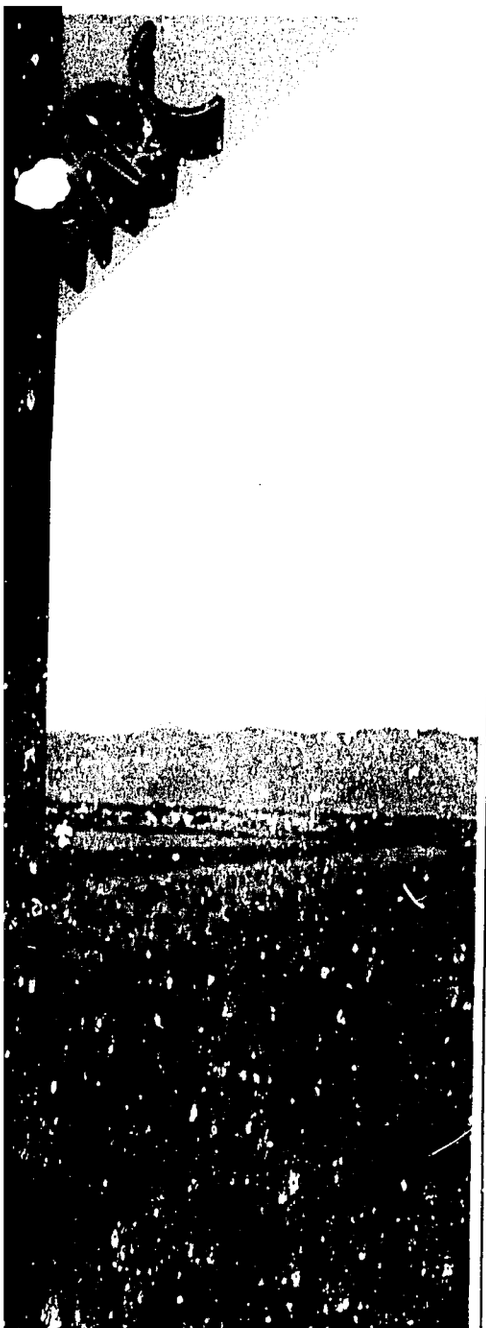
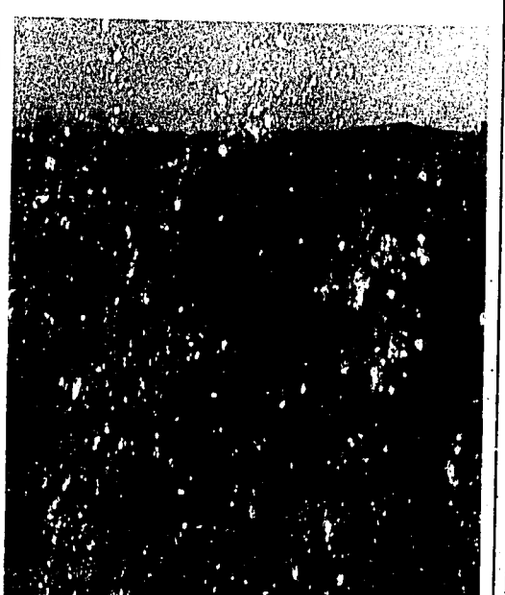
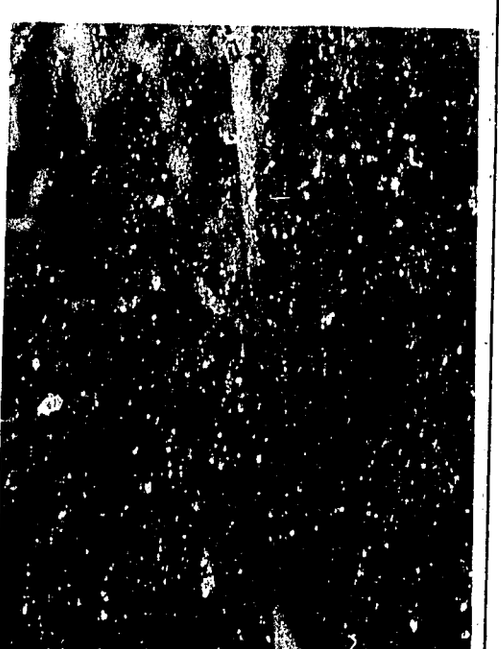
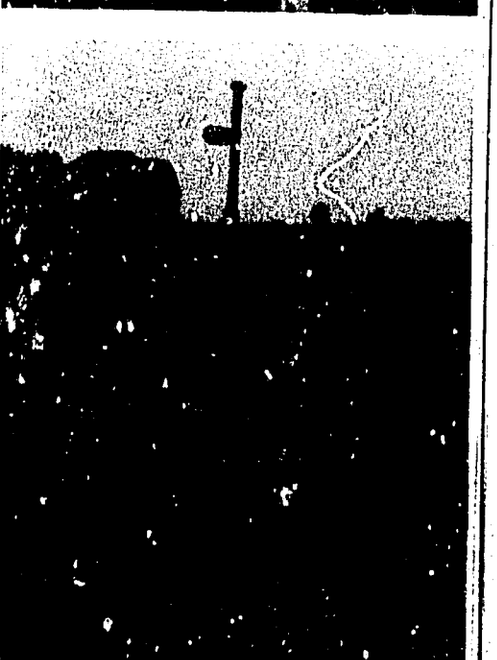
Annual Report 1982-83

Pakistan Agricultural Research Council
Islamabad









FUNCTIONS OF PARC

* *to undertake, aid, promote and coordinate agricultural research*

* *to arrange the expeditious utilization of the research results*

* *to establish research establishments mainly to fill in the gaps in existing programme of agricultural research*

* *to arrange the training of high-level scientific manpower in agricultural sciences*

* *to generate, acquire and disseminate information relating to agriculture*

* *to establish and maintain a reference and research library*

* *to perform any other functions related to the matters aforesaid.*

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ABBREVIATIONS

AARD	– Agency for Agricultural Research and Development
AARI	– Ayub Agricultural Research Institute
ACIAR	– Australian Centre for International Agricultural Research
ADB	– Asian Development Bank
ADI	– Animal Drawn Implements
AEARC	– Atomic Energy Agricultural Research Centre
ARI	– Agricultural Research Institute
ARS	– Agricultural Research Station
ARSs	– Agricultural Research Sub-stations
AVRDC	– Asian Vegetable Research and Development Centre
AZRI	– Arid Zone Research Institute
AZRSs	– Arid Zone Research Sub-stations
BARC	– Bangladesh Agricultural Research Council
CCRI	– Cereal Crops Research Institute
CDRI	– Cereal Diseases Research Institute
CIDA	– Canadian International Development Agency
CIMMYT	– International Maize and Wheat Improvement Centre
CIP	– International Potato Centre
ECNEC	– Executive Committee of National Economic Council
ESCAP	– Economic and Social Commission for Asia and the Pacific
FAO	– Food and Agriculture Organisation
FMI	– Farm Machinery Institute
GSRL	– Grain Storage Research Laboratories
IBPGR	– International Board for Plant Genetic Resources
ICAR	– Indian Council of Agricultural Research
ICARDA	– International Centre for Agricultural Research in the Dry Areas
ICRISAT	– International Crop Research Institute for Semi-Arid Tropics
IDA	– International Development Association
IRDP	– Integrated Rural Development Programme
IRRI	– International Rice Research Institute
MMRI	– Maize and Millet Research Institute
NARC	– National Agricultural Research Centre
NIAB	– Nuclear Institute for Agriculture and Biology
PARC	– Pakistan Agricultural Research Council
PCCC	– Pakistan Central Cotton Committee
PCSIR	– Pakistan Council for Scientific and Industrial Research
PFI	– Pakistan Forest Institute
PIC	– Plant Introduction Centre
PMRI	– Pest Management Research Institute
RNAM	– Regional Network for Agricultural Machinery
RRI	– Rice Research Institute
SARC	– South Asian Regional Cooperation
SAU	– Sind Agricultural University
SCAN	– Soil Capability Assessment Network
SEAFDEC	– South East Asian Fisheries Development Centre
SZARC	– Southern Zone Agricultural Research Centre
TOKTEN	– Transfer of Knowledge Through Expatriate Nationals
UA	– University of Agriculture
UNDP	– United Nations Development Programme
UNESCO	– United Nations Educational, Scientific and Cultural Organisation
UNHCR	– United Nations High Commission for Refugees
USA	– United States of America
USAID	– United States Agency for International Development
USDA	– United States Department of Agriculture
VPCL	– Vetebrate Pest Control Laboratory
WHO	– World Health Organisation
WL&FD	– Wildlife & Forest Department

Contents

Part I

General

Chairman's Report

Agricultural research falls in the high priority areas of the Government. Resulting support, coupled with substantial assistance from donor countries and international agencies has helped to accelerate the pace of infrastructural and manpower development in the Council during 1982-83.

At the Council's premier research institution, **National Agricultural Research Centre** (NARC), spread over 570 hectares near Islamabad, the laboratories and office blocks, training institute and hostel, irrigation channels, farm roads and precision levelling of experimental fields, etc., are nearing completion. Most of the equipment has arrived. The NARC is set for its formal inauguration by March, 1984. When fully operational, this Centre will occupy a pivotal role in our agricultural research system.

The laboratories-cum-office blocks and experimental farms are also nearing completion at the Council's **Arid Zone Research Institute** (AZRI) at Quetta.

Simultaneously, **Southern Zone Agricultural Research Centre** (SZARC), near Sujjawal (District Thatta, Sind), being set up on 12[illegible] hectares, provided to PARC by the Government of Sind, has been further developed. During the next year, research on tropical and sub-tropical crops, suited to delta ecology, will be taken in hand at this Centre.

Like all other research organizations, PARC is handicapped due to shortage of adequately trained and suitably qualified, manpower. Special emphasis was, therefore, continued to be laid on the **manpower development.**

The Council has been making concerted efforts to attract talent for expanding its research programmes. Despite our inability to provide adequate monetary incentives, 132 scientists, including 39 at senior positions, have been inducted during 1982-83.

As part of our overseas training programme, two scientists were sent for M.S. and one for post-doctoral training while 22 others received short-term training at international agricultural research centres including IRRI, CIMMYT, ICARDA, ICRISAT, etc. Thirty seven more have been selected for training leading to M.S./Ph.D. degrees.

Forty seven young scientists were also awarded stipends to attend carefully selected programmes leading to M.Sc. degrees in the local universities. Candidates for the training are selected through a rigorous nation-wide competition.

During the year, PARC organised a number of seminars, symposia, conferences, either on its own or in collaboration with national/international agencies to update the knowledge and expertise of the local scientists through exchange of ideas and experiences. PARC also sponsored the participation of 67 agricultural scientists in international conferences, symposia and seminars held abroad.

Under the auspices of the Council, 54 foreign experts visited PARC and other agricultural research institutions and brought with them latest knowledge and rich experience to help fine-tune the research pursuits of their counterparts in Pakistan.

The year 1982-83 witnessed considerable expansion in the Council's **international collaboration** with agencies like FAO, IDRC, CIMMYT, ICRISAT, ICARDA, AVRDC, etc., and a number of cooperating countries. With the assistance from Canadian International Development Agency (CIDA) an important development project for strengthening of research on *barani* (rainfed) agriculture has been developed for launching during 1983-84. While China has offered technical assistance for introduction of tea crop in the northern parts of Pakistan, Australian Government has agreed to finance research on development of sheep and wool.

Appreciating the pivotal role of **scientific information,** spectrum of activities in this area was further expanded. For promoting international exchange of information, participation in AGRIS (International Information System for Agricultural Sciences and Technology) of FAO was strengthened. Based on AGRIS data base, a Bibliographic Service was started in March, 1983 and 28 bibliographies were procured to meet the specialized demands of the scientists. The first issue of Pakistan Bibliography of Agriculture was published. To disseminate the results of research, 30 publications, including bulletins, reports and conference proceedings were brought out besides regular publishing of three periodicals, quarterly, Pakistan Journal of Agricultural Research; bimonthly, Progressive Farming and monthly, PARC News.

In the library over 2000 books were added during the year and 286 journals were received, out of which 136

were in exchange with our own journals. All additions to the library were continually intimated to the scientists in the country through monthly 'Fresh Arrivals'.

In the following pages a brief account of some salient **RESEARCH ACCOMPLISHMENTS,** elaborated in the body of the report, is presented for easy assessment of the quantum, quality and direction of our research efforts.

In **CROPS,** foodgrains and oilseeds remained our top priority research areas. Major emphasis was laid on the collection, characterization and distribution of exotic and local germplasm to strengthen their breeding programmes in the country.

Germplasm of **wheat** with wider genetic variability was procured from CIMMYT, ICARDA, Nebraska State University and FAO. This material was distributed to NARC, Islamabad; AARI and NIAB, Faisalabad; ARIs, Tandojam and Sariab; CCRI, Pirsabak, and ARS, Bahawalpur to evaluate for desirable traits and incorporate them in the breeding lines. High yield, disease resistance, drought and salt tolerance were the important characters for evolving improved varieties.

National Uniform Wheat Yield Trials (NUWYT) were conducted to test the adaptation of advance lines under a wide range of environments, fertility conditions and exposure to disease complexes existing in various parts of the country. These included normal duration and short duration varieties as well as 12 advance lines for *barani* (rainfed) areas of the Punjab, N.W.F.P. and Baluchistan.

In varietal performance trials 'Pak-81' gave the maximum grain yield of 5025 kg/ha.

Collection, evaluation and hybridization of local and exotic germplasm, rich in the traits for disease and insect resistance, salinity, zinc deficiency and temperature tolerance were the major considerations in **rice** breeding.

One hundred and eleven medium and 74 fine grain lines were tested in replicated yield trials. Lines, '4372', '4086', and '95' were as early as 'KS-282' in medium cultivars. Among fine cultivars, 47 lines produced more yield than 'Basmati-370'. 'PK-198', 'PK-285', 'PK-352' and 'PK-487' were among the most promising lines.

To explore possibility of growing hybrid rice in Pakistan, 6 male sterile, 9 maintainer and 9 restorer lines were received from IRRI The cytoplasmic male sterile (CMS) lines were crossed with their respective maintainer to retain the line sterility for next year use. These lines were also crossed with their respective restorer lines to develop fertile F_1 seeds for planting in the next season The existing CMS lines are of coarse type. As coarse type rice is not preferred in Pakistan, efforts were made to develop CMS lines of fine grain varieties. F lines were developed by crossing, existing CMS lines with fine grain local varieties.

Extensive screening was also undertaken to identify varieties resistant to zinc deficiency and tolerant to salinity. Among the 26 lines which included 'Basmati-370' and 'IR-6', the commercial rice varieties of Pakistan, a strain, 'C-23-3-1' from India showed maximum salt-tolerance followed by strain, 'NR-74-108' of Pakistan.

Country-wide National Yield Trials were conducted to select promising high yielding strains for largescale cultivation. Varieties were also screened for resistance to stem borers, white back plant hoppers, paddy blast, and other diseases under natural field conditions.

Population improvement programme regarding uniform maturity, plant height and reaction to diseases was continued on promising **maize** varieties.

Tropical and sub-tropical material received from CIMMYT was tested at NARC, Islamabad, MMRI, Yousafwala and CCRI, Pirsabak. The varieties, 'Posa Rica 3035', 'Maracay-8023', 'Across-7740', 'Chuquisaca-7845' Tlaltizapan-7934', 'Across-7845', and 'Laplatina-7941' were found outstanding. Hybrid, '7702' gave the highest yield of 7459 kg/ha, followed by hybrids, '3160', '3195' and '8507' in hybrid maize trials comprising 20 lines received from Pioneer Hybrid Company, USA. In varietal performance experiments 'Sultan' outyielded all other varieties, giving 4700 kg/ha followed by 'Composite-15', yielding 4445 kg/ha.

Agronomic studies were conducted on fertilizer requirements of different varieties, time of fertilizer application, and plant population per hectare for short and full season maize varieties to further improve the current production technology. In fertilizer treatments highest yield of 6053 kg/ha, was obtained from plots given 136: 68: 34 kg/ha NPK. 'Sarhad (yellow)' and 'Shaheen' gave the highest yield of 6873 and 6367 kg/ha, respectively, at population density of 70000 plants/ha.

In the National Cooperative Sorghum Yield Trials, conducted at different locations in the country, varieties, 'DS-75', '1747', 'Sarokartuhc', 'BR-123' and '80-RA-7052' gave the best performance under different agro-ecological conditions.

In National Cooperative Millet Yield Trials variety, 'Y-72' gave the highest yield of 2116 and 2993 kg/ha at Yousafwala and D.G. Khan, respectively At Faisalabad, 'DB-2' was the most promising.

Germplasm comprising 238 imported and 26 local varieties of **sugarcane** was evaluated to select lines most suitable for cultivation under local conditions. Desirable traits for such selection included high yield, disease resistance, frost tolerance and ratooning ability. In quality analysis of exotic germplasm regarding total soluble solids (TSS) – a measure for sugar concentration in the juice, variety 'L-75-48' topped the list with 25 84 percent TSS.

