ants in some years could cause considerable damage to peanut pods. The number of ants increased gradually in relation to the crop growth. In terms of economic losses, subterranean ants were considered to be the most serious insect pests of the peanut crop. Control of the ants were difficult because they lived underground. Success was limited in controlling ants by use of poisoned food baits, such as coconut, water melon, papaya, and cantaloupe.

Entries were evaluated for insect resistance at KU, KKU, and DOA multiple sites. Studies were being continued for the development of a sound database for refinement of the IPM program. These included basic insecticide evaluations to improve the timing of application to increase pod fill and total integrated program using host plant resistance, as well as cultural and biological control methodologies.

Insecticides are relied upon heavily in certain areas. Studies to develop a better time table for insecticide application have been successful. Such schedules will reduce insecticide use while maintaining control until more integrated approaches can be developed and implemented.

Studies using sticky board continue to investigate the migration and dispersal of thrips and the possible relationship to virus transmission. These studies have provided important insight into the ecology of this pest which will eventually lead to improved management of the virus disease by effective management of the vector.

2. Research Management

In this Peanut CRSP project, researchers with the North Carolina State University are cooperating with their counterparts who are employed by the Department of Agriculture, Khon Kaen University and the Kasetsart University.

Peanut CRSP activities, including entomological research, are an integrated part of the Thailand Coordinated Peanut Improvement Program, which also maintains close ties with the ICRISAT in India.

Annual research planning meetings are held and attended by all DOA and University peanut researchers. The researchers have excellent collaboration and are pleased with the overall management system.

3. Research Achievements

Yield loss caused by major pests have been studied. It shows that peanut tolerate considerable foliage loss. In the case of leaf miner, the amount of yield loss depended on the level of insect population. Pod damages by subterranean ants were found to range from 15 to 48%, with an average of 32%.

Chemical Control: Two sprays of insecticide during 14-45 days after emergence appeared to be adequate in suppressing the leaf miners and sucking insect population to a level which would not cause a significant yield reduction. Several insecticides have been recommended for control of insect pests. They are Methiocarb, Prothiofos, Thriazophos, Endosulfan, and Monocrotophos at recommended dosages. Systemic insecticides such as Carbofuran applied in furrows at planting time as a granular formation provided several weeks protection against sucking insects, such as thrips, leafhoppers, and aphids.

Crude extract from three species of insecticidal plants appeared to be effective in killing the third instar larvae of army worms.

Natural Control: A number of local natural enemies of the major insect pests were reported. Predaceous stink bug (Cantheconidea furcellata) attacks lepidopterous larvae. Coccinellids (Menochilus sexamaculatus) feed on aphids. The common larval parasites of leaf miners were Tetrastichus sp. and Apanteles sp. while the pupal parasites were Brachymenia minuta and B. Lasus. The nuclear polyhedrosis virus attached the larvae of Heliothis armigera.

Plant Resistance Evaluation: The results from resistance screening experiments under natural infestations of insect pests showed that a wide range of susceptibility and resistance existed among the plant introductions, breeding lines, and cultivars to leaf miner, leafhopper, thrips, and subterranean ants.

4. Training Accomplishments

Training of Thai scientists for entomological research on peanuts is an achievement of Peanut CRSP. Both principal investigators in Thailand, Ms. Turnjit Satayavirut at KU and Manochai Keerati-Kasikorn at KKU, received their Ph.D. degrees at NCSU. Many students at B. S. and M. S. levels received training at KU and KKU, with partial support from Peanut CRSP. Dr. Bill Campbell, former P.I. of this project, prior to his retirement in 1992, spent his sabbatical leave living and working alongside Thai entomologists at Khon Kaen. During this EEP review in Thailand, the panel members met Dr. and Mrs. Campbell in Thailand who were spending their vacation there because of their love for the land and people.

5. Observations

High degree of expertise and sound scientific approaches were apparent from the collaborating research programs.

The EEP received detailed reports and written materials on the entomological studies and research. They also saw illustrated slides and visited with two principal investigators in Bangkok and Khon Kaen. The EEP was impressed by the dedication and high degree of training and professional conduct of the PIs and their graduate students.

6. Recommendations

The EEP strongly recommends another five-year extension of this project with continued emphasis on publications and regional training. In addition, more basic and applied research on control measures for subterranean ants should be continued and continued emphasis on integrated pest management practices and on working closely with breeding and development on host plant resistant varieties to major insect pests.

Peanut CRSP Code: GA/PV/N,TP

Project Title: Peanut Viruses: Etiology, Epidemiology, and Nature of Resistance

Principal Co-Investigators and Cooperators and Collaborating Institutions:

James Demski, Georgia Experiment Station, USA
Co-Principal Investigator: Mike Deom, U. of GA Plant Pathology, USA
Principal Investigator: Sopone Wongkaew, Khon Kaen Univ., Thailand
Principal Investigator: Sommatya Tharmmask, Kasetsart Univ., Thailand

Introduction

Diseases have been a major constraint in the production of peanut throughout the world. After the characterization and identification of the Peanut Stripe Virus (PS&V) were developed by the University of Georgia scientists, it was feared to be the most prevalent virus infecting peanut in the Southeast Asia countries and China. The virus infects a sufficient number of plants to have an economic impact on the total peanut production.

Plant pathological research in Thailand is done as a coordinated program joined by three institutes, Khon Kaen University (KKU), Kasetsart University (KU), and the Department of Agriculture (DOA). At the early phase, the project was a part of the breeding program and its main objectives are assisting the breeders in identifying major diseases and devising techniques for effective screening for disease resistance. The aims evolved, however, as the work progressed because more hidden problems have surfaced. Presently, scientists in KU and KKU have concentrated more of their effort on the biology of foliar pathogens and their reaction towards peanut varieties with different degrees of host resistance. Apart from routine evaluation of peanut entries in foliar disease nurseries, the DOA team plays a key role in studying soil-borne diseases, including aflatoxin related problems. With virus diseases posing an increasing threat to Thai peanut production, the team at KKU has been assigned to concentrate more on this subject. Since this project deals with peanut viruses, only virus experiments and their achievements and public contributions are listed in this evaluation report.

1. Research Highlights

Studies Conducted by DOA are listed as follows:

1. Distribution of peanut virus diseases in Northeast Thailand and their effects on yields.
2. Transmission of peanut stripe virus by some aphids.
3. Effect of peanut stripe virus on peanut yield.
4. Surveys of peanut virus diseases in Northeast Thailand.

Studies Conducted by KKU are listed as follows:

1. Etiology of yellow spot disease of peanuts.
2. Studies on virus diseases of peanuts.
3. Screening for virus disease resistance in peanuts.
4. Detailed studies on peanut stripe and peanut yellow spot diseases.
5. Variation in peanut stripe virus isolates.
6. Screening for peanut lines with low peanut stripe virus incidence.
7. Alternate hosts of peanut stripe virus.
8. Detailed studies of peanut stripe virus.
9. Yield loss assessment for peanut stripe virus in peanuts.
10. Effect of insecticide sprays on the distribution of peanut stripe disease.
11. Purification and serology of peanut stripe virus.
12. Natural alternate hosts of peanut stripe virus.

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13. Peanut stripe virus transmission frequencies in Tainan 9 seeds from different sources.
14. Comparison of peanut stripe virus isolates using symptomatology on particular hosts and serology.
15. Effect of particular peanut stripe virus strains on yield and their seed transmission frequencies in Tainan 9 peanut.
16. Seed transmission frequencies of field isolates of peanut stripe virus in different peanut lines.
17. Reaction of peanut line 324 to peanut stripe virus infection.
18. Survey of peanut virus diseases in the Southern Northeast.
19. Peanut mottle virus: a revised study.
20. Virus disease monitoring and survey on dry season crops.
21. Detailed studies on groundnut bud necrosis virus.

2. Research Management

In this Peanut CRSP, researchers with the University of Georgia are collaborating with their counterparts who are employed by the Department of Agriculture and the Khon Kaen University. In the earlier stages of this project, plant pathologists at the KU in Bangkok were also involved.

There did not appear to be any problems pertaining to fund transfer from the University of Georgia to Peanut CRSP researchers in Thailand. Early anticipation of funding needs and prompt reimbursement of expenditures to the Thai scientists will insure the continued smooth operation of this Peanut CRSP project in Thailand.

3. Research Achievements

Six major peanut diseases found in Thailand were seedling blight, late leaf spot, early leaf spot, rust, peanut stripe, and peanut yellow spot. Among these, leaf spots and rust were predominant only during the wet season while the virus diseases were more prevalent during the dry season. The incidence of seedling blight was related more to seed storage age.

Apart from peanut stripe virus, a considerable amount of work has been done on groundnut bud neurosis and peanut yellow spot disease. These two viruses are considered new members of the Tospovirus group. Their occurrences have been reported only from India and Thailand. It is very likely that these two viruses are in other Asian countries as well. Therefore, the information generated by this project could be of great assistance to the neighboring countries.

Apart from presenting the work (altogether more than 100 papers) in the annual peanut research meetings, the coordinated project has published its work in various journals and newsletters, both domestically and internationally. Research results have also been compiled into pamphlets and books. The publications have been distributed to all levels of people working with peanuts.

4. Training Accomplishments

Through 10 years of Peanut CRSP support, the project has employed 10 research assistants, 8 of them are women. The project has provided funding or research materials for at least 9 M. S. students and 15 undergraduate students. Parts of the research have been used as theses, special problem subjects, and training. More than 100 students from various countries have been trained using the project materials. A Ph.D. student is presently working on interaction of major fungal pathogen isolates on various plant genotypes under the advisement of Dr. T. Sommartya at Kasetsart University.

5. Observations

High degree of expertise and sound scientific approaches were apparent from the collaborating research programs.

This project has been extremely productive in terms of research findings, publications, and training of students. Peanut CRSP monetary investments are reaching maximum returns.

6. Recommendations

The EEP strongly recommends another five-year extension of this project with continued emphasis on publications and regional training.

In addition, continue basic research, especially on the viruses that are specific to the region, such as peanut stripe, groundnut bud neurosis, and peanut yellow spot viruses. Work on effective control measures such as using disease resistance should be continued. Adaptive research should be conducted to testify any control measures claimed effective elsewhere.

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REPORT ON VISIT TO THAILAND

JANUARY 22-31, 1994

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PEANUT CRSP EXTERNAL EVALUATION PANEL VISIT TO THAILAND, JANUARY 22-31, 1994

By Bo Bengtsson

1. Background

I arrived in Bangkok on January 23 and departed on January 31, 1994. The program followed the original in country itinerary (not included).

All the visits were well organized and useful to get an overall view of, CRSP related, ongoing peanut research in Thailand. The program did not, however, include consultations with Thai policy-makers and central staff of the Ministry of Agriculture, the Ministry of Education of the National Research Council.

On January 28, 1994, the three members of the EEP held an internal meeting to discuss certain conclusions and recommendations. These findings were later shared, and discussed, with the Director of the Peanut CRSP, Dr. D. Cummins at a meeting on January 29, 1994.

2. Purpose of the Report

It was agreed that each EEP member, visiting Thailand writes his own report with observations, overall assessment of individual projects and the country program. This report should be made available at the Peanut CRSP Management Office on February 20, 1994.

Each Team Member will be mailed a copy of all individual reports, including those from EEP members visiting the Philippines. The Chairman elaborate a draft report for circulation to all Team members.

3. The Content of this Report

This report presents major highlights of the Peanut CRSP activities in Thailand and of overall peanut research and production in the country. The focus is on research objectives, accomplishments and with attempts of assessments. Tentative recommendations on the future Peanut CRSP in Thailand are given in a final section.

4. The Peanut CRSP

The **purpose** of the Peanut CRSP is to enhance and coordinate the resources of US and less developed country institutions in a long-term research program to resolve common constraints on the production and utilization of peanut in an environmentally sound system. The program was accepted in 1982. Most sources state that activities in Thailand were commenced in 1983.

In general, the Peanut CRSP **works** to develop peanut cultivars, cultural and pest management practices and utilization processes that would lower costs and stimulate peanut utilization as a primary food resource. The program supports research programs in terms of equipment, supplies, travel and personnel. It offers both short-term and degree-oriented training programs for host country staff at US institutions and degree training for selected US students. On a long-term basis, the CRSP provides host countries with on-site consultations and research collaboration with US scientists, which, aim at improving the research capability of host country scientists and institutions.

5. Peanut Production in Thailand

5.1 The general context

Peanuts are the world's fourth most important oil crop, following soybean, cottonseed and rapeseed. In 1989-1991, the world production of peanuts amounted to 22 million tons. India and China are the

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world's leading peanut producers. Their production is about 7-7.5 million tons a year. In contrast, Thailand accounts for less than 1 per cent of world production. Although there is no definite time record of peanut introduction into Thailand, it is believed that the plant was brought by Western seafarers some 3-4 centuries ago.

Since 1985, Thailand is reported to have an annual production of some 160,000 tons. This is about one tenth of the total US production during the same period. During the last ten years, peanuts have annually been harvested from an area of some 119,000 hectare (746,000 rai). The average production figures and yields have also been quite stable.

Table 1. Peanut production and yields in Thailand

Period	Production	Yield
	(1000 tons)	(Kg/rai)
1982-1986	161	211
1987-1992	161	221
Average	161	216

Peanuts are grown by small farmers, mainly in the north and northeast of Thailand. The Spanish type is most common. About 80 per cent of the production is in rainfed areas.

The official national yield is said to be about 215 kg/rai, equivalent to 1350 kg/ha. During the past few years, some new cultivars - recommended for the whole production environments - have been released to farmers. None of these are resistant to major diseases.

In general, most farmers plant their own seed. Seed Multiplications Centers are operated by the Department of Agriculture which multiply the foundation seeds at research centers and through contract farmers. These stock seeds are then handed over to the Department of Agricultural Extension for the production of certified seeds. There are 23 seed multiplication centers to serve 70 Thai provinces. Eight centers are responsible for the production of peanut seeds. Private traders appear to be more effective seed distributors than government channels. In spite of official recommendations, few farmers are reported to use fertilizer on peanuts. Crop protection is said to be practiced by contract farmers but otherwise "hardly practiced". Major production constraints are drought in the rainfed areas, low soil fertility, weeds, diseases and pests. Major pests are leaf miners and leaf hoppers.

In Thailand, peanuts are used domestically (97%) for direct consumption. The use of peanut oil is not significant and there are few small oil mills with low capacity. There is some export of peanuts. In 1987 and 1991, there were annual exports of about 1000 tons of shelled peanuts and an equal amount of whole pods. In 1988-1990, annual exports were only about 250-450 tons.

5.2 Organization of peanut research

In 1970, an Oil Crop Branch was set up within the Department of Agriculture. Several scientists from various disciplines were assigned to conduct peanut research and development at the Kalasin Experimental Station. In the mid 1970's, international collaboration was initiated on the Protein Gap Project with SEARCA and UPLB, including the exchange of seeds among member countries.

Segregating materials for selection were received from University of Florida. In 1978, cooperation began with ICRISAT and Thailand received 250 additional peanut accessions.

In northern Thailand, research on peanuts is now conducted by the Chiang Mai University and experiment stations at Pitsanulok, Nakhon Sawan, Lampang and Petchabon in the north. In northeastern Thailand, peanut research is carried out at the Khon Kaen University with research stations at Kalasin, Sakhon Nakorn, Roi-et, Mahasarakham, Loei, Ubon Ratchathani and Nakorn Ratchasima. In central Thailand, the Kasetsart University plays an important role with research stations at Chainat, Rayong and Praphuthabat. In southern Thailand, peanut research is concentrated at the Prince of Sonkla University and Pathaloong research station.

Official recommendations on cultivar release and cultural practices are mainly issued by the Department of Agriculture, Khon Kaen University and Kasetsart University.

5.3 The peanut CRSP in Thailand

Initially supported by the Thai Government, peanut research program was strengthened by the International Development Research Centre (IDRC), the Peanut Collaborative Research Support Program commencing in 1983. This led to the establishment of a national program. The objectives are to:

- improve peanut cultivars suitable for Thai cropping systems;
- increase the productivity and qualities of peanut cultivars through improvement of cultural practices and post harvests handling;
- coordinate research among various institutions and provide technical support to extension workers.

Research activities in Thailand supported by the Peanut CRSP include the following institutions:

- Collaborating host country institutions in Thailand:
- Department of Agriculture (DOA)
- Kasetsart University (KU) in Bangkok
- Khon Kaen University (KKU) in Khon Kaen
- Chiang Mai University in Chiang Mai

Collaborating US institutions:

- The University of Georgia
- North Carolina State University

6. Brief Review of Research Activities Presented to the Evaluation Team at Visited Institutions with Some Tentative Assessments and Conclusions

6.1 Department of Agriculture (DOA), Bangkok

Research on arthropods on peanuts has been conducted over 13 years. It involves scientists at DOA, KKU and North Carolina State University. The overall objective is to develop sound principles of IPM and sustainable agriculture. Research is stated to focus on resistant cultivars, assessment of insect damage (mainly thrips and leafminers), evaluation of effects of cultural practices, studies of the effects of botanical insecticides and an overall understanding of insect biology. Research on them started in

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1992. In response to questions, the work is said to concentrate on germ plasm evaluation, studies on thrips with sticky boards and IPM studies for providing good demonstrations to farmers.

Some Conclusions

1. The presentation indicated a wide range of research topics of all peanut insects. It seems strange that there is still a need for continued surveys of arthropod pests on peanuts.

2. Since the CRSP contribution has been small, it is questionable whether the broad research approach can be expected to yield research outputs to the most prominent entomological research problems in a short-term perspective of 10-15 years. No specific solution to a major problem was highlighted.

3. The specific content and the extent of a genuine research collaboration on **strategic research issues** with North Carolina State University is unclear except for work on germ plasm evaluation for resistance and some work that demonstrated that tillage can reduce pest population levels.

4. The draft 1993 Annual Report lists 11 publications and presentations, all by US scientist. No report is a joint publication by US and Thai scientists.

6.2 Kasetsart University (KU), Bangkok

6.2.1 Pathology

The peanut scientists at KU are involved in collaborate work with scientists at KKU and DOA breeders. A major task has been training of M Sc students. Between 1985 and 1993, one Ph D and 10 M Sc thesis have been produced. In addition, the KU reports that six B Sc degrees are a result of the CRSP support. The KU concentrates on training (80% of the funds to training). The CRSP has provided 70% of the funds for training M Sc students.

The research work covers a wide range of topics. Black leaf spot and rust diseases are high on the priority list but other diseases are also studied. The focus is on resistance to major peanut diseases. It was, however, argued that it was difficult to focus attention only to the most important disease(s).

The scientists have been rather active in taking part in scientific meetings, workshops, etc. In 1988, there was a 1st National Symposium on Plant Diseases. Recently, a draft textbook in Thai on peanut diseases has been developed. If published, such a CRSP contribution will have long-lasting effect on teaching--not only in Thailand but also in neighboring countries where Thai can be read. In addition to proceedings and annual reports, two scientific articles are mentioned.

Some conclusions

1. The training to the M Sc level has been impressive. Nonetheless, it can be questioned why few students have been encouraged to take a Ph D. If would be logical if the objective was to create a critical mass of scientists focusing on peanut pathology at KU.

2. The support for B Sc training should be a regular tack of the university. The use of scarce, extra funds of foreign exchange from CRSP can therefore be questioned.

3. The research work appears to be conducted through M Sc thesis, only. Thus, it is unclear what coherent research will be maintained once the thesis have been published.

4. Although there are contacts with other scientists, including peanut breeders, the scope and content of such collaborative activities were unclear.

5. If CRSP funds ceased, the major effect will be a reduction in the number of M Sc theses.

6.2.2 Department of Product Development

Research efforts are directed towards evaluating procedures for handling, sorting, packaging and storing peanut. The objectives have been to develop procedures to eliminate aflatoxin-contaminated seeds from lots received from farmers and to prevent growth of aflatoxigenic aspergilli through control of temperature and equilibrium relative humidity during storage. Recently, efforts have been directed towards the development of new and traditional food products with acceptability in Thailand and southeast Asia. In technology development, cooperation has been established with scientists at the Khon Kaen university. An attempt of technology transfer to the village level has been initiated. Training of students to the M Sc level at this department has been made possible in part "due to the judicious use of support provided by the CRSP project".

Many accomplishments including studies of consumer acceptability of many products were reported. They included the improvement and development of the "tuub taab", fermented peanuts into sausage, noodles supplemented with peanut flour, flavor sauce, textured vegetable food, etc. Now, attention is given to cat and dog food.

In the future, the Department would like to establish a Regional Training center in peanut storage and utilization and offer courses also to students from other countries. In all, 15 students had achieved their B Sc and 16 got a M Sc.

Some conclusions

1. The training to the M Sc level has been impressive. No student has been encouraged to take a Ph D. The response given was that there is no Ph D program as yet. If so, it can be argued that the establishment of such a program would have been an important objective if an output should be the creation of a critical mass of scientists on storage an utilization. The KU should be responsible for B Sc degrees-not the CRSP.

2. Although there have been a number of important research activities and several new products have been developed, the department considers training as the major output. It was mentioned that impact of research "is not our job". In discussions, it was agreed that there ought to be a sharper focus in future research. A future emphasis on training will not be successful without good research.

3. The work of the department has attracted both the interest and funds of the private sector. So far, there have been no problems with intellectual property rights on new products of research.

4. It appears that contacts with the University of Georgia have been quite intensive and useful. It is unclear--based on observations from one visit--how much joint research activities there have been.

5. The draft 1993 Annual Report, demonstrates a most impressive list of 70 publications and presentations. Contributions come from all collaborating departments (inc. the Philippines). There are 11 joint US/Thai publications whereas there are 26 by US scientists only and 25 by Thai scientists.

6.2.3 the Development of Peanut Processing in the Huay-Bong-Nua village

The Department of Product Development has been involved in a first attempt in transferring peanut technology to a rural area. The research was conducted on 1991-92. The task was to investigate the transfer of peanut processing technology along with business and marketing management to farmers in Huay-Bong-Nua village, Prao district, Chiang Mai province in northern Thailand. A pilot group of seven women farmers was formed. The designed equipment was set up at the site. The women were trained in techniques for processing and quality control of both oil roasted and ground roasted peanut.

The products were marketed in the area. The processed products contained no aflatoxin, no defects and had low microbial contamination. Only local peanut varieties were grown. Today, shortage of water is the major constraint.

Some conclusions

1. The women had accepted the technology and used it because it was made available to them by the project. There was no arrangements for local repair and/or maintenance of the equipment. If the project were to cease, the women were not in a position to purchase the equipment or even borrow money. They did not know what exactly to do.

2. The women farmers considered the major output was their realization on how to collaborate and join hands. They said they had learned a lot. They were not willing to expand their group since this would reduce their profit.

3. The total cost of all necessary equipment was reported to be 20,000 Baht. In this poor rural area, such a sum of money is very exceptional.

4. From a pure technical point of view, the equipment worked. However, the technology was not suited to the socio-economic environment. The technology seemed to be much advanced and too expensive for rural families in general. It may be suited for more commercial traders with access to cash and/or bank loans.

5. The role and contribution of the staff of the Chiang Mai University was very unclear.

6.3 Khon Kaen University (KKU) and Department of Agriculture (DOA), Khon Kaen

6.3.1 Variety Improvement and Breeding

The major focus in peanut breeding is on earliness, high yields, large seed type, resistance to rust and leafspot and growing before and after rice without irrigation. Some work is done on improved nitrogen-fixation. Host plant resistance to economically important pests is considered a critical feature of future work.

Three new peanut cultivars have been released: KK 60-1, KK 60-2 and KK 60-3. According to the 1993 Annual Report, "KK 60-4" was recently released. It is a high yielding (+ 10 per cent), boiling-type peanut. In the presentation it was said to be "considered for release". Eight B Sc and six M Sc degrees for Thai students have been completed and two more M Sc are forth-coming. In addition, three Vietnamese and three Myanma students have received short-term, non-degree training. Some 30 extension personnel have been trained in production technology by staff of the DOA and KKU.

Some conclusions

1. The presentation illustrated a conventional approach to plant breeding. The research appears to cover most aspects without priorities. A focus on boiling-type peanuts may be justified but this requires realistic estimates of both existing and potential acreage. Such data were not provided.

2. On training, both the output and the underlying policy seems difficult to comprehend with reference to the draft 1993 Annual Report. For Thai students, only "partial support" is being directed to two B Sc, three M Sc and one PhD (in plant pathology). No degrees are reported. In contrast, the CRSP supports one Ph D student from USA "in total" as well as Ph D students from Argentina (2), India (2), and Indonesia (1 - with "partial support"). Two of these students received their Ph D in 1993.

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3. The draft 1993 Annual Report provides quite and extensive list of 40 publications and presentations. It covers contributions from all collaborating departments (including the Philippines). No publication is a joint US/Thai publication. There are 18 publications by US scientists only 12 by Thai scientists.

6.3.2 Plant Pathology: Viruses

The task is to identify major diseases, assist in breeding work and study details of all aspects of peanut diseases. A survey of virus diseases has been completed. It showed that bud necrosis is the most prevalent and economically important virus disease. The incidence of PStV was spotty. PMV was detected in Thailand in 1992. Future research on viruses is said to focus more on basic problems of relevance for the region and with more collaboration with ICRISAT.

Some conclusions

1. The Thai group seems to have played a leasing role in studying new virus diseases. It has identified sources of resistance, developed a very relevant detached leaf technique and established foliar disease nurseries.

2. The group has trained 12 undergraduates and two for a M Sc. Apparently, this has been accomplished - in spite of non-existing CRSP budgets for graduate student training in Thailand (and Nigeria). B Sc training should not be a task of CRSP but the university.

3. The group has been very active in publishing four documents in Thai about virus diseases (one in 4000 copies and assisting in producing an ICRISAT publication).

4. The draft 1993 Annual Report demonstrates and extensive list of 38 publications and presentations. It includes contributions from all collaborating departments (including Nigeria). Two sets of two publications each are a joint product by US/Thai and US/Nigerian scientists, whereas the others are chiefly by US scientists.

6.3.3 Entomology

The presentation at KKU was meant to give additional information to the visit to DOA in Bangkok. The range of research activities seems very extensive. Damage assessment data was provided on leaf miners. They may cause losses of 30-60 per cent. It was concluded that research on the subterranean ant ought to be a priority.

Some conclusions

1. There appears to be a wide ranging research agenda without priorities. The specific objectives are also very broad, for instance "to utilize monitoring devices to gain a better understanding of insect biology and use as a predictive tool for insect occurrence and pest abundance". Or "to study biology and ecology of important pests".

2. There are no reports on publications or training.

6.3.4 Groundnut Biological Nitrogen Fixation

While the first phase of this research on groundnut was financed by CRSP, the second one got support from IDRC. The third phase (1990-93) has been sponsored by the International Scientific Cooperation Programme of the Commission of the European Community. It has been found that only some 10 per cent of native peanut Bradyrhizobium isolates were as effective as a good standard strain. Standard strain was a poor competitor for nodulation.

Recent findings state that peanut is a better fertility crop than other legumes. The N-fixing ability varied among cultivars and locations between 1-- to 200 kg of nitrogen per ha. Peanut stovers need to be

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returned to the soil to benefit from nitrogen fixation. Then, it could increase maize yields equivalent to 60 kg N/ha.

Some conclusions

1. The research area is of great relevance. The presentation provided some interesting data on location--specific aspects of nitrogen fixation.

2. There were no reports on training or research collaboration within Thailand.

6.4 Visits to one commercial sheller and one former peanut farmer in Kalasin

The larger commercial sheller was handling both peanuts and soybeans. He is planning to process peanut oil for export to neighboring countries. This will require a certificate stating that the oil does not contain any aflatoxin.

Another visit was to a former peanut farmer whose whole family had turned into peanut processing, using the technology originally produced by the IDRC project. He could afford to buy it--like a few others in this region--since they had been working abroad (in Libya).

Some conclusions

1. The large commercial sheller indicated an interest in a closer collaboration with peanut scientists at the Khon Kaen University. He would be a competent partner of the private sector.

2. The small-scale sheller used effectively equipment that was only 50 per cent of costs for the machinery that was tested at the Huay-Bong-Nua village.

6.5 Khon Kaen Seed Center

The visit gave a rather confusing picture of the activities. Seed multiplication is the third aspect of the process, the preceding ones being foundation seed and registered seed. The seed centers use mainly contract farmers for the production of registered seed. the goal for peanuts was said to be 20 tons for the wet season although 7 tons are produced annually. The seeds are distributed by the Department of Agricultural Extension.

The 1993 price of certified peanut seed was 14 Baht per kg. The price was the same for local seed.

In an attempt to highlight goals and actual production of peanut seed the following table was produced during meeting:

Table 2. Goal and actual production of peanut seed in Thailand (tons in wet & dry season)

Variety	Goal 1994	Production 1989
Tainan	795	1540
KK 60-1	100	210
KK 60-2	35	32
SK 38	100	-
TOTAL	1030	1782

7. Impact and Some Assessments of the Peanut CRSP in Thailand

It is difficult to make an overall assessment **without having** a) visited the US collaborative research partners, b) detailed information about research in the Philippines, c) discussions with EEP members

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visiting and d) access to the total financial investments made by CRSP to the project activities in Thailand. Nor have I specific information about the financial contributions made by the Government of Thailand. With these restrictions, an attempt is, nevertheless, made below to make some preliminary conclusions at the policy level regarding impact and accomplishments.

1. Most likely, the most important contribution by CRSP is the **establishment of a coordinated, sustainable, national research program** on peanuts with the Department of Agriculture and some Thai universities. In stead of merely individual, professional contacts there is now regularly an annual conference, a joint work plan and certain division of labor to tackle research problems on peanuts. It can be assumed that such a coherent approach have also **influenced the overall research policy** on peanuts.

2. The early focus on **long-term research collaborative arrangements** between US institutions and selected ones in Thailand--and other developing countries--is to be much complemented. Now, this concept is considered a most effective way in which institutions in the South can be given good research support by the North with much less external dominance.

The CRSP has facilitated of the Thai institutions to be members of an **international peanut scientific network** being partners of and access to ICRISAT international peanut germ plasm and IRRI's long experience on cropping systems research between Thailand, Nigeria and the Philippines.

The newsletter "international Arachis"--circulated to Thai peanut scientists--is another component of the "internationalization efforts". It provides relevant news about peanut research.

3. A major **output** has been trained Thai staff in particular to the M Sc level. The Peanut CRSP has helped about 40 students at the Khon Kaen University in Breeding, pathology and entomology. In all, the CRSP has financed 16 + 16 M Sc students at the Kasetsart University.

With few exception, there students are now employed by the private sector or government institutions. However, the CRSP has not been financing many Ph d degrees. This would have been a prerequisite if the major objective of CRSP would have been to contribute to the building up of a critical mass of peanut scientists, thereby strengthening national research capabilities.

The major objective seems to have been the establishment of long-term, viable scientific linkages rather than a) solving short-term, relevant research problems or b) a long-term strengthening Thai institutional research capability. The latter objective has required larger funds and the former one had required more precise research objectives.

4. Another output is new peanut varieties. Generally, the research, production, release and spread of a new crop variety takes a long time. Already in 1932, the Department of Commerce defined three varieties according to nut size and shape, oil contents and palatability: Spanish, African and Chinese varieties. Records indicate that collections of indigenous and exotic varieties were initiated by the Kohn Kaen Experimental Station in 1953. Accessions were grouped into Spanish, Valencia and Virginia. In 1965, five varieties were recommended to farmers:

Valencia (red seed coat)
SK 38 and Korat (white seed coat)
Lampang Spanish
Roi-et 1 & 5

Through CRSP, three new varieties have been developed and recommended for cultivation.

5. Information about the spread of both new and old peanut varieties is currently non-existent. It would have been very useful to prove the importance of the research and development work. It would have allowed an assessment of the actual contribution by CRSP on this specific aspects of the research process. Such an example is presented in 1991 in a US Congressional Hearing by the CRSP Council. It was expected that there was US$ 1.5 million pay off from Peanut CRSP IPM developed technology only for the North Carolina-Virginia growing area.

6. The time span of Peanut CRSP is short, e.g. a little more than 10 years. This explains why there are few scientific breakthroughs. There are, however, a range of emerging solutions to several technical aspects of peanut cultivation in Thailand. It seems, however, unfortunate that too little emphases has been given to the identification of the technical research problems without a proper examination of the overall socio-economic environments in which peanuts are cultivated, processed and marketed.

The Peanut CRSP had originally planned to have a component of socio-economics but this was not implemented due to change in funding. It was to "develop an understanding of land labor management, capital and the pole of sexes as related top production and utilization and relationships of peanuts to other crops in the cropping system". Its inclusion would have facilitated an improved procedure for setting research priorities, sharpened the research objectives and may have speeded up the research.

8. Some Tentative Recommendations on a Future CRSP Support to Peanut Research at Thai Institutions

Some constraints

The Team has only visited Thailand, thus having no chance to discuss the Peanut CRSP research activities in concerned US research institutions and of the corresponding activities in the Philippines. Therefore, no final recommendations can be made at this stage. This applies also to the possibility to honestly assess the accomplishment of the peanut CRSP as a whole in research and its impact on production in both the USA and the concerned developing countries.

Another constraint relates to the relatively small funds that have been made available to the Peanut CRSP in Thailand. Obviously, the size of the funding is appropriate for establishing durable scientific linkages. However, it would not be realistic to assume that the CRSP funds so far would have had too much influence on the overall peanut production in Thailand. There is, however, some influence on the research, its organization and the ability for Thai scientists to participate internationally. The CRSP funds have been too small to achieve a substantial strengthening of Thai national institutions. Nonetheless, they have had and impact on the actual research environments which have been involved in the CRSP program.

Tentative recommendations

1, **The original concept of research collaboration** has proved useful. The results achieved so far should be further strengthened both by the Peanut CRSP and the donor.

2. The Peanut CRSP should continue its support to peanut research in Thailand but with modifications, indicated below.

3. Even though increased funding is recommended, the size of future funds will probably be relatively modest why it is important that future support is confined to strategic research within the southeast Asian region. This should be further elaborated.

4. The past CRSP support has been very instrumental in promoting peanut research in Thailand and has established some productive scientific linkages. By selecting one of these as a focal point, the future CRSP support should be concentrated to the Khon Kaen University. It could serve as a regional node of CRSP in Asia and act more independently as a coordinator for CRSP. This will be more cost-effective to the donor and will transfer more responsibility to the developing country component of CRSP.

In general, the future objectives of the CRSP support should be sharpened and specifically targeted on strategical aspects. They ought to center around:

- to strengthen already established scientific linkages with a focus on Khon Kaen University;
- to support financially some selected, strategical research problems of relevance to the Peanut CRSP, Thai peanut research and peanut research nine neighboring countries;
- to strengthen the Khon Kaen research capabilities regarding scientific equipment, research materials, travels in the region and internationally and
- to ask the Khon Kaen University and their peanut scientists to serve/act as "a broker" for Peanut CRSP within the region for establishing new scientific contacts and research collaboration, advice, etc.

5. A strategical approach ought to include more emphasis on peanut germplasm which is a truly international research activity. This must be at the expense of some other activities and ought to be worked out in close cooperation with ICRISAT.

6. The project on transfer of technology in the Huay-Bong-Nua village should be immediately terminated and the equipment given to the women group. Since tho role of the Chiang Mai University in technology development appears to be very marginal, it should be terminated.

7. The activities at the Kasetsart University, being training in pathology, mainly, should be transferred to the university without CRSP funds.

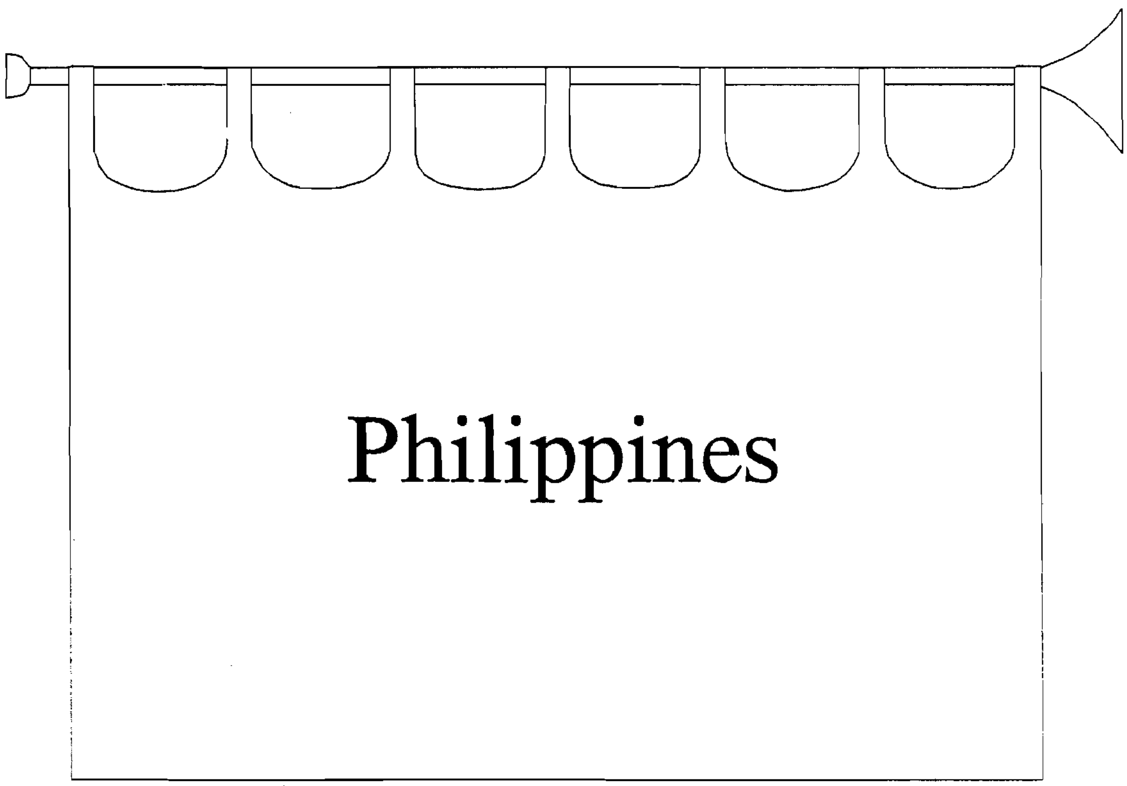
8. It seems feasible to maintain certain research activities on peanut product development. Since there is an established contact between the Kasetsart and Khon Kaen universities in this area, it is recommended that the Khon Kaen university is the future focal point for CRSP support. Its great potential is accentuated by the possibility of an interesting integration of research and product development and research between the Khon Kaen university and the commercial sheller that the Team visited in Kalasin. This may attract private sector funds.