To check the introduction of new pathogens, all exotic material is quarantined for one year at NARC, Islamabad (falling out of sugarcane producing areas). Out of 266 quarantined varieties being maintained at NARC, 64 were given to Agricultural University, Peshawar and 8 to Sugar Crops Research Institute, Mardan for their breeding programmes.

To study the flowering behaviour of sugarcane varieties under natural field conditions, 411 varieties including 237 from NARC, Islamabad and the rest from Punjab, Sind and N.W.F.P., were planted at Sugarcane Research Station at Sujjawal Flowering took place during November, 1982 and March, 1983 in 54 varieties. Cane fuzz from the varieties which flowered, was collected and planted during late March, 1983.

In National Uniform Sugarcane Yield Trials variety, 'BL-19' gave the highest cane yield of 88.91 t/ha followed by varieties, 'IM-61' and 'L-62/96' yielding 72.98 and 62.05 t/ha, respectively. Variety, 'IM-61' gave the highest

sugar yield of 6.28 t/ha followed by th · variety, 'L-62/96' yielding 6.23 t/ha.

Rising imports of edible oils, putting a severe drain on our hard-earned foreign exchange, accelerated our efforts to increase the indigenous production of **oilseed crops.**

Out of 16 promising c ltivars of mustard, selected on the basis of their performance in the previous year in National Uniform Yield Trials, *Brassica carinata* gave the highest yield. Ten lines of rapeseed and mustard such as 'Tobin', 'Altex', 'Westar', 'Regent', 'Zim-1', 'Zim-2', having desirable traits of high yield and yellow seed colour have been introduced from Canada and Australia. Fertility and population studies on *B. carinata* revealed that maximum yield was obtained in plots having rows 45 cm apart with fertilizer dose of 62.5 N and 62.5 P kg/ha.

Groundnut variety, 'NC-FIA-14' proved highest yielding in National Uniform Yield Trials 'Banki' gave the highest yield in flat sowing whereas variety, 'No. 334' produced maximum in ridge sowing. Greater number of pods produced in furrow sowing may be largely due to better moisture storage and its availability.

Of the 16 sunflower varieties 'Inra H9P2', a French hybrid gave the highest yield of 1406 kg/ha. Local variety, 'Noor' also gave a matching yield. Results of another evaluation study involving two Italian open pollinated varieties and three hybrids from U.S.A. suggest that 'Ala' and 'Argentario' from Italy, may be used, after selection, for uniform plant size and maturity, until indigenous hybrids are developed.

In **pulse crops** screening of chickpea germplasm against *Ascochyta* blight continued to be our active research pursuit. About 4000 exotic and 300 indigenous lines were evaluated under artificial as well as natural epiphytotic conditions, to assess their disease reaction. Seven lines showed resistance against the disease and their seeds are being multiplied for breeding new cultivars, resistant to blight.

About 120 exotic and 52 indigenous lines of lentil were evaluated for yield and resistance against *Ascochyta* blight, Botrytis and lodging. All the entries showed suceptibility to *Botrytis* but accessions, 'Pak-40368', 'Pak-40400', 'Pak-40401' were resistant to *Ascochyta* blight.

Six hundred and thirty six exotic and indigenous lines of mungbean were screened at NARC, for resistance to yellow mosaic, *Cercospora* leaf spot and yield. Forty lines were selected on the basis of adaptability, resistance to diseases, days to maturity and yield potential. In varietal trial 'M-133-100' was selected as physiologically most efficient with highest harvest index under rainfed conditions.

In varietal evaluation of pigeonpea and cowpeas, two and three highest yielding cultivars were selected, respectively.

Research in **fruits** concentrated on banana, coconut, stone, pome and nut fruits.

Banana variety, 'William Hybrid-1' has been found cold tolerant with better keeping quality besides yielding one and a half times more than 'Basrai'.

Application of urea and TSP on coconut plants gave better growth in terms of linear length and number of leaves, . Application of farm yard manure also helped to accelerate the plant growth and nutrient uptake 'Early dwarf' variety showed the best response.

Seven varieties of peaches have been selected for commercial plantation including the highest yielding variety, 'Summer set'. In apricot, of the varieties, imported from U.S.A., 'NJA-13' has given very encouraging results.

In sub-tropical apple, cultivar, 'Anna' gained popularity among the growers due to its early bearing, good production and attractive reddish colour.

Research in **vegetable crops** was mainly focussed on radish, turnip, cabbage, peas, tomato, muskmelon, cucumber watermelon, okra and onion to screen the varieties with high yield potential and disease resistance.

Seventeen heat tolerant tomato cultivars were screened in relation to mortality at transplantation time, yield and insect pest resistance at NARC and Faisalabad. 'PARC-HT-1' and 'PARC-HT-2' were top yielders.

Eight cultivars of muskmelon were evaluated for yield, disease resistance and total soluble solids (TSS). Highest TSS were recorded in the cultivar, 'Honey Gold', followed by 'PARC-1'.

Seeds of different cultivars of peas, spinach, okra, watermelon tomato, squashes have also been multiplied at NARC and Sariab, Quetta for further coordinated research experiments.

To identify better yielding, disease resistant and frost tolerant varieties of **potato,** 30 exotic varieties were screened at NARC. Indian variety, 'Kufri Sindhuri' outyielded all varieties besides showing better tolerance against frost. Another study to compare the performance of seed produced at Kaghan with that imported from Netherlands revealed that Kaghan produced seed is almost as good as the imported one.

In **special crops** research efforts were concentrated on the development of production technology for their commercial cultivation.

About 625 crosses were made between selected lines of jute to improve the yield and other desirable characters. In varietal trial variety, 'Nepal-IV' gave the highest yield. Agronomic studies included the effect of seed rate, sowing dates, spacing and fertilizer application on the yield.

About 1.6 hectares of land at village Daively near Battal was acquired to establish experimental Tea Garden. Nearly 19000 Chinese tea saplings, raised at Experimental Tea Nursery at Mansehra, have been transplanted in the Tea Garden at Daively. On the request of PARC, a four-member Chinese team visited Pakistan in May-June, 1982 to advise on tea cultivation. The feasibility report submitted by them after detailed survey of the prospective areas, indicates a considerable potential of tea production in Pakistan. Concerted efforts are being made to establish National Tea Research Station in line with the recommendation of the Chinese experts.

Cultivation of ginger proved successful in Shakargarh, Gujaranwala, Rawalpindi and Lahore areas under partial shade. Seeds imported from China proved high yielding.

Mushrooms, being rich source of proteins besides a relished delicacy, received sufficient attention. Ninety one species were collected from different parts of the country. New substrates for spawn preparation and cultivation of oyster mushrooms have been identified.

Tissue culture remained one of our important research thrusts. Meristem tip culture to produce virus-free plants of potato revealed a linear relationship between the size of the explant and its regeneration potential. The most critical step in tissue culture studies is the transference of plantlets from test tubes to the fields. More than 50 percent plantlets transfered in the field at Murree grew sucessfully.

Plantlets of date-palm raised through this technique were transfered to the pots but after showing rapid preliminary growth they could not survive beyond two months. Technology of hardening is, therefore, being perfected

The objective of building comprehensive **plant genetic resources** was to maintain a pool of maximum genetic variability. Collection, characterization and documentation of germplasm is very important for supporting the breeding programmes through continuous feeding with desirable genotypes. It is also a sure safeguard to live up to a possible crisis of complete break down of some genotype against new pathogens. Presently there are 10349 accessions of major crops in the gene bank at NARC which are available to plant breeders in federal and provincial research institutions as well as abroad.

During 1982-83, three germplasm collection missions, were launched in the Punjab and Northern Areas. These missions collected 958 samples of different crops. About 1800 accessions of wheat, barley, maize, vegetables and fruits were distributed to local and foreign research institutions for their breeding programmes.

Plant introduction was another important thrust. Substantial efforts were directed towards the introduction of new plant material and its evaluation. In total 273 varieties/ cultivars of 45 different plants, imported from various countries, were either evaluated at plant introduction centres of PARC or distributed to different research organisations for testing. Yield potentials and growth patterns were studied in kangroo apple, buffalo gourd, strawberry, grape vine, gayule, bamboo, coffee, coconut, oil palm, custard apple, tamarind, ipil ipil, areca nut, bettel leaf, mulberry, passion fruit, chinese guava, avacado, honey locust, cassava and chicku. Many of these plants have been sucessfully established under different agro-ecological conditions, prevalent in the country.

Insects, diseases, namatodes, mites and some vertebrate pests like rodents, birds, etc. cause substantial losses to field crops, vegetables, fruit plants, forest trees and stored grains. Management of all these pests and diseases, to minimize the losses, were the main components of our **plant protection** research

Research in entomology concentrated on the development of control measures against fruit flies, cone borers, cut-worms, pink bollworms of cotton, borers and hoppers of rice, termites, aphids, sawflies and mites attacking almost all types of vegetation. Plant pathology studies included investigations on rusts, bunts and seed-borne fungi of wheat, leaf spots of broad beans, blight of lentil, wilt and blight of gram, leaf blight of rice, stalk rot of maize and powdery mildew of peas. In virology, yellow mosaic of mung, leaf roll of potato and viral infections of major crops alongwith their control measures were investigated. In the field of nematology, besides taxonomic studies, sugarcane and citrus nematodes were successfully controlled by nematicides like Aldicarb and Carbofuran.

Several chemicals and indigenous plant materials, were tried to save the losses caused to stored grains by different pests. The results are quite encouraging. In vertebrate pest control, Avitrol was found effective against house sparrow.

Residues of DDT, BHC or their metabolites were detected in some of the samples of fruits and vegetables, collected from wholesale market of Karachi. In another study on cotton it was found that Thimet and Disyston are taken up by plants to reach peak level within one week of application. Significant levels of residues of both the products were available upto six weeks after initial application. A new unit of genetic toxicology has been created at our Pesticides Research Laboratories, Karachi.

In weed research, effects on yield of wheat, rice, sugarcane, brassica, peas and maize in relation to weed density were studied. Weed flora in each crop was determined. Effective herbicides for controlling weeds of sugarcane and rice were also identified as a result of field experimentation.

In **NATURAL RESOURCES,** fodder and forage crops, forestry, land and water management, soil fertility, honey-bee management and flora of Pakistan were the fields that attracted significant research efforts.

To support the expansion of livestock in the country, efforts were concentrated on the collection, evaluation and selecton of improved exotic and indigenous germplasm of **fodder and forage crops.** Higher yielding varieties, suited to different ecological conditions have been identified for large scale cultivation. These include varieties '14/11' of berseem; 'Synthetic' and 'Snora' of lucern; 'Avon', 'PD-2-LV-65' and 'Sargodha-81' of sorghum. Prospective varieties of elephant grass, buffel grass, blue panic are also at advanced stages of testing.

Out of 75 Australian varieties of annual medics, 'Jemalong' 'Herbinger', 'Barrel', and 'Snail' have been selected and are being introduced in different ecological zones.

In **forestry,** tree improvement, forest management, afforestation of arid areas, forest pests and shelterbelts received special attention. About 2700 candidate trees of various conifers and broad-leaved species were selected for various ecological zones, of which nine were established for genetic improvement. Out of 46 coniferous species, none of the exotic pines performed better than *Pinus roxburghii* in subtropical regions. While, in the temperate region *P. pseudostrobus* has been found to be the most promising. Results of 26 experiments on 12 tree species revealed that in *Morus alba* application of 200 N kg/ha increases the foliage yield by 85 percent as compared to control.

After extensive testing 16 species have been identified for plantation in the semi-arid areas of the country.

In the area of wildlife management, bird population of Haleji, Khinjer, Manchar, Chuch, Hadero, Garro, Serani lakes and marshy areas of Drigh Dhand, Kanadhani Dhand, Luka Forest, Sonda Forest and natural forest divisions of Sind was studied. Out of 124 species identified, detailed biology of 79 has been described.

Another study was undertaken to determine the population status of various birds and animals in Margalla

Hills, Bannigala and Rawal Lake Forty two avian and eight mammalian species have been described with relation to their vegetation types, habitat and number.

Range management studies revealed that 50 percent overstorey cover gives the maximum forage yield. In Lohibher range, five hectares were reseeded with improved grass species and ten thousand plants of *Leucaena leucocephala* were planted to improve the productivity of the range.

The results of **land and water management** studies in *barani* areas revealed that the average grain yields upto 4 5 t/ha of wheat and maize, can be obtained under 200 percent cropping intensity through better water conservation practices. It was also found that deep tillage of 45 cm increased the moisture conservation alongwith 10–25 percent increase in crop yields

Gully eroded lands received special emphasis to develop economically feasible package of technology Experiments at Fatehjang site have yielded highly promising results

Micronutrient status maps have also been prepared showing the adequate, low, or excess status of zinc, copper, manganese, iron, boron and molybdenum, based on the previous work done at different locations in Pakistan. The results provide enough guidance to streamline research work on different crops and establish their micronutrient requirements in different areas

Major thrusts in **soil productivity** research were the composting of organic wastes and synergistic effects of organic materials on the efficiency of mineral fertilizers. The addition of cowdung showed gradual increase in available phosphorus

Research in **saline agriculture** concentrated on the phyto-ecological surveys and selection of salt tolerant species of plants for productive utilization of waste saline areas.

Survey of coastal vegetation extending from Karachi to Gawadar revealed that *Prosopis juliflora* was the most widespread species and exhibited wide range of tolerance to many edaphic characteristics including salinity and sodicity.

In another experiment on rice crop HCl and gypsum were found to be good reclaments for saline sodic soil, significantly increasing the yield.

To assess the role of fertilizers for increasing the crop yield and to determine the micronutrient requirements of major crops, extensive field experimentation on **soil fertility** was undertaken. In maize, application of NPK @ 180:90:60 kg/ha gave the highest yield while in rice the best dose was 120:90:60 at different locations in N.W F.P., Punjab and Sind.

In another study, application of farm yard manure was proved to enhance the efficiency of the mineral fertilizers.

Another investigation was undertaken to determine the effect of micronutrients on the yield of different crops. Significant increase in yield of maize was noticed at Malakand, Tarnab and Tandojam with Zn application. The addition of Cu, Mn and Fe also enhanced the yield. However, Cu and Zn in combination with NPK resulted in dramatic yield increase in N.W.F.P. In case of rice, application of micronutrients either had no effect or caused depression in yield at D. I. Khan. At other locations, viz. Lahore, Gujranwala in Punjab and Tandojam and Tando Muhammad Khan in Sind, the application of Zn produced dramatic yield increases.

Control of pests, effect of migration on honey yield and large scale plantation of high nectar yielding plants remained the priority areas in **honey-bee management** research.

Honey production of migrated and non-migrated *Apis cerana* colonies was studied in Punjab and N.W.F.P. Average honey yield of colonies migrated to Rawalpindi, Islamabad, Haripur and Swat was 16 08 kg per colony Thus migration of colonies is most profitable for honey production in these areas.

Thirty thousand plants of *Robinia pseudoacacia* and *Vitex negundo* were raised in the nursery at NARC. These are known to produce more than 500 kg/ha honey under optimum conditions. Fifteen thousand plants of *V. negundo* and 600 of *R. pseudoacacia* were distributed to interested persons for growing on government and private lands.

Compilation of comprehensive taxonomic account of indigenous **Pakistani flora** was another important activity. The utility of such a reference work for research on crops, weed control, medicinal plants forestry, honeybee farming, etc. is quite obvious. Accounts of 151 flowering plant families of Pakistan (out of a total of about 200) have been compiled and published. Thirty five new plant records have been found from Rawalpindi and Islamabad districts.

By making substantial contribution to the national economy in the form of milk, meat, hides, skins, wool, hair and draft energy, **ANIMAL SCIENCES** sector qualifies to receive major resource allocations. Areas that attracted maximum research efforts were animal breeding, health nutrition and fisheries.

Prime objective in **animal breeding** was to find out and establish the optimum proportion of exotic and local blood in cattle for high milk yield, disease resistance and adaptability to local environmental conditions. Production performance and adaptability of cows under the sub-tropical environmental conditions of the Punjab were studied in 62.5, 25, 37.5 percent cross-breds of imported breeds, 'Holstein Fresian' and 'Jersey' with local 'Sahiwal'.

Different traits of cross-breds of Australian Illawara Shorthorn and Sahiwal were investigated to find age at first successful service and first calving, dry period and calving interval.

While exploring the physiology of post-partum buffaloes, calving period, hematocrit values, period recquired for involution of uterus, age at which first normal estrus and first post-partum estrus appeared, were determined.

Our buffaloes are the highest milk yielders in the world. Obviously, the only way of breed improvement is through selection. Study of different reproductive traits of this animal was the area where research was concentrated.

Important studies in **animal health** included the occurrence of Salmonella in poultry, Rinderpestlike disease, parasitic infestation of sheep and bovine brucellosis.

Out of about 47000 samples, of poultry tisssue,

poultry products, feeds and feed ingredients, Salmonella organisms were found in eight percent of the samples. Sensitivity tests indicated that all cultures were sensitive to Furazolidone, Gentamycin and Neomycin. Most cultures were sensitive to Oxytetracycline and Chloramphenicol, whereas all were resistant to Penicillin and Erythromycin.

For pathogenecity, 40 isolates of Salmonella were tested, of which only 3 were pathogenic, namely *Salmonella bareilly, S. gatow, S. thompson.*

An outbreak of Rinderpest-like disease occurred at Cattle Colony, Landhi, Karachi which lasted from November to mid-February. Immediate survey of 517 sheds indicated 180 animals infected with the disease. Kidney cultures indicated no Rinderpest virus. Testing of blood samples from sick animals revealed the bacteria, Pasteurella, *Escherichia coli* and Hafinea group. It was observed that the material is negative for Rinderpest virus and the problem is due to intestinal form of pasteurellosis.

Parasitism in sheep results in heavy losses due to decreased mutton production and poor wool yield both quantitatively and qualitatively. A study to assess the incidence of different parasites indicated that *Haemonchous contortus* is the most frequent parasite with 85 percent incidence.

Bovine brucellosis, a disease of great economic importance, inflicts losses in animal production through abortion during late pregnancy, resulting in decreased milk production, infertility and prolonged calving interval in aborting animals. Survey and testing of 471 animals from NARC farm and 7 villages around it, revealed that in cattle and buffaloes the incidence of bovine brucellosis is 2.85 and 2.36 percent, respectivley.

Feeds share the maximum cost in anirnal production and usually becomes the biggest economic constraint in the expansion of livestock industry in Pakistan. Our main objective in **animal nutrition,** therefore, is to formulate cheap rations, mainly based on unconventional feedstuffs, incldiuing organic wastes.

Nutritional value of sugar beet pulp silages prepared with different compositions were determined for commercial uses. These silages have successfully been tried on dairy buffaloes as a main source of feed in addition to the available forages.

In another experirnent, wheat straw was treated with urea. It has been found that urea treatment enhances the nutritional value of straw to a level matching medium quality hay in terms of crude protein equivalent and digestibility of organic matter.

In **fisheries,** important areas of research were rearing techniques of freshwater prawns, collection of Crustacea, trout feeding, toxic effects of pesticides on fish, mangrove fauna of Karachi and reproductive behaviour of carp. About 1600 specimens of Crustacea were collected, preserved, identified and catalogued. Several specimens are new records from Pakistan waters. Studies on the, previously unknown, Mangrove fauna of Karachi Sind coast have yielded species of all the major groups of economic importance.

Major thrusts in **SOCIAL SCIENCES** included crop yield constraints research, farm management, and socio-economic surveys.

Crop yield constraints research was prompted by the need to investigate the reasons for low farm productivity resulting in a wide gap between the on-farm and potential yields of crops. The research programme was, therefore, designed to find out major socio-economic and biological constraints responsible for this yield gap. Results of 201 experiments, widely scattered in the Punjab, Sind, N.W.F.P. indicated that the main reason for the yield gap is less quantities inputs used by the farmers than the recommended levels.

Findings of a study on **farm management research** revealed that the cropping intensity decreases with the increase in farm size. Sample survey in Hyderabad district indicated that above 50 percent of the land was kept fallow during *kharif* due to shortage of irrigation water. Cropping intensity was 47 percent on tenant farms, 58 percent on owner-tenant farms and 48 percent on owner farms.

Economic analysis of sheep and goat farming in Sind indicated inputoutput ratio as 1:1.195 and annual rate of return on large farms as 58.7 percent.

In **wheat situation survey,** the condition of the crop during 1982-83 was found better than the previous year. Wheat acreage on sample farms increased by three percent. 'WL-711' alone accounted for 33.1 percent of the wheat area. Nearly 80 percent respondents reported disease-free wheat crop in the area, while 20 percent reported slight to moderate disease attack.

With the modernisation of agriculture, mechanised cultivation is gaining popularity in Pakistan. Economy of operation and efficiency of output were the primary aims in **farm machinery research.** Improvements in the designs of 2.2 meter reaper-windrower and multi crop thresher were made. Prototypes of groundnut digger and thresher were area tested. Modifications are being made in the light of these findings.

A semi-automatic sugarcane planter was imported from India under mutual exchange of prototypes programme of Regional Network of Agricultural Machinery It was tested and necessary improvements in the design are being made to suit the local requirements.

As part of industrial extension FMI engineers were deputed to assist interested manufacturers to fabricate the machines designed by FMI. Three new firms have made agreements for manufacturing of FMI-developed reaper-windrower.

PARC is still in its formative stages and what has been achieved is solely because of the dedicated efforts of our staff, much short of even the minimum critical mass in many disciplines. I acknowledge the hard work of our scientists and the appreciable cooperation of their colleagues in other federal and provincial research organizations.

The information contained in this annual report besides highlighting the achievements also brings into sharp focus the constraints in the way of realising our objectives.

Notwithstanding our limitations, we will continue to seek Allah's blessings and guidance in our endeavours aimed at achieving a quantum jump in agricultural production through the establishment of a wellorganised national agricultural research system.

Dr. Amir Muhammed
Chairman, PARC

Board of Governors

The affairs of the Council are controlled, directed and supervised by a Board of Governors.

Functions

1. Issues policy directives to the Council.
2. Assigns research priorities
3. Effects the approval of new research schemes and monitors ongoing schemes.
4. Reviews completed projects.
5. Approves the development and non-development budget of the Council.

Composition

The Board of Governors comprises the President, a Chairman and five full-time Members and such 'Other Members' as the Federal government may appoint from time to time on the recommendation of the Chairman, PARC.

Federal Minister for Food, Agriculture and Cooperatives is the President and Chairman, PARC is the Chief Executive of the Council. Five Members of the Council, each encharging a Division, namely, the Crop Sciences Division, the Animal Sciences Division, the Social Sciences Division, the Natural Resources Division, and the Finance Division, are the full-time Members of the Board.

Following are the other Members:

Ex-officio Members

Federal Government Officials

1. Secretary, Food and Agriculture Division
2. Additional Secretary, (Expenditure), Finance Division
3. Additional Secretary, Planning and Development Division

Officials from Federal Organisations

4. Chairman, Pakistan Science Foundation
5. Chairman, University Grants Commission
6. Chairman, Pakistan Atomic Energy Commission
7. Vice-president, Pakistan Central Cotton Committee

Provincial Government Officials

8. Secretary, Agriculture Department, Government of the Punjab
9. Secretary, Agriculture Department, Government of Sind
10. Secretary, Agriculture Department, Government of NWFP,
11. Secretary, Agriculture Department, Government of Baluchistan
12. Secretary, Livestock Department, Government of the Punjab
13. Secretary, Livestock Department, Government of Baluchistan
14. Secretary, Forest Department, Government of Sind
15. Secretary, Forest Department, Government of the Punjab
16. Director-General, Agriculture (Research), Punjab
17. Director, Agriculture (Research), Sind.
18. Director-General, Agriculture (Research), NWFP
19. Director, Agriculture (Research), Baluchistan
20. Director-General, Pakistan Forest Institute, Peshawar
21. Secretary, Agriculture Department, Government of Azad Jammu and Kashmir

University Officials

22. Vice-chancellor, University of Agriculture, Faisalabad
23. Vice-chancellor, Sind Agriculture University, Tandojam, Hyderabad
24. Vice-chancellor, NWFP Agricultural University, Peshawar

Non-official Members

Farmers and Scientists

One farmer from each of the four provinces
One farmer from Islamabad district
Four eminent scientists

Names and Addresses of the Members

1. Vice Admiral Mohammad Fazil Janjua,
   Minister for Food, Agriculture and Cooperatives, Pakistan Secretariat, Islamabad.
2. Dr. Amir Muhammed,
   Chairman, PARC,
   Islamabad.
3. Dr. Riaz Ahmad Khan,
   Member (Social Sciences),
   PARC, Islamabad.
4. Dr. Haleem-ul-Hasnain,
   Member (Animal Sciences),
   PARC, Islamabad.
5. Dr. M. Yousaf Chaudhri,
   Member (Crop Sciences)
   PARC, Islamabad.
6. Dr. C. M. Anwar Khan,
   Member (Natural Resources)
   PARC, Islamabad.
7. Mr. Majeed Akhtar,
   Member (Finance),
   PARC, Islamabad.
8. Mr. Saeed Ahmad Qureshi,
   Secretary, Food and Agriculture Division, Government of Pakistan, Islamabad.

9. Mr. Qamaruddin Siddiqui, Additional Secretary (Expenditure), Finance Division, Government of Pakistan, Islamabad.
10. Mr. S. Habib Husain, Additional Secretary, Planning and Development Division, Government of Pakistan, Islamabad.
11. Dr. M. D. Shami, Chairman, Pakistan Science Foundation, F-7/2, Islamabad.
12. Dr. Mohammed Afzal, Chairman, University Grants Commission, H-9, Islamabad.
13. Mr. Munir Ahmed, Chairman, Pakistan Atomic Energy Commission, F-7/4, Islamabad.
14. Dr. Hesamul Haque, Vice-president, Pakistan Central Cotton Committee, Maulvi Tamizuddin Khan Road, Karachi.
15. Mr. Pervez Masud, Secretary, Agriculture Department, Government of the Punjab, Lahore.
16. Mr. S. M. Wasim, Secretary, Agriculture Department, Government of Sind, Karachi.
17. Mr. Arshad Farid, Secretary, Agriculture Department, Government of NWFP, Peshawar.
18. Brig. Mohammad Usman Secretary, Agriculture Department, Government of Baluchistan, Quetta.
19. Brig. Ijaz Hussain, Secretary, Livestock Department Government of the Punjab, Lahore.
20. Dr. Abdul Hameed Khan Babar, Secretary, Livestock Department, Government of Baluchistan Quetta.
21. Mr. Hameed Ahmed, Secretary, Forest Department, Government of Sind, Karachi.
22. Capt. Syed Naseer Ahmed, Secretary, Forest Department, Government of the Punjab, Lahore.
23. Mr. S. A. Qureshi, Director-General, Agriculture (Research) Punjab.
24. Syed Ahmed Pasha Jagirdar, Director, Agriculture (Research) Sind.
25. Mr. Muhammad Siddiq, Director-General, Agriculture (Research) NWFP.
26. Dr. Hassan Jaffar, Director, Agriculture (Research) Baluchistan.
27. Mian Mumtaz Ali, Vice-chancellor, Agricultural University, Faisalabad.
28. Dr. A. Q. Ansari, Vice-chancellor, Sind Agricultural University, Tandojam, Hyderabad.
29. Dr. G. M. Khattak, Vice-chancellor, NWFP University of Agriculture, Peshawar.
30. Mr. Tariq Masood, Secretary, Agriculture Department, Government of Azad Jammu and Kashmir.
31. Mahmood Iqbal Shaikh, Director-General, Pakistan Forest Institute, Peshawar.

Progressive Farmers

32. Lt. Col. (Retd.) Syed Mukhtar Hussain Shah, Member, Federal Council (Punjab) Model Town, Lahore.
33. Mr. Noor Ahmad Lehri, Village Lore Karez, Sariab Road, Quetta, Baluchistan.
34. Haji Abdul Mannan, Retd. Provincial Agricultural Secretary, Village and P.O. Hangu, Distr. Kohat, NWFP.
35. Begum Mumtaz Rashdi, Rashdi House, Jagatabad, Dadu, Sind.
36. Lt. (Retd.) Ghulam Sarwar, Bara Kahu, Islamabad. (Islamabad Capital Territory)

Experts

37. Mr. A. Jamil Nishtar, Chairman, ADBP Islamabad, (Agric. Credit).
38. Mr. Nisar Hassanally Effendi, Bait-ul-Barkat, G-6, Sen Supta Road, Karachi, (Crop Sciences).
39. Syed Babar Ali, Managing Director, Milk Pack/ Packages Ltd., Shahrah-e-Roomi, Lahore, (Dairy Industry).
40. Sardar M. Habib Khan, 90-A, Satellite Town, Rawalpindi (Presently Advisor to President of Azad Jammu and Kashmir for Forestry)

Organisation and Management

The Pakistan Agricultural Research Council is the apex body on national level under the Agricultural Research Division, Ministry of Food, Agriculture and Cooperatives and is responsible to undertake, aid, promote and coordinate agricultural research in the country. The Council manages its affairs and discharges its functions through Board of Governors, Executive Committee, Members of Division, assisted by Directors of respective sections.

The policy making body of the Council is the Board of Governors consisting of he Federal Minister for Food and Agriculture as its President, Chairman, PARC, five full-time Members of PARC and such Other Members as the Federal Government may appoint on the recommendation of the Chairman.

Under the PARC Ordinance of 1981 an eminent scientist is appointed as the Chairman of the Council by the President of Pakistan. Since 1980, Government has concurrently appointed the present Chairman as the Secretary, Agricultural Research Division. The combination of two offices in one person has been rightly described as a revolutionary step towards strengthening agricultural research in the country.

The principal administrative body of the Council, responsible for executing its policies and discharging its functions, is a full-time Executive Committee, comprising the Chairman, PARC as Chairman and the full-time Members of the Board as Members of the Committee. The Executive Committee exercises control over the research activities of the Council and oversees the various built-in procedures involved in the Council's research undertakings. These include the identification of problems faced by indigenous agriculture, accordance of priorities, formulation, evaluation and approval of research projects, assigning of individual projects to different institutes, and monitoring the progress of ongoing projects. In all this, the Executive Committee is assisted by various technical and other committees, appointed by the Council.

PARC has constituted seven different Technical Committees to review/approve and evaluate research schemes viz., Crop Production; Plant Protection; Animal Health and Production; Fisheries; Land and Water Resources; Range Management, Forestry and Sericulture; and Agricultural Economics.

Eminent experts from Government departments, agricultural universities and private sector have been included in these Committees which meet at least twice a year .

Once the Technical Committee approves a proposal for funding, it is referred to the Executive Committee of the Council which then examines it critically and if the project is of vital importance, it refers the same to the Board of Governors for approval.

The Chairman is the chief executive and effects coordination in diverse activities and involvements of the Council. He is assisted by four technical Members and Member (Finance) each heading one of the following Divisions:

1. Crop Sciences Division
2. Natural Resources Division
3. Animal Sciences Division
4. Social Sciences Division
5. Finance Division

The technical Members plan, coordinate and supervise the research undertakings of their respective Divisions and are assisted by Directors of Research in different sub-sectors of their Division. Member (Finance) takes care of all matters concerned with budget, finance and accounts.

In addition to five Divisions there are following Directorates:

Directorate of Planning and Coordination
Directorate of Training
Directorate of International Liaison and Technical Assistance
Directorate of Scientific Information
Directorate of Personnel Administration.
Directorate of Logistics and General Administration
Directorate of Works and Services.

The organisational chart showing also the research establishments of the PARC is given in Annexure VIII

In-house Research Facilities

To cater for the needs of different ecological regions, and/or to carry out research on various disciplines, which had been neglected previously, PARC has also established its own in-house research facilities.

National Agricultural Research Centre (NARC)

Set up at Islamabad (with sub-

stantial assistance mainly from USAID and also from the World Bank) on an area of about 570 ha, the main objectives of NARC is to conduct research in the areas of national importance where such research is not currently being undertaken, or is seriously inadequate or where the problems are of a complex nature which require best equipped facilities. Besides laboratories provided with latest and sophisticated equipment, NARC has a well-stocked and properly staffed reference library; a germplasm bank with about 10000 accessions of various crop varieties; and a laboratory equipment repair/maintenance facility which is also available to provincial agricultural research organisations. Its Animal Sciences Institute is conducting research on livestock, poultry and fisheries while its Farm Machinery Institute is engaged in research on adaptation/development of agricultural machinery suited to common farmers.

Training of research scientists, extension workers and farmers is the major thrust of NARC's Training Institute in which participants are drawn from all over the country.

Arid Zone Research Institute (AZRI)

With Headquarters at Quetta, having well equipped laboratories and a library, and sub-stations at Bahawalpur (Punjab), Dera Ismail Khan (NWFP) and Umarkot (Sind), the Institute has been established to develop techniques for efficient land use and increased agricultural productivity in arid areas. Experimental farms include 30 ha in Quetta, 73 ha at D.I. Khan, 243 ha in Bahawalpur and 86 ha at Umarkot.

Cereal Diseases Research Institute (CDRI)

Located at Islamabad with sub-stations at Murree and Karachi, it conducts research on cereal diseases as well as on diseases caused by viruses, nematodes and bacteria. It is involved in the screening of disease-resistant crop varieties, particularly of wheat. It has also started screening of maize/rice varieties against these diseases.

Pest Management Research Institute

Located at Karachi, these units deal with pesticide analysis at Vertebrate Pest Control Laboratories, locust research, plant and stored grain protection. A national insect museum and national mycological herbarium are also located at Karachi. It is planned to link all the pest management research facilities in the country with a national Pest Management Research Institute.

Southern Zone Agricultural Research Centre (SZARC)

This is being developed near Sujjawal in Thatta district where research on tropical and sub-tropical crops is being initiated.