9. The Khon Kaen university is probably best placed both scientifically and geographically within Thailand with excellent communications. It is in a good position in the southeast Asian region for serving as a regional research node. The need of research collaboration on peanuts is obvious. The Thai language can be read in several of the neighboring countries. Some of these arguments are further demonstrated below:

Table 4. Harvested area, production and yields of peanuts (in shells) in some Asian countries in 1961-65 and 1979-81.

COUNTRY	AREA HARVESTED (1000 ha)		YIELD (kg/ha)		PRODUCTION (1000 tons)	
	1961 - 1965	1979 - 1981	1961 - 1965	1979 - 1981	1961 - 1965	1979 - 1981
Myanmar	545	490	650	800	360	390
Cambodia	17	5	890	680	15	4
Laos	2	11	720	740	1	8
Vietnam	72	106	970	890	70	94
Thailand	**86**	**103**	**1350**	**1240**	**120**	**130**

Source: FAO Production Yearbook, 1976 and 1992


Philippines

REPORT ON VISIT TO PHILIPPINES

JANUARY 22 - FEBRUARY 1, 1994

Robert Schilling
Member of EEP

CIRAD-CA
Montpellier, France

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EXTERNAL EVALUATION REPORT PHILIPPINES:

1. Peanut Crop Situation

Area planted to peanut average 50,000 ha and total volume of production average 35,000 t representing 60% of national requirements. Region II concentrates 50% of the total area; peanut is planted after corn or rice as a sole crop, inter cropped with maize (sugarcane, cassava, and okra in other areas) or sown between rows of coconut or other perennial.

Research and development efforts are concentrated in region II and neighboring areas, where the "dry" season crop sown in October-November gives higher yields and nuts of better quality than the rainy season crop sown in May-June. Optimum mean daily temperatures range from 22° to 30° c. Daylight fluctuations do not seem to significantly affect the growth and yield of peanut. Well-drained, medium textured, slightly acidic (ph 6 to 6.5), and relatively fertile soils are suitable for peanut production, although planting on clay loam is not infrequent.

Farms growing peanut in the region average 2.15 ha with an average of 0.94 ha devoted to peanut. Almost all of them are entirely dependant on rainfall. Land preparation is generally mechanical (animal drawn plowing and harrowing); planting is generally manual; cultivation is manual or done with animal-drawn implements; fertilizer and chemical applications are not commonly practiced; harvesting is done by hand after plowing between the lines; the crop is sun-dried; threshing, sorting, and shelling for seed are done by hand.

Labor requirements per hectare, as compared with other cropping situations, have been estimated as follow, not including seed preparation which can be done off-season (socio-eco-study 1985-86 in Philippines, IRHO data in Africa):

	South Senegal Animal- drawn (in hours)	North Cameroon Manual/mechanical (in Mandays)	Philippines (in Mandays)
Land preparation	30	8	17
Planting	15	12	7
Weeding	85	17	10
Spraying/fertilizer	10	3	1
Harvesting	100	13	12
Drying	(inc. above)	4	2
Threshing	60	10	N.A.
Total	300	54	(49)

These data reveal comparable cropping conditions answering comparable constraints, with the exception of the Philippine practice of plowing and frequent laying out furrows, a labor-consuming task, whereas land preparation in the African situations considered here is limited to shallow cultivation.

2. Peanut Development Policy and Organization

PCARRD (Philippine Council for Agriculture Forestry and Natural Resources Research and Development) is one of 5 councils under the authority of the ministry of Science and Technology. CRD (Crops Research Division, Director Dr. Estel Lopez) is one of the technical divisions under PCARRD, maintaining research stations and representing PCARRD in 12 inter-institutional National Commodity Research and Development Teams. NCRD teams propose research and development priorities, organize multidisciplinary approach, evaluate proposals, monitor projects, and make recommendations. Dr. Cabral is in charge of the legumes team including peanut, soybean and mungbean.

Ministry of Agriculture is in charge of extension, through regional agencies operating technology adaptation projects and issuing information to farmers in collaboration with research.

Legumes are minor crops in the Philippines, with official support in proportion:

- Total crop acreage: 13 million ha.
- Including: rice 3.5 million
  corn 3.4 million
  coconut 3.2 million
  legumes 0.1 million/including peanut 0.05 million.

The official aim of the National Development Plan is self-sufficiency in Legumes production (peanut imports average 20,000 t/year) in particular through a viable seed production scheme. In fact, National Seed Foundation in charge of this sector has no seed program for peanut, and the only significant development effort on legumes is a FAO soybean project.

3. Peanut Major Production Constraints and Research Issues

3.1: Unavailability of good quality seed is generally mentioned in first position among production constraints. Most farmers still use "the traditional variety", too often a mixture of varieties; 42% of the farmers use their own seed; the others buy or borrow from wherever they can. Official multiplication and distribution of improved seed is negligible and difficult, as peanut seed (although unshelled) cannot be stored more than two or three months at farm level.

The general seed situation is by many aspects similar in the Philippines and in West Africa (Senegal is an exception), humid climate in the Philippines being an aggravating factor:

- Peanut seed is delicate, bulky, sensitive to heat and moisture, exposed to a range of pests under prolonged storage: it is therefore necessary to produce seed during the wet season for the "dry" season immediately following.
- Multiplication rate is very low: 100 to 150 kg of seed is required to plant one hectare with average yields not exceeding 900 kg per hectare.
- Foundation or basic seed is not produced in sufficient quantities; multiplication rate is low; cold storage is not available outside major research stations: credit is difficult; seed production, processing, and storage technology for individual farmers or village communities is not available.
- There is no rational organization of the seed sector based on good coordination and strong linkage between research, seed multiplication units, extension serviced, credit, private sector. These operations are superimposed without efficient vertical integration; there is no seed multiplication scheme with quantified objectives answering actual demand, based on successive genealogical levels starting with foundation seed and ending with systematic distribution in accordance with a varietal map.

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3.2: Basic cultural practices still pose problems:

- Pest management is difficult in the field (including drying); damage can only be avoided after harvest by reducing the storage period; potentially important problems, such as the incidence of nematodes, remain unanswered; fungicide protection of seed, surprisingly, is not practiced, although seed is rare and stands are poor; chemical treatments, when recommendable and available, are financially out of reach of the small farmer.
- Small equipment is lacking and labor-consuming operations are still done by hand: planting (a major bottleneck), threshing, shelling are generally manual. Simple animal- drawn planters, such as used in Senegal, could be adapted and proposed in areas where the crop is grown on flat.
- Fertilizer is not in common use and farmers question their efficiency, complaining that they are effective on haulm but not on pod production. Fertilizer in use, probably adjusted to cereal needs, is N-dominant (urea, 14-14-14, ammonium phosphate and sulfate) and therefore not appropriate for legumes. Positive effects of Ca is often mentioned, but no distinction is made between basic pre-planting application from which correction of acidity is to be expected, and top-dressing after flowering, from which an improvement of podfilling and seed quality is to be expected. These two aspects should be considered separately.

3.3: Appropriate post harvest technology is lacking. The research area is wide but to converging issues deserve attention: The processing of good quality seed for the edible market, presently taken over by imports from China and Taiwan; the production, processing and storage of good quality seed for planting, at farm level or collective level, with technology appropriate for both situations.

3.4: Marketing and credit policy: This very important problem is mentioned for record and deserves specialized attention.

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Project NCS/BCP/TP: Peanut Improvement

Consistent results have been obtained: the project has selected two promising lines, PN 2 (good seed size, high yield, tolerance to late leafspot and rust) and PN 10 (good seed size, high yield, tolerance to leafhopper and late leafspot). More efforts should be made, at this stage, to make these varieties available to the farmer; there was little indication in Ilagan and Isabela, of the "massive seed production" mentioned in the 1992-93 report . . .

The breeding program sponsored by Peanut CRSP has the characteristics of a long-term operation with ambitions goals answering a very wide range of production constraints:

Shade tolerance
Acid soil tolerance
Insect tolerance
Disease tolerance
Aflatoxin control
Improvement of germinative capacity
Improvement of seed size

All these objectives (except probably shade tolerance) are already included in breeding programs under way in other countries with a far greater production potential than the Philippines: international cooperation, and whenever possible introduction of improved populations on varieties, should be given priority. Inter-CRSP coordination and exchange of material should be developed: selection of early maturing large seeded Virginia lines, undertaken in North Carolina, is interesting for West Africa as much as for Thailand and the Philippines; nematode-resistant lines mentioned in the 1992-93 report should be tested in Senegal; (Chico/GA 119-20) -8-3-12 and in general the progeny of Chico X GA 119-20 should be tested in Senegal where GA 119-20 is produced on a large scale (40,000 ha) and where Chico has been used as a genitor in crosses combining earliness and dormancy. This combination could be very useful in the Philippines where non-dormancy is a problem especially in the wet season. Peanut CRSP is in a good position, through its direct involvement in national breeding programs, to develop scientific relationship and exchanges of material between Africa and Southeast Asia, directly for NARS to NARS or through the networks operating in both continents (CORAF in Africa and the Asian legumes network).

The general breeding strategy is not clearly presented: To what extent are the above goals compatible? What is their genetic feasibility and their economic importance? What are the priorities? Are there operational objectives, or varietal ideotypes, towards which the program is aiming? In what time limit can they be reached?

The project, at the present stage, has identified interesting material answering more or less some of the very diverse breeding goals. Further work should contribute to the optimal combination of these goals and give more attention to yield improvement in general and to local requirements and acceptability of the proposed cultivars.

It has not been possible, due to delayed planting, to visit trials and investigate into the experimental techniques in sufficient detail. Statistical designs used for preliminary, general and advanced yield trials seem adequate although a number of reflections of PYT should be increased and plot sizes seem small (2 to 45 m lines) for proper yield evaluation unless stands are perfect. This does not seem to be the case, especially as no fungicidal seed treatment is applied. We should recommend in these conditions, as planting is done by hand, either to put two seeds in each planting hole and thin by hand one week after, and/or to plant in empty seed-holes within ten days after first planting.

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5. NCS/IM/TP: Management of Arthropods on Peanut

The decision to concentrate on insect pests seems to proceed from trials early in the project indicating that untreated plants yielded 40-60 percent less than treated plants without insects. There is no indication of a systematic survey of pests and diseases in generae, comparing the incidence of arthropods, nematodes, fungal and viral disease, and aflatoxin contamination, and the interaction of these components of plant protection. No answer to this question was given during visits or found in the reading material, but farmers interviewed in the field did mention insect pests and fungal disease as their first technical constraint after lack of seed. The major impediment they mention in all cases being low prices, credit unavailability and market uncertainties . . .

The project has achieved interesting results but did not come up yet to a general control strategy in its field of investigation, contributing to plant protection strategy for the humid tropics comparable to the one that has been defined in the dry areas of West Africa.

> Concentration on chemical applications of fungicide and insecticide protection at planting (seed dressing) and after harvest (drying, storage, seed processing).
>
> Answering disease problems, dominant in these areas, mainly through tolerant varieties and preventive husbandry.

Could guidelines of this type be proposed for Southeast Asia, and research work be organized and oriented accordingly on an inter-disciplinary basis?

The principles of IPM applied to above-ground insects are based on well-timed prescription pesticide use rather than calendar-type sprays, the use of cultivars with improved tolerance, the application of adequate tillage methods from which the reduction of pest population levels is expected, and the integration of biological control using Trichogramma species and Bacillus thurigiensis into the system. This control philosophy is certainly indisputable and is to be enforced. Pest survey, genotype testing, definition of spray calendar threshold application have given good results but studies on biological agents (including work on an inhibiting fungus for aflatoxin control) are certainly the most innovative and promising. They will require more efforts and deserve better facilities than those visited. The evaluation trip unfortunately did not allow field or trial visits in Los Banos, but it was disappointing that the proceedings of a recent workshop on this subject was not made available and that the only detailed presentation we could get was on Trichogramma work on corn and Bacillus t. work on rice.

We were surprised to find no information on IPM recommendations in pilot producing areas and no mention of packages of simple protection including a cultivar and the appropriate pest control method. The 1989 evaluation report mentioned (page 109) average yield increased of 34% resulting from the use of an improved cultivar, introducing Trichogramma predators and one or two well-timed sprays. What confirmation, application and transfer of these results have been accomplished 5 years after? What is the expected progress, in the near future, towards an efficient IPM system made available to the farmer?

Unavailability of good quality seed being mentioned as the major technical obstacle to yield and production improvement, a plant protection project should consider this constraint which is not relevant only to entomology. Philippines is the only situation we have met where fungicide and insecticide protection of planting seed is not recommended by research. We are not convinced that this allegation has been established on thorough investigation. Fungicidal seed-dressing in other countries is often the only chemical application technically and financially available to the traditional farmer, improving stands by up to 40% when seed quality and planting conditions are not satisfactory. The product, in many countries, is distributed automatically with the seed when in shell or the other hand is one of the rare situations in developing countries where inoculation is recommended systematically: the problem is then to check whether inoculation and fungicide application are compatible if both are useful.

Underground and storage insect pests (and eventually millipedes) can have serious incidence. This apparently has not been closely investigated. Damage can be direct on yield and indirect on seed and edible quality; damaged pods are a serious factor of Aspergillus contaminations (see Burkina-Faso Peanut CRSP results). These factors may not be conspicuous in the Philippines because on-farm storage is rare and farmers will sell their production as soon as possible after harvest. Any implementation of a rational seed multiplication scheme, and any improvement of on-farm seed production technology, will require appropriate post harvest control and protection adapted to both types of situations.

GA/FT/TP Appropriate Technology For Storage and Utilization of Peanut

Transformation of the raw material for direct consumer utilization has been given successful attention by the projects and deserves to be carried on. Post harvest technology should, as well, improve this raw material and fill the gap between upstream research and the improvement of food products. From this point of view, handling, sorting, packaging and storing peanut can be envisaged considering two converging issues: producing and packaging good planting material and processing edible nuts for home market or export. Both require sound and mature kernels of the proper type or variety, adequately shelled, sorted and stored. Edible kernels will then have to be graded for further processing, with special attention to organoleptic, sanitary and nutritional factor; planting material will have to be processed and stored till the next season, or longer, with special attention to different situations: the requirements of the small farmer producing and storing his own seed; the installation of seed multiplication units and seed processing plants integrated in a seed multiplication scheme involving research, extension, contract farmers and possibly commercial operators.

This double option answers a major constraint of the producer and of the entire commodity system. It is an important phase, in developing countries, of the sequence of operations leading from plant breeding to improvement of food products.

7. General Conclusion

Several Peanut CRSP projects are presently carried out in developing countries under various edapho-climatic conditions. They are based on the major disciplines supporting the improvement of agricultural production, each in its particular field of investigation but the ultimate objective is unique: it is to answer the needs of the small farmer using traditional technology in an environment where climatic hazards and economic constraints impose the application of low-input, risk-reducing strategies. These needs are complex and seldom correspond to the academic specialization of university scientists.

A first phase of peanut CRSP operations, starting in the early eighties, is now nearing its conclusion. It has lead to very rich scientific results in a wide range of disciplines, each of them directed on its sectorial objectives, but none of them answering globally the needs of the farmer.

This phase was exploratory, analytical and discipline-oriented. The output is extremely promising and deserves praise: improved varieties, technologies, and end-products are now available and some have been transferred to the farmer and consumer, sector by sector, country by country in point-by-point response to some problems encountered.

A second phase of operations should now be progressively initiated. The "raw material" accumulated in the first phase should be valorized and integrated into crop management packages and told to aid in decisions adapted to different cropping situations in Peanut CRSP associate countries and in the corresponding regions. The discipline-oriented approach should then give way to a commodity approach; research should be better coordinated on a regional basis; adaptive research should be given priority in the prospect of effective transfer of technology in global response to the farmers' needs.

Post harvest technology and socio-economic aspects related to credit and price policy, input (particularly seed) distribution, marketing organization should be made "researchable". The entire sequence of research operations from breeding to processing of end-products, should be more interactive and integrated vertically between disciplines as well as horizontally between participating NARS and regional/international institutions. Links with extension services and private sector should be developed.

Any interruption of operations at the present intermediate stage would be extremely detrimental. Research results are significant, promising but still fragmentary: one variety, however performing, will not improve farmer income unless properly grown, fed, protected, stored and sold. Good control of one disease or insect might only give way to other diseases or insects if not integrated in a proper management system. Production will remain stagnant if seed is not made available to the farmer or if he is not taught to produce and store his own.

More thought, efforts and better coordination are needed to bring along a shift of strategy and research objectives. Peanut CRSP having enforced and sometimes initiated peanut research in many countries, is in a good position to sponsor and implement this new research orientation.

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REPORT ON VISIT TO PHILIPPINES

JANUARY 22 - FEBRUARY 1, 1994

John Cherry
Member of EEP

ARS/USDA
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External Evaluation Panel Review

Peanut CRSP Code: GA/FT/TP

Project Title: Appropriate Technology for Storage and Utilization of Peanut

Principal Investigators and Collaborating Institutions: Dr. L. R. Beuchat, University of Georgia; Dr. P. Chompreeda, Thailand - Kasetsart University; Dr. V. V. Garcia, the Philippines - University of the Philippines at Los Banos, Laguna; Dr. L. S. Palomar, the Philippines - Visayas State College of Agriculture, Baybay, Leyte.

Collaborating institutions include the Center for Food Safety and Quality Enhancement, Department of Food Science and Technology, University of Georgia (UGA); Department of Science and Technology (DOST), Food and Nutrition Research Institute (FNRI), Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD); Institute of Food Science and Technology, Institute of Plant Breeding, Department of Entomology, and National Institutes of Biotechnology and Applied Microbiology, University of the Philippines at Los Banos (UPLB), Laguna; Department of Agricultural Chemistry and Food Science, Visayas State University of Agriculture (ViSCA), Baybay, Leyte; and Ministry of Agriculture, Cagayan Valley, Isabela, Philippines; Department of Product Development, Kasetsart University (KU), Department of Food Science and Technology, Cheingmai University (CU) and Department of Food Agricultural Engineering, Khon Kaen University (KKU), Thailand; and Ministry of Agriculture and Cooperatives, Department of Agriculture, Thailand.

Project Objectives: Plans are to develop and demonstrate procedures to eliminate aflatoxin-contaminated peanut seed from farmer's lots; to prevent growth of aflatoxigenic aspergilli through control of temperature and humidity during storage; to maintain sensory quality of raw and roasted peanut seed; and to develop and adapt technologies to utilize peanut and peanut products in traditional and new food products which would be acceptable in Thailand, the Philippines, other Southeast Asian countries and the U.S.

Three members of the EEP and the Peanut CRSP Associate Director visited the institutions mentioned above in the Philippines. This report presents only the findings from visits to the food research and collaborating institutions in the Philippines.

Achievement of Objectives: Procedures for handling, sorting, packaging and storing peanut are available to farmers, handlers and food processors. Included are procedures to eliminate aflatoxin contaminated peanut and prevent aspergilli infestation during storage and handling in Southeast Asia. The earlier consumer surveys produced intuitions-insights that have allowed food scientists and technologists to develop new, and improve upon existing traditional, peanut products in the marketplace. The objectives of Peanut CRSP are properly prioritized to the needs of these critical areas of the world and contributing to research programs in the U.S.

The program's researchers in Southeast Asia and the U.S. have had the foresight to evolve collaborative linkages among national and international government institutions, experiment stations and universities to form multidisciplinary teams of food scientists and technologists, agricultural engineers, peanut breeders, agronomists and entomologists. As a growing emphasis began for technology transfer, efforts increased in collaborations between the research institutions and industries - both large and small or entrepreneurial and regulatory agencies. Another major emphasis is the

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training component including advanced degrees for graduate level students and short courses for support personnel. Workshops on advances in peanut utilization for industrial personnel and the nutritional well-being of consumers are having an impact on host countries and the U.S.

Implementation and Management of Projects: Dr. Ester L. Lopez, Acting Director, PCARRD, confirmed full commitment to Peanut CRSP. A National Agricultural Resource Research Network (NARRN) is in place to coordinate research programs at the national, state, experiment station and university levels. Also, in place is an Environmental Research and Development Program (ERDP). These programs are closely coordinated with the Philippines' industries. Cooperation with the Philippines Department of Agriculture through pilot plant research programs and extension services is helping to move research developments to commercialization. A National Commodity Team for each crop, e.g., legumes, including peanut variety improvement at the Philippines Department of Agriculture experiment stations in Isabella, in partnership with PCARRD and UPLB, is greatly improving technology transfer of research developments to the farmers and industries. A National Peanut Workshop presenting advances in the Philippines' programs occurred mid-January 1994. Peanut CRSP is a major component of all of these developments.

A premier science and technology body in the Philippines in 1987, DOST, was charged with the mandates of providing central direction, leadership and coordination of all scientific and technological activities, and of formulating policies, programs and projects to support national development. This includes supporting local scientific and technological efforts, developing local capability to achieve technological self-reliance, promoting public and private sector partnerships in science and technology activities and encouraging the private sector to play a greater role in research and development activities. The objectives for DOST's projects in the 1990's is embodied in a Science and Technology Master Plan which has the goal: "to enable the Philippines to attain the status of a newly industrialized country by the year 2000." This goal includes

(1) Modernization of the production sectors through massive technology transfer from domestic and foreign sources.
(2) Upgrading of research and development capabilities through intensified activities in high priority sectors.
(3) Development of science and technology infrastructures, including institution building, manpower development and enhancement of a science and technology culture.

Five Sectoral Planning Councils of DOST, the Philippines, are responsible for formulating policies, plans, programs, projects and strategies for science and technology development; programming and allocating funds; monitoring research and development projects; and generating external funds. The PCARRD is one of the five Councils and coordinates the funds of Peanut CRSP. The PCARRD offers a National Scientific Literature Service Network which promotes the utilization of research information through various consortia; make available Subject Matter Specialists who provide the vital link between the researchers and the information users and adopters; through communication linkages supports the research activities of the regional research center/consortia; and produces publications to disseminate research and indigenous information and technology to various audiences, primarily to promote research utilization through different mass media channels.

The PCARRD has published in 1993, a "List of Available Publications for Sale," that includes research developments in the Philippines. Among the semi-technical packages of practical technology recommendations on important commodities designed for extension workers and enterprising farmers who have financial resources to apply the recommended technology is "Peanut." Under "Abstract Bibliographies of the State of the Art Series" which complements current status of research activities in a specific commodity area is "Peanut Researches." This work keeps researchers, research communities and research policy makers informed of the current status of programs and the trends in

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their respective fields of interest. A book series, which consists of reviews and compilations of research information, original papers presented by experts in specific fields and disciplines, and proceedings of technical meetings and conferences, lists "Peanut Consumption Patterns in the Philippines" and "Socioeconomic Study on Peanut Production in the Philippines."

Dr. G. F. Arkin, Associate Director, Georgia Experiment Station, confirmed commitment to peanut research and peanut CRSP. He recognized the benefits of Peanut CRSP from international programs, collaborative research and teaching-training within and among host country and U.S. institutions, broadening scientists' thinking-creativeness, expertise and recognition, improving faculty promotion potential and investing in the future of the world. There was a clear appreciation for the problems that confront host countries and their institutions. It was understood that important to Peanut CRSP's success was that research developments solve high priority problems, be targeted for technology transfer to the users, improve through teaching-training the knowledge base of faculty and students, and through these educational efforts strengthen the quality-sophistication of science, equipment-instrumentation and facilities of host country and U.S. institutions.

A major benefit noted at UGA was contributions of scientist's expertise, excellent opportunities for host country researchers to study and train in quality facilities, and laboratories that are well equipped with modern instruments. Collaborations among scientists from the many different non-peanut projects funded at UGA, contribute greatly to the Peanut CRSP work, a benefit of research programs in the university setting. In spite of limited Peanut CRSP funding, the program is productive and is accomplishing more than expected. Because of the strength and enthusiasm of the researchers, and their dedication to the objectives of Peanut CRSP, consumer oriented product research, i.e., factors affecting consumer perceptions-attitudes, food purchase behavior and use, is in place. Complementarity of Peanut CRSP to these ongoing research efforts, and in turn to the development and adaptation of technologies to eliminate aspergilli-aflatoxin contamination and utilize quality, peanut and peanut products in traditional and new food products, is very evident.

Institutional Development: During the past 10 years, the number of faculty at UPLB has decreased from 17 to 10. Where positions have been filled, Ph.D.'s were hired. Noted was that the best qualified students study outside of the Philippines, e.g., Canada, Australia and the U.S. Many of these students do not return. Foreign students studying in the Philippines make up 20%, and come from Southeast Asia, Thailand, Indonesia, Malaysia. The graduate program has 22 M.S. and 8 Ph.D. students. Undergraduate Thesis and Apprenticeship programs whereby students work on industrial-related problems strengthen the department; Apprenticeship students work on industrial problems and may be funded while the thesis projects are supported by the university and PCARRD. Women make up 80-85% of the students. All students find employment. Funds for research projects are obtained from the UPLB, the Philippines Department of Agriculture, PCARRD, Peanut CRSP, and the food industry. It is important to note that Peanut CRSP has been a major contributor to student and faculty development programs. These contributions have helped the peanut industry grow by supplying research developments and human resources. Industry supports projects of immediate concern on processing, mainly analytical analyses. The Philippines Department of Agriculture's Extension Service seeks faculty for workshops on farming developments, and good manufacturing practices, projects that are mainly applied.

Three major peanut studies, breeding, entomology and processing at UPLB are working together to commercialize new high yielding pest resistant and food quality peanut cultivars. The institutes and departments involved are Food Science, Entomology, and Plant Breeding. Strategies include encouraging industries to invest research monies in developing peanut products. Peanut butter is rapidly becoming a popular product in the Philippines. Cottage industries are marketing peanut brittle, and a salted-garlic flavored fried peanut called Adoba. The food industry is paying attention to snack

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foods for the younger generation. These occurrences are encouraging industry to play a major role in prioritizing research needs of peanut.

Municipal, provincial and regional governments in the Philippines are working with national programs to support research projects. Extension services support local governments in their efforts to meet the research needs of entrepreneurs, small industries and farmers. New peanut cultivars from programs supported by Peanut CRSP are being scaled up for distribution to farmers through local Department of Agriculture experiment station programs. Work is proceeding to educate farmers in the use of newly developed cultivars and maintaining pure planting seed each year to assure stable crop production. Demonstration plots are in place via government extension services to transfer this technology to the farmers.

Studies at UPLB on the use of fungi metabolites to biologically control, inhibit or inactivate aspergilli growth, and hence, aflatoxin contamination of peanut seed include collaborations with UGA, the National Center for Agricultural Utilization Research, ARS, USDA, Peoria, IL, Tuttori University, Plant Applied Microbiology Department, Osaka, Japan, and Central Luzon State University, Munoz, Nueva Ecija; the Ph.D. graduate student assigned to the project is from Tuttori University. The program has financial support from the Science and Technology Agency, Japan, and Peanut CRSP. Work also includes soybean. Efforts are underway to find a carrier system for the inhibitory metabolite -- e.g., starch films. This program includes travel to Japan by the graduate student to conduct research for one month each year. Important to note is the support of UGA's Principle Investigator in purchases of instruments, equipment, special chemicals, computer hardware-software and testing kits.

Institutional Development at ViSCA: The Administrative Office at Visayas State College of Agriculture (ViSCA), Leyte, the Philippines, where a new Peanut CRSP project is being initiated with UGA, overviews handling of research funds. Costs to grants are 5 to 15%, 5% for small grants and those of PCARRD. In return, paperwork for purchases, hiring, salaries, etc., are processed and accountability maintained. Accountability includes publication of research results. This includes impact of the work on the agricultural community. The college is an agricultural institute dedicated to the needs of the farming community including farmers and businesses. About 3000 students attend ViSCA at the undergraduate and graduate levels, hence, teaching and training are equally important.

ViSCA has 231 faculty members; 62 are Ph.D.-degreed, 118, M.S., and 51, B.S. A total of 212 projects were implemented of which 55 were new, 39 were completed, 34 extended and 84 ongoing. Of the 191 researchers of ViSCA, 31% were Ph.D.-degreed, 51%, M.S., and 18%, B.S. ViSCA's extension program in collaboration with various government agencies, conducts short-term training in agriculture and rural development. Extension activities include non-formal education, short term training and seminars on various topics including avaca handicraft making, sweet potato processing, root crop and avaca by-product utilization and other technologies developed at ViSCA. Its clientele include farmers, rural women, out-of-school youth, and agricultural technicians. Relative to program linkages, the collaborative research program on peanut established between the UGA and ViSCA was especially noted.

The extension activities at ViSCA emphasizes research and development. Technology transfer includes piloting of mature technologies including dissemination and adaptation, on-farm, in Leyte. This includes extension-related publications, radio, rural theater, farm demonstrations and training activities. For example, hands on training with farmers and small business entrepreneurs by the Department of Agricultural Chemistry and Food Science, ViSCA, include Sweet Potato Processing; Rootcrop Processing and Utilization; Economics of Production; Processing and Marketing; Cassava and Sweet Potato Processing and Utilization; and Bakery Products from Sweet Potato and Cassava.

The Philippines government is restructuring its agricultural responsibilities. Efforts are made to respond to the needs of local governments and was especially noted on Leyte. The linkages involve extension and local government programs working together to transfer technologies of ViSCA. This involves educating local politicians and making them responsible to their constituents; i.e., enforcing local politicians accountability, rather than passing the issue on to the national government.

On Leyte, peanut is considered to be an important cash crop, after corn. Relative to sustainable agriculture, peanut and corn are interchanged. Peanut is processed mainly by small household entrepreneurs, primarily women. Opportunities abound for developing and expanding new foods that include peanut components as ingredients. Work is needed to improve postharvest handling and storage to reduce aspergilli and aflatoxin contamination.

Community-based and social action projects coordinated through ViSCA have enjoyed major accomplishments. These include establishing

(1) a Socio-Economic Assistance Project from which beneficiaries have received small loans to start income generating projects;
(2) a project aimed at accelerating area productivity among rural communities, support agencies and institutions;
(3) and a project aimed at uplifting the living conditions of women and youth through the development of ecologically sound alternative livelihoods such as strengthening of existing business and worker services.

Most of the peanut grown on Leyte is processed in the production areas. Shortening time of handling via new mechanization, processing and roasting technologies will enhance local business development. Making the people of the Philippines, self sufficient in peanut production, processing and commercialization of food products is a major objective of ViSCA's research and training programs.

Adequacy of Science-Technical Merits of Program: Peanut is considered a major legume crop in the Philippines along with mungbean and soybean. Of the total research and development budget for legumes, peanut corners more than 25% of the allotted funds. Legumes got 13% of the total budget for all crops in the Philippines. The UPLB is the National Research and Development Center with eight regional locations and 14 cooperating stations located throughout the Philippines. The areas of peanut production include Ilocas, Cagayan Valley, Central Luzon, South Tagalog, Bicol, West, Central and East Visayas, West, North, South and Central Mindanao and CAR. Peanut production during the latest available year for statistics was mainly in the Cagayan Valley (49% or 21,751 ha of the total 44,563 ha in the Philippines). The other major areas are Ilocos (6,999 ha), Visayas (5,956 ha) and Mindanao (4,148 ha). The total production was about 33,992 net which is about 58% of the total peanut processed in the Philippines; the remaining 42% is imported. Average yield is only about 0.72 mt/ha, far below the projected capabilities of newly released varieties which double this value. Hence, a major ongoing research effort is to improve on-farm yields.

A research objective is to successfully store planting seed from the dry season harvest for the rainy season and next dry season plantings. This would take advantage of the higher yields and better quality planting seed.

The national objective for peanut is to attain self-sufficiency in production by the year 2000. The strategies that support this effort are:

(1) Develop/adopt high-yielding, drought-resistant and pest-resistant varieties and improved production technologies;
(2) Strengthen postharvest facilities and operations to eliminate aspergilli-aflatoxin contamination;

(3) Expand production to non-conventional areas, e.g., intercropping in coconut groves that are slightly rolling upland areas;
(4) Diversify products and utilization of peanut to create higher demand and enhanced value.

Peanut can be grown year-around in the Philippines. The dry season crop planted in October-November gives higher yields and better quality seed than those sown during the rainy season of May-June. The minimum growing season is 90-140 days and optimum temperature is 25-30 C. Soils suitable for peanut production are well drained, medium textured, moderately to slightly acidic (pH 5.5-6.5) with about 50 cm of relatively fertile topsoil.

Projects supporting the peanut development action plan - 2000, include:
(1) Peanut-CRSP for variety improvement, integrated pest management and enhanced utilization nutrition and consumption;
(2) Peanut Technology Commercialization program to promote commercial production of peanut with improved varieties (BPI-Pn_1, UPL-Pn_2, especially in Ilocas and Cagayan Valley);
(3) Seed Support System to Legume Commercialization to establish a viable seed production scheme for Ilocos and Cagayan Valley;
(4) National Cooperative Testing Trial for Peanut to examine the performance of promising peanut cultivars in different areas prior to approval for commercial planting by farmers.

Peanut is planted after corn or rice as a second crop. Another common practice is to intercrop peanut between rows of maize. The combined productivity of the two crops is 30-50% higher than when either is planted alone. Sometimes, intercropping is done with sugarcane, cassava and okra. Also, peanut is planted between coconut, papaya and young citrus trees.

Peanut is mostly consumed as fried (62.5%), peanut butter (60%), and boiled (60.1%). Because of the widespread use of coconut oil, only 3.7% of the peanut is processed for oil. Other uses include raw (13.6), roasted (47.1%), ground (8.4), candies (25.3), and food ingredients (25).

Research work in the Philippines and U.S. on new product development is focused on the needs of small businesses, including cottage industries. Big companies have their own research programs. Many entrepreneurial-based products, i.e., specialty foods made by the homemaker and kept as family recipes are being brought to the marketplace as small businesses and cottage industries. These products are being researched in efforts to scale up for the commercial market. Efforts continue to look throughout the Philippines for traditional products that are endemic to a region. A training module is developed to help local homemakers and entrepreneurs transfer this technology. Micro-cottage industries are being developed in local communities. Efforts are underway to expand these entrepreneurial developments nationally in the Philippines. The role of the government, both nationally and locally is important in these efforts.

Scientists, including breeders, agronomists, entomologists and food researchers representing universities, experiment stations and industries, both nationally and locally throughout the Philippines are increasing communications and collaborations in the Philippines. However, these efforts need to be expanded to Peanut CRSP countries throughout Southeast Asia and globally to Africa and the Caribbean countries. Peanut CRSP can be an essential component in the formation of global teams. Scientists in host countries need to come together and discuss their problems, share in ways they are working to resolve them and design collaborative-exchange research programs. Clearly, many similar problems exist in other host countries. Approaches, although unique in many ways to the individual host country, are being resolved in similar ways. These approaches need to be shared to reduce duplication of effort, a role for Peanut CRSP. The socioeconomic effort must include the development of healthy, nutritious foods from peanut. Aflatoxin control is an essential component of this formula.

An economist should be included in the team to help determine the impact of farmer-to-consumer benefits as they relate to the social aspects of the community.

Further analyses showed that farmers were able to attain only 47% of their potential output. In spite of this low percentage output, profitability for peanut production was attained; this included cash receipts (sales of traders, assembler-wholesalers or wholesaler-retailers offering the most favorable price) and non-cash receipts (home use, give-away, paid to creditors, planting seed, labor and landlord-harvester shares). When the constraints to peanut production were measured as a function of physical factors (farm size, total labor, total operating capital, fertilizer and chemical expenditures) and socioeconomics (age of farmer, experience, and education), only operating capital, farm size and total labor were significant. The farmers identified the constraints to productivity as typhoons, dry spells, pest infestations, planting seed unavailability, poor quality planting seed, and poor soil conditions. They also cited limited operating capital coupled with increasing cost of material input, lack of technical know-how on peanut production as a limitation to higher yields and the probable reason why actual yields are much lower than what are technically feasible.