National Herbarium and Museum

Located at Islamabad, this unit has already collected 60000 specimens.

Planning Coordination and Development Programme

Due to extreme paucity of resources for agricultural research, both human and financial, the planning and coordination of agricultural research activities in the country have to be carefully organised to make the optimum use of the limited resources. The PARC is in the advanced stage of devising an elaborate system for planning, coordination, monitoring and review of all the agricultural research in the country to avoid wasteful duplication and to assign relative priorities to various problems in view of their importance to the national economy.

Planning

Prior to 1981 the functions of planning were assigned to various officers on adhoc basis. In July, 1981, a full-fledged Directorate of Planning was created in the PARC with following main functions.

- collection of data on agricultural research
- forward planning
- development and formulation of projects
- processing of projects through various agencies/channels
- monitoring progress of all ongoing research programmes in the country and their evaluation
- periodic review of agricultural research institutions
- feed-back to the concerned agencies/persons.

1. ***CAREPLANS:*** One of the major functions of PARC is to undertake, aid, promote and coordinate agricultural research in the country.

The PARC has introduced new system in agricultural research planning, namely the CAREPLANS (Coordinated Agricultural Research Planning System). In this system both users and doers of research are involved in the planning process. They jointly identify the research projects. The steps involved in CAREPLANS are:

1. identification of problems
2. according priorities
3. formulation of research projects
4. evaluation of research projects
5. approval of research projects
6. assigning of research projects to various institutes/organisations
7. implementation of research projects
8. accomplishment of research projects
9. accomplishment evaluation.

Under the CAREPLANS, priorities of research have been determined by the scientists of PARC in consultation with the provincial research scientists, extension workers and farmers. These priorities, compiled in the form of a brochure were circulated to research institutions, provincial departments of agriculture, forestry, livestock and fisheries, planning and development, agricultural universities and colleges and the extension workers to elicit their views. The views thus received were examined by the Technical Divisions of the PARC and incorporated in priorities of research already compiled. These national priorities form the guidelines for development of useful research projects

2. ***Agricultural Research Coordination Boards:*** They have recently been setup/strengthened in the provinces on the recommendation of Agricultural Research Review Committee appointed by the Government. Their major job is to strengthen linkages between various research institutes/organisations. Director Planning, PARC has been nominated as the member of these Provincial Coordination Boards.

3. ***Planning of Trained Manpower:*** The PARC, under its charter, is also responsible at the national level to assess the availability and requirements of trained manpower and to plan accordingly for making up the deficiencies in specific areas/disciplines. During the Fifth Five-year Plan PARC has provided the following training facilities to various provincial research institutes and universities:

	Foreign	Local	Total
M.Sc.	40	87	127
Ph.D.	22	1	23
Short-term	110	–	110
Total	172	88	260

During the Sixth Five-year Plan following training facilities will be provided to federal and provincial scientists:

	Foreign	Local	Total
M.Sc.	150	330	480
Ph.D.	100	25	125
Short-term	200	–	200
Total:	450	355	805

Coordination

At present there is a large number of research institutes/stations/sub-stations/centres/laboratories engaged in agricultural research in the country. These institutes are financed from different sources. They develop their research programmes independently. This creates islands of research, cut off from almost every kind of cooperative effort. The lack of systematic communication, aggravates the chances of wasteful duplication of research efforts. This critical situation calls for coordination at all levels – local, provincial, national and international to eliminate the wastage of scarce resources specially the trained manpower by avoiding duplication and overlapping of research pursuits.

With the fore-mentioned objective, PARC has developed a number of National Coordinated Research Programmes in cooperation with other

federal and provincial institutes and agricultural universities. The philosophy behind such programmes is coordinated attack on national problems through cooperative planning and coordinated resource allocation. The National Coordinator appointed by the PARC provides the necessary leadership in the planning and execution of research programmes. The projects are exclusively financed by PARC. Each coordinated programme consists of a number of research projects, whose objectives directly support the coordinated programme. The Principal Investigators of these projects constitute advisory committee for the programme, which provides technical guidance to the Coordinator and determines the contents of the programme.

Development Programme

The Government of Pakistan accords high priority to agricultural research in its national development programme.

During 1982-83, the PARC executed / funded the following projects:

Development projects	14
PL-480 projects	87
Non-development research schemes	65

The projects are being executed in 33 institutions and 6 universities. PARC provided funds to the tune of Rs. 50 million to other federal and provincial institutions and universities for small research projects / programmes to strengthen their research capabilities.

For development projects a sum of Rs. 140.459 million (including FEC Rs. 56.222 million) was allocated during 1982-83. These projects mainly focussed on the building of infrastructure at NARC with facilities of well-equipped laboratories, training institute, reference library, development of scientific manpower, setting up of Arid Zone Research Institute at Quetta with sub-stations at D. I. Khan, Bahawalpur and Umarkot.

Priorities research programmes continued on wheat, barley and triticale; rice; sugar crops; oilseed crops; maize, sorghum and millets; fodder and forage; vegetables and fruits; pulses; water management; soil and water conservation; plant introduction; research on *barani* agriculture; livestock feed resources and nutrition, and development of prototype. These projects have made significant contribution in the evolution of high yielding varieties of crops and development of appropriate production technologies.

In order to tackle these priority areas PARC implemented/initiated following 14 development project besides, the Collaborative Research Programmes between Pakistan and USDA (PL-480).

1. Strengthening of Agricultural Research Capabilities in Pakistan
   Budget (1982-83) – 50.000 million rupees (FEC – 16.000)
   Duration – 1974-75 to 1984-85
2. Pakistan Agricultural Research and Development Project
   Budget (1982-83) – 50.000 million rupees (FEC– 30.000)
   Duration – 1981-82 to 1986-87
3. Arid Zone Research Institute
   Budget – 7.000 million rupees (FEC – 0.200)
   Duration – 1973-74 to 1984-85
4. Research and Introduction of Tea Crop
   Budget (1982-83) – 0.350 million rupees
   Duration – continued since 1973-74
5. Research on Viral, Bacterial, Nematode and Deficiency Diseases of Crop Plants
   Budget (1982-83) – 0.208 million rupees
   Duration – continued since 1977-79
6. Cooperative Research Programme of Food Legumes (Pulses) in Pakistan
   Budget (1982-83) – 0.913 million rupees (FEC – 0.913)
   Duration – 1981-82 to 1983-84
7. Coordinated Research Programme on Saline Agriculture
   Budget (1982-83) – 1.000 million
   Duration – 1981-82 to 1983-84
8. National Out-reach Research Project on Soil Fertility and Fertilizer Use in Pakistan
   Budget (1982-83) – 1.000 million rupees
   Duration – 1981-82 to 1983-84
9. Farm Machinery Institute
   Budget (1982-83) – 3.835 million rupees (FEC–1.230)
   Duration – 1979-80 to 1984-85
10. National Programme for Livestock Feed Resources and Nutrition
    Budget (1982-83) – 7.000 million rupees (FEC – 6.429)
    Duration – 1981-82 to 1983-84
11. Barani (Rainfed) Agricultural Research and Development Project (BARD)
    Budget (1982-83) – 1.000 million rupees (FEC – 0.750)
    Duration – 1982-83 to 1987-88
12. Cooperative Programme for Research Productivity Improvement and Marketing of Potato in Pakistan
    Budget (1982-83) – 1.000 million rupees (FEC – 0.700)
    Duration – 1982-83 to 1986-87
13. Training of Agricultural Research Scientists in On-farm Crop Yield Constriants Research Methodology
    Budget (1982-83) – 0.153 million rupees
    Duration – 1982-83
14. Maximisation and Strengthening of Research in Oilseed Crops in Pakistan
    Budget (1982-83) – 2.090 million rupees
    Duration – 1981-82 to 1982-83
15. PL-480 Research Projects

From the angle of total outlays and being multi-sectoral in scope, the projects fore-mentioned at serial numbers 1, 2, 11 and 15 are the major development projects. A brief resume of these projects/programmes is as follows:

Strengthening of Agricultural Research Capabilities in Pakistan

The project was approved by the ECNEC in 1974 for a period of five

years with a total cost of Rs. 196.88 million including foreign exchange component (FEC) of Rs. 96.20 million. It was re-designed in consultation with the USAID and the total cost of the project was increased to Rs. 252.12 million with FEC of Rs. 69.62 million. The agreement of the re-designed project was extended upto June, 1981. It was further extended for one year without any extra cost.

The objective of the project could not be fully achieved and the USAID was requested to extend the project for another period of three years with an additional cost of Rs. 121.7 million with FEC of Rs. 32 million. The agreement with USAID has been signed for the additional grant.

The main components of the project are:

1. technical assistance
2. training
3. commodities support
4. priorities research programmes
5. construction of NARC complex
6. operation of NARC
7. Off-campus housing (residential flats) for low paid employees.

During 1982-83 a sum of Rs. 50 million was allocated with FEC of Rs. 16 million. This allocation was less than the requirements, therefore, many activities were constrained.

Priority Research Programme on various commodities have continued at NARC and in the provinces. There are 12 Priority Research Programmes in the following commodities. These programmes are meant to support the needs of NARC and provincial institutions including the agricultural universities:

- wheat
- rice
- maize, sorghum and millets
- oilseed
- fodder and forage
- improvement in water management control system
- improvement in soil and water conservation practices
- vegetables
- fruits
- sugar crops
- pulses
- plant introduction.

Construction of roads, canals, three blocks of crop farm centre, hostel, training institute and cafetaria have been almost completed. Work on administration block, laboratories, residences and one block of crop farm centre is nearing completion. Letters of credit for import of laboratory equipment, worth about Rs. 18 million have been opened and tenders for import of scientific equipment are being processed. Under the training programme 113 persons have been sent for M.Sc./Ph.D. courses and 92 have been sent for short-term training.

Pakistan Agricultural Research and Development Project (PARDP)

This project is being assisted by the IDA with a cost of Rs. 396.503 million of which US $ 24 million would be provided by the IDA. The major components of the project are:

- strengthening of PARC
- strengthening of NARC
- agricultural economics research units
- contracted sub-projects
- training
- technical assistance

Utilisation of funds during, 1982-83 remained slow. Out of budget allocation of Rs. 50 million only Rs. 6.13 million were utilized due to non-start of major civil works, delay in the start of training programme and execution of technical assistance component, non-availability of suitably qualified staff and non-clearance of sub-projects.

Laboratory-cum-office block and hostel buildings at NARC are complete. Construction of Headquarters building will be initiated during 1983-84. Designs of other buildings like, FMI, animal farm centre, houses, etc., have been approved by the World Bank.

For the procurement of equipment and machinery, tenders have been invited through international competitive bidding. Contract will be awarded after World Bank clearance.

Under the training programme of the project so far 19 M.Sc. and 18 Ph.D. fellows have been enrolled in the overseas universities and 6 M.Sc. fellows are studying in the local universities.

Funds provided for the appointment of technical experts could not be utilized due to many technical reasons. The experts would be engaged once the agreement with FAO is executed.

An amount of Rs. 45 million has been earmarked for financing research sub-projects at other research institutes and the agricultural universities of the country.

Barani Agricultural Research and Development Project (BARD)

The project started in October, 1982 with the anticipatory approval of the Chairman ECNEC with a total cost of Rs. 183.282 million (FEC Rs. 140.595 million). Rs. 1.000 million (FEC Rs. 0.750 million) were allocated during 1982-83. This amount was much less than the requirements, adversely affecting many activities. The ultimate aim of the project is to improve the quality of farmers' life in *barani* areas through increasing farm productivity and stabilizing the income of the farm families. Major components of the projects are – farming systems, oilseeds, operational research in each province, range management, research contracts, machinery development contracts and administration – each with specific and identifiable goals. Local staff and five Canadian experts have joined their duties, their number would be increased to 182 and 8, respectively. Operational research work at Haripur has started. Oilseed experiments have been laid at NARC.

Collaborative Research Programmes Between Pakistan and USDA (PL-480)

During 1982-83, 106 research projects are being implemented in the fields of crops, animal sciences, agricultural economics, soil and irrigation, plant protection, range management and forestry throughout the country in 35 federal and provincial institutions and universities. In the ADP of 1981-82, a sum of Rs. 24.375 million was allocated for funding 80 ongoing and 26 new projects. For 1982-83 a proposal of Rs. 32 million was submitted for funding 106 ongoing and 29 new projects. The priorities committee allocated only Rs. 15 million which adversely affected the projects.

Development of Scientific Manpower

Without exception, in all the developing countries there is a critical shortage of trained scientific manpower. The manpower deficiency, particularly in the field of agricultural research, is alarming in Pakistan.

The minimum level of academic training for conducting meaningful agricultural research is doctorate. While over 40 major commodities are grown in Pakistan and each commodity has scores of disciplines, which require at least a minimum of 2000 Ph.Ds for agricultural research, the number of agricultural scientists holding Ph.D. in the country is just a little over 200. In addition, there are serious distortions within this available manpower. While there are a reasonable number of agronomy experts, some disciplines do not have even a single expert.

Realising the critical deficiency of trained manpower, PARC has taken several important steps to fulfil its charter obligations.

These include overseas training programme leading to Ph.D./M.S. in foreign universities/institutions of repute, inland academic training programmes and short-term training of research scientists within the country and at the international institutions of repute, particularly at the international agricultural research centres of the CGIAR system such as IRRI CIMMYT, ICARDA, ICRISAT, etc.

Training Programmes

Under the training programme a total of 74 persons were sponsored during the period under report details of which are given as follows:

Level of training	Local	Foreign	Total
1. M.Sc./M.S.	47	2	49
2. Post-doctoral	–	1	1
3. Short-term practical training	2	22	24
Total :	49	25	74

For the less developed areas of Baluchistan, Federally Administered Tribal Areas (FATA) and Azad Jammu and Kashmir (AJ&K), where very few persons with a degree are available, PARC has initiated a special training programme for students with F.Sc. qualifications. The objective of this programme is to provide opportunities to less developed areas to share the benefits of the overall national development. Three persons have been placed for training leading to first degree.

The overseas training programme leading to M.S. and Ph.D. under the Pakistan Agricultural Research Development Project (PARDP) has also been finalized. Under which 37 candidates were selected in open competition. The admission of these candidates is being arranged through FAO in appropriate universities that were identified earlier by PARC. Most of the candidates are to leave shortly.

In addition to the academic programmes, short-term training facilities offered by CIMMYT, IRRI and other internatinnal agencies were also availed.

The details of training provided under the overseas/inland academic programmes are given in Annexure II and III.

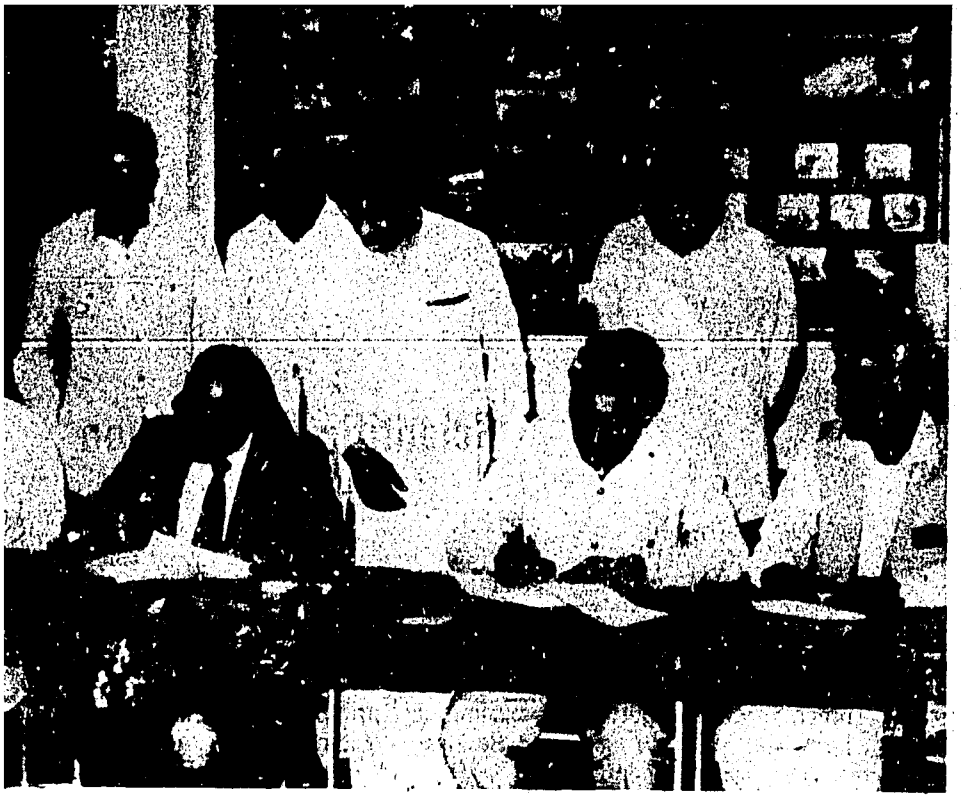
Talent Pool

In addition to the training programme, the PARC has set up a Talent Pool to which recruitments are made on the basis of nation-wide competitions. Brilliant scientists including those with foreign qualifications and training are inducted into this pool at various levels, depending on their research experience. While the Pool scientists will permanently stay on the Council's rolls for purpose of career development, they are seconded to various programmes in the PARC or research institutions/organisations at federal/provincial level to assist them in their research work. Under this scheme, a total of 26 scientists were inducted into the Talent Pool during 1982-83 including 7 for senior positions.