Peanut cultural practices are mainly done by manual labor, or where applicable, plowing and harrowing with the aid of water buffalo; availability of mechanical machinery is limited. Planting with fertilization is done by the drill or hill methods. Weeds are removed by hand. No irrigation is needed. Harvesting is done by hand with the aid of pitch fork, spade or other digging tools; plants are placed in wind rows or stacks for two to three days to sun dry, then the pods are manually threshed. Shelling is done with a small engine-powered or hand-operated portable sheller. A portion of the unshelled pods are stored for the next season's planting seed. The farmers sell their peanut seed to traders, assemblers, wholesalers or wholesaler-retailers visiting the farms during the harvesting period. Production constraints include the occurrence of typhoons, pest (insects, fungal diseases) infestations, weeds, poor planting seed quality and upland acid soils. Especially noted was the major cost of weeding done by manual labor. Clearly a lack of technical know-how and capital exists for powered mechanized machinery to produce, harvest and handle peanut at the farm. This is an area where technology transfer of developments in other Peanut CRSP countries, e.g., Thailand, would help the Philippines.

The advancements of other Peanut CRSP countries, Thailand and Caribbean countries, on manual and powered mechanized machinery (tillers, planters, weeders, strippers, threshers, shellers, cleaners, sizers and grinders) for peanut production and postharvest handling need to be transferred to the Philippines. This equipment has been successfully demonstrated in these two countries by agricultural engineers to extension personnel and farmers in training workshops with exceptionally positive responses via purchases that are improving on-farm operations and profits. The designs are being used for manufacture of equipment by local entrepreneurially formed companies. Observations suggest that improved postharvest equipment speeds up harvesting, cleaning and shelling of peanut and reduces the chances for aspergilli/aflatoxin contamination. These developments are available for technology transfer via workshops to the Philippines. It is through this type of technology transfer where Peanut CRSP can make a strong contribution.

Adequacy of Science-Technical Merits of the Planting Seed Program: The Institute of Plant Breeding (IPB), College of Agriculture, UPLB, Laguna, has as its mission to strengthen plant breeding programs that develop new and improved crop varieties to support and sustain the country's intensified, expanding and diversified agriculture. Its objectives are to

(1) Develop new and improved varieties of dryland crops.
(2) Conduct studies in plant breeding and allied disciplines related to crop improvement.
(3) Collect, introduce, preserve and maintain a germplasm bank of important and potentially useful agricultural and horticultural crops.

(4) Assist other agencies in multiplying quality seed and vegetative materials of recommended crop varieties.
(5) Promote the wide scale utilization of IPB varieties and ensure that seed are made available to small farmers.

Programs include improved varieties, plant biotechnology, increased germplasm collection (the "gene bank" contains 4,818 registered accessions of cereal crops; 9,653 registered accessions of field legumes; 1,833 accessions of 46 species of vegetables; 132 entries of 49 fruit species of fruit crops; and 251 accessions of root crops) and maintenance and seed multiplication. Certified seed is provided to the Philippines Department of Agriculture for food production programs, state colleges and universities researchers, local governments and farmers. A National Seed Foundation (NSF) at IPB produces more, and higher quality, planting materials including seed, seedlings and tissue-cultured plantlets to farmers and growers, nationwide. Linkages are with farmers, government agencies, colleges-universities, private companies, foreign agencies and non-government organizations.

A challenge for IPB is the doubling of peanut acreage to 100,000 ha. Efforts are underway to make peanut a part of the rotation crops in the Philippines. Work is ongoing to enhance quality of planting seed. These activities include increasing planting seed, specifically PN-2 and PN-10, for the farmers. However, emphasis is on the major crops of the Philippines, rice, corn, coconut, vegetables and fruit trees. Peanut CRSP is important in the development of efforts to increase quality peanut planting seed availability to farmers. <u>The IPB supports redirection of Peanut CRSP funds to research studies on planting seed quality and distribution, especially PN-2 and PN-10.</u>

The IPB and the Philippines Department of Agriculture are working together to produce quality planting seed. The Bureau of Plant Industry is also included in these efforts. Noted was that Congressmen from peanut growing regions need to work harder for government support of the peanut farmer. This includes legislation that increases funds supporting the high priority needs of peanut production and utilization. Local municipalities need to get involved; this includes those farmers who have political influence or elected positions. The IPB has as a priority effort to convince congressmen to support seed development and distribution. One area gaining attention for peanut is intercropping with coconut. Two cooperative farmers are working together with congressmen to gain research support for this program. Similar efforts were noted to be successfully occurring in Senegal. Peanut CRSP should sponsor Philippine scientists' travel to Senegal to learn from the experiences of profit-making for peanut seed production and distribution in this country; a technology transfer project.

In its efforts to meet the Philippines challenge of increasing the yield of peanut from 0.7 t/ha to 1.2-1.5 t/ha, and to improve planting seed production and distribution, the IPB is planning to develop a brochure for peanut, similar to those of other crops. The brochure will describe new crop varieties including yields, test locations, seasons planted and basic information about pest resistance, both insect and fungi. The brochure also will describe cultural requirements including land preparation, fertilization, planting procedures, insecticide applications, cultivation, weeding and thinning, and harvesting-drying. This information will help advertise new developments and explain new agricultural practices to farmers. The IPB has analytical laboratories to test composition and nutritional value of seed. Efforts include sorghum (animal feed), corn (becoming a major crop), and mungbean and soybean (high protein food sources). Peanut (also a high protein food source) has been added to this list. Other crops include root crops (sweet potato, cassava), vegetables (ochra, beans, tomato, and leaf produce which are main staples in the Philippines), fruit crops (mango, pineapple, banana, guava), fiber crops (cotton, jute, abaca), forage grasses and ornamentals. Programs include seed production nationwide for distribution to farmers and encourages close collaboration with the Philippines' Department of Agriculture and its extension services.

It was noted that ICRISAT funds a grant to PCARRD for legumes research, which includes peanut. A portion of the funds is used for production of variety PN-10 planting seed on 5 ha for farmers in Isabella. This effort to plant and distribute PN-10 is to encourage farmers to use this new variety.

A project, "Seed Production and Dissemination of Improved Crop Varieties for Countryside Development in the Second District of Laguna" was funded at the Institute of Plant Breeding through the office of a congressman in the 2nd District of Laguna. The objectives were: (1) To produce and disseminate seed and planting materials of improved crop varieties among the constituents of the second district of Laguna. (2) To provide training to enhance production efficiency of these improved crop varieties.

The second district of Laguna comprises the towns of Cabuyao, Calamba, Los Banos and Bay. Agriculture is the major occupation of the people, although industries are developing in the Calamba and Calayao areas. The agricultural areas need to increase productivity to meet the growing population due to the influx of workers and a high birth rate. Nutritional foods are also needed. Hence, IPB has begun a program to meet the two above mentioned objectives. Among the planting materials being produced and disseminated is peanut seed. The plans to ensure success include working closely with the office of the congressman and the municipal government.

Adequacy of Science-Technical Merits of the ViSCA Program: The Peanut CRSP has expanded support to a program on quality enhancement and technology transfer of products containing peanut, mungbean and cassava flours at ViSCA, Baybay, Leyte, Philippines. The study is in collaboration with the Department of Food Science and Technology, UGA, under the leadership of Drs. Larry R. Beuchat and Anna V.A. Resurreccion. Researchers, led by Dr. Lutgarda S. Palomar, Department of Agricultural Chemistry and Food Science, ViSCA, make up a multidisciplinary team to ensure success in this program. The team consists of Dr. Palomar with expertise in product development and quality enhancement, Dr. Leonuel Diamante, food engineering, Professor Julieta Roa, socioeconomics and Professor Remberto Patindol, statistics. The objectives of the study are:

(1) To obtain, through surveys conducted at selected locations in and surrounding Baybay, Leyte, baseline information on socioeconomic and demographic characteristics of potential recipients and users of technologies eventually developed and/or transferred by the project. Survey questionnaires were designed to determine the market potential of selected peanut-mungbean-cassava-based food products appropriately processed, packaged and offered for sale by women-owned and operated production facilities.
(2) To standardize the conditions and procedures for processing peanut and mungbean flours at ViSCA. Particular attention was given to conditions which yield highly desirable nutritional and sensory characteristics upon incorporation of flours into market food products and to maintaining a high level of sanitation at all stages of handling.
(3) To optimize formulations and processing conditions for products containing peanut and mungbean and/or cassava flours.
(4) To enhance the shelf-life of products using appropriate packaging, storage and marketing technologies.
(5) To determine, through survey questionnaires, the marketability, adaptability and profitability of products developed at the level of women cooperators (bakers and other users).
(6) To conduct surveys designed to determine the impact of implementation of project technologies and knowledge gained by training on cottage-scale women processors.

At ViSCA, where the Philippines Root Crop Research and Training Center is located, the use of root crop flours has been extensively investigated. Researchers at this facility have recognized the need to optimize formulations and processes for preparing root crop flours. Also, they are exploring ways to use legumes, particularly peanut, as a source of flour to combine with root crop flours in selected foods. The potential for development, processing and marketing such foods by rural and urban women entrepreneurs in Leyte and other Philippines provinces, is recognized as excellent. The study envisions combining the experiences of ViSCA and UGA coinvestigators for the purpose of investigating the use of composite flours containing peanut and root flours in selected traditional foods anticipated to have high acceptability in the Philippines, other southeast Asian countries and the U.S. Optimization procedures are being applied to proposed and developed products with the major objective being to transfer technologies to low-income rural and urban women who in turn through extensive training by ViSCA personnel, are establishing and operating independent processing and marketing enterprises. The project emphasizes interaction of ViSCA personnel with the community at all stages of development. It is directed specifically toward enhancing the economic and social well-being of women who are contributing to the financial welfare of their families.

The new ViSCA and UGA project has identified cooperators and completed a socioeconomic baseline survey and its analysis structured to determine products and market potential. The recipes and processes for ladyfingers, peanut cookies and peanut casseroles were selected. Training programs in baking operations, packaging, handling and marketing of the products are developed. Graduate students are trained and will play an intricate role in working with the prospective entrepreneurs. Methods for developing packaging design and product line labels are developed. Initial Investment resources, bank loans and equipment, initially from ViSCA's bakeries, are in place. It is noted that the products initially developed in the ViSCA's testing bakery were sold to students to prove their marketability. The ViSCA bakery serves as a support facility for pilot testing and outlet distribution of new products enhancing the success of the entrepreneurial ventures on Leyte.

In the selection of pilot areas, proximity to ViSCA and relatively bigger consumption centers were important considerations. First because of better project manageability, the sites chosen were near ViSCA. On the other hand, a bigger market is needed for the types of products that will be introduced and larger consumption centers usually have better transport networks for market delivery. Thus, access to different parts of the province for market expansion was considered. The selection of cooperators was based on the women groups that were already trained at ViSCA which have entrepreneurial potential and adequate institutional support to meet the needs of establishing an enterprise.

From these considerations, two women processing groups were identified as potential cooperators: (1) the Guadalupe Women's Association (GWA) of Barangay Guadalupe of Baybay, Leyte; and (2) a core group of six typhoon Uring victims in Ormoc City. The project team conducted a reconnaissance survey of the two sites and had informal consultative meetings with the two processing groups.

The GWA is a livelihood group organized by the ViSCA project composed of housewives of upland farmers. The association is less than a kilometer from ViSCA. The objective of the project is to provide supplemental income as an alternative to illegal logging and other activities which destroy the upland ecosystem. This group was trained in rootcrop processing as one among other livelihood sources that they were exposed to and can possibly build on as entrepreneurs.

Organized in mid-1993, the GWA has undergone several group trainings. Various capital enhancement schemes were tried such as hiring the members as emergency labor where a 50% of remuneration is held as member capital contribution. They also engage in simple catering services for project activities where a part of the proceeds is used to buy processing tools and utensils. A processing facility is being built by the members.

The commercial venture will emphasize peanut improved Ladyfinger and drop cookies from Cassava flour and flakes. The group has potential in serving the market which the ViSCA pilot bakeshop has started. The idea is to pilot the technologies to this group and work out their feasibility in their local market. Through this work, the ViSCA project emphasizes technology and entrepreneurship/marketing support services.

The second project, a URIVIC-Meat Processing Group was organized in August 1993. The six-member core team is the residual of a 13-member meat processing group - one of the groups organized by the Philippine National Red Cross (PNRC) in its drive to rehabilitate the typhoon Uring flash flood victims. This group is based in Ormoc City, about 45 kilometers to the north of ViSCA.

The group currently processes meat products (i.e., corned beef, longaniza, etc.) and is being trained in peanut-rootcrop product processing. The enthusiasm and interest of the group as exhibited with meat processing activity are positive signs for the second food processing venture.

The PNRC, through its livelihood program, is providing financial support to enable calamity victims establish their own enterprises. A loan for meat processing together with a processing facility and assistance in marketing efforts has been provided. The meat group was selected for the UGA-ViSCA project to maximize their efforts by serving the peanut-rootcrop products market. The group is being trained, and doing processing and market testing of Ladyfinger and drop cookies in collaboration with the ViSCA project.

A socioeconomic profile shows that the GWA is composed of 12 member-housewives of upland farmers with ages ranging from 30-62 years old. Most have attained elementary education. With about four children on the average, the women members tend a household of 6-7. Their time is devoted between household work and farm labor involving mostly planting, weeding and harvesting of rootcrops, vegetables and corn. Most are active villagers especially in voluntary group work or "pintakasi."

These farming households have low incomes that fall below the poverty line. The meager incomes from the farms are supplemented by engaging in off-farm and non-farm work, a little food processing and remittances from children working in other provinces or outside the country. Only about 30% have savings accounts.

The Ormoc Processing group is composed of six housewives in their early forties managing households of five. Most are high school graduates. These are non-farming households. Incomes from regular and part time employment of husbands as well as sideline businesses. Because of the smaller household size and better incomes, the members of this group are relatively less pressured by housework and have more time to devote to commercial processing of various food products.

The ViSCA-UGA project funded via Peanut CRSP is an excellent example of how one of the major constraints - Inadequate Food Supplies - is being handled. A collaborative survey conducted by researchers in the host country, in collaboration with a U.S. institution, as part of Peanut CRSP has identified consumer perceptions toward peanut and related products. Ways to nutritionally and functionally improve traditional foods and to develop new products that would be consumer acceptable were identified. Processing, social science and marketing-economic studies are included in this program. Shown is the needed progressiveness and innovativeness to advance the developed technologies to small business practices. Further developments will occur at a pace acceptable to the host country entrepreneurs. The U.S. scientists are collaborating with the researchers in the host country in a way that allows them to set their own standards for advancing and adapting new research concepts and available technologies. Furthermore, new research concepts and available technologies are being linked with the social science-economic implications identified in the initial survey. This project will be an example for others to follow and very appropriate for Peanut CRSP funds.

Applicability of Research: Procedures for handling, sorting, packaging, storing and processing peanut seed that eliminate aflatoxin-contamination and prevent aspergilli infestation have been demonstrated by researchers in the Institute of Food Science and Technology, UPLB. This work has presented methods for analysis of aflatoxins and an awareness of contamination levels and their control in food products by health officials of the Philippines. Identification of endemic or traditional food products in the Philippines has been completed and recipes made available for entrepreneurs. The choice of products was based on consumer surveys and institution experiments. Workshops to train interested entrepreneurs in product development and continued cooperation are establishing local enterprises and sales of selected products. The Philippines Bureau of Food and Drugs validated work on aflatoxin analyses of peanut butter conducted by the Institute of Food Science and Technology, UPLB. The focus was on the most popular product, peanut butter. These food scientists found levels in selected products that exceeded 20 ppb. This effort resulted in the naming of Dr. V. V. Garcia, Principle Investigator, to the Philippines' Food and Drug Bureau's Food Safety Advisory Board for Aflatoxin.

The Philippines Bureau of Food and Drug (BFAD) surveyed 69 brands of peanut butter manufactured by 23 licensed Metro Manila firms and showed three brands as having aflatoxin levels greater than 100 ppm. The allowable level of aflatoxin set by international authorities is 20 ppm. Food authorities ordered the firms manufacturing these brands to withdraw their products from the market. The peanut butter-eating public was also warned against unlabeled peanut butter sold in local markets as they're likely to be prepared by unlicensed manufacturers and thus may not have been subjected to BFAD tests for aflatoxin.

A biological or microbial control or preventative method that is safe, inexpensive and practical, is being shown as a means to inhibit or inactivate aspergilli growth, and hence, aflatoxin contamination of peanut seed by researchers in the Institute of Food Science and Technology, UPLB. This approach is in place of the use of vapor-proof containers, storage compartments and chemical treatments, all methods that would reduce already marginal profits to farmers of developing countries. The method involves the use of Cladosporium fulvum to inhibit the growth of toxigenic aspergilli (A. parasiticus) on peanut, rice and corn and thus prevents possible toxin formation. Experiments on the mechanism of inhibition show that the culture filtrate and pigment fractions from C. fulvum are responsible for the inhibition of A. parasiticus. These substances cause the thinning and deformation of mycelium and lessen the number and/or size of the spores produced. Toxicological studies using the chick embryo bioassay show no harmful constituents. Levels of metabolite could be attained that suppress germination as evidenced by minimal hyphal growth and development. This inhibition of hyphal development shows the absence of A. parasiticus growth and hence negative aflatoxin formation. This technology has potential for worldwide impact in the control of aspergilli-aflatoxin contamination of not only peanut, but all foods susceptible to this health-safety hazard.

Studies at the Institute of Food Science and Technology, UPLB, show that the better quality peanut are used in foods processed in Manila. Poorer quality peanut appear in food products including candies. Bitter taste has been related to microbial contamination. A study to analyze peanut at various processing stages for aflatoxin, including water washing to remove the seed coat, boiling for boiled peanut and sodium bicarbonate cooking for peanut brittle products, showed that this contaminant was significantly reduced. Values noted were less than 20 ppb. Hence, processing conditions reduce aflatoxin in foods, except where grossly contaminated. Findings also showed that homemade peanut butter was less likely to be contaminated with aflatoxins because the housewife carefully picks only the quality peanut during homemaking.

Studies show that Philippine traders, key players in the purchase, drying, handling and sale of peanut, will grade for quality. The good quality peanut will be sold to Manila and other larger city markets and those of poor quality go to the local buyers of peanut. This supports the concern that local market entrepreneurs may be selling highly aflatoxin contaminated peanut products.

One solution to control of aflatoxins is educating the farmer, trader, processor and homemaker in handling-storage of peanut for the prevention of contamination. The Philippines Department of Agriculture's extension service is working with farmers in helping them to understand the importance of drying peanut. The Institute of Food science and Technology, UPLB, serves as an information resource for workshops. These scientists have developed brochures and a training module on how to select for and maintain quality peanut for the marketplace. Efforts are underway to extend this information to clientele in the local provinces and municipalities.

Peanut research from the Institute of Food Science and Technology, UPLB, that is being applied include:

- Peanut sauces are commercialized and products processed by a food company are on the market.
- Other marketed products from research studies include peanut soft curd, peanut cake-candies, soft white cheeses, peanut milk concentrate and fermented peanut milk products.
- Peanut milk residue is being used as a cheese flavored peanut spread, liver flavored peanut spread and potted meat flavored peanut spread.
- A publication of recipes of the improved technologies is available. Technology transfer is ongoing via seminars and short courses with industry.
- Studies to locate where aflatoxins are most prevalent in the peanut food chain showed lowest level at the farm, and highest during storage by traders. Levels are highest in rejected peanut. This information is made available to industries by workshops.
- Food products are prevalent and vary in different regions of the Philippines. Products include peanut brittle, Pineato, Peanut Turan, Pastillas, and Peanut Roll. Many are produced by small village industries and cottage entrepreneurs.
- Data show many products exist as outlets for peanut utilization. The problem is not enough planting seed is available for farmers to increase acreage. The farmers would like to have the flexibility or control of selling their harvested peanut to traders. This would expand opportunities to select outlets to sell and improve price competition. Storage studies with facilities are needed. This is an example where Peanut CRSP can assist in the transfer of technology from Thailand and Caribbean Countries (Jamaica) on successful storage and handling programs already completed.
- The Philippines government has set a goal to make this country self-sufficient in peanut production by the year 2000. This will require the upgrading of planting seed quality and production practices. Varieties PN-2 and PN-10 are ready for distribution once planting seed quality and production practices are upgraded. Collaborative studies are ongoing to test the food properties of peanut from these new cultivars.

In 1990, the publication "Peanut Consumption Patterns in the Philippines, by V.V. Garcia, S.M. Rubico, R.C. Arenas and R.D. Valmonte, jointly sponsored by the Department of Science and Technology, PCARRD, Institute of Food Sciences and Technology, UPLB, and Peanut CRSP, UGA. The publication presents peanut production data in the Philippines. It summarizes the results of a survey to (1) Determine the existing consumption patterns of peanut for both raw and processed forms in Philippine households; (2) Determine the consumers' perception of peanut and peanut products; (3) Compare the consumption of peanut with that of various food items; (4) Determine the nutrient composition of the Filipino diet; and (5) Identify the determinants of peanut consumption and utilization. Included is a list of some peanut product manufacturers in the Philippines. The results of the survey included in "Peanut Consumption Patterns in the Philippines" by V. V. Garcia, et al., are as follows. Peanut was found to be popular as fried (62.5%), boiled (60.1%) and peanut butter (61.5%). Peanut oil was relatively unknown to Filipino consumers. The majority of the peanut was purchased at public/flea markets (33.9%), supermarkets/groceries (20%) and home-grown (6.9%). Peanut was considered to be nutritious (74.7%), delicious (57.2%), a health food (29.2%) and expensive (25.3%). The average per capita consumption per month of raw peanut was 182.95 g. The survey confirmed the high acceptability of peanut among consumers, but high cost may explain its minimal consumption in the Philippines. Peanut is usually consumed less frequently (weekly or monthly) compared to other foods (cereals, meat, poultry, fish, and vegetables), which are regularly consumed daily or weekly. There is no need to develop a cheaper alternative source of protein. Peanut has a great potential of supplying the nutritional needs of Filipinos provided the price is reduced.

A "Socioeconomic Study on Peanut Production in the Philippines," by R.R. Huelgas, P.C. Manuel and E.S. Gabriel, supported by the Department of Science and Technology, PCARRD, Department of Agricultural Economics, College of Economics and Management, UPLB and Peanut CRSP, was published in 1990. Some observations obtained from this publication are as follows. Despite the various uses and demand for peanut, and its adaptability to the Philippine climate, its full exploitation as a commercial crop has not been realized. The traditional varieties are still the most popularly planted. Although the average farm is about 2.24 ha, only an average 0.94 ha is used for peanut production. Peanut, despite being a relatively short duration crop, has never been considered as a major cash crop. Instead, it is a single crop after rice, intercrop of corn or an alternative crop for sweet potato, mango, sorghum or watermelon. Peanut production is labor- and capital-intensive. Among the farm operations, hand preparation and harvesting were the most labor-intensive. Fertilization and chemical application are not common practices because of high cost and unfamiliarity of use. Technical assistance, considered limited, came mainly from extension workers, input suppliers and land owners. Most farmers preferred borrowing money from private lenders (traders, landlords, relatives and friends) and Rural Banks. The common complaints of farmers regarding credit were high interest, paperwork, and limited credit facilities.

Work has focused on yield trials of peanut as an intercrop in coconut groves in Isabella, a major peanut producing area in the Philippines. Conditions for intercropping of peanut and corn for quality yields have been developed. Among the varieties studied are those resistant to late leaf spot and leaf hopper. On-farm trials with selected cultivars are conducted. $UPLPN_4$, PN_6 and AO_{10} showed some resistance to Aspergillus parasiticus and A. flavus contamination. Efforts include selection for three-seed pods (PN_8) for the boiled peanut market. Promising shade tolerant and acid soil tolerant cultivars were identified. This work overcame the problem of seed remaining viable for three-four months for planting. $UPLPN_{10}$ is the preferred peanut cultivar by the farmers because of its large size and ease to shell producing few damaged seed. A training package for farmers has been developed to transfer these new technologies. Collaborations with field trials and demonstration trials at the field stations include the Philippines Department of Agriculture, UPLB and local community mayors and bankers. A thresher on wheels was developed for a farmer's cooperative to allow expanded use of this equipment to farmers throughout the peanut growing region. Studies are underway to use dry growing season seed, stored through the wet growing season, for planting during the dry season. Wet season yields are low because of high foliage production, hence the farmers would like to market this entire crop. Technologies for storage of planting seed are present in Senegal that could be transferred to the Philippines. Research studies are also ongoing in the Philippines. Efforts are needed to develop a collaborative effort between these two Peanut CRSP programs.

Mykovan-1, a soil-based bio-fertilizer containing spores, infected roots and propagules of beneficial mycorrhizal fungi, developed at the Mycorrhiza Laboratory, National Institutes of Biotechnology and Applied Microbiology, UPLB, is used by farmers at a cost of $1.00 per kilo (for 450-500 plants), for agricultural crops, including peanut; other crops are upland rice, corn, tomato, mungbean, cowpea, lady finger, eggplant, fruit trees, forest trees, etc. These fungi, when used to inoculate seedlings, infect

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roots and form symbiotic associations with plants. In particular the fungi help in the absorption of nutrients, e.g., phosphorus and water, control pathogenic root infections and secrete growth promoting substances. The result is improved peanut seed yields, hence helping to contribute to the objective of making the Philippines self sufficient in peanut production by the year 2000. The program contributes to the further strengthening of collaborations among agronomists, breeders and food scientists.

Researchers at UGA continue to extend research programs of their host country counterparts to improve understanding of compositional and functional properties of peanut and peanut products for new and improved foods and tests for aspergilli-aflatoxin contamination and their removal to improve food quality. For example, ongoing work has shown the potential of unhydrogenated palm oil to effectively stabilize peanut butter. Levels of 2.0-2.5% palm oil prevents oil separation in peanut butter for at least one year at 21-24 C. Such studies are helping the Philippines food industry overcome peanut butter instability in Southeast Asia. A low-fat milk-like beverage with typical roasted peanut flavor (but without milk) has been developed with little or no chalky mouth feel as a nutritious milk substitute. Maintenance of sensory quality of raw and roasted peanut is also a high priority program. The capabilities of researchers in the Philippines have been greatly improved by training and cooperative studies with UGA. Through Peanut CRSP and UGA, increased collaborations have occurred with ICRISAT, and other USAID CRSP, etc. Such upgrading of capability has enhanced the confidence of host country researchers in the development of quality research programs. Researchers have had opportunities to visit-observe research facilities and expand collaborative efforts worldwide. Through Peanut CRSP, attendance at international and national scientific meetings-symposia have been realized.

Observations-Strengths: New high yielding, insect-resistant peanut cultivars are available and efforts are underway to make planting seed available to farmers. These efforts are of particular importance to meet the long range food needs projected for the Philippines and Southeast Asia where population pressures will continue to increase. These countries also have the objective of becoming self-sufficient in peanut production to reduce food import pressures by the year 2000. Food scientists/technologists, entomologists, agronomists and plant breeders are working together to make substantial progress on the objectives of this project GA/FT/TP, entitled, "Appropriate Technology for Storage and Utilization of Peanut." Noteworthy are the human capital developments in Southeast Asia as a result of this project. These educated human resources are entering the industries, universities and government institutions and advancing peanut seed as a major source of nutritious, aflatoxin-free, high quality food proteins and oil products.

Research accomplishments have progressed to where a brochure will be prepared for workshops where farmers will be shown the "how to" of Integrated Pest Management (IPM). Peanut CRSP funds will be used to support these programs. The work with Trachiganana has allowed farmers to reduce to one-half the amount of pesticides used. Similar developments are occurring with Bacillus thuringenesis. Pesticide use will be less in the future, especially early in the season; their use will mainly be in late season applications. A combination of factors including plant breeding, biocontrol and moderate pesticide use is working to control pests in peanut. The result is improved peanut production for pesticide-free and safer food products.

Studies have shown that Bacillus thuringenesis is effective against defoliator insects. The proper time is important for most effective control of these insects. Farmers are applying this technology. Experiments are including controlled IPM fields in areas where farmers are using biocontrol for comparisons of results. The Philippines Department of Agriculture is collaborating in these efforts to demonstrate IPM trials to farmers. These studies include recently released PN-2 and PN-10 that involved a multidisciplinary team of entomologists, plant breeders and food scientists; the latter are examining these peanut seed for food use.

The Philippine Seed board cultivars UPLPN-4, PN-8 and PN-10 showed moderate resistance to thrips, leafhoppers and defoliations; PN_8 and PN_{10} were developed by Peanut CRSP supported studies. Hence, yields are expected to be significantly improved. Work is ongoing to examine cultivars PN-2 and PN-10 for food product development. These cultivars are being released to the farmers to replace presently used materials. Collaborations will include plant breeders doing further studies to improve these cultivars in demonstration plots and food scientists and technologists expanding their marketability.

The Philippines' major problem is considered to be insect infestation of peanut crops. Leafhoppers and leafeaters significantly reduce peanut production. Problems during postharvest are the number two concern. One reason is that production is not at a level where long term storage poses a problem. All harvested peanut move quickly to processing and marketing. However, in the future, as peanut production outpaces utilization, storage will be necessary and problems, such as aspergilli and aflatoxin contamination, will become an even greater issue. Efforts should be strengthened to determine potential storage problems and the development of preventative measures. Also, storage technologies being developed in other Peanut CRSP countries should be made available and tested at this time in the Philippines.

Observations-Weaknesses and Ways to Improve: The food researchers are not receiving all advanced varieties and breeding lines from plant breeders. Seed is most likely to be shared with food researchers just prior to being released to farmers for demonstration plantings. There is a need to strengthen collaborations among these scientists to assure experimental resources have the proper nutrition and functional properties that meet marketing, processor and consumer needs early in development before being released.

Peanut CRSP should enhance programs to support meetings, workshops and exchanges of researchers among host countries, especially in the area of utilization. This would enhance discussions of research priorities and comparison of ways, either planned, underway or completed, to solve them. Many of the problems that exist are similar among countries, and also among commodities. That is, problems identified as high priority for enhancing peanut development are also noted for cowpea, mungbean, maize, sorghum, etc. Exchanges that occur between U.S. and host country researchers are important to research planning and progress to solve the problem; however, these communications should also include meetings within and among host countries. For example, developments in Southeast Asia, specifically Thailand and the Philippines should be shared in a regional workshop possibly sponsored by Peanut CRSP and ICRISAT in collaboration with host country agencies. The workshop should emphasize an area of research program, e.g., utilization, focusing on harvesting, handling, storage, processing and marketing of peanut. This would include the issues of aspergilli and aflatoxin contamination and their control.

Recommendation: The positive-supportive observations and recommendations of the 1989 EEP for the postharvest-utilization programs in Southeast Asia still hold and are clearly being met; i.e., Peanut CRSP was extremely successful in its concepts and all objectives were being met relevant to the food needs of host countries and the U.S. Peanut CRSP is staffed with competent scientists successfully working within funding constraints to complete accountable programs in food science, technology and production. The regulatory agencies, industries and consumers are rapidly becoming aware of controlling aspergillus-aflatoxin contamination, developing and marketing new foods and the consumer is eating more peanut products. Peanut food entrepreneurs are increasing in numbers. The leadership provided by the Principle Investigators and support institutions are excellent. One major benefit noted and continues today, was contributions of expertise, equipment-instruments and facilities, at no cost from scientists not on the Peanut CRSP through collaborative programs; this is especially observed at UGA and beginning to occur at UPLB and ViSCA. In spite of limited funding, the programs are productive, and are accomplishing more than expected. To date, a continually strengthening research foundation has been built and will serve as a springboard for a 5-year extension of Peanut CRSP. The postharvest-utilization research is proceeding much more rapidly and if additional funds were provided or redirected to this program, the accomplishments and technology transfer would be greatly strengthened. Host country researchers have developed the expertise and facilities to provide a broad program of food science and technology and nutritional analyses, including aflatoxin detection, removal and prevention. Collaborative studies and meetings-workshops among institutions doing sustainable agriculture and postharvest-utilization research within and among host countries and the U.S. should be strengthened and regularly occur. Efforts should be made to increase availability of planting seed from newly released insect resistant and high yielding cultivars PN-2 and PN-10. The newly funded program on quality enhancement and technology transfer of products containing peanut, mungbean and cassava flours by collaborating entrepreneurs in beginning business ventures at ViSCA, Baybay and Ormoc City, Leyte, the Philippines is strongly supported and should enjoy increased funding. This is technology transfer at its best. Peanut CRSP is the vehicle through which all these needs can be developed.

PEANUT CRSP EVALUATION REPORT: THE SOCIOECONOMIC IMPACT ASSESSMENT COMPONENT OF THE FIVE YEAR EXTENSION (1990-1994)

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I. Introduction

To paraphrase remarks by Onuma Okezie and David Cummins at the meeting of the Board of Directors and External Evaluation Panel, July 17, 1993, the principal purpose of the E.E.P. is to assess the impact of the Peanut CRSP, especially since 1990, and to address issues germane to its goals and future activities. The focus of the impact assessment, of course, is on the goals of the Peanut CRSP, its activities and achievements. The activities of the Peanut CRSP directly impact U.S. Colleges of Agriculture and Agricultural Experiment Stations, and developing-country research and development institutions. Through these agencies, Peanut CRSP activities less directly affect U.S. and developing-country, agencies, farmers and their families and consumers. Peanut CRSP activities, in many important respects, fall in the realm of the biological and technical sciences, and to this extent, the evaluations by members of the E.E.P. who are expert in these fields are most relevant. In affecting research and development institutions, agencies, farm families and consumers, however, Peanut CRSP activities also have social and economic impact, and these are the special concern of this particular review.

A socioeconomic impact assessment is guided by a perspective that views the Peanut CRSP as both affecting and being affected by socioeconomic aspects of its "environment." This socioeconomic environment consists not only of the host U.S. and developing country institutions but also the country, and international markets in which peanuts are sold and consumed. The first step in this evaluation is to outline the perspective from which the socioeconomic impact assessment is being made. Subsequent sections of this report then deal with aspects of the socioeconomic assessment: Peanut CRSP goals and research plans, activities and accomplishments, components of the socioeconomic impacts, and impact issues and recommendations.

Socioeconomic Impact Assessment of the Peanut CRSP

The Peanut CRSP for purpose of this assessment is regarded as primarily an information development (research) and disseminating system for the advancement of "the potential of the peanut as a crop for human food and animal feed in developing countries and the United States, as it contributes to the increase of rural incomes and sustains agricultural land" (Strategic Plan for the 1990's: 2-3). As an information development and disseminating system, the Peanut CRSP mobilizes resources--human, material, social and economic--in knowledge generating (research) and communication activities which facilitate this purpose. The information generated by the system has social and economic value because it enhances the capacities of (1) material objects, (2) humans, and (3) socioeconomic organizations.

In this respect, information and prototype techniques generated by the Peanut CRSP increases the material, human, and social capital of its users. Broadly conceived these include all components of national food systems--input developers, financial and credit agencies, farmers, manufacturers, distributors, and consumers. But, the principal focus of the Peanut CRSP has been and remains on seed developers, farmers, and food manufacturers. One general measure of the Peanut CRSP's impact thus is the increase in the capital values of users.

The increase in material, human, and social values is both direct and indirect. Directly, the Peanut CRSP builds host-country human, material, and social capacities in doing research, i.e., in cloning itself. Moreover, through the supply of information and/or prototypes, it directly increases the capital values, for example, of seed reproducers and of manufacturers of peanut products. Indirectly, through the new technology and/or information provided by intermediate users to farmer clientele, the Peanut CRSP increases the capital values of producers and others in the food sector. Moreover, indirectly, the Peanut CRSP aims to enhance the sustainability of land resources as well as the well-being of consumers.

Accomplishment of these aims requires a continual flow of scientific and/or technical information and prototypes. This implies both the institutional capacity to develop information and the existence of users who are actively seeking or demanding such outputs in order to increase their material, human, and social capital. However, it is characteristic of developing countries that both of these factors are problematic in considerable degree. That is, development of the peanut industry in a particular country is foremost an institution building task. The task is to develop not merely the institutional capacity to generate a flow of technology, which responds to industry constraints, but also to build user demand, i.e., markets, for information, prototypes, and products. Consequently, the development of both capabilities must become recognized aims of the Peanut CRSP. Typically, CRSPs have recognized the importance of building research and technology development capacity but have tended to overlook and neglect the building of user demand. But, it is the latter that nourishes and sustains the former.

User demand often is weak due to the lack of appropriate and/or of risky technology (Harwood; Chavas) and to inadequate relationships between researchers and farmer clients. User demand is strengthened and developed by bringing intermediate and ultimate users into the research and technology development process, by reducing risks, and by building relationships between scientists, input suppliers, and farmers (Acker; Chambers et al.; Frankenberger; Kaimowitz). User demand is increased too by the general development of users' human and/or social capital through general, vocational, and technical education.

Paradoxically, in making resource sustainability an important aim of technology development, the Peanut CRSP has increased research and development risks. Risk reduction strategies will require that CRSP scientists pay greater attention to farmers' resource management problems and to strive to increase farmers' management skills, i.e., their human and social capital. This entails increased interaction between researchers and farmers. The net effect is to drive up the costs of research (Lynam) in a stable to declining funding climate.

Consideration of effective demand and sustainability issues highlight the point that attainment of CRSP objectives is possible only with the cooperation and coordination of a broad array of agencies and organizations--extension, the media, private and governmental organizations. The effectiveness of the Peanut CRSP will be reflected in the extent to which these groups have been engaged in the technology development and transfer process. The cultivation of such groups, as indicated above, must be an important objective of the Peanut CRSP.

In view of the foregoing considerations, the activity of the Peanut CRSP is evaluated on four dimensions:
(1) institution building,
(2) research and technology development policy, planning and organization,
(3) research projects and technology development, and
(4) monitoring and impact assessment.
This entails examination on these dimensions of the constraints, goals, and efforts of the Peanut-CRSP scientists and administration with a special focus on the five-year period 1990 to 1995.

This evaluation report does not cover the worldwide scope of Peanut CRSP. While sections one, two, and four are concerned with the total research and technology development and planning process, section three is primarily limited to the research projects dealing with Southeast Asia.
The evaluation strategy is to collect and analyze data on Peanut CRSP
(1) inputs,
(2) system and human capital development,
(3) research output-communication, and
(4) technology utilization by clientele.

The Peanut CRSP inputs include information (e.g., constraints, concepts, theories, etc.), financial and human resources. System and human capital development includes networking and research capacity building of the Peanut CRSP itself as well as networking both with other scientists and various clientele and user groups. On the human side this includes the training of scientists and technicians. Research output-communication includes publications, workshops, conferences, seminars, etc. for Peanut CRSP and/or other scientists and clientele. Technology utilization includes information and technology prototypes, (e.g., varieties released) used by clientele, and CRSP trained personnel employed in the research and development system.

The information sources for this report are primarily the documents supplied by the Peanut CRSP office--previous evaluation reports, global plan, research plans, and annual reports--and materials and information obtained in visits with PIs at North Carolina State University, PCARRD scientists at Los Banos, researchers at the Ilagan and Iguig research stations, and farmers at Damurog in the Philippines.

II. Institution Building

Institution building refers to the broad range of activities concerned with the development of research and technical capacity. This includes the development or training of scientific and technical manpower. But, it also includes the development of institutional and organizational capacity through the development of systems of research administration and management, the building of scientist networks, and the development of information systems. It also importantly includes research funding, including the purchase of essential research equipment.

Institution building has been recognized by Peanut CRSP Board, administration, and scientists as an essential component of its activity. The Global Plan indicates that "the Peanut CRSP was designed around a set of constraints to sustainable production and utilization identified during the 1980-1982 planning process." The Global Plan and Extension Proposal for 1990-1995 identifies three institutional constraints "that are global in nature and extend to all regions, namely:
(1) inadequate numbers of trained researchers and support personnel,
(2) "lack of adequate equipment to conduct research, and
(3) information not available to beneficiaries for support of production and utilization activities." In the five-year Global Plan, the inseparable nature of research and training is recognized, both to upgrade the skills of present researchers and to provide graduate training to fill present and future voids. Moreover, as a previous E.E.P. remarked, the Peanut CRSP's contributions to human capital development are likely to be its most enduring legacy. When the Global Plan was prepared, consideration was given to "an in depth evaluation of training needs for peanut scientists on a country and possibly regional basis as recommended by the Administrative Review Team".

The Strategic Plan for the 1990's, however, envisions a smaller future role in training than during the 80's due to having trained "enough personnel to fill the posts that the host governments are willing to fund themselves for the foreseeable future." In the future, greater emphasis would be "given to in-country training by organizing traveling seminars ..." with Peanut CRSP, ICRISAT, ACIAR, University and other personnel.

The Global Plan envisioned that there would be less need for equipment in the next five years and suggested that only essential equipment would be provided.

The inadequacy of information flow was dealt with in terms of "an expanded thrust in Communications and Outreach" (Global Plan, p. 35) with continued cooperative publication of International Arachis Newsletter, emphasis on publication of research results, workshops, and participation in networks.

The 1990's Strategic Plan identifies a number of "new challenges," several of which relate to institution building. One is the opportunity to pool resources and work with other CRSPs--Small Ruminants, INTSORMIL, Beans and Cowpeas, TROPSOILS, and Nutrition--especially through the CRSP Council. Equity issues and the roles of women and children in production are other challenging issues because institutions have to be developed and scientists and administrators sensitized to attend to these issues in research planning and technology development.

The Past: 1980's

The contribution to human resource development during the previous decade has been documented. According to the Strategic Plan for the 1990's (p. 7):

The Peanut CRSP has provided funds and training for over 50 M.S. and Ph.D. students from the host countries, over 30 M.S. and Ph.D. students from non-host countries, and 40 M.S. and Ph.D. students from the U.S. Over 30 students have been trained at the M.S. and one at the Ph.D. level in host-country institutions. Over 200 man-months of short-term training at U.S. universities were provided to over 75 developing-country scientists. U.S. scientists provided over 80 man-months of technical assistance in the host countries.

Research capability in both the host countries and the United States was enhanced through the provision of funds for labor, supplies, and equipment.

The institution of research and technology development extends both horizontally to other interested scientists around the world and vertically to producers and consumers.

Since its inception, the Peanut CRSP has enhanced research and technology transfer activities through synergistic relationships with other international organizations. Cooperative planning, support for research, and conduct of workshops and other outreach activities characterize these global relationships (1990's Strategic Plan: 4).

ICRISAT, ISC, IRHO, CORAF, IDRC, and ACCIAR are organizations with whom the Peanut CRSP has cooperated.

This world wide network of science is mobilized, however, in support of the paramount goal of collaborative research between scientists in host-country institutions in four regions--West Africa, Southeast Asia, the Caribbean, and the Near East--and U.S. institutions. The principal beneficiaries are the people in host countries and constituents of U.S. institutions.

During the 1980's, the Peanut CRSP addressed the needs of beneficiaries by supporting publication of research, workshops and conferences as well as on-farm pilot projects. According to the 1990's Strategic Plan (p. 6), "about 200 scientific journal articles, 9 book chapters, some 200 miscellaneous articles, and over 200 abstracts were published..." The Peanut CRSP also published the International Arachis Newsletter in cooperation with ICRISAT. It also sponsored or co-sponsored over 35 workshops and conferences, and helped organize annual meetings of scientists in Philippines and Thailand.

The Present Five Years

Human Resource Development. Peanut CRSP support during the 1990's has continued to strengthen human resource capacity, although at a reduced rate, and the focus of training has shifted from U.S. to host-country universities where training is less expensive (Appendix 1). Compared to the total of 103 students provided at least partial support toward M.S. or Ph.D. degrees during 1982 to 1989, 85 have been supported during the present five-year period:1990-1994. Those trained at U.S. institutions have dropped from 86 to 44 while the number trained at host country institutions have increased from

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17 to 41. The Peanut CRSP is currently supporting 22 students working toward post-graduate degrees at U.S. universities--5 from host countries and 10 from non-host countries, and 13 students at host-country universities. Moreover, the Annual Reports 1991, 1992, and 1993 indicate that twelve people received short-term training in the United States during 1991-93 and many others in host countries.

No less critical to development than the lack of scientist manpower in developing countries is the shortage of technicians in technology transfer institutions. Thus, the Peanut CRSP support in 1992-93 (An. Rpt. 1993) for training of 30 Philippine technicians on peanut seed production and 30 Thai extension workers in peanut production technology is especially notable.

The Peanut CRSP has made a substantial contribution to human resource development during this project-funding period. Unfortunately, an overall plan has not existed, either at the CRSP or individual project level, which serves to guide human resource development. Lacking a clear statement of human resource needs in host countries, the precise contribution of the Peanut CRSP in filling these needs can not be assessed. CRSP management seems to have been operating in the dark.

Institution building. A notable institution building achievement was the development and publication of Policy and Operating Procedures of the Peanut Collaborative Research Support Program (CRSP). Griffin, GA: Peanut CRSP, The University of Georgia, Georgia Experiment Station, 1991. This policy paper identifies the administrative units of the Peanut CRSP, their functions, and responsibilities. It also indicates the main Peanut CRSP operating procedures and will facilitate administrative operations.

The Board strengthened the Management Entity's ability to provide fiscal and programmatic leadership in authorizing the hiring of an Assistant Director.

As part of its major Communication and Outreach thrust, the Peanut CRSP has continued building participation in the worldwide research network relating to genetic resources, diseases, and plant protection. In 1991, the Peanut CRSP sponsored (An. Rpt. 1991):

- West African Groundnut Workshop with ICRISAT Sahelian Center
- Training Course on Quality Evaluation and Utilization of Food Legumes and Coarse Grains with Kasetsart University

It networked with:

- ICRISAT to co-sponsor groundnut workshop; publish the International Arachis Newsletter, and promote research exchanges.
- the Groundnut Virus Research Network Group.
- IRHO to plan future cooperation.
- CARDI to help extend technology to CARDI countries.

The Peanut CRSP published three general bulletins and numerous articles, abstracts, and reports through its sponsored projects.

These efforts continued in 1992 (An. Rpt. 1992) with sponsorship of:

- Second International Groundnut Workshop with ICRISAT.
- Workshop on Social Science Research and the CRSPs with other CRSP Council members.
- Fourth ASIAN Food Conference.

The Peanut CRSP networked with:

- ICRISAT to organize Second International Groundnut Workshop, publish the International Arachis Newsletter, and promote research exchanges.
- CARDI to promote research collaboration.

In addition, the Peanut CRSP published seven special publications and support publication of numerous articles, bulletins, reports through its sponsored projects.

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During 1992-93 (An. Rpt 1993), the Peanut CRSP supported participation in:
- Workshop on "Improving Production and Quality of Peanut" in Jamaica.
- Workshop on "Transfer of Peanut Production and Utilization Technologies" at Kasetsart University, Thailand.
- Third West Africa Regional Peanut Workshop in cooperation with ICRISAT Sahelian Center in Ouagadougou, Burkina Faso.

The Peanut CRSP also sponsored five special publications.

Important as the foregoing activities are, the outreach activities that reach the Peanut CRSP's main beneficiaries--the farmers and their families, food processors, and consumers--are even more noteworthy. In this regard, the Peanut CRSP has supported (Annual Reports 1991, 1992, 1993):

- A pilot project in the Cagayan Valley, Philippines to extend new varieties and improvements in IPM.
- A seed multiplication program to extend new varieties to Thai farmers.
- A program in Jamaica with CARDI to promote adoption of a new CARDI-Payne variety.
- A pilot transfer of peanut processing technology to women entrepreneurs in a Thai village.
- Members of a San Antonio Cooperative in Belize in use of a dryer facility that was modified and enhanced through Peanut CRSP postharvest research and outreach.
- Short courses by the Institute of Food Science and Technology, UPLB for small scale producers, teachers, and housewives.
- Farmers in a Philippine cooperative assisted in identifying peanut products for processing.

Documentation of the expenditures for research equipment and the support of research operations in host countries has not been made available to this panel member.

The Future: 1995 and Beyond

Human resource development, research collaboration and support should continue to be the central focus of the Peanut CRSP. The nature of this collaboration, however, will necessarily evolve and the research systems in host countries mature. U.S. scientists should search for and develop relationships with expanding groups of scientists and practitioners in host countries. The aim should be to encourage the development of networks or systems that distribute new technology whether these are new seeds, machines, or food products.

It is notable that Peanut CRSP management is thinking about the organization of the Peanut CRSP for 1995-2000: "Improving Global Peanut Production and Use for Economic Growth, Environmental Sustainability, and Human Health and Nutrition" (undated). The most innovative idea is the establishment of Global Teams "to increase program flexibility and responsiveness, to improve coordination across projects, and to augment program efficiency." The tasks envisioned are to:
(1) "identify priority research areas and multidisciplinary projects... [for] U.S. institutions,"
(2) "establish and maintain a high level of scientific rigor in multidisciplinary setting," and
(3) "reduce redundancies, and identify opportunities to enhance transfer of information and technology" among collaborating institutions.

In my view, the first, i.e., priority setting, and third of these tasks, i.e., providing institutional resource leadership, are the most important and most feasible. The second task is stated as though it would be an administrative function, but this is impractical. As a resource group, the global team might offer advice to the end of improving scientific rigor if it felt competent to do so. One problem that does not seem to be satisfactorily resolved in the working document is the functional separation and relationship of the Global Teams and the Technical Committee which to some extent the global teams supersede. It seems to this reviewer that the Global Teams would function best as idea forming, priority setting,

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integration facilitating, resource advisory bodies while the Technical Committee has the responsibility of dealing with, advising, and budgeting of actual projects.

"Country (Regional) Coordinating Committees" and "Country Coordinators" have been found to have useful administrative functions in other CRSPs and should be useful in the Peanut CRSP also. The Regional Coordinating Committee is most useful when the CRSP has evolved to the point that particular host countries serve as lead institutions for on-going collaborative work in closely related countries as, for example, the Philippines might for Southeast Asia.

It is perhaps unfortunate that a systematic study of human resource needs was not undertaken as initially suggested in the Global Plan. The undated report on "Human Capital Development," however, is an important document which indicates the important contributions that the Peanut CRSP has made to human resource development during the past three years. However, the lack of a systematic plan to guide activity on this objective has left a notable gap. Such a plan would indicate target clientele, human resource targets, and types of training activities. These in turn could be incorporated into research project and/or management entity operating plans. With a human resource development plan, it would be less likely that important clientele would be overlooked in training and Peanut CRSP management could assess whether human resource development objectives were being attained.

Demand for trained scientist and technical personnel will continue to grow as host countries develop. People trained for particular scientific and technical positions tend to be highly mobile and replacements are frequently needed. Moreover, occupants of important research and administrative positions are often relatively young and inexperienced and in need of the counsel and advice of experienced senior scientists and administrators. The idea in "Human Capital Development" for "short-term strategic training at U. S. institutions" and regional workshops seem particularly appropriate. This is in line with the more varied role of U.S. collaborating institutions.

While the need for scientific input is likely to decline as highly trained nationals fill host country institutions, the need for training people in the arts of technology transfer and of developing linkages with important local peanut production and processing clientele has hardly been initiated. Creating the institutional rules and procedures, and administrative support to engage in productive work and to transfer it to clientele is likely to increase. Thus, working with host country scientists and their supporting institutions is likely to be the major future need.

The Annual Reports have not been informative with respect to Peanut CRSP support for research equipment. However, maintenance of existing equipment and replacement of outmoded equipment are continuing problems.

The increased emphasis on publication is most welcome, especially the informative Annual Reports, and this is likely to continue. There is need for collaboration in increasing host country publications of all kinds.

While the Peanut CRSP has supported pilot outreach projects to small farmers, entrepreneurs, and housewives, these efforts have been limited in number and largely unsystematic. Missing from the networks are contacts with officials in national Ministries and Departments of Agriculture through which linkages with extension services and regional experiment stations might be established which would further facilitate outreach. Missing too are the networks with PVO's despite the claim that such would be established. These are important institution building challenges for the future.

III. Research and Technology Development Policy, Planning and Organization

This section is focused on the research planning and decision making process. How are the research decisions made; what is the basis? Who is involved in the research planning and decision making process? It is in this process that factors which are most critical to the impact of research and development on beneficiaries occur. For this reason, it is important that informational input be factual, from a wide range of sources, and that various interested groups be involved in the assessment and decision making.

The Global Plan... is quite clear about the policy basis for the research program (p. 1) "The Peanut CRSP is designed around a set of constraints... [and] the External Evaluation Panel in 1989 evaluated ... the following constraints and found them to be valid as a basic framework for the Peanut CRSP in the near future."

- Low yields because of unadapted cultivars and lack of cultivar resistance to diseases, insects, and drought
- Yield losses due to infestations of weeds, insects, diseases and nematodes
- Health hazards and economic losses due to mycotoxin contamination
- Food supplies inadequate and lack of appropriate food technologies to exploit relatively well adapted peanut crop that is not generally considered a primary food source
- Physiological and soil microbiological barriers to higher yields
- Resource management (agronomic, engineering, economic, and sociological) situations that prevent efficient production and utilization
- Inadequate numbers of trained researchers and support personnel
- Lack of adequate equipment to conduct research
- Information not available to beneficiaries for support of production and utilization efforts

Recognizing the global role of the peanut in the food system and the foregoing constraints, the starting point in research planning for the current five-year plan was the development of three global thrusts to relieve the identified constraints (Global Plan, p. 2-3).

- Sustainable agricultural production and food delivery systems that are environmentally sound...
- Resource management systems to relieve situations that restrict efficient management of production and utilization
- Communication of research outputs to clientele

Responding to governmental policy mandates, the Global Plan (p. 3) also recognized special issues of providing information and technology of value to "small farmers, which include rural women, as well as food processors and both rural and urban consumers."

Research agenda to address the constraints, global thrusts, and research issues "were discussed at various levels--... national and Peanut CRSP scientists, at the Technical Committee, and Board of Directors and management Entity meetings, and at international and regional meetings where the Peanut CRSP cooperates and is operationally engaged" (Strategic Plan for the 1990's, p. 28). Particularly important in helping set the research agenda for the 1990's was a meeting of over 200 scientists representing 44 countries in Hyderabad. The working groups recommended that the following areas of research were "the most relevant and important."

- Socioeconomics, including FSR to identify farm level constraints and problems of technology adoption
- Biotic constraints

- Genetic resources and germplasm enhancement
- Utilization
- Information transfer
- Others, including research on abiotic constraints and cropping systems

The strategy for the 1990's envisioned research on socioeconomics constraints and impacts, biotic constraints, genetic resources and germplasm enhancement, peanut utilization, and training (already referred to under institution building). Although the importance of both ex post and ex ante research on the socioeconomic impacts of technology was recognized, none was specifically planned. Such research was regarded as feasible only when requested by host countries and when conducted in conjunction with extension agencies and non-governmental organizations. As noted earlier, the strategy for the 90's also envisioned a reduced training role, due to perceived full staffing of research positions in host countries, and the focus of future training mainly in-country at the technical level.

More specifically the Strategic Plan states (pp. 5-6):

Genetic Resources

"The Peanut CRSP has accessed the world collection of peanut germplasm and used it to develop ... genetic lines with superior attributes... Development of other cultivars [than the 15 already released] with tolerance to drought and aflatoxin is ongoing." Implementing this goal was primarily the responsibility of TX/BCP/S,BF,N--Disease-Resistant Peanut Varieties for Semi-Arid Environments, NCS/BCP/TP--Peanut Varietal Improvement for Thailand and the Philippines, and GA/PV/N,TP--Peanut Viruses: Etiology, Epidemiology, and Nature of Resistance.

Integrated Pest Management

"Research is ongoing in genetic control through resistant cultivars, cultural control, biological control (fungal, bacterial, and parasitic insects), and naturally occurring chemicals. Improved IPM programs promise to provide economic and safety benefits to farmers and to lessen the potential harmful effects of chemicals on the environment..." (Strategic Plan..., p.6). The research has been conducted under GA/IM/BF--Integrated Pest Management (IPM) Strategies for Peanut Insects in SAT Africa, NCS/IM/TP--Management of Arthropods on Peanuts in Southeast Asia, and TX/MM/S--Mycotoxin Management in Peanut by Prevention of Contamination and Monitoring.

Food Products and Consumer Use

The Peanut CRSP seeks to harvest, store and process peanut in ways that will supply adequate quantities of safe and acceptable products to consumers. A major objective is to minimize and detoxify aflatoxin, a highly carcinogenic metabolic product of Aspergillus flavus in food products. Other objectives are to increase awareness of the high energy and protein value of peanut; to increase the use of peanut in traditional foods; and to develop new products that are culturally acceptable" (Strategic Plan 1990:5-6). Three projects focused on this goal: AAM/FT/BF--An Interdisciplinary Approach to Optimum Food Utility of the Peanut in SAT Africa, GA/FT/TP--Appropriate Technology to Storage/Utilization of Peanut, and GA/PH/CAR--Post-Harvest Handling Systems for the Small Peanut Producer.

Natural Resource Management

As described in Detailed Project Plans for 1990-1995 (p. 175):
The Peanut CRSP ... adopted the model used by ICRISAT... which includes agronomy (soil fertility, cultural practices, such as seed rate or row spacing, agroclimatology, farming systems, entomology and pathology, agricultural engineering, and socioeconomics. The Peanut CRSP will also integrate aflatoxin and food technology efforts into the agronomic system.

Agronomy: Technology that has an agronomic or biological nature will be evaluated in the resource management system context.

The three agronomic components envisioned were breeding programs relating to food technology, mycotoxin, and insect management, cooperative efforts with other in-country, regional or international programs, and inter-CRSP activities involving interdisciplinary research.

Socioeconomics: The four components would focus on socioeconomic evaluation of new technology, the economic benefits, determination of need and acceptability of food technology, and assessment of market development and government policy problems.

Specific regional plans for the resource management components are outlined in the Global Plan for West Africa (pp.25-7), and Southeast Asia (pp. 31-2).

Communications and Outreach

The aim, as stated in the Detailed Project Plans... (p. 177), is "to encourage publication of results in recognized outlets while increasing capability to communicate results to policy makers and extension workers. Support of participation in workshops, networks, and pilot programs to stimulate technology transfer... [and] cooperation with ICRISAT in the publication of the International Arachis Newsletter will continue." It was hoped, if funding allowed, to add a communications specialist, increase the number of workshops, strengthen network relationships, and support pilot programs.

Research Policy Inputs and Changes: 1990-1993

1. Sustainable peanut production--The issue of conducting research and technology development in furtherance of sustainable agriculture was addressed specifically by the 1991 E.E.P. in noting that the effort on biological control was consistent with this aim. The E.E.P. also recommended that guidelines be developed for calculation of proportionate effort devoted to increasing sustainability.

A thoughtful assessment of sustainabilty as a goal of agricultural research was made by John Lynam, "Sustainability: The Challenge for International Agricultural Research." One implication of the paper is that the focus on natural resource management should not detract from the priority of increasing productivity of the commodity and farmer income. Another is that any effort to deal with sustainability/resource management issues requires greater attention to adaptive research in selected agroecological sites. Correspondingly, greater attention is needed to methods of impact assessment. Finally, new institutional arrangements for technology transfer will be needed if the complex technologies are to be diffused and adopted. The general thrust of the argument is to increase the importance of collaboration among researchers in order to deal with the complex resource-management problems at particular sites and the encouragement of monitoring, impact assessment, and feedback.

2. The 1992 E.E.P. Report gave qualified support to bioengineering research to develop insect and viral disease resistance in plants. It also encouraged continued exploration of Inter-CRSP research in Honduras and Egypt and collaborative research in Malawi. The E.E.P was especially impressed with the food science and technology work and recommended prioritizing research projects. It approved Board decisions to drop TX/BCP work in Niger, suggested discontinuance of GA/PV while commending the food science and technology work as impressive.

3. The Annual Report 1992 (pp. xxi-xxvi) "Peanut CRSP in Relation to the Export Competition" satisfies the legal constraint that no U.S. funds be used to support competitors of growers in the U.S. The report analyzes annual production and disappearance data by country and gives a capsule review for each West African country and overall for Southeast Asia and Caribbean. The key sentence in the

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overall summary is: "Host countries of the Peanut CRSP are not [U.S.] competitors in the export market for edible peanut" (pp. xxi).

4. A major policy input was made by publication of the Groundnut--A Global Perspective. Proceedings of an International Workshop. 25-29 Nov 1991 edited by S. N. Nigam. World and regional economic situation bearing on research policy--As summarized by Fletcher et al. (1992: 19),"while world groundnut production has increased [from the 1970s to the 1980s], ... the increase ... is primarily in Asia with east Asia being the major contributor... In contrast, Africa had 17% decrease in production from the 1970s to 1980s with eastern and southern Africa being the main subregions contributing to this loss... Africa's share [of world production] dropped from 27% to 19% while Asia's share increased from 56% to 67%.

These shifts in production are due to changes in harvested area and yield." While the harvested area in Asia increased by 12%, Africa's decreased 13%. Meanwhile, yields per ha. in Asia also increased 26%, and African yields declined marginally overall although W. African groundnut yields increased by 4% from the 1970s to 1980s.

The conclusion is that (p.28) peanuts have lost ground to rape seed (canola) and sunflower seed as oil producer. "This change in ranking may be attributable to the emergence of health concerns in the industrial countries... Thus, groundnut oil properties need to be reexamined in light of the current health concerns. Also, groundnut oil is not as price competitive on the world market. This was seen in the decline of the African countries in the world groundnut oil export market and the EEC in the groundnut oil import market... (p. 29) Two key factors exist that may change the groundnut environment in the 1990s and beyond. One of the factors is aflatoxin. This factor is a key item in the edible trade as well as the domestic market. The USA, the EEC, and other developed countries are lowering the limits allowed for aflatoxin in edible groundnuts. Aflatoxin is a key problem of African countries wishing to enter the edible trade market on a large scale.

The second factor is GATT, which, if consummated, would change world trading and production patterns due to preferential developing country trading relations.

With respect to S.E. Asia, Fletcher et al. (1992) report that peanut production in the 1980s averaged 27.4% larger than in the 1970s--8.6% in area and 17.3% in yields. These increases, however, were far below those attained in E. Asia (China, Japan, Korea, Hong Kong, and Taiwan). Lagging peanut production in S.E. Asia is a special concern of the Peanut CRSP in that Thai production has been able only to keep pace with domestic demand while the peanut production in Philippines fell during the 1980s (Jogloy et al. 1992). This tends to reinforce the importance of maintaining improvements in productivity as a research priority of the Peanut CRSP.

Future Research Priorities

1. The foregoing analysis suggests that research on the properties of peanut oil, aflatoxin, and improving productivity should continue to have high priority.

2. If sustainable agriculture is an important Peanut CRSP goal, it is evident that ways of working with regional research teams, such as in the Cagayan Valley, Philippines, must be found to evaluate new technology in real system contexts. This could range from on-farm, large-scale, field trials, as recommended by Brandenberg and Bailey (1994), to more complex over-time farm trials of new seeds and new IPM strategies. In such studies, monitoring and assessment of technological impact becomes a more important focus of research. In as much as this includes farm families and their members, studies of sustainability would reveal the impact of technology on women and small farmers, topics thus far neglected by the Peanut CRSP.

3. Current Philippine production satisfies only 58% of domestic demand and has been declining (PCARRD 1994). It is notable that yields, which had declined during the 80's, have been increasing slowly during the 90'S, but the 0.7 mt/ha average is less than half the potential. It is apparent, therefore, that the national goal of "self-sufficiency" by the year 2000 could be attained, without any increase in acreage, if target yield levels were reached.

The constraints to increased productivity, however, are numerous and include economic factors (e.g., credit, price and seed supply) as well as natural (e.g., drought), genetic, agronomic, and pest and disease factors (Jogloy et al. 1992: Table 4; Huelgas et al. 1990). Higher yielding varieties are being developed and released (Annual Reports 1991, 1992, 1993). Philippine data indicate that the principal constraints, apart from weather factors, are (1) unavailability of seeds of the high producing varieties, (2) use of poor quality seeds, i.e., low producing varieties and/or low germination rate, and (3) pest infestations (PCARRD 1994). Since higher yielding varieties exist, the first two factors point to problems of seed multiplication and distribution and of seed storage as the main constraints to higher on-farm yields. This assessment is echoed by Brandenburg and Bailey (1994).

The peanut seed industry is not well developed. Doubtless this arises in part from the fact that commercialization of peanut has had a relatively low priority. However, if national targets are to be met this must change. With new, higher yielding varieties becoming available, a supply of improved seed must be available. The reasons for the lack of development of the seed industry are various and seem not to be well understood. Improvement in peanut production in the Philippines is in many respects inseparable from improvement in the agricultural economy generally. For example, some solutions to the seed storage problem would require improved farm credit to purchase seed. Improvements in infrastructure--transportation and communication--farm credit, inputs (seeds, fertilizer) which benefit cropping generally will have a significant impact on improving productivity and profitability of peanuts, thereby increasing the production incentives. <u>Socioeconomic studies are necessary to resolve issues of (1) the marketing (sale) of new seeds, (2) development of the peanut seed industry, (3) marketing of peanuts, (4) comparative profitability of crops, and (5) governmental policy impacts</u>.

4. Seed is a major cost of peanut production, i.e., from 23% (Huelgas et al. 1990) to 42% (Senna 1994) of the cash costs. Satisfactory seed storage not only would have the effect of substantially reducing costs but also as Brandenberg and Bailey (1994) point out of helping retain the purity of released lines, thereby sustaining yield increases of new varieties. Consequently, development of improved and effective, low cost, seed storage, which would improve seed viability for dry season planting and render wet-season planting unnecessary, would be a major factor not only in increasing yields but also in substantially reducing production costs, increasing yields and profitability.

In the Philippines, it is apparent that the public research and technology development system has failed to enlist the private sector sufficiently in the development of peanut production and its use (Brandenberg and Bailey 1994; Resurreccion 1993). Peanut CRSP "Global Teams" and "Country Coordinators" should encourage problem and need assessment workshops of farmers, buyers, sellers, and researchers which help define what each group in the production and distribution system want and require. (For example, see Brandenberg and Bailey 1994:8.)

<u>In the Philippines, the seed industry and storage should have high research priorities</u>.

IV. Research and Technology Development: Plan Implementation

This section is concerned with research project goals and their implementation: the accomplishments and outputs as well as the range of the technology development process. Ideally, the technology development process extends from farmer to the research laboratory, prototype development, and back to farmers' fields--i.e., farmers first and last (Chambers et al. 1990; Acker 1992, Frankenberger 1992). The question is: what is the scope and accomplishment of Peanut CRSP research projects?

The work of the Peanut CRSP is conventionally organized in research projects, but research project contributions relate to program thrusts: genetic resources, integrated pest management, natural resource management, food products and consumer use, human resource and institutional development, and communications and outreach. During the 1980s, the research effort made a substantial contribution to some of these thrusts. These accomplishments were summarized by the EEP (1989) and reported by Cummins (1992):

Genetic resources: 13 new cultivars developed and released, which have higher yield potential, increased tolerance to diseases and insects, and better quality and consumer acceptability. Development of other cultivars with tolerance to drought and aflatoxin is ongoing.

Integrated pest management: Peanut CRSP researchers have determined insect life cycles, alternate plant hosts, time of appearance of insects on the crop, insect population levels, and subsequent damage to the plant. Such knowledge provides the basis for IPM recommendations and programs...

Food Products and consumer use: A major objective is to minimize and detoxify aflatoxin. Sorbent clays were found to detoxify peanut oil and animal feeds. Studies have provided the informational base to increase consumer awareness of the high energy and protein value of peanut; to increase the use of peanuts in traditional foods; and to develop new products that are culturally acceptable.

From 1990 to 1993, research activities have been carried on under the following 9 projects:

- NCS/BCP/T,P - Peanut Varietal Improvement for Thailand and Philippines
- GA/PV/N,T,P - Peanut Viruses: Etiology, Epidemiology, and Nature of Resistance
- GA/IM/BF - IPM Strategies for Peanut Insects in SAT Africa
- NCS/IM/T,P - Management of Arthropods on Peanuts in Southeast Asia
- TX/BCP/S,BF,N - Disease-Resistant Peanut Varieties for Semi-Arid Environments
- TX/MM/S - Mycotoxin Management in Peanut by Prevention of Contamination and Monitoring
- AAM/FT/BF - An Interdisciplinary Approach to Optimum Food Utility of the Peanut in SAT Africa
- GA/FT/T,P - Appropriate Technology for Storage/Utilization of Peanut
- GA/PH/CAR - Postharvest Handling Systems for the Small Peanut Producer

Due to the division of regional responsibilities in the EEP, I will look mainly at the goals and accomplishments of the four projects with activities in Southeast Asia: NCS/BCP/T,P; GA/PV/N,T,P; NCS/IM/T,P; and GA/FT/T,P.

Research Project Goals and Accomplishments

A. NCS/BCP/T,P Peanut Varietal Improvement for Thailand and Philippines.

Goals. (1992 Annual Report) To increase yields and quality of peanut in the U.S. and cooperating Asian countries while decreasing the dependency on chemical inputs. This should improve not only the economic situation for farmers but also have a positive impact on the ecology and sustainability of agriculture. Breeding efforts need to be directed toward development of cultivars that fit current and future cropping systems and marketing potential.

Thailand Objectives.

(1) To develop peanut cultivars that can be established in specific cropping systems and seasons. Cultivars with high yields, early maturity, large seeds, resistance to ...[various specific diseases]. (2) Provide information on plant pathology required for development and utilization disease resistant cultivars.

(3) Develop cultivars for the boiling-type market.

Accomplishments

(i) Taiwan 2 x UF71513-1 identified as 10% higher yielding in farm trials than the check variety boiling type peanut and was released in 1993 as Khon Kaen 4 (An. Rpt. 1993).

(ii) Several high yielding cultivars have been identified in regional trials for different types of cropping systems (An. Rpts. 1992, 1993) and are being further evaluated.

(iii) Technical training on peanut seed production given to three Myanmar agricultural officers, and more than 30 extension have been trained in peanut production technology (An. Rpts. 1992, 1993).

Philippine Objectives.

(1) To develop peanut cultivars that have high yields and resistance to ...[various specific diseases].

(2) Identify peanut genotypes adapted to present cropping systems and potential new systems such as mixed cropping in coconut or palm nut groves.

Accomplishments

(i) UPL Pn10, a high yielding variety with good seed qualities, resistant to defoliators and leafhoppers, moderately resistant to Aspergillus flavus, and high storability/viability, was approved by the Philippine seedboard and released. Like other large seeded varieties it is susceptible to rust and Cercospora leafspot (An. Rpt. 1992).

(ii) IPB Pn 85 2-40 is rust and late leafspot resistant and in two dry-season, regional trials produced 12% more than UPL Pn 10 and has been recommended for seed increase prior to release (An. Rpt. 93).

(iii) An advanced line (IPB Pn 85 10-68) was recommended for seed increase and on-farm trials across major peanut-growing areas. It is resistant to leafhopper, late leafspot, moderately resistant to rust, and higher yielding but has lower seed weight than check varieties (An. Rpt. 1993).

(iv) On-farm trials of several shade tolerant varieties.

(v) Peanut seed production training given to technicians and farmers in four growing areas (An. Rpt. 1993).

U.S. Objectives

(1) Aid in the identification of useful genotypes and implementation of material in crossing programs for use in the Philippines and Thailand.

(2) Obtain greater understanding of the interrelationships between peanut host and pathogen or environmental stress...

(3) Improve breeding and selection techniques. Break barriers prohibiting incorporation of desired traits into adapted material via interspecific crossing and molecular engineering techniques. Improve screening techniques for resistance to pests and tolerance to stress.

Accomplishments

(i) Breeding: resistance to the soil-borne disease, CBR was identified in N90013 and several other lines (An. Rpt. 1993).

(ii) Resistance to the root-knot nematode was evaluated on several tetraploid lines (Peanut CRSP 1993b).

(iii) Four interspecific hybrids were released as germplasm resources for resistance to early leafspot and three of the lines have moderate resistance to late leafspot (An. Rpt. 1993).

(iv) Progress has been made in improving breeding and selection techniques.

(v) Graduate and post-graduate training provide to two Thai students.

Observations.

By the end of 1993, there was evidence of important accomplishments on each of the research objectives for Thailand and Philippines. New varieties which should raise yields and increase profitability are increasingly available. However, evidence of farmers' use of the new varieties or of their impact on the "bottom line" is almost completely lacking. Such impressionistic information as is available suggests that there has been little impact so far in either country due to the lack of availability of most of the improved seed varieties.

The Thai breeding program reportedly is fully developed in the sense that lines are being developed that have disease and pest resistance and are high yielding. The program is oriented to seed development for both seasonal and cropping variations. They have well-trained and hard working scientists. They no longer need U.S. leadership but rather advisory support.

The Philippine program seems to be in better shape in terms of leadership than in the recent past. Personnel turnover, interdisciplinary competition, and funding difficulties have handicapped development. Unfortunately, the North Carolina materials aren't useful in the Philippines. However, greater contact and/or prioritization of problems would help U.S. scientists contribute to this program.

In the Philippines, the linkages between regional experiment station personnel involved in station and field trials and groups of farmers involved in trials is impressive. The close friendly relationship observed, especially in the Cagayan Pilot Project at Damurog, is optimal for serious farmer consideration of any new technology and generates a demand for new technology that is manifest back up the line to seed multipliers. This relationship also provides rapid and effective feedback on the relative merits of new technology. Never the less, it seems that, for whatever combination of reasons, the peanut seed industry is not well developed. Consequently, the problem of utilization seems to be that the infrastructure is unable to supply the new technology rather than its inappropriateness or of farmers' reluctance to use it.

There is substantial evidence of progress on the first of the U.S. (North Carolina) objectives. Farmers in North Carolina have benefitted from release of two varieties, one of which is CBR resistant, that are utilized on one-fifth of the acreage. Important progress has been made on the third objective, and notable accomplishments seem imminent within the next year or two.

This is a large and important project. Especially notable is the interdisciplinary collaboration and integration of research effort in the United States. The work on germplasm improvement through bioengineering and wild species selection is impressive and holds substantial promise although long term. The collegiality among the PIs supports and enhances the effective working relationships. There working relationships with host country PIs also seem to be satisfactory although contacts are not as frequent and U.S. PI-host country PI collaboration perhaps not as effective as is desired in order to quicken the pace of technology development. Difficulties in the smooth and efficient transfer of funds to host-country PIs create frustration and perhaps contribute to a slower pace of development.