During 1982-83, the Council recruited against various positions (including the Talent Pool) a total of 132 scientists. As many as 40 were taken in senior positions including Dr. Mohammad Yousaf Chaudhri, an eminent research scientist with vast experience in international organisations including FAO who has joined as wholetime Member (Crop Sciences), PARC. List of senior staff of PARC is given in Annexure 1.

Seminars, Symposia, Meetings and Study Visits

Seminars, symposia and conferences play an important role for updating the professional knowledge through the exchange of ideas and experiences amongst the participants. Besides organising 39 major meetings, (Annexure IV) the PARC arranged the facilities for 67 scientists including persons from all the provinces to participate in internatinal seminars and conferences as well as study tours (Annexure V).



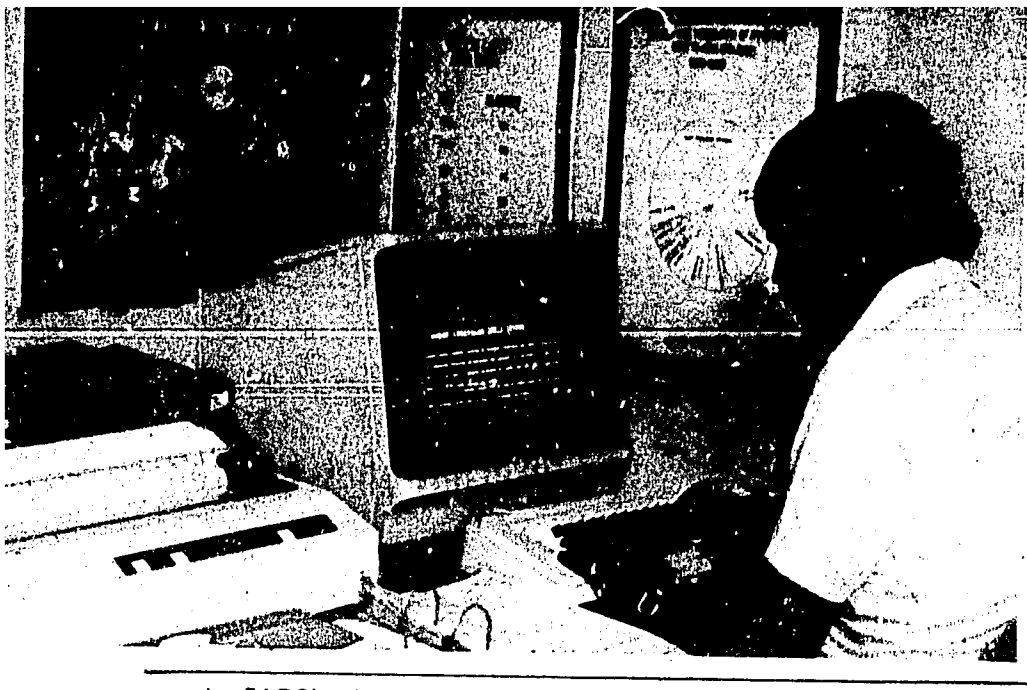
International Liaison

External linkages for an agricultural research organisation, encompassing a national system, are very important in the formulation and implementation of strategies for the strengthening, survival and success of its operations. It is through such linkages with the outside that the research organisations influence technical and institutional changes in society and in science and technology. Realising these imperatives, PARC formalised its international liaison operations sometime back and has achieved a meaningful and effective progression in this direction. The linkages are established through the mechanisation of formal or informal agreements that exist at various levels such as regional (intercountry or multicountry), international, bilateral or multilateral and personal to PARC scientists of international repute. The objectives of external linkages is to share knowledge, expertise and resources with the international community in order to upgrade agricultural research capability in the country.

The most beneficial collaboration of PARC, which has strengthened during the last couple of years, has been with Consultative Group or International Agricultural Research (CGIAR), the donor consortium which coordinates the 13 International Agricultural Research Centres including CIMMYT (Wheat and Maize), CIP (Potato), ICARDA (Dry Areas), ICRISAT (Semi-Arid Tropics) and IRRI (Rice). Chairman, PARC has been representing the Asian and Far Eastern Region on the Board of Governors of CGIAR for the last three years. He is also a member of the Board of Governors of ICARDA. These linkages, as well as the collaborative research programmes with Centres like CIMMYT, CIP, IBPGR (Genetic Resources), ICARDA, ICRISAT and IRRI allow an extensive and tangible exchange of information and research material besides provision of training facilities to Pakistan and availability of high-level international expertise from these centres. PARC has created direct or indirect liaison with a number of national, Governmental and UN bodies such as BARC (Bangladesh) AARD (Indonesia) ESCAP, ADB, USAID, CIDA, ACIAR, SIDA, FAO, UNDP, IDA, UNESCO. These linkages have proved quite useful in strengthening research capabilities in Pakistan.

The year 1982-83 witnessed strengthening of already existing linkages as well as substantial expansion by way of collaboration with more countries. At the Government level, technical cooperation under Scientific and Technological Agreements and Protocols was affected with China, Turkey, Indonesia, Italy, Egypt, Nepal and USA. The UN and Regional Cooperation System, particularly FAO, UNDP, IDA, ADB and SARC further consolidated linkages with PARC. Bilateral agreements of PARC with ICAR, Nepal, Turkey are under process at present.

Participation in international workshops/seminars and study tours by scientists is an effective tool for exchange of the latest research achievements and expertise. PARC sent out 49 scientists during 1982-83 under this programme. On the other hand, it received 69 scientists from abroad, besides arranging acquisition of expertise of 7 Pakistani expatriates under TOKTEN and National Talent Pool programme of the Government of Pakistan.



Scientific Information

In PARC's charter, generation, acquisition and dissemination of scientific information besides establishing a reference library has been represented as one of the major functions.

The Directorate of Scientific Information, to fulfil its vital role, is assisting agricultural scientists in updating their knowledge through continuous feeding with latest information, gathered from within the country and abroad. The Direcorate is also engaged in disseminating the latest research findings. Functionally the Directorate comprises, Documentation Section, Library, Publication Section and Audio-visual Section.

Documentation Section

As in other fields of science the volume of agricultural information is increasing at such a rapid pace that it became almost impossible for any one country to handle it efficiently. Responding to this situation, FAO established two information systems, namely, International Information System for Agricultural Sciences and Technology (AGRIS) and Current Agricultural Research Information System (CARIS). The objective of these systems was to share among themselves the information being generated within member countries. The Documentation Section is functioning as National Liaison Office for both the systems in Pakistan.

Pakistan started submitting the input in 1978. Annual input averaged 100 documents till 1981, when we strengthened our participation in AGRIS and substantially increased the input. During the year under report 821 documents were reported to AGRIS data base. A new activity started this year was, the indexing of AGRIS input by using AGROVOC thesaurus. Although AGROVOC indexing is taking too much time in the beginning still we were able to surpass our last year's input. Due to the absence of well-knit infrastructure to locate and collect all the material published in the country, our input in the data base is not as comprehensive as it should be. Taking cognizance of the potentials of AGRIS, a proposal is in the pipeline to establish a network of AGRIS Input Sub-centres; one in each province to exploit full utility of the system.

The first issue of Pakistan Bibliography of Agriculture containing about 1700 references derived from AGRIS data base has been published. Copies of the bibliography were widely distributed in the country besides sending one copy to each National Liaison Office of AGRIS. Anticipating demand for documents reported in the bibliography, efforts are being made to complete our collection by procuring documents published abroad.

To facilitate scientists a Bibliographic Service has been started since February, 1983. It provides on demand specialized bibliographies based on retrospective searching of AGRIS data base. During the period under report 28 bibliographies were procured on the request of PARC as well as scientists of other agricultural research and academic institutions of the country. Multiple copies of these bibliographies, received in the form of computer print-out, were prepared. Besides providing copies to PARC, NARC and requester's library, these were also supplied to the libraries of all the agricultural universities and other concerned institutions involved in research on that particular topic.

One of the major activities of the Documentation Section is document/reprint supply service. During 1982-83 about 295 requests for the procurement of literature from abroad for PARC as well as other agricultural scientists of the country were processed. The original copies of the documents after indexing were retained in the PARC Library while their photocopies were supplied to the requesters. Sixty documents were supplied in response to requests received from different countries for Pakistani agricultural literature

To plan the future research in a systematic way, the review of past and present developments are of paramount importance. This facilitates the identification of the inherent gaps and imbalances in the crucial areas of research. Realising this fact, FAO established CARIS in 1976 to help its member-States in sharing their information on current research.

Being the National Liaison Office, the Documentation Section, sent input for 60 research projects to be included in the pilot data base to be demonstrated at the time of Second Technical Consultation of CARIS and the Agriculture Ministers Conference at FAO headquarters to be held in October, 1983.

Inspite of limited resources, the Reprographic Unit of the Centre has

started the microfilming of the documents. In the first phase, only PARC publications will be microfilmed. With the installation of necessary equipment, its coverage will be extended to the entire country. The Unit is also providing the photocopying facilities. To further strengthen this service, a plain paper copier with the provision of reduction and enlargement has been installed. During the year under report about 0.450 million copies of the documents were prepared.

Library

Taking congnizance of the urgent need and vital role that a well-stocked library plays in research, efforts were concentrated on resource building. To optimize the spending of limited resources, we were highly selective in case of books but our major emphasis was on procurement of research journals.

During the year under report 286 journals are being procured. Due to foreign exchange stringency, only 150 journals could be subscribed. However, our publications exchange programme gathered more mass and now we are receiving 136 journals (49 local and 87 foreign) in exchange with our Pakistan Journal of Agricultural Research and Progressive Farming.

During the year 2164 books were added to the holding. Except for some reference books, in all the selections the concerned scientists were closely associated to ensure procurement of books of immediate need and relevance. Drawing on our past experience that title lists and catalogues are not indicative of content quality of the books, three book exhibitions were arranged at PARC/NARC. Leading book sellers of the country participated in these exhibitions. It provided an opportunity to the scientists for having a direct access to the publications. They were able to scan the material and evaluate the quality as well as relevance of the contents.

Besides reference services to the scientists, the current awareness service has also been started and periodicals entitled "Fresh Arrivals of Journals" and "Fresh Arrivals of Books" are circulated amongst the PARC scientists, libraries of other research and academic institutions on monthly basis.

Publication Section

The Directorate publishes three periodicals, namely Pakistan Journal of Agricultural Research (quarterly), Progressive Farming (bimonthly), and PARC News (monthly). The research journal publishes research papers emerging out of research being undertaken, both inside and outside the PARC. Progressive Farming contains general articles written on popular topics for practical guidance of extension workers and progressive farmers. The PARC News covers day-to-day activities of the Council and its establishments.

The Directorate published the proceedings of important seminars, symposia, workshops, etc sponsored by the Council. The purpose was to benefit those who could not attend these seminars and to preserve the material for present utilization and future reference.

The extension publications mainly comprised recommendations formulated by technical committees on various commodities which include in their membership eminent scientists working on that specific commodity/discipline in different institutions of the country. These recommendations are evolved after critically analysing experimental data obtained by different scientists and reaching consensus. During the year, 30 publications were brought out (Annexure-VI). The comprehensive list of publications of PARC scientists are given in Annexure VII. Mere publication of periodicals and bulletins is an incomplete exercise unless it is supplemented by a comprehensive dissemination network,. Keeping this important factor in view, the Directorate is maintaining mailing lists at various levels. These lists are so compiled that the PARC publications reach the hands of all categories of people connected with agriculture as a whole. During the year under review, 117000 copies of these publications were distributed. For extension publications, to ensure widest distribution, copies were sent to each Union Council of the districts in which that commodity is grown.

This section also provided designing, composing, layout and printing facilities in other miscellaneous jobs such as introductory brochures, seminar folders, title covers, letterheads, seasonal greeting cards etc.

Audio-visual Section

This Section is providing to PARC scientists the audio-visual facilities during seminars, workshops, meeting, etc. Audio-visual coverage was provided at 76 such functions.

To record various aspects of the experiments at different developmental stages, service for technical photography, to be used in publications and presentation purposes was also provided. This facility helped the scientists in the interpretation of research results in a better and effective manner. Another important in-house facility for colour and toned transparency film processing has been developed.

During the year under report 1158 black and white and 1306 colour slides; 2065 black and white and 1480 colour photographs were prepared. In addition to this 365 wall charts, graphic illustrations, maps, etc were also produced.

Bourlaug medal, named after famous wheat specialist and Nobel laureate Dr. Norman E. Bourlaug, was designed to be awarded every year to an outstanding agricultural scientist in recognition of his contribution.

To highlight the PARC activities, tastefully decorated stalls were arranged at the science conferences, agricultural exhibitions and on days of national importance displaying PARC publications and research contributions.

FUTURE THRUSTS

During 1983-84 the Directorate will initiate following new activities strengthening the present ones:

1. Installation of micro-computer for the computerization of different services of the Directorate.
2. Initiation of Selective Dissemination of Information (SDI) service based on AGRIS data base.
3. Start bimonthly periodical "Contents of Current Journals" comprising content pages of journals received in the library.
4. Survey of agricultural libraries/information units in the country to compile inventory of agricultural information resources.
5. Expand the exchange of publications with the International and local research institutions.
6. Start the compilation of Union Catalogues of Books and Journals.

Budget

After the promulgation of the PARC Ordinance on December 29, 1981, the funding of the Council activities on a sustained basis was ensured in the form of Government's grant-in-aid.

The finances provided by the USDA as part of its collaborative research programme under PL-480 were also made part of the Annual Development Budget of the Council.

The budget of Rs. 50 million was approved under Current Expenditure for 1982-83 but later it was reduced to Rs. 46.706 million due to economy cut and was allocated to various PARC Units as under.

	Allocation (Million Rs.)
PARC (Main)	21.692
Current Research Schemes	14.986
Plant Genetic Resources	0.152
Honey-bee Research Programme	0.221
Pest Management Research Institute	4.633
Cereal Diseases Research Institute	0.918
Animal Sciences Institute	2.851
Documentation Section	1.253
	46.706

The Sector-wise details in respect of Current Research Schemes are as follows:

	Allocation (Million Rs.)
Crops Production	3.580
Crop Protection	1.300
Land and Water Resources	2.533
Range Management and Forestry	1.082
Watershed Management	1.900
Animal Husbandry	2.084
Fisheries	0.700
Agricultural Economics	1.707
Miscellaneous	0.100
	14.986

For 1982-83 the Development Budget amounting to Rs. 140.450 million was approved under ADP for various development projects of PARC. The break-up is given as follows:

		Allocation (Million Rs.)
Strengthening of Agric. Res. Capabilities in Pakistan	FEC	50.000 (16.000)
Pakistan Agric. Res. Development Project (World Bank)	FEC	50.000 (30.000)
Arid Zone Research Institute	FEC	7.000 (0.200)
Research on Viral, Bacterial, Nematode and Deficiency Diseases of Crop Plants		0.208
Research and Introduction of Tea Crops		0.350
Cooperative Research Programme of Food Legumes (Coordinated Pulses Project)	FEC	0.913 (0.913)
Coordinated Research Programme on Saline Agriculture		1.000
National Out-Reach Research Project on Soil Fertility and Fertilizer Use in Pakistan		1.000
Farm Machinery Institute	FEC	3.835 (1.230)
National Programme for Livestock Feed Resources and Nutrition	FEC	7.000 (6.429)
Barani (Rainfed) Agricultural Research and Development Project	FEC	1.000 (0.750)
Cooperative Programme for Research Productivity Improvement and Marketing of Potatoes in Pakistan	FEC	1.000 (0.7000)
Training of Agric. Res. Scientists in On-farm Yield Constraints Research in Pakistan		0.153
Maximization and Strengthening of Research in Oilseed Crops in Pakistan		2.000
PL-480 Research Projects		15.000
Total:	FEC	140.459 (56.222)

FEC: Foreign Exchange Component

Part II

Crop Sciences

Technical

Wheat, Barley and Triticale

OBJECTIVES OF RESEARCH PROGRAMME

1. To collect, evaluate and characterise germplasm.
2. To improve varieties for higher yield, quality and disease resistance and maintain pre-basic seeds to ensure purity.
3. To undertake agronomic studies to find out the economically most acceptable cultural practices.
4. To undertake seed multiplication for wide testing, leading to increased production for distribution to farmers.
5. To carry out test for promising genotypes and identify the best high yielding lines/varieties for different agro-ecological zones.
6. To impart training to wheat scientists/extension workers.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

1. *Varietal Improvement and Hybridization:* To accelerate the varietal improvement programme, germplasm with wider genetic variability was procured from international agencies such as CIMMYT, ICARDA, Nebraska State University and FAO. The material was distributed to NARC, Islamabad; AARI, Faisalabad; ARI, Tandojam and Sariab; CCRI, Pirsabak, ARS, Bahawalpur and NIAB, Faisalabad for further evaluation of traits of economic importance.

Fresh crosses were made to evolve high yielding, disease resistant, drought and salt tolerant varieties of good quality under the hybridization programme. The selected entries were tested in preliminary small and large scale trials.

2. *Bread Wheat Screening:* To screen out the best lines having desirable characters with special emphasis on rust pathogenecity, 255 lines were planted, out of which 13 were selected for further testing.

3. *Rust Resistant Group:* Two hundred and seventy nine lines were planted for selection of resistant lines out of which 22 lines were retained for hybridization programme.

4. *International Spring Wheat Yield Nursery:* It was received from CIMMYT and planted for evaluating the yield potential under our agro-climatic conditions. Six best yielding, disease resistant and good looking lines were selected to be included next year in station trials.

5. *Dryland Bread Wheat:* Single plant selections were made on the basis of good spike length, better tillering, grain size and maturity. Eighteen lines were selected and planted at Summer Wheat Nursery Kaghan for testing against rust pathogenecity.

6. *Regional Bread Wheat Yield Trial:* Out of 24 lines, 12 were selected having good yield potential, disease resistance and other desirable traits.

7. *Bread Wheat Observation Nursery:* This nursery was received from ICARDA and planted to select the rust resistant and good looking lines. Twenty eight lines were retained for further evaluation.

8. *International Durum Yield Nursery:* As we have already gained self-sufficiency, durum needs more attention. Out of 30 cultivars/lines from CIMMYT, 4 high yielding lines were retained.

9. *Regional Rainfed Durum Yield Trial:* Out of 24 lines tested under rainfed conditions, 2 were selected for further evaluation.

10. *Regional Durum Yield Trial:* Out of 21 lines, 4 best yielding having other desirable traits were selected for further testing.

11. *Durum Observation Nursery:* Out of 150 lines received from ICARDA for evaluation, 7 best suited were retained.

12. *International Triticale Yield Nursery:* Fifty lines were planted to be compared with other cereals. Eight lines having good grain filling and better test weight were selected.

13. *Barley Observation Nursery:* Out of 150 lines received from ICARDA, 16 were selected for further evaluation.

14. *Harvest Index Trial:* Adaptation to prevailing conditions and different genetic make up of cultivars may result in a wide range of yield variations. Cultivars with the highest harvest index are found more efficient in converting their dry matter into grain yield and vegetative part. Twenty cultivars were included in the present study to select the physiologically most efficient cultivars. 'Pak-81' and 'Arz' were found to be the most efficient possessing higher harvest indices and comparatively more biological yield among the cultivars. Positive correlation was found between biological yield and economic

yield, and harvest index and economic yield.

15. *Varietal Performance Trial:* Out of ten tested varieties, 'Pak-81' and 'Arz' gave maximum grain yields of 5025 and 4825 kg/ha, respectively.

16. *N : P Effect Trial:* Nitrogen and phosphorous were applied to wheat plots in different combinations. The treatment means were statistically significant as compared with the control. The maximum grain yield was obtained under 4: 3 treatment followed by 2:3 giving 5575 and 5250 kg/ha yield, respectively.

17. *Organic Fertilizer Trial:* In this trial organic and mineral fertilizers were tested in different proportions at two doses, 75:50 and 90:60. Urea and super phosphate were used as mineral and compost as organic fertilizers. The statistical analysis showed the significant difference among the treatment means. The best combinations were 100 percent nitrogen + P_2O_5 (mineral) and 75 percent nitrogen (mineral) + 25 percent nitrogen (organic) + P_2O_5 (mineral) at a dose of 90:60 kg/ha.

18. *Mixed Cropping Trial:* To study the effect of increasing population of brassica on the yield of wheat when mixed cropped or inter-cropped, a number of treatments were tested and the treatment with 90 percent wheat seeds and 10 percent brassica proved the best and economical giving 2500 kg/ha wheat and 840 kg/ha brassica as compared with wheat or brassica alone.

19. *Tillage Trial:* Various tillage practices were compared (Table 1) to identify their effect in wheat performance. The tillage experiment (primary and secondary) was conducted using a

Table 1. Wheat yield as affected by various tillage practices

	Yield (kg/ha)
Primary tillage	
Mould board	4304
Sub-Soiler	3800
Chisel plough	3574
Cultivator	3720
Secondary tillage	
Mould board	4008
Cultivator	3680
Sweeps	3872
Disc	3816

Barley has also a good promise to supplement the production of foodgrains

Split Plot Design. Primary mould board tillage resulted in a significantly higher wheat yield than the other tillage practices. Secondary tillage practices differed little from each other in grain yield.

20. *Weed Control Trial:* Two trials were conducted at two locations, to evaluate 16 different herbicides in controlling both broad-leaf weeds and grass weeds. Herbicides, Avenge, Illoxan, and Arelon satisfactorily controlled grass weeds. Broad-leaf weeds were controlled by Dosanex, Afalon, Tribunil, Dicuran-MA, MCPA and DMA-6.

National Uniform Yield Trials (NUYT)

Wheat

1. *National Uniform Wheat Yield Trial (NUWYT) (Normal Duration).* The trial is designed to test the adaptation of advance wheat lines of normal duration under a wide range of latitudes, climates, fertility conditions and exposure to disease complexes existing in Pakistan.

The trial comprises 20 varieties (19 advance lines and 1 local check). Sixty sets were prepared to be planted in the four provinces. The yield performance and reaction to rusts and diseases is given in Table 2.

2. *NUWYT (Short Duration):* Wheat is planted in many areas of the country after the harvest of cotton, rice etc. Wheat varieties which mature in 120 –130 days are needed to fit in these rotations. This trial was designed to test the advance lines, particularly in those areas, where wheat is planted in December – January (Table 2).

3. *NUWYT (Rainfed):* This trial included 12 advance lines. About 1/3 area under wheat is rainfed. Hence, there is a need to develop high yielding, disease resistant lines for *barani* (rainfed) tract to increase total production of the country. This trial was planted at about 20 locations covering *barani* zones in the Punjab, NWFP and Baluchistan. The yield performance and potential rust reaction is evident from Table 2.

Barley

National Uniform Barley Yield Trial (NUBYT): Barley is diploid, which is a disadvantage in breadth of adaptation of individual lines as compared with other cereal crops. This trial was designed to test the adaptation of eight superior barley lines produced by national programme (Table 4).

Triticale/Durum

National Uniform Triticale/ Durum Yield Trial (NUTYT/NUDYT): World-wide interest has been shown in the man-made cereal, triticale, a plant produced by crossing wheat and rye, which has now reached the stage of having valuable commercial capabilities in several countries. By improving the growth habit, plant type, disease resistance, and fertility, the productivity of triticale has risen and now it out-yields wheat in several environ-

Table 2. Sites average yield and potential rust reaction of candidate wheat varieties/lines under NUWYT, 1982-83

Variety/line	Source	Sites average yield (kg/ha)					Disease reaction	
		Punjab (irrigated) (23 sites)	Punjab (*barani*) (7 sites)	Sind (7 sites)	NWFP (6 sites)	Baluchistan (7 sites)	Yellow rust	Leaf rust
Normal Duration Varieties								
'V-5685'	ARS-Bahawalpur	3655	3557	3216	2047	4010	30 MS-S	80S
'S-19'	NARC-Islamabad	3820	3957	3175	2925	4126	10MR-40MS-S	10MR
'MTWV-81-82 ('V-5')	ARI-Sariab, Quetta	3559	3857	3304	2942	3619	5S	30MR-MS
'V-79100'	AARI-Faisalabad	3519	4331	3200	2872	4325	40MR-MS	10RMR
'P-94'	AEARC-Tandojam	3547	3436	3094	2576	4193	80MS-S	40S
'V-2' ('141')	ARI-Sariab, Quetta	3502	4198	3247	2836	4389	30MS-S	10RMR-30S
'V-80078'	AARI-Faisalabad	3752	3897	3078	2698	3728	50MS-S	60S
'V-5890'	ARS-Bahawalpur	3754	3600	3318	2594	3840	5MS-S	60 S
'V-79143'	AARI-Faisalabad	3785	4278	3038	3219	3778	40MS-S	TMR
'V-3'	ARI-Sariab, Quetta	3478	2941	3298	2338	4169	80MS-S	90S
'S-82' ('Bob white')	CCRI-Pirsabak	3763	4197	3194	3052	3936	10MSS-20S	TMRMS-20S
'P-89'	AEARC-Tandojam	4082	4137	3503	2828	4078	50MS-S	20S
'SS-5'	UA-Faisalabad	3865	4042	2991	2667	3726	70MS-S	80S
'V-79353'	AARI-Faisalabad	4010	4412	3251	3206	4153	60MS-S	20R
'Mant-7'	ARI-Tandojam	3699	3812	3342	2614	4124	70MS-S	30S
'V-81579'	AARI-Faisalabad	3479	3326	2823	2448	4169	70MS-S	10MR-MS
'Lu-26-S'	UA-Faisalabad	3874	3631	3003	2728	3829	60MS-S	80S
'V-80196'	AARI-Faisalabad	3668	4449	3173	2571	4288	20MS-S	10MR-50S
'S-83'	CCRI-Pirsabak	3706	3887	3312	3205	4072	50MS-S	TMR
Local check	–	3940	3705	3439	3515	4172	40MSS-90S	80S
Short Duration Varieties								
'V-81627'	AARI-Faisalabad	3294	4038	3342	2882	4555	5R-40S	30MR-MS
'V-4'	ARI-Sariab, Quetta	3327	3116	3335	2612	4686	5MS-S	10MR-MS
'V-80289'	AARI-Faisalabad	3171	3387	2896	2299	4092	10S	60MR-MS
'V-5648'	ARS-Bahawalpur	3416	2880	3039	2259	3754	40MS-S	80S
'V-79391'	AARI-Faisalabad	3421	2851	3078	2706	4109	30MS	10MR-MS
'Mant-13'	ARI-Tandojam	3574	2772	3519	2904	4693	40S	20MS-S
'V-1130'	AARI-Faisalabad	3204	3272	3078	2707	4132	50MS-S	20MS-S
'Lu-26-S'	UA-Faisalabad	3425	2853	3344	2419	4106	70S	50S
'V-1299'	AARI-Faisalabad	3002	2061	3079	2108	4299	40MS-S	5MR
'V-79438'	AARI-Faisalabad	3309	3238	2557	2441	3559	50MS-S	10MR-MS
'V-81608'	AARI-Faisalabad	3258	4124	2933	2547	3890	5MS	5MR
Local check	–	3673	3157	3175	2303	4185	90S	60S
Barani (Rainfed) Varieties								
'V-79359'	AARI-Faisalabd	–	3781	–	2803	770	40MS-S	SR
'V-79388'	AARI-Faisalabad	–	3679	–	2992	708	20MR-10MS	10RMR
'V-79324'	Barani Stn.–Rawalpindi	–	3696	–	2693	750	20MR-30MS	30MR
'V-79142'	AARI-Faisalabad	–	3459	–	3209	646	10MR-40MSS	30S
'K-342'	AARI-Faisalabad	–	3505	–	2853	688	10MS-S	TMR
'S-19'	NARC-Islamabad	–	3671	–	3110	604	10MR-5MS	TMR
'V-80099'	AARI-Faisalabad	–	3254	–	2518	1188	S-10MSS	50S
'V-1235'	Barani Stn.–Rawalpindi	–	3507	–	2135	1270	20MR-10MSS	TMR
'V-80067'	AARI-Faisalabad	–	3757	–	2574	979	10MR-40MS	10R
'V-1283'	AARI-Faisalabad	–	3754	–	2929	729	10S	30MR
'V-79353'	AARI-Faisalabad	–	3486	–	2771	1020	40S	30MRM
Local check	–	–	3352	–	2585	604	40MS	70S

S = Susceptible; MS = Moderately Susceptible; MR = Moderately resistant; R = Resistant

Table 3. Sites average yield of candidate varieties/lines under NUTYT/NUDYT, 1982-83

Variety/line	Source	Sites average yield (kg/ha)			
		Punjab (irrigated) (9 sites)	Punjab *(barani)* (2 sites)	NWFP (2 sites)	Baluchistan (3 sites)
'D-80-52'	AARI-Faisalabad	4229	5128	3280	2125
'D-80410'	AARI-Faisalabad	4219	3982	2550	2104
'D-797[illegible]7'	AARI-Faisalabad	3961	4196	2903	2319
'L-79736'	AARI-Faisalabad	3878	3788	2475	2792
'V 1' (Triticale)	ARI-Sariab, Quetta	3909	4972	3149	2521
'T-80513'	AARI-Faisalabad	3829	3794	2866	2722
'T-79624'	AARI-Faisalabad	3687	3906	2719	2284
'NIAB-T-183'	NIAB-Faisalabad	4165	4962	3036	2430
'T-80523'	AARI-Faisalabad	3885	4512	2965	2750
Local check		3989	3456	2572	2507

Table 4. Sites average yie[illegible] of candidate varieties/lines under NUBYT, 1982-83

Variety/line	Source	Sites average yield (kg/ha)				
		Punjab (irrigated) (4 sites)	Punjab *(barani)* (2 sites)	Sind (1 site)	NWFP (1 site)	Baluchistan (3 sites)
'M-69-69'	AARI-Faisalabad	3564	5800	3529	2400	3361
'Eva'	AARI-Faisalabad	2632	4569	3452	2038	3389
'Maricoho'	AARI-Faisalabad	3036	4088	3556	2671	3597
'AS-54-Tra'	AARI-Faisalabad	2766	4706	3278	2454	3479
'Traill 8-DL 70'	AARI-Faisalabad	2465	4656	3327	2304	3448
'Mzq-DL-71'	AARI-Faisalabad	3076	4956	3308	1320	3132
'V-I'	ARI-Sariab, Quetta	2620	2938	3031	2171	3729
Local check		3117	3894	3790	2492	3472

ments. Increased interest in durum wheats has been generated in recent years as the country thinks of exporting wheat.

The primary aim of the NUTYT/NUDYT is to develop durum and triticale materials having high yield potential for areas and conditions appropriate for maximum expression. The trial consisted of ten advanced lines including one local check. The yield performance is given in Table 3.

THRUSTS FOR NEXT YEAR

1. Identification and commercialisation of high yielding varieties with adaptation to specific agro-ecological zones.
2. Evolving high yielding disease resistant varieties for rainfed situations and suitable for various cropping patterns in the country
3. Research on varietal development for problem soils and suiting the requirement of export.

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Rice

OBJECTIVES OF RESEARCH PROGRAMME

1. To collect, evaluate and characterise germplasm.
2. To breed for dwarf and high yielding 'Basmati' varieties.
3. To evolve high yielding, medium grain and early maturing varieties.
4. To screen and develop rice cultivars resistant to diseases and pests.
5. To identify high yielding varieties with improved grain, milling and cooking quality.
6. To evaluate resistant material for zinc deficiency.
7. To screen varieties for heat tolerance, salinity/alkalinity, cold temperature and cold water.
8. To determine package of appropriate technology and its dissemination at farm level.
9. To study post-harvest losses at farm level.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

1. *Maintenance of Germplasm:* Pure seed of 916 varieties of Pakistan origin was obtained from germplasm bank of IRRI and were planted for seed increase and distribution to provincial institutes. About 60 varieties did not flower. Rest of the varieties were harvested, threshed and pure seed preserved in the germplasm bank at NARC.

2. *Hybridization:* Efforts were made to collect the rice varieties rich in the traits for disease and insect resistance, adverse soil tolerance like salinity, zinc deficiency and temperature tolerance. A hybridization programme was carried out to combine the desirable characters into a single variety. About 125 different cross combinations for different objectives were made and the seeds harvested have been preserved for growing as F_1 for further evaluation.

3. *IRYN-VE (International Rice Yield Nursery-Very Early):* Out of 28 entries, 26 showed earliness than 'IR-841' check variety; 15 entries gave higher yield than check. The entries 'PA-4045-2' and 'BG-276-5' gave maximum yields of 4999 and 4866 kg/ha, respectively, compared to 'IR-841' giving 3699 kg/ha. These two entries are being promoted to micro-plot trials. 'IR-19743-25-2-2-3-1', 'TKM-9', 'TNAU-9426-7' and other promising entries are being tested but the remaining entries will be maintained in the germplasm.

4. *IRYN-E (International Rice Yield Nursery-Early):* This nursery comprised 28 entries, out of which 13 were earlier and 15 gave higher yield than 'IR-841' check variety. The maximum yields of 5532 kg/ha and 5466 kg/ha were obtained from entries, 'UPR-254-24-1' and 'IR-13029-716', respectively, in comparison to 'IR-841' which yielded 4199 kg/ha. Two high yielding entries have been promoted to micro-plot trials and entries, 'IR-220-1-1', 'IR-13240-82-2-3-2-3-1', and 'UPR-254-14-1' have been selected for further testing.