This project has had and should continue to have an important human resource development (training) component. Unfortunately, this is not reflected in the project goals and objectives. Consequently, the training contribution appears as an unplanned coincidence, and one can not determine whether the project is accomplishing its purpose in this regard.

The EEP (1992) praised
(i) progress in development of varieties with adaptation to acid soils and to shade in Philippines,
(ii) the development of new boiling type peanut for Thailand which could favorably impact the U.S.,
(iii) encouraged cooperation with GA and TX researchers.

B. GA/PV/N,T,P Peanut Viruses: Etiology Epidemiology and Nature of Resistance

Goals
The overall goal... is to develop strategies and control measures to minimize incidence of the major peanut virus diseases, to foster interdisciplinary studies between countries and to develop linkages between supporting food production agencies.

Nigerian objectives (An. Rpts. 92 & 93)
(1) Establish a program of breeding for resistance to GR at the Institute for Agricultural Research.
(2) Multiply seed resistant lines so that they are available to farmers.
(3) Develop networks of collaboration with breeding programs in Burkina Faso and the ICRISAT Sahelian Center.

Accomplishments
(i) Development of an efficient, mechanical inoculation technique for GR permits the rapid and reliable testing of peanut plants for resistance. Plant breeders in greenhouses gain a generation each year (An. Rpt. 91).
(ii) A disease rating has been developed for assessing the effects of GR for different peanut lines. This rating is useful in GR breeding program (An. Rpt.91).
(iii) Breeding program established, and 33 lines identified that are free of GR (An. Rpt. 92).
(iv) Two medium maturing lines, which are resistant to rosette virus, have been identified for release, and one short season variety, which is susceptible to rosette, but high yielding in the Sudan Savannah ecological region, has been submitted for release (An. Rpt. 93).
(v) A total of 4.89 tons of foundation seed of four varieties (SAMNUT 10,11,14,16) and 100 kg of breeders seed were produced in 1992 (An. Rpt. 93).
(vi) Nigerian PI attended regional peanut workshop in Malawi (An. Rpt. 1992), received training at U.G.A. on virus programs, and attended the Groundnut Virus Diseases Working Group meeting in Dundee, Scotland (Cummins and Demski 1993). Mr. L. Belem from Burkina Faso was given three weeks training in rosette screening and aphid manipulation (An. Rpt. 93).

Thailand and Philippine objectives
(1) Identify lines that are resistant to PStV and PMV; determine if the traits are genetically controlled, and, if so, incorporate resistance into acceptable cultivars.
(2) Test the "Southern Runner" variety for resistance to BN and yellow spot viruses, and, if present, develop resistant lines for S.E. Asia.

Accomplishments

(i) Thailand coordinator (Dr. S.Wongkaew) received short term training in Georgia virology lab and attended Am. Peanut Research and Ed. meetings (An. Rpt. 92).

(ii) Bud necrosis (BN) was determined by survey to be the most prevalent and economically important viral disease while yellow spot and PStV, although present, did not have serious economic impacts (An. Rpt. 93).

U.S. objectives

(1) Gain understanding of the nature of TSWV epidemics in peanut.

(2) Evaluate methods of transforming peanut with DNA sequence coding for the coat protein of PStV and TSWV.

Accomplishments

(i) TSWV infection was found to reduce the three-year average number of seed produced 67%, average weight 25%, and the total yield by 72% (An. Rpt. 91).

(ii) Arachis diogoii and A. helodes are two species that have good resistance, but not immunity, to PStV and PMV (An. Rpt. 92).

(iii) Eleven lines with resistance to PMV, PStV, and TSWV and one line with immunity to these viruses have been identified (An. Rpt. 93).

(iv) A model system to regenerate peanut from protoplasts has been developed (An. Rpt. 92). Over 200 shoots develop from a single seed. The system virtually by-passes the callus stage and is considered a major advance in peanut regeneration (An. Rpt. 93).

Observations

The EEP (1991) praised the work in Nigeria on GRV, and it is evident that substantial progress has been made with respect to each of the Nigerian objectives. A breeding program for GRV resistance has been established. Several resistant lines have been developed and released, and foundation and breeder seed produced for distribution. While this should impact Nigerian production, there is no evidence at this early stage of the actual utilization of any of the new lines or of the actual increased sustainability of small farmer production. Finally, some linkages with other breeding programs have been made, but the annual reports do not indicate that these are frequent. Thus, despite the progress made in attaining each of the Nigerian objectives, the project has only just started to produce results and must press ahead vigorously on each objective and especially in the technology transfer area in order to have any real impact. The 1991 EEP questioned the importance of the virology work in Thailand and Philippines due to low incidences of viral diseases. However, a survey determined that severe economic losses occurred in Thailand due to bud necrosis, and this indicates the importance of pursuing a research objective of developing resistant lines to this disease.

Work in Thailand on other viral diseases--PStV and yellow spot--has been justified, however, on the grounds of their importance of their economic impact elsewhere in S.E. Asia and the presence of a trained virologist (Dr. S. Wongkaew). This argument gains strength as a result of the abandonment of the research program at the Institute for Plant Breeding, Philippines (EEP 1992). However, this perspective implies that a regional network connecting S.E. Asian countries and research centers in the U. S. exists or will be developed. The 1992 EEP report commends the PIs for participation in scientist networks and the development and sharing of germplasm. Whether these efforts justify continuation of a broad-based program in Thailand requires further examination.

Significant accomplishments have been made on each of the U.S. objectives. Studies indicate the economic impact of TSWV, and several lines with resistance to PMV, PStV, and TSWV have been identified. The work will benefit from development of a model system to regenerate peanut from protoplasts.

The 1992 EEP praised the effort to develop short season rosette resistant varieties; the high quality of research publication; participation in spotted wilt virus consortium; and, the development and distribution of genetically-altered peanut plant materials.

C. NCS/IM/TP Management of Arthropods on Peanut in Southeast Asia

Goals

Effectively manage those arthropod pests that limit peanut production through an effective pest management program based on sound principles of IPM and sustainable agriculture.

Objectives

(1) Evaluate genetic material for insect tolerance or resistance to single species and arthropod complexes.

(2) Develop damage assessment data for arthropod complexes as related to host plant phenology to determine IPM thresholds.

(3) Study the biology, ecology, and pest abundance and status of the important arthropod pests.

(4) Determine the effects of cultural practices on insect populations and host plant damage.

(5) Utilize monitoring devices to gain a better understanding of insect biology and to predict insect occurrence and abundance.

(6) Develop an effective IPM program and demonstrate benefits in North Carolina, Thailand, and Philippines.

(7) Added in 1992: Evaluate the potential for biological control as a realistic approach to arthropod management in peanuts.

Accomplishments

Philippines

(i) Through continuing studies of peanut germplasm an excellent data base of insect resistance/tolerance has been developed, and lines with resistance/tolerance have been identified for further evaluation (An. Rpt. 92). This knowledge base has been expanded with data from various regional locations (An. Rpt. 1993). In addition, the effect of cropping patterns and multi-crop systems on arthropod complexes, their composition and abundance are being studied (An. Rpt. 1993).

(ii) Improved understanding of insecticide timing, off-target effects, economic benefits, and incorporation of insecticides into IPM programs (An. Rpt. 92).

(iii) Biological control of Lepidopterous pests using Trichogramma sp. and a microbial insecticide Bacillus thuringiensis have been successful. Trials to evaluate thresholds and efficacy of alternate control strategies in realistic farm settings undertaken (An. Rpt. 92).

(iv) Drs. Ocampa and Cadapan spent time in NC in training during 1991 and 1992. Dr. Cadapan attended APRES 1993 and worked with PIs in North Carolina.

(v) Review and Planning Workshop on Peanut Integrated Pest Management at PCARRD to update the status of peanut IPM, identify problems of peanut in Philippines, to develop short- and long-term solutions, and to prepare recommendations for improving IPM programs in Philippines.

Thailand

(i) Continued studies of insecticide timing, host plant resistance, pest prevalence, and pod fill establish a data base for improving IPM programs (An. Rpt. 91,92,93).

(ii) Studies and demonstrations of refined IPM programs carried out in several locations (An. Rpt. 92).

(iii) The refinement of IPM programs and farmer training has improved grower management practices (Peanut CRSP 1993b).

(iv) Growing understanding of the relationship between thrips and virus transmission continue to build the basis for improved management of viral diseases through better management of the vector (An. Rpt. 93).

United States

(i) Development of an adequate data base to further refine the development of a sustainable agricultural system for peanuts is ongoing. Efforts to integrate biological control and cultural practices, to predict pest outbreaks and pesticide use have been expanded, complementing Thai studies (An. Rpts. 92,93).

(ii) Improved understanding of relationship between thrips over wintering, migration, and within fields in relation to TSVM in peanuts aids disease management; complements Thai studies (An. Rpts. 92,93).

(iii) Promising initial results of the impact of tillage practices on insect populations also complements Thai studies (An. Rpt. 1993).

Comments

The 1989 EEP report evaluation and recommendations have been used to guide the activities of the present project as the 1991 EEP recommends. Although the project was slow to get underway due to personnel changes in U.S. and Philippines, the pace of research to develop improved IPM has picked up, showing progress on nearly all of the project objectives. However, only in Thailand has this progress been translated into trained field personnel to provide improved farm-level pest management. In the Philippines, the technology transfer process is only on the threshold of implementation. Unfortunately, the screening of germplasm for pest tolerance/resistance (Objective #1) has been hampered by damaged seed shipments and poor seed germination.

The biological control work in Philippines is impressive and should be expanded.

Especially notable in this project are the linkages of researchers at Khon Kaen, Thailand, and UPLB, Philippines with researchers at regional research centers and outlying field sites where evaluation and demonstration is undertaken. In this respect, an important basis exists for transferring technology. It creates demand for new technology. Unfortunately, in the Philippines, contact between the PIs in UPLB and regional centers is limited by distance which slows the progress of work (Ingram 1994). The limitations of distance on personal contacts between U.S. and host country PIs also results in slower and less effective progress of research and technology transfer than would be desired. The feasibility of delegating more of the initiative for research to responsible regional personnel should be considered.

Human resource development is not indicated as a goal or objective of this project, and assessment of the adequacy of that which has occurred thus is difficult to make.

D. GA/FT/TP Appropriate Technology for Storage/Utilization of Peanut

Goals

1. Enhance the capabilities of scientists, technicians at Kasetsart University, UPLB, and UGA.
2. Enhance institutional capabilities to improve and assist economic and human development.

The project activity is formulated in terms of annual project objectives which change from year to year.

Kasetsart University Objectives and Accomplishments

1. To develop nutritious snack foods using defatted flour.

Crispy peanut-based snacks for school-age children were formulated from whole peanut and egg yolk, and nutritional qualities compared to four commercial products. A snack composed of defatted flour and tapioca flour developed and had higher protein than a commercial product (An. Rpt. 91). Shelflife in aluminum foil bags was two months and consumer acceptance was 95% (An. Rpt. 92).

2. To study a cottage-industrial process for production of peanut tempeh products and develop uses.

Peanut tempeh was successfully produced on a commercial scale from partially defatted peanuts and the chemical composition and stability was determined (An. Rpt. 91). Thai sausage with 30% tempeh equal in color, flavor, texture, and acceptability. Vegetarian and non-vegetarian consumers rated tempeh substitution for dried shrimp in a hot chili paste as equally acceptable (An. Rpt. 92).

3. To improve qualities of ground roasted peanuts.

Safer and less rancid ground roasted peanut product produced which 150 consumers and 50 restaurateurs rated as highly acceptable (An. Rpt. 91).

4. Transfer Peanut CRSP technology to users (e.g., Huay Bong-Nua, Chingmai Province) and evaluate the socioeconomic impacts.

(i) Based on socioeconomic information obtained in a study of Huay Bong-Nua, technologies for processing oil-roasted and ground-roasted peanuts were transferred to 7 housewives who were also trained in marketing. Profit from selling product is presently 1,088 Bahts/month/group (An. Rpt. 92). Technology transfer and monitoring activities extended into 1993 (An. Rpt. 1993).

(ii) A Workshop on Transfer of Peanut Production and Utilization Technologies in Thailand was held at Kasetsart University which was attended by 70 people, about half from the food industry; proceedings were distributed (An. Rpt. 1993).

5. Develop a seasoning sauce from peanut press cake.

The sauce made from mungbean protein isolate and peanut press cake containing 70% protein met Thai standards and was free of aflatoxin (An. Rpts. 92,93).

6. Improve and further develop the quality of tuub taab.

Sensory evaluation of test tuub taab product was acceptable, but consumers' preferred packaging in cellophane which gave the shortest shelflife (Peanut CRSP 1993b).

7. Develop a protocol to determine peanut quality, especially aflatoxin levels, at various points of post-harvest handling systems.

Research protocols were established with Khon Kaen U. and a questionnaire developed and survey made to identify constraints in post-harvest handling chain (An. Rpt. 1993).

UPLB Objectives and accomplishments

1. Improve quality of existing peanut products.

(i) Peanut kisses and cake developed which had high sensory acceptability (An. Rpt. 92).

(ii) The quality of soft peanut curd was improved using high peanut to water ratios, and the product's storage life was evaluated (An. Rpt. 1993).

(iii) Study demonstrates that a bland tasting peanut can be produced for use in food products by acid treatment (An. Rpt. 1993).

(iv) Several cookie, snack, and bakery products developed at the ViSCA food technology laboratory (Resurreccion 1993).

2. Transfer food product technology to end users.

(i) Institute of Food Science and Technology, UPLB conducted several short courses on peanut processing for small-scale producers, teachers, and housewives. Leaflets describing processes for making peanut products were distributed (An. Rpt. 92 & 93).

(ii) Personnel and farmers in the newly formed USAPPA cooperative in Siquitjor (Region 7) were assisted in identifying peanut products for processing (An. Rpt. 1993).

(iii) DA officer, cooperative leaders, trainers, and selected farmers in Iguig, Cagayan were given a slide lecture on peanut products and processing (An. Rpt. 1993).

Other Related Technology Transfer Activities

(i) Bakery training programs by researchers at ViSCA have resulted in commercial production and marketing of bakery products (Resurreccion 1993).

(ii) Dr. L. Palomar organized and hosted a Food Expo and Trade Fair at Baybay, Leyte with exhibits and booths by several food companies (Resurreccion 1993).

(iii) Twenty-five selected persons trained at ViSCA in bakery operations to produce pan-de-sal and loaf bread and specialty breads (Resurreccion 1993).

3. Study the effect of processing on aflatoxin content.

(i) Aflatoxin content considerably reduced by boiling, roasting, and the addition of baking soda and soda ash (An. Rpt. 92). Reduction of aflatoxin levels in processing peanut products is primarily due to the effect of processing rather than dilution (An. Rpt. 1993).

4. Determine conditions for microbiological control of aflatoxin production and to identify and characterize the safety of such systems.

A metabolite produced by Cladosporium fulvum, which inhibits Aspergillus parasiticus, was extracted, isolated, and purified. Optimal conditions for inhibitory activity were studied, and studies are ongoing to develop a process for production of a stable form of the agent (An. Rpt. 93).

5. Develop products using residues of peanut milk.

Peanut milk residue was used in the formulation of (i) pork- and liver-flavored spreads, (ii) a yogurt drink with reconstituted skim milk, and (iii) a soft white cheese (An. Rpt. 1993).

6. Monitor aflatoxin levels in commercial peanut products.

In 1992, only one of the samples of eight brands of peanut butter exceeded WHO standards of aflatoxin of 20ppb. although six brands had some aflatoxin (An. Rpts. 92 & 93).

University of Georgia Objectives and Accomplishments

1. Develop alternative uses of peanut in foods.

(i) Peanut extract was used as a protein base to produce coffee whiteners in liquid and dried forms. The powdered whitener was rated equivalent in flavor to the liquid whitener and comparable in color and lightness to commercial controls (An. Rpt. 91). The development of liquid whitener is optimal in a 50% extract formula (An. Rpt. 1993).

(ii) Up to 46% substitution of peanut for wheat flour produces tortillas of equivalent quality (An. Rpt. 91). Substitution rates of fermented peanut milk for buttermilk, sour cream and yogurt in salad dressing, muffin and cookie formulations were determined (An. Rpt. 92).

(iii) An extruded snack derived from cornstarch and peanut flour, flavored with nacho cheese, Cheddar cheese, or sour cream and onion was acceptable to consumers and highly salable (Peanut CRSP 1993b; An. Rpt. 1993).

(iv) The potential for use of peanut combined with sweet potato in nutritionally enhanced cookies was demonstrated (An. Rpt. 1993).

2. Optimize conditions for separating mold-infected seed from sound seed.

A method was developed to separate 85.5% of peanut containing 50 ppb aflatoxin with a residual aflatoxin content less than or equal to 5 ppb (An. Rpt. 92). Use of a 0.075% hydrogen peroxide treatment does not result in detectable sensory quality alteration of peanut brittle (An. Rpt. 1993).

3. Determine the mechanism of "detoxification" of aflatoxin contaminated peanut by a bacterium, **Flavobacterium aurantiacum and methods for detoxification.**

Work in progress.

Comments

The 1991 and 1992 EEPs gave highly satisfactory evaluations of this project, not only for progress in attaining its objectives in product development, but also for its technology transfer component. It is apparent, however, that the goal of the project is inadequately stated, and the project objectives tend to be primarily a list of yearly tasks. The goal of the project presumably is to rectify both inadequate numbers of trained personnel and inadequate food supplies. The objectives, which indicate primarily what the principal investigators plan to do in a given year, inadequately indicate why they want to do those things, which is what an objective should do. In consequence it is often difficult to determine the more general directions in which research and development work on this project is headed.

Despite the favorable comments of earlier EEPs on the technology transfer component, this activity has not been much reflected in the annual project reports until 1993. In fact, if judged on this basis alone, the technology transfer activity would seem to be quite unsatisfactory, and this also is Ingram's (1994) assessment. The reports reviewed indicate that a definite effort to link with small producers has been made in Thailand, but this is only a beginning. What effort is being made to extend this to other markets? The 1993 Annual Report chronicles similar efforts in the Philippines which at least is a beginning. Fortunately, the Resurreccion (1993) Trip Report indicates that substantial technology transfer is taking place outside the organized efforts of the PIs involved in the project.

Despite the extensive research and development of food products using peanut milk and flour, the project reports are opaque as to linkages with producers of commercial peanut product. The researchers should be closely linked with commercial producer groups, responding to their interests and feeding information and product developments to them. But, there is only occasional evidence of this occurring. The slide lecture held in Iguig is one of the few instances where the opportunity to inject some of the peanut processing technology into local communities has been seized.

Although human resource development has been an important part of the project goal, it has not been formulated in systematic terms with target clientele, types of training activities, or levels of training projected. It rarely appears as objective but rather as an occasionally occurring activity. Moreover, it seems that sufficient attention has not been given to identifying target clientele in the food industry and of developing linkages with such groups.

E. Philippine Regional Research Stations and Technology Transfer

The Cagayan Valley Integrated Research Station (Ilagan) and the Cagayan Lowland Agriculture and Marine Research Station (Iguig), both located in Philippine Region 2, are administered by the Regional Department of Agriculture and responsible to its Director. Extension Service Officers are administratively attached to the office of Mayor of municipalities in the region. The staff--breeder, plant protection, etc.--of the regional research stations have functional relationships--training, advising, counseling--with the local extension officers.

The Regional Research Station at Ilagan, but not at Iguig, has on-station trials of the most promising new seed varieties (e.g., 20 varieties) approved by the Philippine Seed Board for evaluation in the National Cooperative Testing program. This program extends to four growing seasons--two wet and two dry seasons. After the first two seasons, the most promising of these varieties (e.g., 4 varieties) are selected by the Technical Working Group (TWG) for on-farm trials at the testing research stations.

The on-farm trials--8 rows X 4 meters and 4 replications--are managed by researchers and the local extension service officer with the farmer assisting. The objective is to fine tune general recommendations for the local, regional conditions. After the fourth season, i.e., second year--four seasons on station trial and two on farmers' fields--the TWG examines the performance data and decides which varieties will be recommended to the Philippine Seedboard for release after commercial multiplication. Once a variety is released, the breeder's seed can be released by the breeding institution, e.g., PCARRD. The Department of Agriculture provides training in seed multiplication and marketing and those who undergo training can be licensed by the Department of Agriculture. Seed Inspectors of local governmental units test quality of seed in field, and after harvest a sample is evaluated in the Seed Quality Control laboratory. Regional Research Stations can produce registered and foundation seed. However, they can not produce sufficient seed to meet local demand.

Once new variety seed becomes available, extension officers work with farmers on their own farm trials.

The competence and enthusiasm of people like Drs. Val Pardido and Ed Senna, Directors of the two research stations in Region 2, is impressive (as Brandenberg and Bailey confirm). They and their staffs provide excellent organizational and human resource vehicles for transferring technology to farmers in the region. It seems doubtful that adequate advantage is being taken of these resources.

The **Cagayan Valley Pilot Demonstration Project** at Damurog is administratively managed by the staff of the Cagayan Lowland Agriculture and Marine Research Station. The on-farm trials are a partnership of researchers, local extension officer at Damurog, and farmers. The farmers reportedly ave. 0.5 ha of peanut in dry season and come close to harvesting 2 t/ha. They plant peanut mainly in summer dry season. They seem to be relatively prosperous by Philippine standards. Farms ave. one ha and have 3-4 workers per family.

The information needs regarding peanuts mentioned by farmers were: marketing alternatives, better prices. Major constraints were the availability of seed, quality of seed (storage), yields, and lack of credit. Peanuts are sold locally to those who have provided credit or to local or regional traders.
The regional research stations are limited in the ability to develop relationships with farmers in promoting peanuts. The Iguig station, for example, is doing peanut trials in four areas, which is the maximum they can handle due to the fact that peanut is secondary to rice and maize and to the lack of foundation seed to give to farmers outside the four-project area, to lack of vehicles and manpower.

The group interview with farmers in the pilot project was friendly, open, and easy. It seems clear that the farmers' relationships with the Director of the Research Station (Ed Senna) and the extension officers--man and woman--were as good as, for example, farmers with extension and research in the U.S. They felt the Research Station staff was responsive to them and they appreciated the information which they got. The Station provides information and advice with respect to seed, culture, storage, fertilizer, inoculant, and pest control.

In this area, the major constraint is the lack of the best high yielding varieties (e.g., Pn 10). There is clearly demand for the seed and the institutional mechanism for getting it in the hands of farmers who want it. The problem is in the "Inadequate Seed Supply System" (Senna 1994), which is manifest in (i) lack of reliable source of breeder and foundation seeds, (ii) inadequate cold storage facilities, (iii) or supply of high quality seed to farmers, and (iv) training facilities for seed growers. Farmers typically plant peanut in the wet season so that they can have dry season seed as seed will not remain viable in farm storage longer than three months. This process represents a substantial cost which reduces the profitability of peanuts. It is a cost that farmers growing maize do not have.

The problems of credit, storage, transportation, and marketing are problems of institutional development and agricultural policy in general. It seems clear that working to alleviate these problems will help peanut growers along with producers of other commodities. Put otherwise, Philippine farmers will make progress in achieving national development goals of self-sufficiency in peanut production in as much as progress in modernizing the infrastructural and support institutions are modernized.

V. Monitoring and Impact Assessment, Feedback

As stated in the Global Plan (p. 1)), the goals of the Peanut CRSP are to enhance the capabilities of U.S. and host-country institutions to do research and develop technology that alleviate constraints to sustainable peanut production and utilization. It, thereby, hopes to enhance "the potential of peanut as a crop for human food and animal feed in host countries and the United States, while contributing to the increase of rural incomes." The Peanut CRSP is "constraint driven," meaning that in the initial planning surveys were made of the principal limitations to production and utilization of peanut, and these constraints have been the focus of research project goals. But, whether the solutions derived through research satisfactorily reduce constraints of farmers in particular communities is problematic.

Peanut CRSP scientists have developed various new seeds, pest management strategies, food products, and the like. The "Communication and Outreach" component is designed to facilitate the transfer of these techniques--knowledge and prototypes--to potential users or beneficiaries--farmers, food processors, and others. But, technology transfer and its impact on small farm family incomes are problematic. Technology is not finished, is not finally and fully developed, until it is in the hands of those who finally develop the management skills which enable the technology to fit into an existing production or consumption system. If they are unable to do so, or find the technology does not increase productivity or incomes, the new technology will not be used and the hoped for impact will not occur. Since rural economies, farming situations, world conditions, and even natural conditions are dynamic, constraints, resource conditions, and technology requirements continually change. Consequently, continual monitoring and impact assessment are necessary to enable scientists to generate useful solutions to present constraints.

This section is organized in terms of the following questions:

- What methodologies of monitoring and impact assessment have been employed?
- What deficiencies, if any, are identified?
- What is now required?

A. <u>Monitoring and Impact Assessment and Feedback during the present project period</u>
The principal mechanism is semi-formal. In compiling information for annual project reports and through the periodic contacts among PIs and cooperators during the year, much information is gained about acceptance and/or difficulties encountered with respect to new technology or new products by beneficiaries. Unfortunately, being semi-formal, it is not systematic, and the information obtained, although often insightful, has dubious reliability, generality, or analytic depth. Never the less, this is the principal feedback mechanism available for modification of project research objectives and research planning.

Several studies have been conducted which represent systematic efforts to determine the resource situations or particular technology impacts. In the Philippines, the studies by Garcia et al. (1990) and Huelgas et al. (1990) provide invaluable information about peanut consumption patterns and the role of peanut in farming systems, respectively. Guidance with respect to issues in, and expected results from, adoption of IPM techniques is contained in the Peanut CRSP sponsored study of <u>New Directions in Integrated Pest Management Technology Transfer</u> (Troost et al. 1992). Peanut CRSP (1993a) also reports that "the effectiveness of IPM practices developed over the last ten years in the Southern Philippines were conducted at Cebu with good success..." Haruthaithanasan et al. (1992) provide a preliminary assessment of impact of transferring peanut roasting technology to Huay-Bong-Nua Village in Thailand. The most systematic effort to assess the economic impact of a new technology was the study of the CARDI/Payne cultivar (Purcell et al. 1992). This study produced the startling information that the new variety provides a 42% yield increase over the conventional variety and could result in a $600,000 increase to the Jamaican economy--a notable impact indeed.

More limited in scope, but essential to product development, marketing and consumer acceptance, are studies evaluating consumer acceptance of new food products, which have been conducted in connection with AAM/FT/BF and GA/FT/TP. Related to this is the systematic effort to monitor <u>aflatoxin</u> levels in peanut paste products in the Philippines and Burkina Faso, and to work with processors to reduce the problem.

Finally, the Cagayan Valley Pilot Project in Philippines and the Thailand pilot projects and demonstrations (An. Rpt. 1992; Peanut CRSP 1993a) provide a rich source of farm-level impact information. The Cagayan Project, for example, provides the information that in the five-year period--1988-89 to 1993-94--the number of cooperators increased from 24 to 291, and average yields

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increased by 70%. It is also a rich source of information on local constraints to increased productivity of peanuts. It is not clear, however, that the system functions adequately to feed the information to persons in research and agricultural policy-making positions.

B. Deficiencies and problems

The 1992 EEP report remarked on the inadequate attention "given to the impact (or potential impact) of the newly developed lines in the 1991 report" (p. 9), and commended the TC for acknowledging the problem and allocating funds to correct it. The studies and reports mentioned above reflect the welcome attention that monitoring and impact studies have received.

Never the less, substantial deficiencies and problems remain. Although the number of improved cultivars released is growing, what is happening? It will not be satisfactory to wait four or five years after release to gather data with which to estimate economic impacts. Economic impacts can be simulated if satisfactory baseline information is available on farmers and farming systems. If such farm level information does not exist, then the Peanut CRSP needs to insure that studies of the Huelgas et al. (1990) type be done to provide the necessary data. The new Peanut HYVs are part of a larger complex of new crop seeds that is making farmers more productive and bringing about the slow transformation of farming systems and rural communities. Large scale field trials, if carefully monitored, provide an opportunity to assess both farmer and environmental responses to new technologies analogous to sensory trials of new food products. Such information would enable researchers to anticipate and measure some of the impacts of new technology before public release.

Second, as noted earlier, serious effort to deal with issues of sustainability will require continual monitoring and evaluation of soil nutrient, ecological, and socioeconomic impacts. No evidence has come to my attention that the TC has addressed this problem despite indications in the Global Plan that this would be done. It seems that the Peanut CRSP is operating almost totally in the dark with respect to this thrust. The exception is the effort in the IPM area to minimize environmental impacts and to assess grower acceptance of IPM techniques.

Third, except for the Garcia et al (1990) and the earlier studies in Sudan and the Caribbean (Wheelock et al. 1989), information on the dietary utilization of peanut products is lacking. Due to market price distortions, farm level prices for types of peanuts are not always a safe guide to consumer demand. It must be recognized that market development for farmers depends on market development by food processors and retailers.

Fourth, the monitoring and feedback mechanisms for obtaining both farm level and consumer (utilization) data and feeding this into the policy making and research objective setting processes are weak. It is not sufficient to argue that this is a reflection of weaknesses of host country institutions who have this responsibility as the Peanut CRSP also has institution building and human resource development responsibilities. Thus, with other donor agencies and institutions, the Peanut CRSP shares responsibility of working with host country institutions to develop the necessary capacities for gathering and analyzing data on peanut production and utilization.

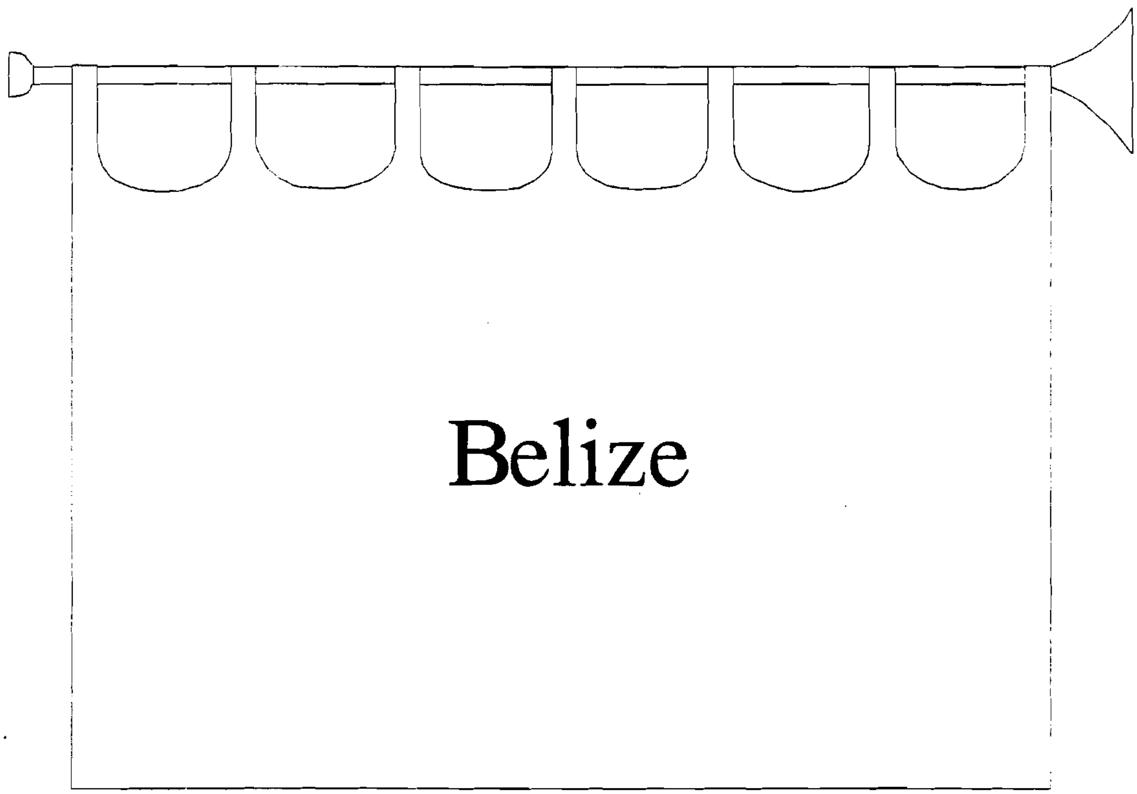
C. Some alternatives

Although natural resource management and communication and outreach are global thrusts of the Peanut CRSP, they have been only partially incorporated into the project organization of CRSP activities. The IPM projects have a resource management focus but it is limited to management of pests. At present the farm level research of peanut breeding projects is limited to the objectives of yield trials. This must change if resource management is to go forward. That is, farm level resource management with crops and pests should become project objectives and ways found for conducting research.

Communication and outreach has been incorporated into research projects primarily to the extent of professional publications and participation in international workshops and conferences involving other scientists. While outreach to the beneficiaries of Peanut CRSP in host countries is primarily a host country responsibility, the Peanut CRSP has institution and human resource building capacity and responsibilities sufficient to enable it to work systematically with host-country institutions in the development of outreach, monitoring and feedback capabilities. This too should become a more certain objective of the research projects and a responsibility of the PIs.

It is apparent that there is greater potential for monitoring and impact analysis in the pilot project areas, such as at Cagayan and Huay Bong-Nua, than is being realized. The Peanut CRSP PIs should work with relevant officials and agencies to develop and expand these potentials.

It is evident that the Peanut CRSP can substantial benefit from systematic studies of the socioeconomic impacts of new technology as well as of peanut production and utilization. Moreover, in Thailand and Philippines, at least, the scientist manpower to conduct such studies is in place.



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REPORT ON VISIT TO BELIZE

APRIL 25 - 28, 1994

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TRIP REPORT

Milton Coughenour
April 25-28, 1994
Belize, C.A.

Executive Summary

Despite unfortunate delays in route to Belize, nearly all scheduled contacts were made after we arrived. The team of Drs. Milton Coughenour and David Cummins was graciously received everywhere and the travel was superbly handled by Dr. A. K. Sinha who should be highly commended for hosting the team.

The purpose of the trip was to review and evaluate the Peanut CRSP/CARDI peanut research and development program. The cost of production has been the major economic constraints in making peanut profitable and the cost of the harvesting and post harvest handling--digging, threshing, drying, storage, and shelling--have been identified by CARDI as the components of the process requiring major improvements. CARDI, with technical assistance from the Peanut CRSP (notably GA/PH/CAR), has made substantial progress in developing satisfactory prototype machines to deal with these constraints. The technical assistance provided by GA/PH/CAR clearly has helped speed the development of prototypes for reducing these cost and quality constraints to profitable peanut production. It is notable that advantage has been taken of Peanut CRSP connections to acquire Thailand post harvest technology for evaluation in Belize as both the 1991 and 1992 EEPs recommended.

While further work remains to be done in developing or acquiring satisfactory diggers, threshers, and dryers, the success so far attained has led, as expected, to the emergence of other constraints, e.g., planters, means of weed control, and land. This highlights the point that increasing efficiencies attained through mechanizing other parts of the system to realize additional efficiency gains.

New types of risks, perhaps additional ones, are created in the process of capitalization of agriculture which is unfolding in Belize. Capitalization of farming operations (mechanizing) requires farm managers to become increasingly sophisticated in capital management. Needless to say, farmers will differ in their abilities to handle these risks and to establish profitable competitive positions, Some will fail. Advisory officials must take care to be especially cautious in recommending new investments.

Thus far, socioeconomic development of the target area in Belize, in overall terms, has been a spectacular success. To the extent that the Cristo Rey and San Antonio village communities are typical, the farming system has been radically transformed from traditional slash-and-burn milpa subsistence agriculture to modern subsistence-commercial production which is dynamic and continuing to improve in efficiency. This transformation has occurred in the past ten years or less. The change in agriculture has brought a dramatic improvement in the standard of living: from huts with thatched roofs to frame houses with electricity, refrigerators, hi fi's, trucks and other amenities.
The principal instruments of this transformation are four-fold.

(1) On the institutional sided, the development and success of the Belize Federation of Agricultural Cooperatives (BFAC), which has provided dependable input supply and product marketing enabling farmers to enjoy steady incomes from commercial agriculture and to earn surplus for capital and lifestyle investments.
(2) The successful intervention of CARDI representatives with, and the development and transfer of new technology to, farmers in the BFAC area, and their ability to utilize this technology in constructing a new, more efficient, system of farming.

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(3) The favorable market oriented policies of the Belize government and the participatiôn in CARICOM also have been important contextual factors in the economic development of agriculture over the last several years.
(4) The acknowledged linchpin of the agricultural and village development has been the emergence of a commercial peanut industry in Belize. The commercialization of peanut production, although not the only commercial crop, has provided the surplus income for further capital and lifestyle investment. The technical support provided by the Peanut CRSP to CARDI representatives has been a notable component of the development of the industry.

The profitability of the peanut industry, at the farm and processor level, over the past several years created expansionist fever, More farmers want more land to grow peanuts and other commercial crops and to mechanize other parts of their farming operation. For this strategy to be successful, markets must continue to expand, and this means market development both in the form of new and better quality products at lower cost. For this to happen, Belize institutions--BFAC and CARDI--will need new types of technical assistance, which the Peanut CRSP is able to provide, e.g., new large seeded and pink skinned varieties of peanut for farmers to grow and improvements in processing as well as new and improved snacks and foods. These newer, second generation constraints, will be just as serious and important to continued development, and will require as mush, if not more, research and technical assistance by CARDI and the Peanut CRSP as have the first generation constraints which are being successfully addressed.

Detailed Report

The principal purpose of the trip was to review and evaluate the Peanut CRSP/CARDI peanut research and development program in Belize. The schedule, which is appended, included meetings with USAID and Belizian Ministry of Agriculture officials, BFAC managers and farmers, and processors as well as Dr. Anil K. Sinha, CARDI Representative, and our host.

Departure from Lexington was on time at 6:20 a.m., April 25 and flights went smoothly until the last leg from Miami to Belize City, which was delayed more than three hours die to equipment problems. This delayed our (Milton Coughenour and David Cummins) arrival and the scheduled meetings with USAID. We were met at the airport by A. K. Sinha, who drove us to USAID.

1. April 25, 4:30 p.m. met with George Like, Agricultural Development Officer. Prior to his present assignment, George Like was in Indonesia and was familiar with the University of Kentucky Strengthening Grant and Matching Support Grant programs there as well as the Univ. of KY Sumatran Agriculture Education Project. He knows Dr. Herbert Massey (International Agriculture Programs) and Dr. Russell Brannon (Vice President of International Programs). The discussion the current situation of the Peanut CRSP, the Belizian Mission's current projects and future prospects, and highlights of the Belizian economy and agriculture.

David Cummins appraised George Like of the USAID administrative decision to take $5m. from CRSP funds for the IARCs, and to reduce funding for the Peanut, Small Ruminant, and TropSoils CRSPs in FY 95 by 50% and entirely eliminate funding thereafter. The Peanut CRSP is pursuing various strategies for obtaining continuing support.

The USAID Mission's planning horizon extends only two more years, i.e., until Sept. 1996 when it is scheduled to close. The Missions in Costa Rica and Barbados also are scheduled for closure due to county prosperity (compared to such as Guatemala and El Salvador). They are "right sizing" existing bilateral programs which are scheduled to be finished along with most "centrally funded" projects. But, it is possible that some centrally funded projects might continue. The major ongoing projects focus on natural resource management (e.g., park administration, wildlife management), short term training,

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tourism, and soil conservation on fragile lands. These projects have been successful: the training has been good and people have returned to help develop the country.

The government is responsive to development and people take pride in government. It is stable. Population is growing slowly, but no exploding despite the pressure of "economic refugees" from Honduras, El Salvador, and Guatemala where wages are generally lower and relatively high growth rate (2.5%). Population pressure is attenuated by relatively high out-migration to the US and Great Britain. Traditional agriculture is declining in Belize and commercial ("modern") agriculture is increasing. See selected statistics below.

The Mission has a "very loose relationship to the Peanut CRSP." There is little oversight and no accountability. George likes to keep informed of the work through CARDI, especially of the travel. The Mission has generally supported centrally funded projects.

2. Tuesday, 8:30 a.m., we were scheduled to meet Minister Russell Garcia, but he did not arrive until after 9:00 a.m. He was quite gracious, was pleased to see us, and quite interested in the purpose of the visit and in the problems and prospects for peanut production and utilization. He noted that some farmers who wanted to grow peanuts didn't have dryers, e.g., in Hopkins. With respect to the apparent decline in domestic consumption, the Minister felt that more systematic information about consumer preferences was needed. In particular, the role of peanut in diets, especially of immigrants, is not known, the importance of the protein contribution, the kind of packages, and the kinds of snacks desired. There are apparent price and quality problems with Belizian peanut butter. Grinding equipment, which would provide better quality and reduce cost, is somewhat costly but within reach of present producers.

3. Tuesday, 9:20 a.m. met briefly with the acting Secretary, Ministry of Agriculture, who has administrative responsibility for Belizian extension, research, and veterinary programs.

4. Tuesday, 10:00 a.m., A. K. Sinha stopped at the CARDI office and supplied documents on Belizian population and agriculture.

Population (Source: 1991 Population Census, Central Statistical Office, Ministry of Finance, Belmopan, Cayo, Belize.)

(i) Population: 189,392 (adjusted to 192,877).

(ii) 48% urban, and 52% rural, which reverses trend to majority urban population of previous censuses.

(iii) Ethnic composition
- Mestizo 43.6%
- Creole 29.8%

(iv) Language facility

	Spoken English	Spanish
Very well	54.3%	43.8%
Not so well	22.5	11.1
Not at all	23.2	45.1

(v) Income
- * 50% earn less that $8,640BZE.

Agriculture (Source: Agriculture Production Statistics, Ministry of Agriculture)

Although the relative importance of the agricultural commodities produced in Belize is difficult to assess since the monetary value of the annual production was not made available, the Ministry of Agriculture production statistics indicate that the major commodities in volume are sugarcane, citrus--oranges and grapefruit--corn, rice, beans, and bananas. With 1991 as the last year of officially available statistics, the production of rice and sugarcane had remained relatively stable during the preceding decade; citrus production had steadily increased of five years, until 1991, and the production of bananas, corn and beans had doubled between 1986 and 1991.

Nationally, peanuts is one of the minor crops, along with cocoa beans, soybeans, cabbages, tomatoes, and sweet peppers. Production statistics on most of these crops were not kept prior to 1987. Since then, peanut production seemingly has declined, having been 210,000 kg. and 184,000 kg. in 1987 and 1988, respectively, and only 158,000 kg. in 1991, and dipping to a reported low of 106,000 kg. in 1993. Meanwhile, soybean production has jumped dramatically, from a minuscule 19,000 kg. in 1987 to 275,000 kg. in 1991. there is reason, however, to doubt the reliability of the official peanut production statistics.

The capsule history of peanut growing in Belize, provided by A. K. Sinha, is that it was introduced by the Mennonites and diffused to surrounding Mayan communities in Cayo district during the 1970's. CARDI became interested in the crop because "(a) it was a small farmer crop, (b) it could replace imports, (c) it will add to the farmer's crop base and income, and (d) a project for peanut development was being funded by EDF through CDB" (Technology Generation and Transfer: Belize Experience by S. Parasram I. Ameen. CARDI, August 1990, p. 7) and started working with farmers in San Antonio in 1979. At that time farmers were using "slash and burn" to prepare milpa, and CARDI representatives sought to improve the system. In 1982, several cooperatives were formed, and 1983 peanut production expanded sufficiently to make Belize self-sufficient, and in 1985, peanut butter making was started.

In the "Status of the Peanut Industry in Belize" Azucena Quan (February 11,1991) reports that the production of Tennessee Red peanut--principal variety grown--is concentrated in the Cayo district where 350 to 500 acres are cultivated annually, representing about 50% of Belizian production. "Commercial yields commonly fluctuate between 800 to 1800 pounds per acre . . . compared to an average of 2000 pounds per acre in the U.S." Quan argues that "with adequate husbandry, yields could improve by some 25% to 50%" (p.2). While domestic consumption had averaged about 187,000 pounds per annum, export sales had only promoted by BEIPU (Belize Export and Investment Promotion Unit) since 1989. Export through CARICOM to Barbados and Trinidad has increased from 17,500# in 1989, to 86,170# in 1990, and 157,000# in 1991, earning BZ$182,000 in the latter year.

Writing on the "Role of CARDI in Agricultural Research and Development in the Caribbean Region and Belize," A. K. Sinha declared that Belize could "maintain a sustained production of peanut," (p.9) but that production of cheaper and quality peanuts was constrained by:

* foliar diseases
* lime induced chlorosis in some fields
* insufficient inputs
* manual harvesting
* manual picking of pods
* poor match between varietal quality and use

From a cost standpoint, contended A. K. Sinha, the major constraints are in harvesting and post harvest handling. The Peanut CRSP and CARDI have collaborated in reducing these constraints. (1)

Work to develop mechanized threshing started in 1987 with modification of an imported harvester from Georgia--adding car wheels to improve mobility. A locally made thresher, which GA/PH/CAR designed, is now available, but it is relatively costly at BZ$7,000 and has problems when the pod stems are green and wrap the threshing drum instead of snapping off. A lighter, more mobile thresher is needed, and one from Thailand is being obtained for testing. (2) Harvesting of the main crop in September, when sun for drying is unreliable, requires artificial drying to prevent A. flavus and rotting. San Antonio built a dryer with wood as a heat source. The dryer was modified to dry hybrid corn, and with design help form GA/PH/CAR, a kerosene burner and fuel drums were substituted for wood. New, butane burners, which are cheaper, easier to use, and cleaner, likely will replace the oil burners. However, the dryer is big and expensive. A smaller, portable dryer, which can handle 1,000 lbs. at a time, is needed. Jamaica also needs a small dryer because they grow several varieties of peanut and don't want to mix them in drying. (3) To speed the digging of peanut, Urban Wilson (trained as agr. engineer with Peanut CRSP support) designed a digger which works well in the dry season, less well in the wet season. It will be tested in Hopkins. (4) Although not of much concern to farmers, processors require improved shellers which handle larger peanuts and have blowers that do a better job of cleaning.

Fortunately, with present production and harvesting methods, aflatoxin is not much of a problem in Belize. Moisture content of stored peanut is less than 10%. In a whole year study never found above allowable aflatoxin levels, and now only test exported peanuts. Haven't checked domestic peanut butter.

5. Nelson McAndrew, CARDI Seed Technologist--Farmers save the seed of Tennessee Red, which is the only variety, each season for planting. But, the seed quality is not very good. The farmers don't save the best quality seed and they don't run germination tests. The Belize Federation of Agricultural Cooperatives (BFAC) could produce and sell better quality seed. Seed should be replaced with better foundation seed every three years.

Labor in planting and harvesting is the main input in peanut production.

Observations and comments

Mechanization that protects quality of the product, such as a dryer, should be distinguished from mechanization that is labor saving. While the former is a necessity, the latter may or may not be constraining depending on the opportunity cost of labor, i.e., the availability of, and the alternative uses for, labor including the availability of additional land. If labor is available and there is no better use for it, mechanization increases, rather than reduces, costs. This highlights the importance of the opportunity to acquire additional land, which can be harvested with the same labor and new machines. Alternatively, an additional economic crop might be produced. But, the issue is likely to be more complex because the additional land, or crops, must first be planted and cultivated. This means that the farmer must also master the technology for the other crop(s) and/or be able to buy or "lease" a tractor, planter, and a cultivator (if he doesn't already have one. On the other hand, if he already owns a tractor and planter, then the additional land likely is needed for its efficient use.) Individual farmers are likely to differ in what is the best management decision for them. Administrators should be vary of assuming that the decision to machinize is the best option for everyone.

With the increase in mechanization, socioeconomic analysis to measure the conditions of its efficient utilization becomes increasingly imperative. For example, would a smaller, more portable dryer be more cost efficient than the larger, stationary one? How many smaller ones would be needed? Is the total cost, then, more, or less, than with one large dryer? How does the cost benefit situation change, if a new, larger seeded, variety of peanut is introduced? What are the comparative cost benefits? Capital investments, like other investments, incur risk. Some farmers are better able to handle these than others. Success (or failure) increasingly depends on the ability to manage capital and handle machines.

5. Tuesday, noon check in and lunch at the St. Ignacio Hotel.

6. Tuesday, 1:00 p.m. met with Mr. Bert Enriques (Manager) at the Belize Federation of Agricultural cooperatives (BFAC).

"BFAC's mission is to assist the cooperative farmers to improve their standard of living through increasing their incomes thereby enabling the cooperative to which they belong to become self sustainable.

"BFAC is committed to the Holistic and Sustainable Development of the Cooperative farmer and provides the following services:

* marketing
* training and education
* technical assistance
* production and productivity
* women in development
* youth training
* cooperative activities
* environmental conservation."

<u>Question</u>: What is the attitude of farmers to BFAC?

There is a continual educational program on BFAC benefits and services. It seems that farmers' believe that the benefits outweigh the pains.

With respect to the services, marketing is the key; BFAC buys the farmer's crop(s) and sells them. BFAC provides a complete package--recommending what to grow, providing the inputs, which are purchased in bulk, and selling the product profitably. Technical assistance is provided by a team--agronomist and extension worker--funded by the Interamerican Foundation. Another group, including A. K. Sinha, provides technical advice. BFAC extends credit for purchase of necessary inputs using the crop as security for the loan. The loan is repaid from receipts of the crop sale. Managers of member cooperatives are trained through a Management Assistance program.

<u>Question</u>: What is BFAC's specific role in peanut production?

Peanuts were part of the subsistence farming system when BFAC was established, but they were commercialized through BFAC's marketing and technical assistance programs. Under the traditional "slash and burn" system, farmers averaged about 800#/acre; now, they grow about 1,030#/acre, a 28.8% increase. In 1992, the BFAC farmers grew 102,410 lbs, and in 1993, 200,000 lbs (90,909 kg) on about 350 acres. BFAC exports, in 1993, primarily to Barbados, were 175,000 lbs.

Notice, BFAC production alone is only slightly less than the official estimate of total production in Belize, which brings the official estimate in question. It is important of policy purposes to know what the trend in production and consumption--domestic and foreign is. From the BFAC perspective both trends seem upward while the official figures lead to the opposite conclusion.

With mechanization and the success in commercial production of peanut, farmers in San Antonio desire more acreage. The IRC Quick Impact Project is supporting land clearing for this purpose.

Question: What are the important problems facing BFAC?

our biggest problem is "market funding," i.e., obtaining the credit to purchase and market what farmers produce. At present, we can't obtain sufficient credit to purchase the entire crop; so, farmers sell the surplus to middlemen.

Why can't credit be obtained? The major source of credit is development agencies at 8.5%. Local funding institutions are reluctant to lend to unsecured creditors and are biased against cooperatives because of the early history of failure of cooperatives to repay loans. So far, local institutions have not been willing to consider the improved performance. The National Development Corporation can only lend $50,000 and wants repayment in 60 days. This is only a small portion of the amount needed, and Caribbean countries sometimes take 120 days to pay for imports. This forces BFAC to take an overdraft at high interest and juggle funds to come up with funds to purchase farmers' crop.

Technically, B. Enriques argues, planting, harvesting, and storage are the biggest problems. If farmers could be persuaded to use diggers and strippers (harvesters), production costs could be considerably reduced, enabling BFAC to sell to Trinidad. Harvesting by hand costs BZ$.12/lb while machine harvester would reduce cost to BZ$.03/lb. One farmer can dig only .5 acre/day = BZ$20 while machine digging enables a farmer to ore than quadruple the productivity. With faster digging, faster stripping ad drying become more imperative. At present, a stripper (harvester) that works well with green stems is a bottleneck. More over, if farmers become more labor efficient in the post harvest present, planting is primarily done by hand, but in planting larger acreage hand planting will be a constraint. This will put pressure to either cultivate mechanically or to use chemical pre emergent and post emergent herbicides.

Hence, notice that mechanizing the post harvest production process generates pressure to mechanize all of the parts.

7. Tuesday, 4"00 p.m. met Rudolfo F. Tzib, Chairman of the BFAC Board. He started growing peanut in milpa in 1978. But, he began converting his farming system in 1986. He has used fertilizer for three years now and has a tractor and electricity in his home.

Traveled in A. K. Sinha's truck to Cristo Rey village and examined the peanut storage shed, where some peanuts from a "failed crop" were spread out drying. Contact person was not there. The trip was continued to San Antonio village, meeting Eduriges Tzib, nephew of Rudolfo, and Chairman of the San Antonio cooperative. This cooperative started with a few members in 1986. The big problems in raising peanut at present are the shortage of harvest labor--one family can only harvest about 3 acres--and of land. an effective stripper (with green stems) also is a problem. A dryer and other equipment is available.

Note: the lack of land thus is a constraint to further mechanization. If more land becomes available, the incentive will be strong to mechanize rapidly.

Mr. E. Tzib and family now has a nice two-story frame house. It was wired for electricity two years ago, and he now has a refrigerator, hi fi, electric lights, fans, and a truck. The major problem is the lack of a satisfactory source of water. Even so, his lifestyle is substantially better than formally.

Later, met Alfredo (?) who was not a member of the San Antonio cooperative. He raises pigs as well as subsistence crops and some peanuts which he sells to the Mennonites. Presently, his problem in producing fat hogs is that feed costs are rising and protein quality of affordable feed is low. A. K. Sinha offered suggestions on how to get better quality feed. Alfredo also owns a truck.

A. K. Sinha emphasized that 10 years ago the people in San Antonio lived in huts with thatched roofs. Only the persons who did trucking has trucks, and, of course, there was no electricity or electrical appliances. Now, families have wood or concrete frame houses with tim roofs. The commercialization of peanut production, along with fat hogs, has been the main development factor. Income from peanuts has been invested in harvesting and drying equipment, improved life style and citrus, which had favorable prices for several years. Now, the citrus is about ready to begin production but the prices for concentrate have fallen. (Clearly, there is a market development problem.)

Observation and comment

The extent and pace of socioeconomic and technical change in San Antonio and doubtless in the other BFAC villages has been quite remarkable. The change encompasses both the system of agriculture and the way of life. In less than 10 years, the system of traditional subsistence agriculture has been radically changed to modern, commercial agriculture. And, the way of life has become transformed too, including a number of important amenities. The principal instruments of this transformation, in so far as this brief visit reveals them, are the quality and extent of technical advisory assistance provided primarily be CARDI representatives and the reliable supply and product market outlets provided through BFAC. The close working relationship between CARDI and BFAC also should not be overlooked.

Much of this could not have occurred without the fortunate recognition of the opportunity of commercializing peanuts through CARICOM. While peanut has not been the only commercial commodity, it seems to have been the one to bring in the more money, providing the surplus which has enabled other developmental investment to occur. Thus, transformation of the system of peanut production has been central to developmental success. In this, the primary set of constraints have been in the post harvest production process--digging, striping, drying, and storage. Although fully satisfactory solutions to mechanizing these operations have not been attained, partial solutions have been made which have enabled farmers to increase both labor efficiency and protect the quality of the crop. CARDI's collaboration with the Peanut CRSP, notably GA/PH/CAR, has been important in the successful development of several of these machines as well as in supporting the training of several key scientists. Without this collaboration, the present level of technical development would have been delayed, if not deferred.

8. Wednesday, April 27, 9:00 a.m. met Herman Velasquez, Piache Tours and foods at his peanut processing facility.

The visit provided the opportunity to review the steps in making peanut butter:

1) Shelling--removing and separating the seed from the husks.
2) Roasting--Uses kerosene burner to provide heat to a rotating oven. Technician does checks manually on the progress of roasting.
3) Cooling--Nuts are transferred to an open bin with circulating air for cooling.
4) Shredding--removal and separation of the red hull and heart (germ) from remainder of the peanut.
5) Cleaning--manual removal of defective peanuts and any other foreign material.
6) Mixing--adding stabilizer, salt, sugar and any other additives.
7) Grinding--the mixture is ground and heated at 70 degrees Centigrade.
8) If it is to be "crunchy" peanut butter, the coarse ground nuts are added.
9) Packaging--8 oz. and 16 oz. jars are filled.
10) Pounding--jars are tapped manually on board to facilitate removal of air bubbles.
11) Labeling--Labels put on jars.
12) Boxing--jars placed in crates for transport and sale.

With present facility and workforce, H. Velasquez can produce about 20 to 30 cases of 8 oz. and 16 oz. jars per day. Principal problems are in separation of oil and peanut medium in peanut butter, apparently due to difficulties in grinding and with stabilizer. The latter problem has been corrected, and A. K. Sinha recommends purchase of an improved grinder which will cost about BZ$7,000.

H. Velasquez is processing only about 20,000# peanuts annually. He purchases surplus peanuts that BFAC can not market overseas. The market, he says, was slow but is picking up. Thus, he doesn't have evidence of a decline in domestic consumption; he believes peanut butter consumption is increasing. He has competition from Trinidad and Jamaica but has a price advantage.

9. 10:00 a.m., Friendly Family Foods, Joseph Theissen, Manager.

FFF purchases about 150,000# peanut annually. 80,000# goes into the domestic market and 70,000# are exported. The principal products are: 1) crunchy, smooth, and natural peanut butter, 2) brown sugar and chocolate peanut brickle, 3) packaged salted peanuts, and 4) unshelled roasted peanuts. Both the domestic and foreign markets are slowly expanding. FFF regards Piache as a competitor in the domestic market.

The peanut butter production process is essentially the sam as that used by Piache, but it may be better controlled and the product quality may be better. They can produce about 36 cases per day of peanut butter.

10. 11:15 a.m. departure for Belize airport.

11. 1:45 p.m. depart Belize for Miami, arriving at 5:45 p.m.

Scheduled departure for Atlanta was delayed until 8:30 p.m. by bad weather in the Atlanta area. Arrived in Atlanta about 10:30 p.m.

Left Atlanta at 8:30 a.m., April 28 and arrived in Lexington at 9:50 a.m.

Observation and comment

It seems evident that the constraint priorities and collaboration at the present time are too narrowly conceived. While Tennessee Red has served market needs to a degree, the dark color, relatively sharp taste, and relatively small seed make it less suited to consumer tastes than other varieties. Belize farmers probably should be growing different varieties of peanut which may be better suited to consumer demand for peanut butter and salted peanuts. This is the next level for peanut production in the Cayo district to move. More over, it is apparent that the fledgling processing industry could benefit from technical assistance in product development, processing, and packaging. (Research on blending peanut varieties grown in Belize to produce a better quality peanut butter is planned for 1993/94 under GA/PH/CAR.)

The domestic market for peanut products, as seen from the vantage point of producers and processors, seems to be expanding, rather than contracting. With a growing population and rising personal incomes, which is occurring in Belize, the domestic market for peanut products will likely continue to expand. With economic recovery in the U. S. and Europe, the Caribbean regional economy also is likely to be in an expansionary phase and, thereby, the export markets as well. Producers and those providing technical and marketing infrastructional support should be positioning themselves to take advantage of the market opportunities and to meet both the foreign and domestic competition. The lack of product/consumer analysis probably has contributed to CARDI's and BFAC's slowness in recognizing the importance of these constraints and the emerging opportunities and in seeding collaborative assistance to reduce them. Doubtless, the Peanut CRSP has the resources, especially in the food technology and breeding projects, not only for market analysis but also to provide the necessary technical assistance in the development of new varieties. If new varieties, better suited to consumer demand are developed, experience elsewhere show that seed multiplication (and distribution) is likely to emerge as a constraint.

One implication of this analysis is that it would be a serious mistake to assume that collaboration is less needed now that the first generation of constraints are well in the way to being solved. Historical experience shows that the second and third generation constraints, which emerge as the industry develops, are quite as much threats to further development as were the first generation constraints. Therefore, ways of providing the collaborative research support for further development of the peanut industry in Belize should be explored.

Itinerary

APRIL 25-27, 1994

PEANUT CRSP TEAM

MONDAY 25 APRIL, 1994

12:00 noon ARRIVING

2:00 p.m. Meeting with USAID Acting Director Mr. Dakan and the Agricultural Development officer Mr. G. Like.

Overnight in Belmopan at the Bull Frog Inn

TUESDAY 26 APRIL, 1994

8:30 a.m. Minister Russell Garcia, Minister of Agriculture.

9:00 a.m. Mr. Rodney Neal, Permanent Secretary, Ministry of Agriculture.

10:00 a.m. CARDI Research Station

11:00 a.m. Travel to San Ignacio

1:00 p.m. Mr. Bert Enriques, Manager, Belize Federation of Agricultural Cooperatives (BFAC).

2:30 p.m. San Antonio and Cristo Rey

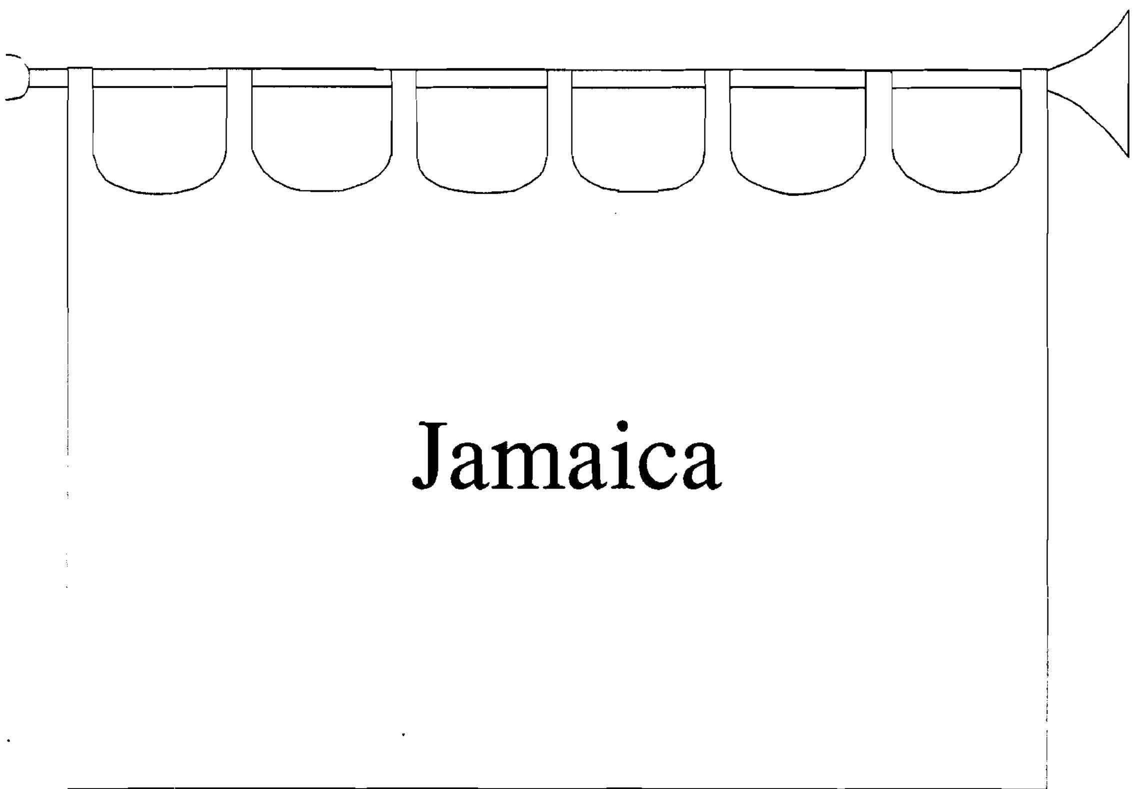
Overnight at San Ignacio, San Ignacio Hotel

WEDNESDAY 27 APRIL, 1994

8:30 a.m. Herman Velasquez, Manager, Piache Enterprises.

9:30 a.m. Joseph Thiessen, Owner, Friendly Family Foods.

10:00 a.m. Depart to Belize City


Jamaica

THE JAMAICA COMPONENT OF THE PEANUT CRSP EVALUATION REPORT: SOCIOECONOMIC IMPACT ASSESSMENT OF THE FIVE-YEAR EXTENSION 1990-1995

Handy Williamson, Jr.

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Knoxville, TN

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Executive Summary

A. Major Observations

This evaluation report represents the results of activities and interpretations which characterize the Peanut CRSP's progress in Jamaica. Also, this evaluation represents an earnest attempt to characterize economic impact under extremely difficult time constraints. Since the earlier economic/yield impact study, not much has changed. Therefore, this evaluation and summary focused on impact in the utilization sector.

Several aspects of the CRSP and this evaluation are summarized as follows.

- Several limitations to the impact assessment were discussed in the report. However, the major limitation was felt to be the incompleteness of the social science survey component of the project. The survey is well under way and would perhaps be completed by the official ending date for the CRSP. The data to be generated by that survey is critical to studying the impact of post harvest technology in Jamaica.
- The place of peanuts in (formal) Jamaica's economy appeared to be unsteady due to insufficient development and use. It was mentioned that demand for peanut in Jamaica is not being met with local production. Some suggest that a desirable, high yielding variety is the constraint. Also, post harvest technology is not seen as problematic, by some agriculture opinion leaders.
- Environmental enhancement attributes of the peanut and its increased and strong potential as a food crop argue for a more sustained place in Jamaica's economy combined with the role as a cash crop these factors make a strong case for continued research and education to exploit the peanut crop.
- The Peanut CRSP practitioners chose to focus efforts on "mitigation of post harvest technology constraints." This was allowed to drive approaches, project design and CRSP resource allocation. However, when talking with the various stake holders in the research program, it appeared that the assumptions regarding CARDI/Payne's acceptance and abilities were not well guided. Many persons suggested directly and unintentionally that the post harvest technology is not the key problem. Rather consumer non-acceptance of CARDI/Payne and the lack of a "suitable" cultivar is the key constraint.
- The country level, project specifications brought identity to achievable tasks and expectations. They varied by country, but collectively called for the following: (a) cultivar improvement, (b) integrated pest management, (c) improved food products, (d) enhanced disease control, (e) control of aflatoxin, (f) control of the rosette virus, (g) improved processing technology, and (h) enhanced supply of peanut for human food and livestock feed. Jamaica was to feature on the latter two elements of food-feed supply and post harvest technology. Sadly, not much progress was made on either front.
- Accomplishments have been recorded and vented through annual review reports. The most striking accomplishment was the release of CARDI/Payne. An earlier impact report showed tremendous yield response and rapid adoption by farmers. Discussions during this visit and review of documents fail to substantiate the wide adoption claim. Failure to accept CARDI/Payne reflects lingering concern about less desirable features of the new cultivar.
- Economic impact was given initialization with an earlier review in 1992. That review measured change in yield due to new varieties and measured the value of that yield in world market prices during the applicable years. That analysis alone suggested benefits which outweighed costs, in the short run. The amount of a projected increased yield ranged from 1,000,000 to 3,000,000 pounds. The yield figure and implied impact assumed broader adoption. That broader use has not yet materialized and farmers and consumers exhibit some reluctance in switching from Valencia to CARDI/Payne.
- Post harvest technologies are still evolving. There have been some successful attempts to copy and fabricate machinery for threshing, shelling drying and storage. The redeemable aspect of

this activity is that the fabricator used locally available materials and lessened the constraining impact of using imported technology and materials. However, much of what has been developed needs to be tested and refined for safety and mechanical durability.

- The much talked about and written about "drying facility is in line to be dubbed a "white elephant." Although the building is complete and equipped with drying and storing capacities, the facility is not being used. The much touted technology for drying is taking a back seat to traditional drying methods. Some claim that the facility is poorly located. Others suggest that cooperative type utilization arrangements need to be made. There, is also concern for theft and perdition.
- Labor costs emerged as a key constraint to increased peanut production and utilization. Farm hourly labor for planting, cultivating, harvesting and threshing, etc., nearly doubled in recent years. This prompted some farmers to shift to job (piece) work allocations. A partial enterprise budget suggested that labor would cost more than J$8,000 per acre to grow peanut. Technology development would help abate the impact of increased labor cost. The new CARDI/Payne variety has the potential of increasing cost due to more weeding required and to the difficulties in picking and shelling (by hand).
- Prospect for expanded and increased utilization of peanut are not presently rosy. The processors expect to utilize more peanuts, but the quantities may be small. New uses of peanut, except for in weaning food, were not readily discussed. At best it can be hoped that Jamaica's farmers will be able to supply a larger share of the peanut consumed in the country.
- The price of peanuts presents a hefty challenge to the government and to farmers. Typically, the farmers will respond to higher prices within desire to grow more peanuts, causing the supply to increase and the price to fall. Such adjustments are not without market stress on both the up and down sides. Currently, the price of peanuts is artificially high. The processors find it difficult to acquire peanut for weaning food, paste, candies and pastries. When prices rise due to hoarding (as may be the case presently), the profit is reaped by monopolistic entities rather than the masses.
- Complete enterprise budgets from crops were not available. During the discussion, certain labor costs (per acre) were disclosed. They are: Planting, J$1,500; Weeding, J$3,500; Pulling, J$1,500; and Picking/Threshing, J$8,300 per acre. The cost of machinery for land preparations, cultivation and shelling along with the cost of drying and storage would drive total cost even higher.

B. Conclusions

This is not an exercise in negative issues raising. However, this evaluator felt compelled to focus (briefly) on issues that influence the CRSP's impact and capacity to sustain the economic benefits expected. They are shared below.

- CARDI/Payne is yet fraught with utilization problems: longer growing season rules for more labor for weeding, more expense for chemicals. The strong vine attachments and tougher hull lessens desirability to farmers and others. This may be overcome with machinery development for post harvest processing.
- CARDI/Payne is yet blocked by consumer acceptance concerns. The Valencia variety remains the strong peanut of choice by consumers. The skin color, texture and taste of CARDI/Payne are yet seen as objections by locals.
- CARDI/Payne and Valencia usage in infant weaning food has met with technical difficulty. The oil and moisture content of the peanut flour tend to clog the flour mill at JCF. Further research and adjustments are needed to protect and utilize this outlet for peanut.
- The current export market is not felt to hold potential for generating substantial increase from peanut sales aborad. If CARDI/Payne is to be promoted and accepted and yields are captured, there must be suitable outlets for the product in both domestic and export markets.
- Crop Enterprise Data--not readily available. It is not possible to conduct comparative impact assessment on new technology (post harvest) without benchmark data.

- Labor Cost Data for various farm enterprise activities was not available on a scientific basis. Without such comparative valuation of tasks amount to a continual guessing game.
- The new Drying Facility (at Newton) was not being fully utilized. While CARDI is working out suitable administrative arrangements, there exists the notion that the farmers have problems with the location and security.
- The appropriate postharvest technology for threshing, shelling and drying is within reach of the people and sustainable materials and methods are used. However, more care should be given to user safety.
- Some collaborators in the agriculture sector do not concede that the CARDI/Payne is a breakthrough (new and viable) variety. In government published newsletters the call is on for the selection of "viable high yielding peanut variety, acceptable to consumers." This might suggest an information dissemination problem.

C. Recommendations

- Reassess the exclusive focus on post harvest technology. Would suggest more stress on producer and consumer acceptability of CARDI/Payne.
- Conduct safety tests on fabricated equipment and evaluate more thoroughly the cost and time savings from increased mechanization. Necessary data enterprise data, time and motion and safety) adjunct to these determinations should be collected, analyzed and interpreted.
- More attention should be focused on utilization. Find ways to generate new products which would utilize peanuts. Should also explore possible non-traditional market outlets for the products.
- Don't abandon the CRSP initiative at this time. The vexing problems of acceptance, utilization and marketing represent the final curtain of constraint precluding derivation of benefits from the "new variety," CARDI/Payne.
- Explore ways of capitalizing private sector investment in the utilization of peanuts and in refining the appropriate technology so vital to the agriculture and people of Jamaica.

Scope and Objectives of the External Evaluation

A. Introduction

The External Evaluation Panel (EEP) is a required component of the Peanut Collaborative Research Support Program (CRSP). The panel concept was agreed upon by the United States Agency for International Development (USAID) and the CRSP performing organizations' management entity--The University of Georgia. Historically, panels have been organized and have systemically evaluated the CRSP's performance. Those evaluations have been effectively executed. While prior evaluations have been effective, they were said to have fallen short of conducting relevant sociological and economic impact assessments in most host countries. Jamaica has been the exception. This EEP and final report were to follow up on prior impact assessments and cover post harvest technology. The social and economic impacts were to be assessed.

This current external evaluation comes at a critical time, when AID's support base and budgetary capacities, and country programs appear on the wane. It also is conducted at a critical transition for the Peanut CRSP and for other CRSPs. Ten years have passed since the Peanut CRSP was initially funded and considerable support has been expended in hopes of capturing results from many years of promising research. Therefore, this team tasks turned on not only evaluating impacts, but also as making critical recommendations about future directions.

B. Structure and Scope of the External Evaluation Panel

To achieve a comprehensive evaluation, and respond to earlier recommendations, it was determined that the panel (EEP) should have members who were practicing sociologists and agricultural economists. They would work in colleagueship with the technical scientists to "round out" the evaluation. The management entity achieved that milestone by building a panel of the following individuals:

- Dr. John Cherry, USDA/ARS, Food Technology
- Dr. Bo Bengtsson, University of Agricultural Sciences, Upsalla, Sweden
- Dr. Milt Coughenour, Professor of Sociology, University of Kentucky, USA
- Dr. David Hsi, National Academies of Sciences, New Mexico, USA
- Dr. Robert Schilling, CIRAD-CA, Montpellier, France
- Dr. Joe Smartt, Professor of Biological Sciences, University of Southhampton, UK
- Dr. Handy Williamson, Jr., Professor and Head, Agricultural Economics and Rural Sociology, The University of Tennessee, Knoxville, USA

The collective expertise of these panelists would allow for proper subject matter coverage and for encompassing the desired socio-economic impact analysis. Additionally, the group represents a tremendous body of ability in terms of years of experience and geographic coverage, country knowledge. methodology and familiarity with the intent of the CRSP.

The evaluation task was to collect and evaluate data on Peanut CRSP:
(1) inputs.
(2) system and human capital development,
(3) research output-communication, and
(4) utilization of technology by clientele.

The Peanut CRSP inputs include information (e.g., constraints, concepts, theories, etc.), and financial and human resources. System and human capital development includes net-working and research capacity building with the Peanut CRSP and networking (i.e., building relationships, not merely with other scientists and CRSPs) with various clientele (user) groups. On the human resources side this included the training of scientists and technicians. Research output-communication included publications, workshops, conferences, seminars, etc., for Peanut CRSP and/or other scientists and clientele. Technology utilization included information, technology prototypes (e.g., varieties released) and trained personnel obtained from the Peanut CRSP by clientele or other research systems, and the use of these "products."

A more detailed delineation of the EEP's scope of work as reflected in specific question sets, is included in the appendix section. The foregoing merely served to provide the general boundaries of expectation faced by the EEP/consultant.