5. *IRON (International Rice Observation Nursery):* It consisted of 350 entries from various countries planted at ARI, Mingora, Swat. Standard evaluation system for rice, as developed by the International Rice Testing Programme (IRTP), was used for recording traits like vigour, panicle exertion, phenotypic acceptability, plant height and time to flower. About 20 entries were selected for further testing next year.

6. *IURON (International Upland Rice Observational Nursery):* There were 185 entries, which were screened under drought conditions by irrigating at 15 days interval. The trial was non-replicated having 'IR-84-1' as check. Forty one entries out-yielded the check by giving yield of 2500 kg/ha while the maximum yield of 6500 kg/ha was given by entry 'C-894-21'.

7. *IRLRON (International Rice Lowland Rainfed Observational Nursery):* There were 120 entries which were screened in low lying areas. Thirty seven entries gave higher yield than check variety, 'IR-6'. The maximum yield of 4333 kg/ha was obtained from 'IR-21074-153-P1' in comparison to check (1791 kg/ha).

8. *IRLRYN-82 (International Lowland Rice Yield Nursery):* Fourteen entries out-yielded check variety, 'IR-6' in the nursery of 30 entries. The maximum yield of 2708 kg/ha was given by entry 'CN-540' in comparison to check which gave 1379 kg/ha.

9. *IRCTN (International Rice Cold Tolerance Nursery):* The nursery consisting of 166 entries from various countries was planted at Baghdheri

and was getting cold irrigation water direct from river Swat. The data were recorded on daily water temperature, daily atmospheric temperature, plant vigour, leaf colour, plant height, days to flower, panicle exertion, sterility, cold tolerance, disease attack and phenotypic acceptability, following IRTP system.

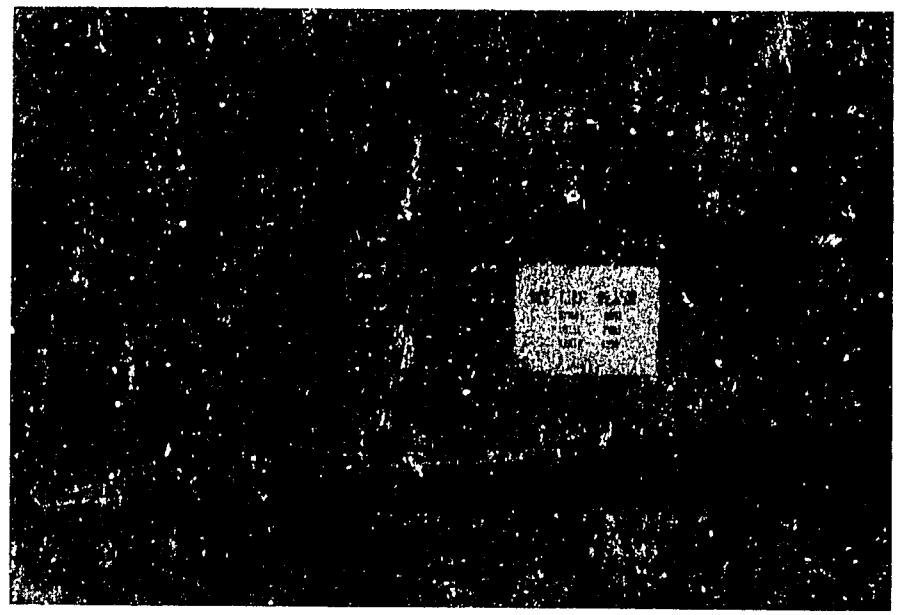
The nursery showed a clear response to the effects of cold temperature and cool irrigation water. Twenty two entries have been selected for further testing on the basis of phenotypic acceptability.

10. *Incorporation of Earliness and Short Stature in 'Basmati-370':* A micro-plot yield trial of the promising recombinants in F_4 generation was carried out to confirm the breeding behaviour and yielding ability. Most of the recombinants bred true for both the characters. However, yield potential could not be estimated due to heavy damage caused by wild boar. Meanwhile, data recorded about important yield influencing attributes showed that selected genotypes differ significantly from the respective parents in respect of the desired traits.

11. *Genetic Analysis of Induced Mutants:* Genetic studies made in F_1 crosses involving two semi-dwarf mutants, 'DM-16-5-1' and 'DM-107-4', and a early maturing variety, 'Kashmir Basmati', and the parent variety 'Basmati-370' revealed over dominance with additive effect in case of plant height while heading date showed partial dominance. Fresh cross combinations including reciprocals between a few newly developed mutants namely, 'DM-15-4', 'DM-11', 'DM-178-1', 'DM-179-1' and the parent variety, 'Basmati-370', were made.

12. *High Yielding Medium and Fine Grain Varieties:* One hundred and eleven medium and 74 fine grain lines were tested in replicated yield trials. Nineteen lines out-yielded 'IR-6'; 13 lines were found late maturing but lines, '4372', '4086', and '95' were as early as 'KS-282' in medium cultivars. Among fine cultivars, 47 lines produced more yield than 'Basmati-370'. 'PK-198', 'PK-285', 'PK-352' and 'PK-487' were promising lines.

13. *Hybrid Rice Production:* To explore possibility of growing hybrid rice in Pakistan, a collaborated programme with IRRI has been started. During this report period, 6 male sterile, 9 maintainer and 9 restorer lines were received from IRRI. The cytoplasmic male sterile (CMS) lines were crossed with their respective maintainer to maintain the line sterility (for next year use). These lines were also crossed with their respective restorer lines (S) to develop fertile F_1 seeds for planting in next season. The following seeds were obtained in this study.



Rice germplasm: combining desirable traits of high yield, disease and pest resistance, salt tolerance requires a breeding stock with maximum genetic variability

Crosses with maintainers

Cross	No. of seeds harvested
'V20 A' x 'V 20 B'	295
'V20 A' x 'IR-10154-23-3-3'	65
'V20 A' x 'IR 10179-2-3-1'	5
'Er-Jiu Nan 1A' x Er-Jiu Nan 1 B'	182
'Er-Jiu Nan 1A' x 'IR-10176'	41
'Er-Jiu Nan 1A' x 'IR-10179-2-3-1'	142
'Yar Ai Zhao A' x Yar Ai Zhao B'	407
'Yar Ai Zhao A' x 'IR-10176-24-6-2'	11
'MS 577 A' x 'MS 577 B'	21

Crosses with restorers

'V 20 A' x 'IR-36'	224
'V 20 A' x 'IR-50'	65
'V 20 A' x 'IR-54'	407
'Er Jiu Nan' x 'IR-50'	146
'Er Jiu Nan' x 'IR-54'	81
'Er Jiu Nan' x 'IR-2307'	118
'MS 577 A' x 'IR-50'	5
'MS 577 A' x 'IR-54'	46
'MS 577 A' x 'IR-2307'	176

14. *Development of Cytoplasmic Male Sterile (CMS) Line with Fine Grain:* The existing cytoplasmic male sterile lines are of coarse type. As coarse type rice is not prefered in Pakistan, efforts were made to develop CMS lines bearing fine type grain. To persue this, F_1 lines were developed by crossing existing CMS lines with fine grain local varieties. The pattern of seed setting obtained in various combinations is given as follows:

Cross	No. of grains harvested
V 20 A' x 'Basmati-370'	4
'V 20 A' x 'Kashmir Basmati	28
'Er-Jiu Nan 1 A' x 'Kashmir Basmati'	28
'Yar Ai Zhao' x 'Plamen'	105
'Yar Ai Zhao' x 'Kashmir Basmati'	44
'MS 577 A' x 'Santhi'	44

15. *Screening of Varieties Resistant to Zinc Deficiency:* One hundred and ninty seven lines/varieties were screened for resistance to zinc deficiency. Out of these 25 lines/ varieties were resistant, 105 moderately resistant, 64 moderately susceptible, and the remaining 3 were highly susceptible to zinc deficiency.

16. *Selection for Salt Tolerance:* Twenty six elite salt tolerant strains of wide geographical origin alongwith the strains of local origin were evaluated for soil sodicity in the artificially salinized cemented field basins. Regressions of soil sodicity levels over yields for all the strains were computed and the respective values of soil sodicity (ESP) corresponding to 50 percent

reduction in yield (LD_{50}) was calculated for each strain.

Among the 26 lines which include 'Basmati-370' and 'IR-6', the commercial rice varieties of Pakistan, a strain, 'C-23-3-1' from India showed maximum salt-tolerance followed by strain, 'NR-74-108' of Pakistan.

17. *Effect of Date of Transplanting and Spacing:* Four varieties, 'Swat-I', 'Swat-II', 'Kashmir Basmati' and 'JP-5' were transplanted on five dates, viz., third week of May, first week of June, third week of June, first week of July and third week of July in one experiment and were spaced at 30cm x 30cm, 25cm x 25cm, 20cm x 20cm and 15cm x 15cm in another trial.

Different varieties responded differently to the date of transplanting. The varieties, 'Kashmir Basmati' and 'JP-5' have given highest yield of 3.79 and 7.30 t/ha, respectively, when transplanted in first week of June, while 'Swat-II' produced the highest yield of 7.75 t/ha when transplanted in the third week of June. While 'Swat-I' did well when transplanted in third week of May and produced 5.96 t/ha.

Moreover, all the varieties have given highest yield with 15 cm x 15 cm spacing. The highest yield of 7.91 t/ha was given by 'JP-5' followed by 'Swat-II', Swat-I' and 'Kashmir Basmati'.

18. *Deep Water Rice:* Six varieties were planted in the low lying area in a Randomised Complete Block Design. Fertilizer NPK was applied @ 70:60:0 kg/ha.

The results in Table 1 indicated that all the varieties have out-yielded the check variety, 'IR-6'. The highest yield of 5840 kg/ha was given by variety, 'BKN-4' followed by 'BKN-6986' and 'IR-579' which yielded 4650 and 4600 kg/ha, respectively.

19. *Water Requirement and Weed Density Under Dry and Wet Application of Fertilizer:* The low efficiency of N fertilizer in rice fields with standing water is to be modified in such a way that N efficiency is enhanced. The experiment was non-replicated on 'IR-6' crop. Under wet conditions, puddling was started ten days before transplanting. Basal dose was applied at last ploughing and planting. Under dry conditions the soil was well prepared and basal dose was mixed with the soil. Irrigation was done just before transplanting.

Weed density was much high in dry soil incorporation of fertilizer. The paddy yield was 12 percent more than that of puddled soil. Three additional irrigations were given to puddled soil during the operations.

20. *Evaluating Ammonium Chloride as a Source of N Fertilizer:* The experiment was laid out in Randomised Complete Block Design on 'IR-6'. The plot size was 6m x 4m. The efficiency of three nitrogenous fertilizers, NH_4Cl, $(NH_4)_3\ SO_4$ and urea at 60, 90 and 120 kg N/ha was compared.

Treatment with 90 kg/ha, $(NH_4)_3\ SO_4$ gave 51.11 percent more yield than control. This was followed by 90 kg/ha urea and 120 kg/ha NH_4Cl treatment. Lowest yield was however, given by 60 kg/ha, NH_4Cl while 90 kg/ha NH_4Cl and 60 kg/ha urea were giving 38.44 percent more yield than the controls.

Moreover, urea is the principal N fertilizer for rice crop. Broadcast application of urea causes losses upto 50 percent of N. Deep placement of urea super granules and use of sulphur-coated urea (SCU) are effective in increasing yield. If it is not available, the alternate is to coat the fertilizer with soil or farm yard manure (FYM) in the ratio of 1:1. Variety, 'IR-6' gave 59.37 and 49.81 percent more yield over control when treated with FYM or soil, respectively, in addition to 90 kg N/ha.

21. *Fertilizer Trial:* The experiment was laid in a Randomised Complete Block Design with three replications on four coarse rice varieties, 'IR-2053', 'IR-6', 'IR-841' and 'IET-4094'. Four NP treatments were given (T_1 = 0:0 T_2 = 45:45, T_3 = 90:45 and T_4 = 135: 67 kg/ha). The crop was transplanted on July 20, 1982 and all P_2O_5 and 1/3 N treatment was given a day before that while another 1/3 N was given 15–20 days later and the

Table 1. Performance of deep water rice varieties

Variety	Days from seeding to maturity	Tillers/hill	Yield (kg/ha)
'BKN-6986'	149	22.0	4650
'Pokali-4'	168	19.0	3590
'BKN-4'	149	18.0	5840
'Chenab-64'	148	20.0	4290
'IR-579'	147	18.0	4600
'IR-6' (check)	138	15.0	2640

Table 2: Effect of fertilizer in rice varieties

Treatment	Variety	Yield (kg/ha)	Cost-benefit ratio
T_1	'IR-2053'	2835	–
T_2	'IR-2053'	3895	1:4.16
T_3	'IR-2053'	4500	1:4.05
T_4	'IR-2053'	4420	1:2.57
T_1	'IR-IET-1094'	3580	–
T_2	'IR-IET-1094'	4290	1:2.72
T_3	'IR-IET-1094'	5300	1:4.10
T_4	'IR-IET-1094'	5385	1:2.87
T_1	'IR-841'	2500	–
T_2	'IR-841'	2885	1:1.47
T_3	'IR-841'	3570	1:2.55
T_4	'IR-841'	3360	1:1.36
T_1	'IR-6'	2890	–
T_2	'IR-6'	3800	1:3.49
T_3	'IR-6'	4475	1:3.74
T_4	'IR-6'	4885	1:3.17

remaining 35--55 days after transplanting. Harvesting was done on October 30, 1982. Results in Table 2 indicated that the most favourable economical dose of N:P for all the test varieties is 90: 45 kg/ha.

Variety, 'IR-6' was further tested with 16 treatments of NPK which revealed that combination of N + P is better than N + K and P + K, giving 42.33 percent more yield over control.

National Uniform Yield Trials

1. *Scented Group:* Five entries of scented rice were evaluated in this trial. Fertilizer NPK was applied @ 50:30:0 kg/ha. Higher yields than the check variety, 'Basmati-370', were obtained in all five test varieties (Table 3).

2. *Non-scented Group:* This trial consisted of eight test varieties. Varieties, 'IR-6' and 'IR-841' were used as check, the former being a medium maturing variety and the later an early maturing variety. Fertilizer NPK was applied @ 100:50:0. Among medium maturing test varieties maximum yield was given by variety 'IET-4094'. Two early maturing varieties, ('Rashte 507' and 'IR-622' x 'IR-760') out-yielded their respective check variety (Table 3).

Table 3. National Uniform Yield Trial (average of four replications in Randomised Complete Block Design)

(t/ha)

Variety	NARC	Chuharkana	Gujranwala	Dokri
Scented Group				
'Basmati-370' (check)	2.8	3.8	4.0	2.5
'4010'	4.9	3.7	7.2	3.4
'4001'	5.2	3.6	6.0	3.1
'4266'	5.9	3.9	7.2	3.5
'NIAB-786'	4.4	4.0	6.0	2.6
'Basmati-198'	3.6	3.9	4.7	3.0
Non-scented Group				
Medium maturing				
'IR-6'	8.3	5.0	8.9	8.5
'US-282'	7.5	3.7	8.5	9.7
'Swat-I'	5.0	2.5	6.0	5.5
'Swat-II'	5.7	4.8	8.6	6.0
'IET-4094'	8.5	5.0	8.2	9.9
'IR-1153-153-2-3'	5.0	3.8	9.0	5.5
Early maturing				
'IR-2053'	5.4	5.8	6.0	5.9
'Rashte 507'	7.1	7.0	8.4	6.3
'IR 622 x IR 760'	8.7	5.0	7.5	8.5
'IR-841' (check)	5.8	4.9	7.6	5.6

Plant Protection

1. *Screening of Varieties for Resistance to Stemborer and White Back Plant Hopper:* Ninty six varieties were transplanted in the field to observe their behaviour towards pest attack. Out of these, 44 promising varieties/ lines including '4010', '4266', and '4370' were free from stemborer attack. On account of very dry season, the white back plant hopper did not appear during the year under report.

2. *Screening of Varieties Against Paddy Blast:* Paddy blast is a serious disease of fine rice varieties in Punjab. International Rice Blast Nursery (IRBN) was sown with 342 varieties received from IRRI and 120 of the local material and screened for blast resistance. Out of these one line ('UPR-221-70-7-2-2') was found highly resistant and 58 were resistant.

3. *Screening and Maintenance of Promising Varieties/Strains Against Diseases:* The experiment was conducted to screen and maintain 55 promising rice varieties/ strains against different diseases under natural field conditions. All the operations like irrigation, gap filling, weeding, roughing, insecticidal and fertilizer applications were carried out properly. The observations were taken on the incidence of kernel smut, narrow brown leaf spot, brown spot and glume discolouration. The procedure was followed with screening system of 0–9 standard scale. Thirty six varieties have shown broad spectrum resistance against all the four diseases.