C. Scope and Limitation of the Socio-Economic Inquiry

The evaluation task in Jamaica was to collect and evaluate data on research output-communication and utilization. The sources of data were: (1) project PIs, (2) research managers--U.S. and host country, (3) other researchers, and (4) extension agents or surrogates, media, peanut processors, marketing agents, governmental agencies, etc. The data relate to all forms of research informed activity of CRSP scientists and CRSP programs: (1) goals and types of research activity including research publications, reports, news releases, workshops, seminars, conferences, training programs, etc., (2) target audiences clientele, trainers, etc., and how and why selected, (3) relationships with client groups, organizations, colleagues, etc., and purposes, (4) kinds and types of information received from target audiences, clientele, trainees, etc., (5) role such information has played in research

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communication, and/or training decisions and output, and (6) difficulties, constraints encountered in attaining goals.

Knowledge production and dissemination would be assessed by another set of questions related to (1) the role of the peanut within local food systems and within the Peanut CRSP research system; (2) linkage of the peanut's traditional role to the Peanut CRSP's knowledge production and dissemination goals; and (3) harmony between the knowledge production goals, (e.g., varietal testing and post harvest technology development, etc.), and the traditional role for the peanut and overall regional or country-wide priorities. These approaches would aid in understanding whether the CRSP had generated new knowledge and propagated conditions where knowledge production and dissemination priorities would have been negotiated and pursued.

D. Scope and Limitation of the Impact Assessment

The impact assessment for the Caribbean has a defined and finite scope. First, the geographic scope is confined to those specific countries visited or targeted. They are Jamaica and Belize. To some extent other islands in the region are referred to and embraced because the CRSP Plan projected that they would become involved and might be impacted.

The geographic focus, while directed toward Jamaica, has a round of limitations induced by within-country (and parish) disuniformity of soil types and ecological conditions and governmental regulations. Therefore, it would be difficult to extrapolate, with high confidence, regarding the "real" impact of technology on peanut yield, utilization and distribution outside a given sub-region in Jamaica. Moreover, it is difficult to extrapolate, with confidence to multi-country regions of the Caribbean. Therefore, the assessment of impact is not without some real limitations.

From a temporal perspective, there are some limitations as well. The new variety which has shown yield enhancing properties (CARDI/Payne) and which has been released, has not been broadly adopted (only 10 percent of farms use it). Therefore, the results obtained under research conditions may not be sustainable. Over time, these new releases could undergo evaluation under "farmer field" and village level management conditions. Such conditions would allow for evaluating (over a large sample) factors such as variability in : (1) fertilizer availability, (2) pest control conditions, (3) soil types, (4) rainfall and irrigation moisture availability, (4) length of growing season, (5) disease control, (6) cultivation technology, (7) cultural practices, (8) utilization patterns, (9) consumption preferences and (10) socio-cultural norms to be addressed. Until that time comes, assessment must be done with less than desirable temporal observations.

The final limiting factor comes from a flawed initial design in the CRSP's methodology. The limitation emerges because the CRSP proposers did not design the project to allow for continuous monitoring of social and economic impact indicators related to post harvest technology utilization. Therefore, what is known about the economy of peanut production and social impacts has not been gathered in a CRSP project context. To add to the difficulty, is nearly impossible to gather consistent, completely relevant and reliable social and economic data, in just a three-day period, especially, when trying to evaluate a ten-year-old project. At best, the economist and sociologist could do quick and dirty monitoring and set the stage for sound social and economic assessment on post harvest in future periods. That analysis is precisely what has been planned and it would draw on data gathered by the social science survey. All is or was not lost.

In spite of the above limitations and disclaimers, it was possible to gather a sense of the CRSP's economic impact. Hopefully, that will become clear in the impact assessment section of this report.

E. Organization of This Report

This report's conclusions represent the thoughts, understandings and opinion of one team member--the Agricultural Economist. The basic findings and data are the intellectual property of others. The report is a temporarily, stand-alone document which is intended to fulfill obligation for the socio-economic impact analysis. Hopefully, the information contained herein will be blended into the overall "team report." Such would facilitate the task of communicating comprehensive evaluation results to final audiences.

This report is organized into several (7) sections: Part I covers the scope and objectives of the evaluation. It encompasses background structure of External Evaluation Panel (EEP), the scope of work of the EEP and limitations of the impact assessment methodology and results.

Part II covers background on the commodity (peanut), region and on the CRSP. The evaluator anticipated that the CRSP personnel would find this part redundant. However, important decision makers in AID and elsewhere might find it convenient to have backgrounding and an immediate sense of context. All too often, assessments and conclusions are misinterpreted due to varying contextual frames of reference.

Part III was developed after careful review of the five-year extension plan (1990-1995) and other CRSP documents. It carries the title of "Planned Activities: 1990 - 1995." Each of the major expectations were categorically examined and stated to insure that the evaluation and assessment covered those items which the CRSP personnel committed to pursue during the extension.

Part IV is direct. It categorically describes the accomplishments reported by CRSP personnel. It is intended to give the reader a picture of the results obtained to date in Jamaica. To a limited extent, the evaluator tried to provide extrapolative commentary on selected (key) accomplishments.

Part V contains the trip report and evidences of the impact. It contains interpretations. Collectively, they should depict the economic and social impact of the Peanut CRSP. Limitation on certain data and the time constraint precluded thoroughly assessing economic impacts.

Parts VI and VII contain a summary and the appendix, respectively. The brief summary is followed by a delineation of issues and some reasoned recommendations.

The Appendix, Part VII, contains tables, references, acronyms, the scope of work, the travel itinerary and consultant bio-data. Hopefully, all the parts and sub-components will add to the reader's ability to use, interpret and value this impact assessment.

II. Background: Peanuts, the CRSP and Jamaica

A considerable part of the information in the section cam from review reports and documents developed by other researchers. The reviewer has re-organized existing facts to help elucidate the background and understanding of the EEP's evaluation effort.

A. The Place of Peanuts in Jamaica's Economy

Peanut in Jamaica was promoted by the English during the colonial period as a source of vegetable oil (Fletcher, 1992).[1] Similar activities were supported in other Anglophone countries and Regions.

[11]Peanut production and use data for the CRSP host countries presented in this report, were compiled by Dr. Stanley Fletcher, Department of Agricultural Economics, The University of Georgia, Georgia Station. Dr. Fletcher is a part of a team that maintains a data base on the world peanut supply and movement in support of the U.S. peanut industry. The data is based on U.S. Department of Agriculture, Foreign Agricultural Service information.

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Although yield and production are relatively low, peanut remains as an important crop in Jamaica, especially for the small farmers. Overall, about 5,000 acres of agricultural land is devoted to peanut production, during an average year. Total area planted as to fluctuate over the 1979 to 1993 period, with the high occurrences at 6,511 acres and the low of 4,145 acres. Peanut yield has also been variable, ranging from a low of 424.83 kilos per acre (198 to a high of 554.67 kilos per hectare in 1981. Virtually all of the production is consumed domestically as peanut, peanut butter, snacks, confectionery products and (recently) as a component of infant weaning food. Jamaica's production does not show up in world production data.

B. Production and Use Benefits

The peanut crop has been viewed by many as an environmental enhancement crop. As such, the peanut crop canopy provides nearly full ground cover. Whether grown alone or in sequence with other crops, peanut cultivation reduces exposure of soil to erosion from rainfall or wind (see Table II.1). The closed peanut canopy also suppresses weeds to reduce weed pressure, especially when peanut is intercropped with a grain crop. In either case, reduced weed pressure reduces need for environmentally-harmful chemical weed control (TFR/AID 1188).

The peanut contributes to economic growth as it provides a source of cash income for small-holder farmers and rural and urban processors in Jamaica and other developing countries. Certain properties make it economically attractive, such as, biological nitrogen fixation. Biological nitrogen fixation by peanut reduces dependence on purchased nitrogen fertilizers. Often, the peanut crop is processed within the village or country that produces the crop. Thus, peanut production stimulates local food processing industries and adds value to the crop. As a versatile crop, peanut provides growers with many options to spread risk. With a short growing season, peanut fits well as a cash crop within a large range of cropping systems. It may be grown as monoculture where the rainy season is short, in sequence with grain crops, or beneath a long-lived orchard crop such as banana or coconut.

Improved human health and nutrition status are connected to the peanut. Peanut has special potential as a famine prevention crop. It may be planted late in a rainy season if the previous crop has failed. At 25 percent protein and 45 percent oil, peanut provides an inexpensive, high-protein, high-energy food for humans and livestock. It is one of the most nutritive crops available as a complement to cereal grain. Peanut supplies a high-quality, healthy vegetable oil for cooking. Supply of cooking oils is often inadequate in developing countries.

[12]AID Task Force Report on Sustainable Agriculture--1988.

[13]The CRSP Annual Progress Report--1993.

[14]Ibid.

TABLE II.1. Categorical Benefits Expected from Peanut Production in the Selected Host Countries During the Five Year Extension (1990-1995)

Category	Description of Benefits
Source of Protein	The peanut provides a readily consumable and desirable source of protein and food energy for humans and animals. The seed for humans and the fodder and hulls for livestock.
Expandable Capital	The peanut and its products provide expandable capital for small resource farmers. It also augments sustainability through capital for farm implements, fertilizer and labor.
Source of Vegetable Oils	The peanut contributes, significantly to meeting needs in Africa in the world market.
Contributor to Conserving the Soil	As a legume, peanut fixes nitrogen for its own use and leaves a positive nitrogen balance in the soil for other crops.
Helps Make Cropping Systems Work	The short season peanut cultivars fit into various cropping systems of SAT environments. Most notably: a) mono-crop, b) intercropping, and c) under-story planting in tree crops.
Tolerates Drought	The peanut has inherent drought tolerance and is highly suited to SAT conditions. The short season varieties also escape drought.
Combats Soil Erosion	The near closed canopy plant structure during growing seasons shields the soil from rain erosion.
Abates Wind Erosion	Late rainy season planting with maturity well into the dry season, helps the peanut absorb available moisture for plant growth and extends cover for dry soil when subject to wind erosion.
Suppression of Weeds	When inter-cropped with grains, the peanut suppresses weeds. It, therefore, helps reduce labor.

SOURCE: Task Force Report. Environment and Natural Resources: Strategies for Sustainable Agriculture. AID, February, 1988.

C. The Peanut CRSP: General Background

The context for the evaluation panel's work was set by a scope of work and during discussion at the EEP meeting in Huntsville, Alabama. The unfamiliar reader of the evaluation report should be spared from having to read through the voluminous reports and documents to understand the CRSP's goals and related issues. With this premise in mind, several CRSP documents were reviewed to develop generalized context and understanding of the goals and approaches.

1. Impetus for the Peanut CRSP

The initial impetus goes back to the Title XII legislation and initiatives which flowed therefrom. One of the many CRSP documents (CRSP-1993) gave the following description:

> "The Collaborative Research Support Program (CRSP) was created to implement Title XII of the United States Foreign Assistance Act of 1975. The goal of Title XII is to prevent famine and to establish freedom from hunger through land-grant university involvement in international development. To help attain these goals, the Peanut CRSP was established in 1982 to enhance the research capability of developing countries through training and research support, and to support research at U.S. land-grant institutions."

2. The Constraints

Initial constraints to the Peanut CRSP were numerous and not well understood, initially. Over the ten years of experience, the constraints have been examined and challenged. In spite of past success, many initial constraints remain and are yet to be addressed. The 1993 Annual Report carried a section which delineated the current constraints. The report carried the following description:

The Peanut CRSP was started in 1982 to address a set of global constraints to sustainable peanut production and use. Those constraints served as the initial basis for planning and organizing the Peanut CRSP in 1980 to 1982. Based on past Peanut CRSP accomplishments and the assessment of the External Evaluation Panel in 1989, the following constraints associated with peanut production were confirmed to be valid for the current 1990 to 1995 phase of the program:

- Environmental constraints
- Socio-economic constraints
- Health and nutrition constraints
- Research capacity constraints

Removing the constraints would "enhance the potential of peanut as a cash crop for human food and animal feed in Jamaica and the United States. The Peanut CRSP contributes to increasing rural incomes, sustained productivity of agricultural land, and improved health and nutrition of peanut consumers. Furthermore, the Peanut CRSP contributes to enhancing the research capacity in Jamaica. Collaborative research on peanut is producing new and improved technology that improves the well-being of people in developing countries and the United States. (CRSP/AR-1993).

3. The Peanut CRSP Goals

The broadest expression of goals has been labelled the "global thrusts." Reviewing these thrusts, frequently, provides continued context for the CRSP evaluators and others. As expressed in the 1993 Annual Report and vernacular of one reviewer, the "goals" are: a) to develop sustainable agricultural production and food delivery systems that are profitable, environmentally-sound and relieve important constraints to peanut production and use: b) to resolve resource management situations that restrict appropriate research or diminish efficiency of systems for peanut production and use: and c) to communicate research outputs to beneficiaries in developing and industrialized countries.

Attainment of the above goals would require massive cooperation by countries and organizations. Ultimately, such cooperation would lead to an expected stream of benefits. The CRSP practices have clearly noted that the beneficiaries would be: farmers and peanut growers; food processors; food

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[15]Ibid.

[16]The CRSP Annual Progress Report--1993.

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exporters and marketers and consumers in both rural and urban locations. To some extent, companies involved in development and sale of mechanical and scientific technology would reap benefits.

D. Profile Information on Jamaica

During the pre-Columbian period, Arawaks were the primary inhabitants of Jamaica. The social structure was not complex, and they subsisted on fishing, hunting and small scale cultivation of cassava (GOJ-1992). Contact with the Spanish proved to be devastating as the Arawak communities disappeared within eighty (80) years of the contact. Jamaica did not have gold and thus was only useful to the Spanish as a base from which to launch attacks on the gold-rich Americas.

From 1655 to 1830, slavery dominated the source of labor as the British imported large numbers of Africans to work the sugar plantations. After emancipation, many ex-slaves were settled on marginal lands in the plains and others settled on small farms in the mountains. Estate farms on the better land was to be occupied by the Europeans. The legacy of this settlement system weighs residual impact on farming today.

Jamaican population now stands at above 2.4 million. The average annual population growth rate was about 1.1 percent during the 1980-1992 period. The population is young with 45 percent of the people being under 19 years of age. By 1982 48 percent of the population was urban.

Agriculture is the largest employer of all economic sectors, possibly due in part to the low level of productivity in the sector. Agriculture's share of GDP declined from 8.5 percent (1986) to around 5.0 percent (1991). The main agricultural exports are coffee, sugar and banana. A large part of Jamaica's agricultural production is used for home consumption. Thus, it never sees the formal market. Peanut is not presently a "major" crop and is grown predominantly in St. Elizabeth's Parish. Area planted has ranged from a low of 4,145 acres (1988) to a high of 6,650 acres (1985).

III. Planned Activities in Jamaica: 1990 - 1995

In the Caribbean the Peanut CRSP focus was to have been concentrated on the English-speaking islands and Belize. Because of prior success in locating, screening and adapting CARDI/Payne, it was possible to shift the Caribbean focus to post-harvest constraints and technology during the 1990-1995 period. The initiative was to have been pursued via a project entitled, "Post-Harvest Handling Systems for the Small Peanut Producer," and led by the University of Georgia. CARDI was to provide collaborative involvement of participants from Jamaica, Trinidad, Belize, St. Vincent and Antigua. The goal, as expressed via the Global Plan, 1990 - 1995, was to (Peanut CRSP, Global Plan, 1990):

- . . .Identify and adapt appropriate technology for mechanization of post-harvest operations and to evaluate these on a systems approach to determine their socio-economic acceptability. An integrated system of harvest, threshing, shelling, drying, handling and transporting will be designed. . . .That system would increase the availability of low cost, high quality and nutritious peanut to the processor and consumer.

  Other aspects of the goal encompassed. . . .:
- . . .evaluation of the extent and control of aflatoxin through proper post-harvest handling techniques.
- . . .Cooperation with the Alabama A&M University food technology project in the employment of the post-doctoral food scientist proposed in the optimal budget for the University of the West Indies, Trinidad.

[17]GOJ=Government of Jamaica Development Report--1992.

The foregoing is a general and rather direct characterization of the goals intended to be accomplished during the 1990-1995 period. Given the funding level and available resources, expertise and support, these seemed reasonable. Progress and achievements toward meeting the goals is described in Part IV of this document, as excerptions from project reports and noted during the site visit.

IV. Accomplishments in Jamaica (1990 - 1995)

A. Overview

The Peanut CRSP made notable progress toward achieving project goals over the 1990-1994 period. To be sure, there were some setbacks which may not have been anticipated. This section of the report focuses only on accomplishments that pre-dated the 1992 impact assessment and those reported thereafter. Hopefully, the reader "could note these achievements and judge their significance against stated objectives.

B. The 1992 Impact Assessment

Several findings from an earlier study (Purcell, Joseph C, et al., 1992) provide underpinnings for recently reported accomplishments and for the overall Peanut CRSP impact in Jamaica. Some of those findings are:

- CARDI/Payne exhibited a yield advantage under field conditions of 274 pounds for acre. Yields from CARDI-Payne averaged 921 pounds per acre, compared with 647 pounds per acre for Valencia.
- From a sampling of approximately 100 farmers, roughly 83 percent were aware of the CARDI/Payne cultivar. Thus, there was demonstrated effectiveness in getting information out on the new variety and its abilities.
- The economic impact of the Peanut CRSP in Jamaica is limited by a small cropland base and an extremely small area (5,000 acres) planted to peanut. However, the CARDI/Payne could increase Jamaica's peanut production by 1,000,000 to 3,000,000 pounds.
- The potential returns to the research cost range from 5 to 15 times the investment annually.
- Were outside funding removed, a small peanut improvement program would likely be funded by the Government of Jamaica (GOJ).

C. Accomplishments Reported in 1994

A summary of accomplishments were reported in the 1993 Annual Report and released in 1994. They are as follows:

- Peanut Sheller--A Mennonite-designed electric-powered peanut sheller was evaluated and used for demonstration to the farmers. This type of sheller is in use in several areas of St. Elizabeth and Clarendon. This sheller is too expensive for a small farmer. However, it would be suited to cooperatives or if one farmer acquires and provides the service at a cost to other producers.
- Pedal Operated Thresher/Winnower--A pedal-operated thresher/winnower imported from Thailand was demonstrated on several farms in Clarendon and St. Elizabeth. Four evaluations were carried out. Farmers are enthusiastic and at least one local equipment manufacturer has expressed interest in fabrication of the thresher.
- Dryer/Storage Facility--This facility was visited during a workshop field trip in January. During the year several improvements were made to the drying/storing facility at Newton, St. Elizabeth. Although there have been ongoing discussions with the RADA (Rural Agricultural Development Authority) to manage and operate this facility, to date a suitable arrangement has not been worked out.
- Socioeconomic Study--A proposal for research into the socioeconomic aspects of postharvest technologies in peanut production in Jamaica was developed in conjunction with the Institute of Social and Economic Research (ISER). The study will identify factors that affect the utility,

functionality, and feasibility of specific postharvest technologies that are being introduced into this production sector.

- Peanut Germplasm--Several peanut cultivars are being held and multiplied. This is intended to hold a set of certified seed stock from which farmers and others interested in acquiring and multiplying seeds can be supplied. Among the cultivars being held are:

CARDI/Payne	ICGV 88401	ICGV 88402
Kidang	ICGV 88403	ICGV 88405
NC-2	ICGV 88407	ICGV 88369
NC-7	ICGV 87184	

- Peanut Field Days--Several field days were held. Approximately half of the participants were women farmers.
- Workshops--A workshop on Improving Production and Quality of Peanut was held in Mandeville from January 12-14, 1993. The workshop was well attended (60 persons) by private sector, farmers, government officers from the Ministry of Agriculture, and ALCAN (Bauxite mining company). In addition, there were attendees from the Caribbean (Trinidad and Tobago, St. Lucia, Antigua and Belize), the U.S. and Thailand. The first day consisted of the presentations made on global, regional and local perspective of production and postharvest handling of peanuts. The feature of the second day was a field trip to view production and processing of peanut. On the third and the concluding day a participatory discussion session was held to assess the present situation in the peanut culture in Jamaica and possible future recourse.

D. The Socio-economic Study

One of the planned activities was the conduct of a socio-economic study (focused on post harvest) to determine factors (socio-economic) that impact or influence production, handling and marketing (disposal even informally) of peanut in Jamaica. Part of the study was to delve into those factors that could possibly impinge upon the utilization of post-harvest technology that is now being introduced. Focused keenly on the production sector, the technology component would examine such elements as functionality, feasibility and utility.

The study, is indeed timely and needed. During the visit, it was possible to visit sites of where small hand-operated shellers and threshers were being fabricated. The EEP member also visited a few sites where recently fabricated dryers and roasters were in use. If introduced properly the technology could have longstanding popularity and utility, especially if the fabricators are careful to make it user safe and user friendly. The socio-economic study should encompass safety and ease of operation.

The 1993 Peanut CRSP Report suggested that the contract for conducting the study had been consummated. The individual who is to conduct the study was visited during the EEP trip to Jamaica. The consultant is highly qualified to conduct the study. Their strengths are: a Ph.D. in Sociology from Notre Dame (U.S.A.), the M.A. in Sociology from Howard University and the B.A. in Sociology and history from UWI at Mona. Research experience has been in Socio-agronomics, socio-economics, rural life needs, study of groups and organizations, relationships of people and institutions and urban problems. Methodological capabilities and experiences are also strong.

The survey instrument was produced. The instrument consists of 15 pages of 50 questions calling for a mix of Multiple-range responses: multiple choice, fixed quantum reply, narrative, etc. Demographic inquiries cover location, age, sex, education, household size and labor resources. The land resource segment delves into ownership (tenancy), size of farm, crop systems and animal enterprises. Focus was placed on labor required for land based tasks: land preparation, planning, weeding, reaping, threshing and shelling peanuts. Considerable details are elicited on each of the labor requirement segments of the survey instrument. Additionally, marketing, income, problem identification, crop loss, storage, drying and input procurement were specific points of inquiry. The survey instrument is well constructed and on target. The study will yield valuable information, not only for the Peanut CRSP but for advancing organizational information, critical to improving Jamaica's agriculture.

V. Trip Report: Probing for Impact

A. Overview

The economic potential and impact of the CARDI/Payne variety was established in an earlier evaluation report. This document does not "re-invent the wheel" by reporting that effort. The focus of this impact is on what the stakeholders and users had to say regarding the CRSP's initiative. Hopefully, the site visit notes and the interview transcript contained in this section will convey those opinions and the essence of the impact the CRSP has had.

B. Site Visits

1. Jamaica Cereal Foods Limited (JCFL/Kingston/Wednesday, April 27, 1994)--

The EEP team's first site visit was with Jamaica Cereal Foods (JCF) Limited in Kingston Jamaica. Initially, the visit was scheduled for Thursday, April 28, 1994, at 10:00 a.m. The itinerary was changed to accommodate changing schedules of the hosts. While at JCF we met with a Mr. Eimert Branderhorst, instead of Mr. Elgar Stewart. Mr. Branderhorst has served the JCF since 1992 as a Senior Technical Advisor to the project entitled, "Strengthening Jamaica Cereal Foods, Ltd." The main duties of the Senior Technical Advisor are to: a) set up manufacturing facilities for weaning food produced by women, and b) develop a marketing strategy including social marketing techniques, using women vendors for downtown-poor ghetto areas. The visit with Dr. Branderhorst yielded several observations:

- Infant malnutrition in urban areas is three times as high as in the countryside. Hence, the JFC focused its marketing in the urban ghettos.
- The make-up of the weaning food consists of corn (68 percent), soybean (23 percent), peanut (5 percent) and sugar (4 percent). There was a deliberate decision to utilize the 5 percent peanut because it is grown locally and is already agreeable to the Jamaican pallet.
- Oil fats and lipids have given rise to a problem whereby when content of whole peanuts is used, the hammermill screen becomes clogged. At contents of higher than 5 percent for peanut, the problem would become more acute.
- Prices of peanut often fluctuate widely and can sometimes be sustained at artificially high level. When prices are high, the tendency is for the government to import peanuts from abroad. Since JCF uses relatively small quantities of peanuts and prefers to purchase local product, its bottom lines suffer when prices and imports increase.

The secondary observation to be drawn from this site visit are:

a) Other donors are already utilizing the peanut in increased and different ways and could be impacted by lower priced peanuts.
b) Increased utilization will require further research and technology development not only for refining old processes, but for solving problems associated from new uses of peanut.

2. Donaldson Farms (May Pen/Thursday, April 28, 1994)--

Donaldson Farm is an "estate farm" now run primarily by Bruce Donaldson who was born and completed his schooling in Jamaica. The farm was originally operated as a sugar cane plantation, before being shifted into tobacco. Currently, the farm produces pumpkin, tobacco, corn and peanuts. The pumpkins are produced for export to Europe, while about twenty (20) acres of peanut are grown under contract.

During the visit several observations were noted:

- The Donaldson Farm had benefitted from the Peanut CRSP and had received help from Drs. Taylor and Wilson. Problems with drying and subsequently aflatoxin had been addressed. Poor germination and weed control had been noted and addressed.
- Current yield is about 1,200 pounds per acre, while they have been as high as 2,200 pounds per acre (on a particular spot of land). The higher yield was realized in part due to good water supply, good soil and ability to ward off predators.
- The main loss for Donaldson Farm (in peanut production) comes after reaping and during the field drying stage. Human predators manage to dispose of a high percentage of the crop yield, without permission.
- Donaldson's outlook does not show a potentially large export market for peanut grain and peanut oil, although some could be exported to Trinidad (small quantities). The greatest potential rest with the possible export of a peanut-molasses paste to the Middle East. Additionally, it is felt that peanuts could be domestically processed into some type of confectionery consumables for sale on the local tourist market.
- The key constraints to ideal production and yield conditions/outcomes are water supply, chemical application and residues, deforestation and labor cost. In recent times labor costs have increased to about $90 (Jamaican) per day and the workers bring their own lunch. Subsequently, the Donaldson Farm hires few day workers. Rather, it hires by the job. For example, they pay roughly $8.50 per half bushel for threshing peanuts.
- The labor supply for farm work has some gender implications. About 50 percent of the workers are female. Women are the primary harvesters of peanuts, while men do the planting and fertilizing. Women do the majority of the "gleaning" work. On the Donaldson Farm, the crops are harvested and the field is left open for the public to glen. About 10 percent of the Peanut crop is captured by the gleaners.

3. Pioneer Chocolate Company (PCC/near May Pen/Thursday, April 18, 1994)--
To allow the EEP an opportunity to look at potential for processing and utilization of peanut, a trip was made to the Pioneer Chocolate Company. While the primary focus is on chocolate, some use of peanuts occurs in the manufacturing of a fruit and nut chocolate candy bar. Mr. Robert Cunningham was gracious to spend several minutes with the team as a stand in for Mr. J. J. Cunningham who was not available due to schedule changes. Following overview comments by the younger Cunningham, a foreman took us on a tour of the cocoa oil extraction and cake molding facility and of the chocolate powder and candy molding operations.

Although the facilities were well used and had served the estate for a long time, they were yet capable of the tasks required by the Cunninghams. The employees (nearly 75) were predominantly female, who carried out a full range of activities, down to the wrapping of candy and several cocoa products by hand. Of particular note was the hand wrapping of the chocolate bar which allegedly contained peanuts. Five out of five bars sampled by oral ingestions failed to demonstrate discernable evidence of peanuts or peanut residue.

During the visit and interview sessions, several observations were shared:

- More than five (5) years ago several farmers were growing the local peanut variety known as Valencia. The farmers had "decent" yields, were poorly organized and could not compete for the best market prices.
- Trinidad imports peanuts from the USA and exports peanut butter to Jamaica. Nonetheless, Cunningham prefers to use peanuts produced in Jamaica. Hence, it contracts with local small farmers to supply peanuts needed for its products.
- Several years ago, CARDI came along with a new peanut variety which had promise. The new variety had larger pods, grew in a tighter bunch, had stronger pod attachment, lighter skin color

and a slightly different taste. The yield per acre was also higher. That variety was the "CARDI/Payne."

- The taste of the CARDI/Payne was noted as different and less desirable. To overcome this problem, the Cunningham blended the CARDI/Payne with the Valencia to achieve optimal texture and taste.
- In recent years, farmers have begun to overcome the problem and some have been able to negotiate a price with the chocolate company. They did get a better and a more realistic price.
- During the first quarter of 1994, peanut prices have demonstrated upward pressures. Early in the year, peanut prices were up to $300(J) per bushel (shelled). Peanut butter was sold in Jamaica at prices lower than in Trinidad and in the U.S. By late February, peanut prices per bushel (shelled) had risen to $450(J) and were still exhibiting upward pressures. In March, a price of $700(J) was common place in the market. At that time, the plant was closed for 1.5 months. The price was still $700(J) some three weeks ago.
- Quite likely, some entity purchased a large proportion of the available supply of peanuts, which may have resulted in the ability to influence prices.
- The $700(J) price is not likely to be sustained for long. Mainly because there are many large crops about to be harvested and placed on a market that has yet to dispose of this "$700" peanut supplies. These two factors could lead to a collapse of the inflated price.
- Cunningham expects a possible expanded utilization of peanuts in the future. They produce the Panda brand peanut butter which has seen a demand increase of nearly 100 percent. Panda is consumed in Jamaica, Trinidad and Barbados. Cunningham expects strong contracts with farmers in St. Elizabeth Parish.

4. Rural Agricultural Development Authority (RADA)--
The RADA opened for business in August, 1990, to serve small and medium-size farms. The commodity focus was on both crop and livestock.

The RADA serves as the Extension Service of the Ministry of Agriculture (MOA) and as such engages in demonstrations trials for agri-technology. RADA is presently engaged in conducting fertilizer trials aimed at using the research findings and recommendations to improve the productivity of soils on which vegetables, peanuts and yams are grown (SNAP-News/Oct 1993). In the Soil Nutrients for Agricultural Productivity (SNAP) Report on RADA's role, the following was shared:

- "Peanut has been grown in Jamaica for a long time, mainly in St. Elizabeth Parish. Increased production, however, has not matched the continuously growing demand. This is not due to unavailability of suitable soils, but rather to the absence of a high performing variety and tested fertilizer recommendations. . .."
- "Increasing quantities of peanuts are imported annually and the non-existence of a ready source of this raw material has stymied the growth of an agro food industry that already has equipment suitable for peanut processing."

This perspective runs counter to what has come to be known about the CRSP's impact. The general sense of CRSP practitioners is that CARDI/Payne, if grown extensively, would supply an increased supply of peanut "raw material." During the RADA interview several valuable insights were shared:

- The CARDI/Payne was introduced in 1981 and since then we have seen an increase in hand-shelling by CARDI.
- Over 400 acres of peanut are harvested in St. Elizabeth's Parish. This accounts for ninety percent (90%) of Jamaica's peanut acres harvested, annually. Since, on the average, two crops are grown each year, only about 2,000 acres of land are actually utilized. Only about ten percent (10%) of acreage is planted to CARDI/Payne.
- We have seen an increase in total production of peanut in other parishes. The price is now very high, but it will fall to $30.00 (Jamaica) per bushel.

- CARDI/Payne is a "bunch" variety, and it was chosen for planting partly because it could be more easily harvested by hand. In addition to growing in a nice bunch, the peanuts' strong stem attachment to the vine helped to reduce harvesting loss. The down-side is that the strong attachment called for more energy exertion in thrashing and picking. Also, the CARDI/Payne's thicker and protective hull calls for more energy in the shelling process.
- The peanut is grown as a cash crop and a "short term" store of wealth. Peanuts are stored and "at Christmas time they are sold for money." Likewise, when school opens they are sold for money to pay for fees, clothing, etc.
- The CARDI/Payne requires a longer growing season, during which there is a need for more weeding. Hence, there is the need for more chemicals for broadleaf weed control.
- It is "hard to get labor to weed peanuts." The price of labor, per hour, has increased considerably.
- Intercropping of peanut with corn is practiced by some farmers.
- Crop rotation (peanut followed by other crops) is not practical on a wide scale basis.
- Yield increase stemming from new variety has not lead to a decrease in acres planted.
- Acceptance of CARDI/Payne has been slow. When demonstrations are held, many farmers and others see the benefits of the new variety.
- The hagglers have helped inhibit consumers' acceptance of the CARDI/Payne variety; so you see "the middle people" are the problem. The contended disadvantage is that the CARDI/Payne has a delicate skin and is not suited for roasting.
- Farmers "do not like CARDI/Payne over Valencia, mainly due to the amount of time it takes to get a crop."
- Complete enterprise budgets from crops were not available. During the discussion, certain labor costs (per acre) were disclosed. They are: Planting, J$1,500; Weeding, J$3,500; Pulling, J$1,500; and Picking/Threshing, J$8,300 per acre. The cost of machinery for land preparations, cultivation and shelling along with the cost of drying and storage would drive total cost even higher.

5. The Visit to Tim Widmer's Small Farm Equipment Fabrication Shop (Santa Cruz)
This operation was truly a subsistence "welding operation." The laborer who was present showed several crude pieces of equipment copied from items secured from outside. The items being made were threshers, shellers, dryers and roasters. Most of the items were made to order.

6. The CARDI Peanut CRSP Drying Facility (Newton)
The drying facility was built by CARDI, utilizing CRSP funds. The location is a bit out of the way, according to intended users. At the time of the EEP visit, there was no sign of recent usage. The electricity was not connected and the land at the rear of the building was flooded, due to recent rains. The signage proclaiming the facility's erection by CARDI and the Peanut CRSP was obscured by vegetation.
It appeared that the drying technology had not been properly accepted.

C. An Interview with CARDI's Dr. Joseph Lindsey April, 1994

HW: Of CARDI/Payne--do you have a processing advantage with it?

JL: Yes. Mr. Horostein it's names after CARDI/Payne was the agronomist when I joined here. They received the different varieties from the CRSP project. Some came through Georgia after they

[18]This interview transcript is an approximation from hurriedly taken notes and, as such, may contain a misinterpretation. Participants in the session were Keith Ingram (KI), Dr. Joseph Lindsey (JL) and Handy Williamson, Jr., (HW).

selected the different varieties with potential for processing. The CARDI/Payne variety which is currently grown was farmed out to the processors including Mr. Blake. Some people are not excited about it. Several varieties were tested for taste, sugar and oil content and processing ability and so forth. CARDI/Payne came out one of the top ones (as a processing peanut). It was also selected because of the bunch type peanuts and because it is grown predominately by small farmers when they could pull it just like the common type.

HW: So, it was easily extracted by hand from ground. Did it have a stronger attachment?

JL: Yes. Some of the farmers feel it is more work to remove the CARDI/Payne from the stems than for the Valencia. But, that would also prevent them falling off more easily when they are pulling it from the ground. The disadvantage is that it created more work for the farmers.

HW: So, now all of these advantages were not enough to outweigh the risk of say a 30-day longer growing period for the CARDI/Payne?

JL: They felt that the additional yield that you're getting should go to the addition of timing.

HW: Is that 30 days or longer?

JL: More or less--3 weeks. It depends on the moisture content because the moisture content decreased rapidly and it will tend to mature early.

HW: But now, during that three weeks is there potential that you will have additional weeding problem.

JL: That is the concern of some of the small farmers. With the Valencia they may weed once, with the CARDI/Payne they have to weed twice.

HW: More labor is involved and cost increases?

JL: Yes, more labor is involved in cost. It is also very resistant to rot. That is one of the reasons why it was selected.

HW: What about the color of the flesh of the CARDI/Payne?

JL: The color is some problem for the local purchasers. People who would purchase from the farmer take it to Kingston for predominantly snack food where people are more used to the red color. Some resistance to the brown color. Due to color the CARDI/Payne looks like the immature Valencia type.

HW: So, there is some consumer resistance based on sight?

JL: If it is roasted, the difference between the two is not as distinct. When it's roasted, it changes color and comes closer to the Valencia. But the taste is definitely a sweeter peanut.

HW: Larger in Size?

JL: It is larger in size.

HW: I see. So there is some risk associated with this new variety which would impact decision to grow it--actually to distribute it?

JL: Yes. There are two sources which is the way we ought to go. That is your contract farming, that is a contract to Pioneer Chocolate. They also signed contract with Jamaica Cereal Foods. So, they don't really have a marketing problem. The project has been fairly successful and it has been complete. Peanut was introduced and has been in Jamaica as a traditional crop for probably 50 years. It was sort of introduced and the crops developed around it.

HW: Sister Shirley's group? Now they call themselves a farmers' union. Are they doing ok while the co-op hasn't done so well?

JL: That is true. . .but I am saying that traditionally the co-op thing has not done well. . .But this one is doing well, and it is probably the multi-purpose. . .peanuts is not the only thing, they are also growing some corn which they could also sell to Jamaica. They are looking at goats, sheep. . .If you are in a group, you will probably give a ram to the group and get two ewes so you can upgrade your stock. You also get information. There are several activities in the co-op which probably help to make it sustainable.

HW: I would like to get back to that in a minute or so. Let me move to another thing. It's a crucial thing that I want to get an impression from you since you have some idea as to which proportion of the peanut is used for home consumption versus the share that's used for processing in industry. What is the allocation?

JL: I would think very little is used for home consumption. It's a cash crop. The farmer can hold it there and when he wants to get some money, he sells on the road and gets cash. Some of it is eaten, but I have not got a feeling for the amount. That is what we are trying to get from this survey. It would be relatively small.

HW: That survey--would it ferret out this kind of question?

JL: Yes.

HW: Has the peanut not really been seen as a staple food crop yet? Is it a recreational snack crop?

JL: Because of the cash you can get from it, your price will always be low and there is not always a market for it. you can store it for 4-6 months. If you want it properly dried, then if the price is too low, you can hold it and hope that the price will go up and you can fetch a better price. What is likely to happen is that this spring a lot more people will plant it, peanut will call the price, $600-700 a bushel.

HW: Now, what about oil extraction. Do you produce peanut oil?

JL: The bulk of the oil here is from soy beans, imported from the States.

HW: Soy bean oil is important.

JL: We buy the soy bean for the soy bean oil. . .the oil is extracted here and the meal is used in livestock feed.

HW: So you import soy bean from the United States, but you don't export peanuts to the United States?

JL: No, we don't.

HW: OK. What about peanut butter production and consumption here.

JL: It's low. Because it is expensive.

HW: What is the cost of peanut butter?

JL: It is more than U.S. $58 or something. . .

HW: Now, if the peanut butter was lower in cost, do you think consumption would increase?

JL: Yes, it would increase.

HW: Are you suggesting that there is a taste for peanut butter here?

JL: There is a taste for it. It is not as wide. . .we are going through several programs looking at post-harvest technology. But I don't think there has been a proper program to encourage consumption and use of peanuts.

HW: Off the top of your head--if someone said I'll give you $1,000 for ideas that you have on different ways to use peanuts in the food system here in Jamaica, what would come to mind for you, as a professional?

JL: I like two things--in terms of the processing people who make foods--someone like Margaret Hinds or someone was doing a lot of work in peanuts. Publishing up like a recipe book with peanut use and several recipes and so on.

HW: That's a good idea, that approach. From the standpoint of the CRSP project that has been on-going worldwide for some time, do you know that (in West Africa, Burkina Faso, for example--and even in the Philippines) the peanut flour can be used to fortify the flour from other grain sources? Maybe, when they get done with analysis, they'll discover some things about the nutritional value of the peanut flour versus others. So, that would mean that peanut flour can be used in baking and in other products. The extracted oil could also be used. Then, from the standpoint of snacks, other than roasted, I guess there are peanut snacks being developed.

JL: Some like chocolate with peanuts and there are some peanut brittles. It is just basically sugar where it is just like boiling sugar for syrup and then putting the peanuts in. Put in a bar and then cut into blocks and market it.

HW: Couldn't you envision that if you had this peanut developed along those lines, it could be fed to the tourist industry to the United States as chips and candy to carry home?

JL: Yes. That is a big potential there. Again, there needs to be a lot more public education.

HW: What about research on it, too?

JL: What I'm saying. . .they have been doing a lot here about technology, adaptation and transfer and the principle, even CARDI and all varieties that if somebody has developed it already, and it has worked, the matter of just bringing it here and retesting it, demonstrating it, adapting it and trying to send it out so that we would not go on to rediscover all those things. If we have the methodology and expertise here, to assist the food technology institute here.

HW: Does it work with the CRSP project?

JL: We have had some discussions with. . . .spoke several times. . . looking at aflatoxin and potential of doing the aflatoxin tests for us.

HW: I'd like to go back to Sister Shirley. . .she's got three districts in the farmer's union?

JL: We call it a union.

KI: Has anyone tried to duplicate that in another area?

JL: There are others not for peanuts I know there no other triple district one.

KI: But is it something that would grow naturally. Do farmers of neighboring districts see that this union is a benefit and try to develop their own cooperative.

JL: If they are a neighbor, they will probably want to join it if they see the benefits from it.

KI: So, they would want to join instead of form their own?

JL: Than to form their own. But, I am guessing. . .there are other types of other groups. I know there is one with dairy cattle in parts of Manchester where they are actually making cheese from the milk from the farm and looking at the use of indigenous feed materials. And another integrated one, but there are not many of them in Jamaica. But, there might be a revival of this sort of thing in the country.

KI: One of the problems that came up yesterday was that this dryer had been there and had handled at least six farmers, is not being used. It is being under utilized. That dryer is just down the road from where Sister Shirley has her project, or at least where she was having her meetings. Is there some way to try to link Sister Shirley's group with this dryer so you can get better usage?

JL: There are two things involved. Understandably, . . .because of the rainfall there, because there is much more rainfall than normal, they cannot utilize the dryer very effectively. Not only for the peanuts but for the soy beans. The bean is also linked into the system. Because of that it is almost always running. What's happening there. . .the peanut is planted at the start of the rainy season to take advantage of rainfall distribution pattern here. Peanuts are generally planted two times as well, spring and fall. By the time the peanut matures, it is quite dry and sunny. Once the small farmer pulls the peanut, he picks off the vine and takes it home to dry where he has closer supervision. There is also a problem of transport. When one is not in a convenient district near the dryer, people could not conveniently take their materials there. That also poses a problem. Because lots of other farmers don't have (necessary) transportation, is very rough in a developing country (Jamaica). The farmer will have to take the thing there twice: transport it from his house to the dryer and then from the dryer back to his house. Utilization of the dryer is not built around an organized co-op. The idea behind the dryer is that you dry and store and sell from there. We have been in good stead, for more than a year, with the Jamaican Agricultural Society (JAS) which operates the whole country. However, JAS it's not functioning very well. We have made a proposal for JAS (in terms of a minimal cost) to maintain the facility, and we also showed them the cost of fuel for maintaining the dryer engine. We have been going down almost every week to try and finalize an agreement.

HW: Did you get it started?

JL: I have the proposal. We have had about three meetings, but we have still not got the thing initiated. Even if they would operate it, considerable effort would be needed just to get the thing functioning. They have got facilities that the school offered them. This whole thing (facilities at the school) came up after the dryer was already built. The problem with the dryer was the location.

KI: Why not move it?

JL: The dryer can't be moved. I'm talking about the old storage and drying facility. Initially, it was difficult finding a suitable location for it because many farmers actually lease the land to grow the peanuts. The co-ops are a group themselves that don't own land. So, the farmers are not necessarily landowners in the peanut area and 98% of the farmers in this area would be growing peanuts.

HW: Can you give us a better idea of what fraction own their land and who the landowners are who lease land to grow peanuts?

JL: I would assume that at least 50% of it is not owned, and again the (upcoming) survey will pick this up because this is the thing we are looking at: the ownership and the investment made. The government owns a lot of land, and they have got these land-lease projects.

KI: If the farmer would transport his peanut for shelling, why wouldn't they transport it to one place and have it dried and shelled at one time?

JL: Because a lot of the shelling is done by the entity which buys in shells and later sells the nuts for snacks. It would buy from a middle man who is holding the peanut, or buy directly from the farmer. Generally, the farmer is not going to shell and the peanut is not sold shelled. The only time the farmer is going to shell is for seed to plant or for doing some processing himself. Generally, it is not shelled by the farmer. For longevity and proper storage, it must remain in the shell. Even if you are going to plant; to shell and hold the nut for a period of time will cause it to lose its longevity. So if you are going to plant next week you shell over this weekend. It is held in the shell.

HW: So, the farmers don't want their seed shelled immediately after harvest?

JL: No. Not until they are ready to be planted.

HW: What about the others, do they sell in shells?

JL: Yes, they sell in shells, that's how it is sold.

HW: So, who wants the sheller?

JL: The sheller is wanted if the farmer is ready to plant because it is going to take him almost a day to shell a bushel by hand. So, it will take several days to do what would be shelled in five minutes at a sheller. So, you shell for the farmer when he is going to plant. The snack food people buy directly from the farmer or from the middle man. They come to the sheller and have it shelled whenever they need to.

HW: So, does the middle man use shellers as well?

JL: The middle man or the person who would buy it from the middle man. That would be a middle man the person who would roast and then sells to the end user. The farmer is only going to use the peanut sheller at the time of planting. The market is supplied with so many bushels and its sold when you want to buy say 2-1/2 bushels to 5 bushels. It is sold like that.

KI: What if there is a snack food vender in Kingston who would sell at the stadium. Would they buy peanut in the shell?

JL: Yes, he would buy peanut in the shell.

KI: He would buy peanut in the shell and then roast it and then sell it?

JL: Yes, because there are several things. There are some people who roast it in the shell and it is sold in the shell. There are others who roast it in the shell and then have it shelled afterwards. So, the nut that you are getting. . .from the particular vender is impacted by the method that he uses. Getting salt on the peanut is a method not developed very well, because the vender does it in the shell. He uses the method where he puts salt (there's one guy who went through and punctured each nut) in the boiling water and soaked it for several hours. Then he dried it and roasted it. This was a tedious process.

HW: Is that a high-priced and "fancy" peanut?

JL: I don't think so. There are others who would shell the peanut completely, try to remove the seed coat and then use butter mixed with salt to get the salt on it. It's very dependent on the vender and the particular market.

HW: Let me ask you a specific question while Keith is getting his notes down. The farmer would bring his peanuts in just at planting time, and I heard you say it would take him about a day, on the average to shell peanuts to plant his farm. Is this five hectares or acres?

JL: Far less than that. It's about 4-1/2 bushels per acre what it takes to plant and then you could get 40-50 bushels.

HW: So, how many bushels did he shell per day?

JL: We are estimating that he couldn't shell more than about 1-1/2 bushels, especially CARDI/Payne. It is much more difficult to shell by hand.

HW: What's the labor cost per day for a good farmer?

JL: Well, the farmer and his wife should shell it, or all the children would shell it; or the other farmers would sell it. In any event, it's going to cost J$150-200 for the day.

HW: Are you saying J$200 (average) per day to shell the peanuts and that a bushel would cost about J$200, shelled?

JL: Yes, whereas, the machine is going to cost about J$10 to shell the bushel.

HW: So, he's going to get it shelled by the machine and pay J$10? So you'll say J$190, just by using the machine?

JL: Yes, because of that savings the shellers are becoming increasingly more popular. And they are located so people would take the peanuts there and have them shelled. But to get back to the dryer, the thing is that a lot of the guys have barbecues (dryers) at home or spread the nuts along the roadside to dry. Some put them on their rood and its's dried in three days based on the studies we conducted on the barbecues. In three days, with sunshine, you can take the moisture down to 10 percent. Under these conditions, somebody in the family provides security. After harvest, it goes into larceny and nobody's going into the fields to pick one up and pull it up. But, if it's already shelled and dried, then it is really easy to take and one can dispose of it very easy. Mainly, because everybody will buy peanut as something you can eat right away. It is a very peculiar crop.

HW: A questions about this drying business; now you say the farmer will dry it on his roof?

JL: Yes, or on the barbecue or spread a piece of plastic or tarpaulin or sew bags and join them together.

HW: Barbecues are concrete, are they not?

JL: Barbecues are concrete slabs which were tradition in Jamaica for cocoa, coffee and pimento. In some of the areas because there is a shortage of water, quite often, people around build barbecues with another purpose to catch rain water. So, it's a common thing in certain locations. It's utilized. The guy knows there's someone right there watching it, so he has security and he's not paying anything for it.

HW: You had objectives here, the first one was to identify the segments of post-harvest handling systems and the various constraints. You were going to develop a quantitative relationship among those segments. Could you help me a little bit in interpreting what was intended there?

JL: I am familiar with that. I am just reading the objective as it is stated. Because it (the project) started before I cam here. I joined in August, 1990. The work has been focused on since that time. Wilson came on board in 1990 or 1991 and did the construction of the dryer and storage facility, with the help of an Israeli engineer who went back to Israel. But, he has come here several times. We felt that based on previous work, there was enough information in terms of the management of the crop. Especially about how it is planted, fertilized, provided with pest control. There is also information on the variety trials in which the CARDI/Payne was selected. And then this was a third stage. Knowing that you can produce the peanut interest turns to what the post-harvest problems are and how can you solve them. The research lab brought in a pedal operated thresher. That one that came originally was converted to gasoline engine so you could take it to an area where farmers could then bring their peanuts for threshing.

KI: You would really prefer to have the thresher go out into the field. . . .correct?

JL: That is the point I am making, because you have to pull it by tractor and put it in one spot. The farmers bring their peanut to the machine. It was not working too well. It was working on a big farm. The second thing that does well was to dry the pods for a certain time. You turn the vine and it loses more moisture. If you thresh when green, you crush the peanut. There is the threat of predial larceny (common stealing). What we make in Jamaica is food, and looting is some of the problems you have. If you leave the peanut in the field to dry (unattended), it will disappear.

That constrains the use of the thresher if it's on a large farm. All large farms have guards because of the amount of predial larceny. There is a limitation there. The smaller one has a pedal operated one, but you still have the same problems, you've still got to leave the peanut in the field for a day or two. But for small farmer this one person could use it so its much easier that this farmer could use it and the one next door could use it the next day. . .

KI: Would you expect one person to own it and then lease it out like they do the others?

JL: No. It is like with the sheller. People know when they come to utilize it, there will have to be a contract to rent it for one day. The next farmer might rent it for two days. Or like with Sister Shirley's group. They could purchase one and use jointly. They could have a roster on who will use it today and who will use it tomorrow and so forth. But the amount of time that the farmer will use it, it doesn't make sense for one farmer except that he is going to contract it out. Even with the sheller, he doesn't have enough demand. One sheller could shell probably all of the peanuts in Jamaica. If you had a factory and were running it all the while, you could probably shell all the peanut produced in the country.

HW: Thank you. This has been informative.

VI. Summary: Impact Issues and Recommendations

A. Summary

This evaluation report represents the results of activities and interpretations which characterize the Peanut CRSP's progress in Jamaica. Also, this evaluation represents an earnest attempt to characterize economic impact under extremely difficult time constraints.

Several aspects of the CRSP and this evaluation are summarized as follows:

1. Several limitations to the impact assessment were discussed in the report. However, the major limitation was felt to be the incompleteness of the social science survey component of the project. The survey is well under way and would perhaps be completed by the official ending date for the CRSP. The data to be generated by that survey is critical to studying the impact of post harvest technology in Jamaica.

2. The place of peanuts in (formal) Jamaica's economy appeared to be unsteady due to insufficient development and use. It was mentioned that demand for peanut in Jamaica is not being met with local production. Some suggest that a desirable, high yielding variety is the constraint. Also, post harvest technology is not seen as problematic, by some agriculture opinion leaders.

3. Environmental enhancement attributes of the peanut and its increased and strong potential as a food crop argue for a more sustained place in Jamaica's economy combined with the role as a cash crop these factors make a strong case for continued research and education to exploit the peanut crop.

4. The Peanut CRSP practitioners chose to focus efforts on "mitigation of post harvest technology constraints." This was allowed to drive approaches, project design and CRSP resource allocation. However, when talking with the various stake holders in the research program, it appeared that the assumptions regarding CARDI/Payne's acceptance and abilities were not well guided. Many persons suggested directly and unintentionally that the post harvest technology is not the key problem. Rather consumer non-acceptance of CARDI/Payne and the lack of a "suitable" cultivar is the key constraint.

5. The country level, project specifications brought identity to achievable tasks and expectations. They varied by country, but collectively called for the following: (a) cultivar improvement, (b) integrated pest management, (c) improved food products, (d) enhanced disease control, (e) control of aflatoxin, (f) control of the rosette virus, (g) improved processing technology, and (h) enhanced supply of peanut for human food and livestock feed. Jamaica was to feature on the latter two elements of food-feed supply and post harvest technology. Sadly, not much progress was made on either front.

6. Accomplishments have been recorded and vented through annual review reports. The most striking accomplishment was the release of CARDI/Payne. An earlier impact report showed tremendous yield response and rapid adoption by farmers. Discussions during this visit and review of documents fail to substantiate the wide adoption claim. Failure to accept CARDI/Payne reflects lingering concern about less desirable features of the new cultivar.

7. Economic impact was given initialization with an earlier review in 1992. That review measured change in yield due to new varieties and measured the value of that yield in world market prices during the applicable years. That analysis alone suggested benefits which outweighed costs, in the short run. The amount of a projected increased yield ranged from 1,000,000 to 3,000,000 pounds. The yield figure and implied impact assumed broader utilization. That broader use has not yet materialized and farmers and consumers exhibit some reluctance in switching from Valencia to CARDI/Payne.

8. Post harvest technologies are still evolving. There have been some successful attempts to copy and fabricate machinery for threshing, shelling drying and storage. The redeemable aspect of this activity is that the fabricator used locally available materials and lessened the constraining impact of using imported technology and materials. However, much of what has been developed needs to be tested and refined for safety and mechanical durability.

9. The much talked about and written about "drying facility" is in line to be dubbed a "white elephant." Although the building is complete and equipped with drying and storing capacities, the facility is not being used. The much touted technology for drying is taking a back seat to traditional drying methods. Some claim that the facility is poorly located. Others suggest that cooperative type utilization arrangements need to be made. There, is also concern for theft and perdition.

10. Labor costs emerged as a key constraint to increased peanut production and utilization. Farm hourly labor for planting, cultivating, harvesting and threshing, etc., nearly doubled in recent years. This prompted some farmers to shift to job -piece) work allocations. A partial enterprise budget suggested that labor would cost more than J$8,000 per acre to grow peanut. Technology development would help abate the impact of increased labor cost. The new CARDI/Payne variety has the potential of increasing cost due to more weeding required and to the difficulties in picking and shelling (by hand).

11. Prospect for expanded and increased utilization of peanut are not presently rosy. The processors expect to utilize more peanuts, but the quantities may be small. New uses of peanut, except for in weaning food, were not readily discussed. At best it can be hoped that Jamaica's farmers will be able to supply a larger share of the peanut consumed in the country.

12. The <u>price</u> of peanuts presents a hefty challenge to the government and to farmers. Typically, the farmers will respond to higher prices within desire to grow more peanuts, causing the supply to increase and the price to fall. Such adjustments are not without market stress on both the up and down sides. Currently, the price of peanuts is artificially high. The processors find it difficult to

acquire peanut for weaning food, paste, candies and pastries. When prices rise due to hoarding (as may be the case presently), the profit is reaped by monopolistic entities rather than the masses.

B. Impact Issues

There are several issues which could be raised with regard to the Peanut CRSP's design, approach and impact. The multifaceted issues arise due to the sheer complexity of the CRSP project and the constraint addressed. Moreover, the issues emerge at the points of intervention where research or related action could impact peanut growth, yield, viability, processing or consumption.

This is not an exercise in negative issues raising. However, this evaluator felt compelled to focus (briefly) on issues that influence the CRSP's impact and capacity to sustain the economic benefits expected. They are shared below.

- CARDI/Payne is yet fraught with utilization problems: longer growing season rules for more labor for weeding, more expense for chemicals. The strong vine attachment and tougher hull lessens desirability to farmers and others. This may be overcome with machinery development for post harvest processing.
- CARDI-Payne is yet fraught consumer acceptance concerns. The Valencia variety remains the strong peanut of choice by consumers. The skin color, texture and taste of CARDI/Payne are yet seen as objections by locals.
- CARDI/Payne and Valencia usage in infant weaning food has met with technical difficulty. The oil and moisture content of the peanut flour tend to clog the flour mill at JCF. Further research and adjustments are needed to protect and utilize this outlet for peanut.
- The current export market is not felt to hold potential for generating substantial increase from peanut sales abroad. If CARDI/Payne is to be promoted and accepted and yields are captured, there must be suitable outlets for the product in both domestic and export markets.
- Data on yield--not readily available. The local contacts did not appear concerned about maintaining current and accurate data.
- Crop Enterprise Data--not readily available. It is not possible to conduct comparative impact assessment on new technology (post harvest) without benchmark data.
- Labor Cost Data for various farm enterprise activities was not available on a scientific basis. Without such comparative valuation of tasks amount to a continual guessing game.
- The new Drying Facility (at Newton) was not being utilized. While CARDI is working out suitable administrative arrangements, there exists the notion that the farmers have problems with the location and security.
- The appropriate post harvest technology for threshing, shelling and drying is within reach of the people and sustainable materials and methods are used. However, more care should be given to user safety.
- Some collaborators in the agriculture sector do not concede that the CARDI/Payne is a breakthrough (new and viable) variety. In government published newsletters the call is on for the selection of "viable high yielding peanut variety, acceptable to consumers." This might suggest an information dissemination problem.

C. Recommendation

1. Reassess the exclusive focus on post harvest technology. Would suggest more stress on producer and consumer acceptability of CARDI/Payne.
2. Conduct safety tests on fabricated equipment and evaluate more thoroughly the cost and time savings from increased mechanization. Necessary data (enterprise data, time and motion and safety) adjunct to these determinations should be collected, analyzed and interpreted.
3. Attention should be focused on utilization. Find ways to generate new products which would utilize peanuts. Should also explore possible market outlets for the products.

4. Don't abandon the CRSP at this time. The vexing problems of acceptance, utilization and marketing represent the final curtain of constraint precluding derivation of benefits from the "new variety," CARDI/Payne.

Peanut Production Levels

Tables VII.1. PEANUT PRODUCTION 1978 - 1992 JAMAICA (Tonnes)

Year	Production	% Change
1978	2,803	52.0
1979	2,422	-13.4
1980	2,280	-5.9
1981	2,085	-8.6
1982	2,263	8.6
1983	2,596	14.7
1984	2,533	-2.4
1985	3,216	27.0
1986	2,134	-33.6
1987	2,870	24.5
1988	1,598	-44.3
1989	2,431	52.3
1990	1,861	-23.5
1991	2,386	28.2
1992	4,109	72.2

TABLE VII.2. PEANUT: AREA PLANTED, PRODUCTION YIELD, PRICE AND VALUE, JAMAICA 1979-1989

Year	Area	Yield (kilos/ac)	Production (1000 kilos)	Change from 1979 Base	
				Yield	Production
1979	4994	554.67	2770	--	--
1980	4711	533.22	2512	-21.45	-258
1981	4197	547.53	2298	-7.13	-472
1982	4524	551.50	2495	-3.16	-275
1983	5592	511.80	2862	-42.86	92
1984	5876	475.15	2792	-79.51	22
1985	6640	533.89	3545	-20.78	775
1986	4927	476.96	2350	-77.70	-420
1987	6511	485.95	3164	-68.72	394
1988	4145	424.85	1761	-129.82	-1009
1989	5282	507.38	2680	-47.28	-90

SOURCE: Impact Analysis Study; CRSP, Wheelock, et al., 1992.

TABLE VII.3. Comparative Yields of Cardi-Payne and the Traditional Valencia Cultivars. Total of 32 Fields of CARDI-Payne and 33 Fields of Valencia Over Two Growing Seasons in 1989-1990.

Site	CARDI/Payne	Valencia	Difference
	Pounds/Acre		
1	600	828	-228
2	1450	1233	217
3	1600	1000	600
4	446	363	83
5	333	195	138
6	955	489	466
7	888	680	208
8	1466	800	666
9	550	237	313
Average	921	647	274

T = 2.97, PR>{T} = 0.0179
SOURCE: Impact Analysis Study (CRSP), Wheelock, et al., 1992.

TABLE VII.4. Population by Parish, 1991

PARISH	MEAN POPULATION '000	MEAN POPULATION 100.0
JAMAICA	2366.0	100.0
Kingston & St. Andrew	643.8	27.2
St. Thomas	84.2	3.6
Portland	76.0	3.2
St. Mary	107.9	4.6
St. Ann	149.0	6.3
Trelawny	71.6	3.0
St. James	156.1	6.6
Hanover	65.9	2.8
Westmoreland	128.2	5.4
St. Elizabeth	144.1	6.1
Manchester	164.9	7.0
Clarendon	212.3	8.9
St. Catherine	361.5	15.3

SOURCE: Government of Jamaica, Resource Book for Business and Investment, published in 1992.

SOURCE: Government of Jamaica, Resource Book for Business and Investment, published in 1992.

TABLE VII.6. Distribution of Jamaica's Economic Activity among Key Sectors: 1986-1991

	1986	1987	1988	1989	1990	1991
GDP, current J$mil	13713.0	16364.9	19137.6	22798.9	29822.7	42367.0
GDP, 1986 J$ mil	13713.0	14730.0	15160.3	16141.7	16916.1	16954.4
GDP per capita, 1986 J$	5962.2	6404.3	6316.8	7018.1	7048.4	7064.3
Rate of growth of real GDP,%	1.6	7.4	2.9	6.5	4.8	0.2
Gross Fixed Capital Formation						
(GFCF) as a % of GDP	18.2	22.2	26.0	29.4	29.3	
Agriculture						
as a % of GDP	6.2	6.0	5.6	4.9	5.2	5.2
as a % of total employment	13.1	15.5	15.3	15.4	15.2	10.9
avg annual growth rate(%)	1.9	4.6	-4.6	-7.5	12.1	0.4
Manufacture						
as a % of GDP	21.5	20.9	21.4	21.3	21.3	20.3
as a % of total employment	13.1	15.5	15.3	15.4	15.2	10.9
avg annual growth rate(%)	0.9	4.7	5.1	5.9	5.0	-4.5
Mining						
as a % of GDP	6.6	6.5	6.0	7.7	8.6	9.1
as a % of exports	58.0	47.7	56.7	58.7	63.9	57.3
as a % of total employment	0.7	0.7	0.7	0.7	0.8	0.6
avg annual growth rate(%)	7.7	6.0	-4.5	35.6	18.1	5.8
Tourism						
visitor expenditure,US$mil	516.0	595.0	525.0	593.0	740.0	764.0
hotel room occupancy (%)	57.0	61.7	56.5	59.1	62.1	57.9
total visitors, '000	954.6	1037.6	1020.3	1163.2	1236.1	1340.5
direct emp as % of total	1.9	1.9	2.0	2.1	2.3	2.5
Services (excl. utilities)						
as a % of GDP						
Distributive Trades	20.4	21.1	20.7	20.1	19.3	18.3

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	1986	1987	1988	1989	1990	1991
Financial Institutions	6.8	6.8	7.9	8.6	9.8	10.8
Real Estate	8.0	7.7	7.7	7.4	7.5	7.9
Public Administration	9.3	8.7	8.8	7.9	7.5	7.5
Total Services	62.8	63.0	63.4	62.1	61.6	62.7
Service, (incl. utilities)						
as % of total employment	47.4	46.6	46.9	48.8	53.3	54.6
Population, millions	2.3	2.3	2.4	2.3	2.4	2.4
Birth rate, /1000	23.2	22.3	22.7	24.9	24.8	24.7
Death rate, /1000	5.7	5.3	5.2	6.0	5.1	5.5
Rate of natural inc, /1000	17.5	17.0	17.5	18.9	19.7	19.2
Labor Force, '000	1059.0	1069.7	1078.4	1062.9	1058.5	1072.5
Unemployment rate (%)	23.7	21.0	18.9	18.0	15.3	15.4
Exports, US$mil	605.1	709.1	883.1	998.1	1157.5	1145.2
US	34.6	36.9	34.0	34.4	28.8	
UK	17.0	17.5	13.4	15.3	16.7	
Canada	16.4	13.6	13.3	13.6	10.6	
Japan	1.1	1.2	0.4	0.9	0.7	
Venezuela	n.a.	n.a.	n.a.	0.0	0.1	
Netherlands Antilles	1.1	n.a.	3.8	0.1	0.0	
USSR	4.1	4.1	7.2	2.2	0.4	
Caricom	7.0	7.1	7.3	6.7	7.7	

SOURCE: Government of Jamaica, Resource Book for Business and Investment, published in 1992.

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Full EEP Scope of Work
External Evaluation Panel Assessment Rating Form for Individual Peanut CRSP Project #9

U.S. University and Host Country Site Visits

I. **Background**--This section will be completed for EEP information prior to travel.

A. General information will be provided for the location, either U.S. University of Host Country site.

B. Project Title(s): Each site may involve one or more projects. EEP team visiting that site will have general observation responsibilities and particular responsibilities for a particular project(s). Other information on project funding, etc., will be provided.

C. EEP members: Team for a particular site.

D. Collaborating Entities: U.S. University--administrative and departmental involvement/individuals involved, etc. Host Country--primary institution/individuals, other cooperating institution(s).

E. USAID Mission Staff

F. Other information as provided or requested.

II. General Overview of Program

A. Background information to be provided.

(Items B-F. EEP would add to this section based on discussions during visits.)

B. Peanut industry

- Importance of crop
- Cropping systems, etc.
- Domestic uses, markets, etc.
- Other items

C. Relationship of CRSP to State/Host Country Research and Development Program--information collected by EEP during visits.

- Extent of local program, priorities, etc.
- Complementarily of CRSP to local program.
- Relationship to other programs/donor programs/IARCs/etc.

D. How does the Peanut CRSP program fit into the USAID mission current and future country strategy? How does the mission view the interface of agriculture/sustainable agriculture in the environment/natural resource management program area? Other items may arise in discussions with missions that can be reported.

E. Assess the level of commitment of each organization for the near-term (1-2 years), and long-term (2-5 years).

   Opportunities for additional support for research (AID mission, other entities in country/region.

F. Other

III. Review of Individual Project

Primarily consider progress since program extension in July 1990, but may at times need to consider the long-term, from 1982 forward.

Review and collection of following information will be done for U.S. and Host Country components separately. We will decide as a group how to prepare report to eliminate duplication, integration of both components in report.

1. Achievement of Objectives

   1.1.-1.n. List

2. Implementation and Management of Projects

   2.1. Administrative involvement

   2.1.1. Attitude towards, support and perceived relevancy to the institution.

   Adequacy of current management; university, host institutions, management entity.

   2.1.2. Fiscal/logistical assistance

   How adequate is funding? Is funding too small to be effective?

   Problems regarding funding; procurement, release of funds, timely reporting for reimbursement, etc.

   Institutional contributions to funding.

   Cost effectiveness.

   2.1.3. Resource commitment (faculty/facilities)

   2.2. Adequacy of planning.

   Annual Work Plans

   Communications between and among participants, etc.

   2.3. Comments

3. Institutional Development

   Would particularly apply to host country institutions, but some items relate also to U.S. institutions.

   3.1. Complementarily to ongoing research efforts.

   Integration of domestic and international research programs with CRSP projects.

   3.2 Strengthening of scientist/equipment/facility capabilities.

   Has the program had an impact on general capability to do research?

   Faculty/scientist recognition for international activities.

   3.3 Extent of collaborative actions

   Has the collaborative mode been effective; interaction between scientists, etc. How could improvements be made to improve the impact of program?

3.4. Training

Long-term student training, short-term training to scientists or technicians.

3.5 Comments

4. Adequacy of Science

Technical merits of program.

4.1 Progressiveness and innovativeness of the science/research.

Concern with biodiversity, sustainability, natural resource conservation, food supply, etc.

4.2 Social science/economic implications.

Income generation, gender concerns, fit of technology into social scheme, etc.

4.3 Appropriateness of research (basic/adaptive).

4.4 Comments.

5. Applicability of Research

5.1 Relevancy and transferability of research to host country or U.S. programs.

Publications, efforts to make information available.

Is the technology developed being used (i.e., new variety, IPM practice, post harvest handling, new or improved food product), or is there potential for impact? What are impediments or constraints to use of technology? Extension, pilot efforts to use technology.

5.2 Relationship to other international research programs.

Is there evidence of networking in country/region, IARCs and other entities? Transfer of technology through networks, short courses, workshops, etc.

5.3 USAID/host country perceptions of Peanut CRSP.

5.4 Comments.

6. Observations

6.1 Strengths

6.1.1.-6.1.n. List

6.2.1.-6.2.n. List

y. Recommendations

CODE: E = Excellent, HS = Highly Satisfactory, S = Satisfactory, NS = Not Satisfactory

Insofar as possible, put host country comments before U.S.

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Travel Itinerary

Handy Williamson, Jr.

Peanut CRSP External Evaluation Panel
Jamaica
April 27 - May 2, 1994

Wednesday, April 27, 1994--

Lv Knoxville, TN	6:30 am	Arr Atlanta, GA	7:17 am
Lv Atlanta, GA	8:25 am	Arr Miami, FL	10:11 am
Lv Miami, FL	11:10 am	Arr Kingston, Jamaica	11:52 am

Saturday, April 30, 1994--

Lv Kingston, Jamaica	8:30 am	Arr Montego Bay, Jamaica	9:00 am

Monday, May 2, 1994--

Lv Montego Bay, Jamaica	9:35 am	Arr Miami, FL	12:10 pm
Lv Miami, FL	1:45 pm	Arr Atlanta, GA	3:41 pm
Lv Atlanta, GA	5:10 pm	Arr Knoxville, TN	6:00 pm

Proposed Itinerary for the Peanut CRSP Evaluation Team Visit to CARDI/Jamaica April 27 - 30, 1994*

Dr. Keith Ingram
Assistant Director
Peanut CRSP
University of Georgia

Dr. Handy Williamson, Jr.
Professor and Head
Department of Agri Econ & Rural Soc
The University of Tennessee

Wednesday, April 27, 1994--

11:52 am Arrival of Drs. Ingram and Williamson
AA 1047, Check-In--Courtleigh Hotel

2:00 pm Dr. Chris Brown USAID (Holiday-tentative)

3:00 pm Visit JADF--Mr. Paul Brown (tentative)

Thursday, April 28, 1994--

8:00 am Department hotel for field trip

9:30 am Visit St. Jago Farms, Sevens May Pen Clarendon

11:00 am Visit Pioneer Chocolate Co.--Mr. J. J. Cunningham

1:00 pm Visit RADA, St. Elizabeth--Mr. Hines/Mrs. Wilson & Co.

2:00 pm Visit Sister Shirley--Mr. German's farm

2:30 pm Visit drying facility--Newton

3:30 pm Visit Blakeys Packaging--Mr. Len Blake

Depart for Courtleigh

---

*Had to be changed due to availability of persons and time pressures.

Friday, April 29, 1994--

8:30 am Visit USAID (tentative)

10:00 am Visit Jamaica Cereal Foods Ltd.--Mr. Eglan Stewart

11:00 am Visit RADA--Dr. R. Harrison/Dr. W. Nelson

12:30 pm Lunch meeting CARDI--Ingram, Williamson, Reid, Lindsay, Allen, and Taylor

2:30 pm Visit with Dr. R. Mitchell/Socio-economist

3:00 pm Rap-up discussion

Saturday, April 30, 1994--

8:30 am Dr. Williamson departs via Montego Bay

12:50 pm Dr. Ingram departs for Miami

Listing of Principals with Whom The EEP Met During Site Visit to Jamaica

Dr. Eimert Branderhorst, Jamaica Cereal Foods, Ltd.
Dr. Joseph Lindsey, Project PI, CARDI
Mr. Morris Taylor, Project Technician
Mr. Bruce Donaldson, Farm Owner/Manager
Mr. Robert Cunningham, Pioneer Chocolate Owner/Manager
Mr. Hines, St. Elizabeth Parish Manager, RADA
Mrs. Carol Wilson, RADA Technician
Mr. Blake, Peanut Processor, Chairman of St. Elizabeth Parish Advisory Board
Mr. Watson
Mr. Lawrence, Shop Technician for Tim Widmer
Dr. Janice Reed, Director, CARDI
Mrs. Beverly Morgan, Director, JADF
Mr. Paul Brown, CEO, JADF
Mr. Ian Maxwell, Technical Manager, JADF
Mrs. Elsie Garcia, Technical Services, JADF
Mrs. Shelah Heaven, Secretary to CEO
Dr. Chris Brown, USAID (Telephone)

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Biodata of Consultant

B-I-O-D-A-T-A

HANDY WILLIAMSON, JR.

Handy Williamson, Jr., is Professor and Head, Department of Agricultural Economics and Rural Sociology at the University of Tennessee. In this position he is responsible for leading and managing research programs, resident instruction and outreach functions. He took over the current position in July 1988.

Dr. Williamson formerly served as Deputy Director for Research and University Relations, Bureau for Science and Technology (S&T/RUR), Agency for International Development (A.I.D.), Washington, D.C. (1985-1988). In this role he allocated and provided oversight for a $10 million annual budget to support grants with U.S. universities in the fields of agriculture, education, public health, medicine, natural resources, and development. He served on the White House Committee on HBCU's and represented AID, broadly. While employed at Tennessee State University-Nashville (1977-1985), he held the position of Associate Professor of Agricultural Economics, Director of the Cooperative Agricultural Research Program, and Coordinator of International Agricultural Development Activities.

He was formerly Associate Director of the Center for Rural Development Research and Assistant Professor of Agricultural Economics at Tuskegee University-Alabama (1974-1977). Dr. Williamson has been a consultant on many projects and review teams in Africa, the Caribbean, the Far East and the United States. Several state, regional and national committees, boards and task forces have benefited from his professional/technical contributions. He has testified before committees of both the U.S. House of Representatives and Senate.

Dr. Williamson received the Ph.D. in Agricultural Economics from the University of Missouri-Columbia; the M.S. in Agricultural Economics from the University of Missouri-Columbia; the M.S. in Agricultural Education from Tennessee State University; the B.S. in Vocational Agriculture from Alcorn State University, Lorman, Mississippi; and the AA in Liberal Arts from Pineywood Jr. College, Pineywood, Mississippi.

Williamson's research and publications include economic and rural development studies affecting land use, resource management, manpower training, research and extension development, and efficiency of small and large farms in diverse geographical settings. His works have been published in journals, bulletins, special reports, books, book chapters and in the Congressional Record.