4. *Screening of New Breeding Lines/Strains for Different Diseases under Natural Field Conditions:* The experiment was conducted to screen 30 new lines/strains received from IRRI and local breeding crosses against different diseases under field conditions. The observations were recorded on brown leaf spot, narrow brown leaf spot, glume discolouration and kernel smut diseases using 0–9 standrad scale. Twenty two varieties have shown broad spectrum resistance to all the diseases.

THRUSTS FOR NEXT YEAR

1. To undertake genetic studies for resistance to important insect pests of rice.
2. To carry hybrid rice studies.
3. To evaluate international rice nurseries.
4. To conduct applied research trials on fertilizer use efficiency and agronomic practices on farmers' fields in Sind and the Punjab.
5. To launch rice maximization programme in district Gujranwala to disseminate production technology on farmers' fields.
6. To work on rice based cropping systems.
7. To organize National Uniform Yield Trials for testing the performance of new rice entries under different agro-ecological zones of Pakistan.

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Maize, Sorghum and Millets

OBJECTIVES OF RESEARCH PROGRAMME

1. To establish an inter-disciplinary and inter-provincial maize, sorghum and millet variety development programme by means of incorporation of superior exotic and local germplasm, testing of progenies and experimental varieties and testing simultaneously for insect and disease resistance.
2. To develop integrated production system for new varieties thrnugh on-station and on-farm testing programmes for both irrigated and *barani* (rainfed) conditions.
3. To maintain a close linkage with concerned international agencies.
4. To arrange training and production programme for extension staff at provincial levels.
5. To develop long-range plans for research on maize, sorghum and millets.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS / ACHIEVEMENTS

Maize

1. *Population Improvement Programme:* Population Improvement Programme regarding uniformity in maturity, plant height, reaction to diseases and yield potential, was continued on promising maize varieties, viz., 'Faisal', 'Sultan', 'Composite-15 (white)', 'New Shaheen', 'Sarhad (yellow)', and 'Pool-10', 'Pool-20', 'Pool-30', and 'Pool-40'.

Under the programme for early maturity, suitable for Islamabad and its surrounding territories, 'Islamabad Pool-10' (NARC Population-10), 'Islamabad Pool-20', the future varieties, were improved accordingly. In 'Islamabad Pool-10', a total of 396 selected ears from previous cycle were planted in half sib recombination block in spring 1982. Out of these 350 ears were finally selected and planted in half sib recombination block during *kharif* 1982. At harvest 226 ears were selected and kept for generation of full sibs during spring 1983. Out of 'Islamabad Pool-20' a total of 135 full sib progenies, generated in Mexico were planted in half sib recombination block during *kharif* 1982. At harvest 126 ears were finally selected to be used in spring 1983.

2. *Testing and Screening of International Materials of Maize:* Under these trials tropical and subtropical material received from CIMMYT (Mexico) was tested at NARC, Islamabad and other cooperating units, viz., MMRI, Yousafwala, and CCRI, Pirsabak. The trials consisted of 'EVT-14A', 'EVT-14B', 'EVT-15A', 'EVT-16A', 'EVT-16B', 'QPMT-11B', 'IPTT-45' and 'IPTT-46' cultivars. The promising cultivars were selected on the basis of early maturity, uniformity in plant height, disease reaction and desirable characters, and will be used for the development of promising varieties. The yield of these selected progenies ranged between 2381 and 5869 kg/ha as compared to 1556 and 2355 kg/ha for check varieties. The varieties, 'Poza Rica 3035', 'Maracay-8023', 'Across-7740', 'Chuquisaca-7845', 'Tlaltizapan-7934', 'Across 7845', and 'Laplatina-7941' were found outstanding among the varieties received from CIMMYT.

3. *Hybrid Maize Trials:* Twenty maize hybrids received from Pioneer Hybrid Company, USA were grown alongwith two local checks viz., 'Pool-17' and 'Pirsabak-7930'. Hybrid, '7702' gave the highest yield of 7459 kg/ha, followed by hybrids, '3160', '3195' and '8507' giving yield of 7000, 6844 and 6811 kg/ha, respectively. All these hybrids outyielded the local checks (3940 kg/ha).

An alternate programme of producing F_1 hybrids without going into the conventional method of inbred lines production and crossing, the six single crosses and back crosses maintained through sibbing were planted during *kharif* 1982. These crosses were maintained by sibbing and nine new combinations were made.

4. *National Cooperative Maize Yield Trials (Short Season):* Based on the performance of different short season varieties in the previous years, five varieties namely, 'Faisal', 'Afrat', 'Pirsabak-7930', 'New Shaheen' and 'Pool-17' were further tested for their desirable characters at different locations in the country.

5. *National Cooperative Maize Yield Trials (Full Season):* Full season maize varietal trials were conducted at different locations in the country. On the basis of overall performance 'Sultan' out-yielded

rest of the varieties giving a yield of 4700 kg/ha followed by 'Composite-15', (4445 kg/ha).

Agronomy

Agronomic studies on different aspects were carried out to develop appropriate production technology. These trials were conducted on fertilizer requirements for different varieties, time of fertilizer application, and plant population per hectare for short and full season maize varieties.

The use of Primextra @ 2.5 kg/ha confirmed its effect in controlling different kinds of weeds in maize crop. At Sarai Naurang the highest yield of 7667 kg/ha was obtained from Complete Technology Practice (CTP) treatment where all inputs were applied. At this location the CTP-V (omitting improved variety) was the lowest yielding, i.e., 4667 kg/ha. At Swat the highest yield of 7920 kg/ha was obtained from plots with CTP-K which showed that potash alone does not affect the yield, a similar trend for yield was observed at Pirsabak.

Primextra herbicide was tested for its efficacy for control of weeds in maize crop by using two different doses of 1.50 kg/ha and 0.75 kg a.i /ha against manual weeding. The economics of Primextra herbicide in relation to manual weeding and no weeding revealed that maximum return of Rs. 9301 was obtained from Primextra application at the rate of 1.50 kg a.i /ha followed by its lower dose of 0.75 kg a.i/ha where the return was Rs. 8882 per ha. The manually weeded plots gave Rs. 7478 per ha and the control plots gave a return of Rs. 5603 per ha

From fertilizer trials it was concluded that yield was directly proportional to the nitrogen dose. Potash did not contribute. Phosphorus fertilizer slightly increased the yield. However, the highest yield of 6053 kg/ha was obtained from plots treated with 136:68:34 kg/ha NPK.

'Sarhad (yellow)' and 'Shaheen' gave the highest yield of 6873 and 6367 kg/ha, respectively, at the density of 70000 plants/ha while 'Pirsabak-1081' yielded significantly at 50000 plants/ha. The trials conducted at Swat have shown that variety, fertilizer, and weeds, affected the yields more than other inputs like insecticides and plant density.

Irrigation to spring maize at water table depth of 1–2 m should be based on 25 percent depletion of available moisture to obtain higher yield and better water use efficiency. Saving the irrigation, water upto 60 percent is possible for growing spring maize at water table depth of 0.5m as compared with 1–2 m.

Entomology/Pathology

The entomological/pathological work comprised:

1. Screening of breeding material against insects and diseases under natural as well as artificial conditions.
2. Evaluation of insecticides/fungicides to test their efficiency against insect pests and maize diseases.

Different doses of Furadan were applied using soil and whorl application methods. Application of Furadan before sowing was most effective.

No significant differences were observed between different number of leaf blight inoculations on the yield. Twelve different varieties were screened against stalk rot diseases. 'EV (late)' proved the best with 6507 kg/ha yield, and only 4.58 percent attack of stalk rot followed by 'Sultan' which gave a yield of 6000 kg/ha and 9.25 percent attack. The highest affected variety was 'FV (short)' with 4720 kg/ha yield and 23.37 percent attack.

Sorghum

1. *National Cooperative Sorghum Yield Trials:* Eight varieties were put in National Cooperative Yield Trials at different locations in the country under different agro-ecological conditions. On the basis of overall performance, 'DS-75', '1747', 'Sarokartuho', 'BR-123', and '80-RA-7052' were found with desirable characters.
2. *International Sorghum Varietal Trials:* Twenty two exotic cultivars were tested for their adaptability to different local agro-climatic conditions. Hybrids, '13' and '17' gave the highest yield of fodder while the grain yields were at par with the local improved variety, 'Pak-SS II'. The overall results showed that variety, 'A-6278' was superior in grain and fodder yields. Varieties, 'A-6201', 'CSH-6', 'A-6196' and 'A-6142' also produced significantly higher yields and also had other desirable characters.

Pearl Millet

National Cooperative Millet Yield Trials: In these trials, conducted at different locations variety, 'Y-72' gave the highest yield of 2116 and 2993 kg/ha at Yousafwala and D.G. Khan, respectively. At Faisalabad, 'DB-2' was most promising for different desirable characters. Variety, 'Y-72' was outstanding with a yield of 1074 kg/ha at ARI, Sariab, Quetta. Varieties, 'IVS-P-78', 'Y-72' and 'G-47' performed significantly well in three different trials planted at Dadu, Sind. 'DB-2' with a yield of 1990 kg/ha was significant yielder in comparison with other varieties at Bhalwal.

THRUSTS FOR NEXT YEAR

1. Population improvement programme of maize varieties will be continued.
2. New promising maize, sorghum and millet cultivars will be tested under varied agro-ecological conditions.
3. Suitable maize, sorghum and millet material will be screened out from CIMMYT and ICRISAT trials.
4. Agronomic studies will be continued to improve appropriate package of technology for promising cultivars of maize, sorghum and millets.
5. Efforts will be made to produce good quality seed of maize, sorghum and millet varieties for distribution among the farmers..
6. Maize maximization programme will be carried out in potential maize growing areas to enhance the maize yield.

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Sugarcane

OBJECTIVES OF RESEARCH PROGRAMME

1. To procure and quarantine exotic germplasm for distribution to provincial institutions.
2. To establish germplasm nurseries both of local and exotic cane varieties.
3. To study flowering behaviour of different sugarcane varieties, to establish a breeding programme/ station in the lower southern part of Sind province and to find out varieties producing viable seeds.
4. To coordinate all the national and international research activities pertaining to sugar crops.
5. To conduct uniform varietal trial in the provinces with the cooperation of provincial experts in the cooperative programme.
6. To launch out-reach programme to maximise sugar crops production in the potential areas.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS / ACHIEVEMENTS

1. *Germplasm Nursery:* Two hundred and thirty eight sugarcane varieties procured from sugarcane growing countries like Louisiana, Canal point (Florida, USA), Barbados and Indonesia, and 26 varieties collected from provincial sugarcane research institutes were planted on an area of 80m x 120 m with row length of 20m at NARC for the third consecutive year. Necessary data regarding agronomic and qualitative characters, observations on insect pests and diseases and frost effect was recorded. The varieties were studied under strict quarantine.

Out of 266 quarantined sugarcane varieties being maintained at NARC, 64 were distributed to Agricultural University, Peshawar and 8 to Sugar Crops Research Institute, Mardan, NWFP.

2. *Quality Analysis of the Exotic Varieties:* All the varieties maintained in sugarcane germplasm nursery were also studied for quality analysis. Quality analysis in terms of total soluble-solids (T.S.S.) of the varieties was recorded fortnightly with the help of Hand Refractometer starting from November, 1 1982 to March 31, 1983. Ten canes from ten different plants of each variety were used in each case, taking juice sample from middle part of cane.

On the basis of observations of T.S.S. the sugarcane varieties were grouped into high T.S.S., medium T.S.S. and low T.S.S. varieties having 22, 18–22 and 18 percent T.S.S., respectively. Moreover, from these observations, varieties may be grouped into early, medium and late. However, actual grouping into early, medium and late can only be made after complete quality analysis in the laboratory.

In this study highest T.S.S. of 25.84 percent was observed in variety, 'L-75-48' followed by 24.98 percent T.S.S. in variety, 'CP-73-345', and 24.84 percent T.S.S. in variety, 'L-75-44'.

3. *Screening of Varieties Against Frost:* All the varieties in sugarcane germplasm nursery were screened against frost from November, 1982 to February, 1983. Frost effects were examined on leaves, stems, and apical and side buds using a sample of ten canes from each variety. Three levels of frost effect viz., susceptible, moderately tolerant, and tolerant were studied for characterisation and documentation of varieties. Frost occurrence continued intermitently in second fortnight of December, 1982, first three weeks of January, 1983 and occasionally during first week of February, 1983. It was very severe during the month of January. Frost was identified by vision of thick white layer of frost deposited on grass, land and on standing water in the mornings at NARC, Islamabad.

Among 266 varieties, 80 were identifed as moderately frost tolerant and could be successfully grown in the frost areas. Moreover, these could be put in the future breeding programme for frost tolerance.

4. *Chewing Varieties Trials:* Ten thick, sweet and soft varieties were selected out of the imported germplasm and put in a replicated trial alongwith three local varieties to see their performance and suitability as chewing varieties in the locality of Rawalpindi. This was the second year of the experiment.

Randomised Complete Block Design with four replications and a plot of 10 m x 4 m was used for the trial. Analysis of the data revealed

that variety, 'BNS-2324' gave the highest stripped cane yield of 100.25 t/ha followed by the variety, 'BNS-2152' with the yield of 92.85 t/ha. Variety, 'B-46364' ranked third with the stripped cane yield of 84.75 t/ha. Chipping quality of the varieties, i.e., 'BNS-2324', 'BNS-2152', 'B-46364', 'CO-402', 'CO-436', 'BNS-688' was very good. Whereas chipping quality of varieties, 'BJ-6437' and 'B-6705' was poor. Varieties, 'CO-402', 'CO-436', 'BNS-688', 'BNS-2324', 'BNS-2152', 'B-72292', '57-NG-76' and 'B-46364' were very juicy.

5. *Flowering Trial:* To study the flowering behaviour of sugarcane varieties under natural field conditions in coastal areas, 411 sugarcane varieties including 237 from NARC, Islamabad and the rest from Punjab, Sind and NWFP, were planted at povincial Sugarcane Research Station, Sujjawal (Distr. Thatta), Sind in October, 1981 on one acre with row length of five metres. Flowering took place during November, 1982 and March, 1983 in 54 varieties. Cane fuzz from the varieties flowered, was collected and planted during late March, 1983.

In compliance to the decision in the meeting of PARC Board of Governors, sugarcane experts surveyed the lower Sind area during February, 1983 to know the flowering intensity of sugarcane at different locations and viability of cane fuzz, collected from these locations. Sugarcane experts after surveying the area, recommended that Sujjawal is the best location for establishing a sugarcane breeding station. Cane fuzz collected by provincial sugarcane specialists from these locations, was sown at provincial sugarcane research stations. The viability of the fuzz was, however, found to be lower than that of the last year.

6. *Import of Cane Fuzz (True Seed):* Sugarcane seedlings raised from 20 crosses were transplanted in the field during September, 1982. Selection of good clones from seedlings will be done during March, 1984 taking into consideration their agronomic and quality characters.

7. *Coordinated Uniform Variety Yield Trials:* The trial included six varieties each from Punjab, Sind and NWFP making a total of 18 varieties. The trials were laid out at Faisalabad, Tandojam and Mardan. The data of the trial conducted at Sugar Crops Research Institute, Mardan are presented in the following table. From the data it is evident that variety, 'BL-19' gave the highest cane yield of 88.91 t/ha followed by variety, 'IM-61' and 'L-62/96' yielding 72.98 and 62.05 t/ha, respectively.

Sugar yield is the resultant of cane yield and commercial cane sugar (CCS) percent. Variety, 'IM-61' gave the highest sugar yield of 6.28 t/ha followed by the variety, 'L-62/96' with a sugar yield of 6.23 t/ha. Data regarding cane and sugar yield from different varieties is given in the following table.

8. *Agronomic Characters of the Exotic Varieties:* All the varieties included in Sugarcane Germplasm Nursery Trials were observed at different growth stages starting from germination till the harvest.

Sixty nine varieties were identified to be high yielding. Their 20-stripped cane weight was more than 20 kg. In second group, which comprises 120 varieties, weight of 20-stripped canes ranged between 15 and 20 kg. Whereas 75 varieties were having below 15 kg weight per 20-stripped canes. Variety, 'BNS-1128' out-yielded the other varieties giving yield of 32 kg per 20 canes followed by variety, 'BNS-2152' and 'CP-75-1553' yielding 30 and 28.6 kg per 20 canes, respectively

THRUSTS FOR NEXT YEAR

1. The process of procurement of sugarcane fuzz and varieties setts from important sugarcane growing countries of the world will continue.
2. The screening and checking of new insect pests and diseases on the imported material in the quarantine will continue.
3. Efforts will be made to start sugarcane breeding work at Southern Zone Agricultural Research Centre, PARC at Sujjawal in Sind.
4. Collection of sugarcane fuzz from lower Sind area with the cooperation of provincial sugarcane experts will be continued.
5. A travelling workshop on sugarcane will be organised.
6. Maximization programmes for boosting sugarcane yield per unit area will be launched in different agro-ecological regions.
7. Cooperative Programme which has taken off from last year in the provinces will be strengthened.
8. The work on purification of sugarcane varieties from viruses will be initiated.

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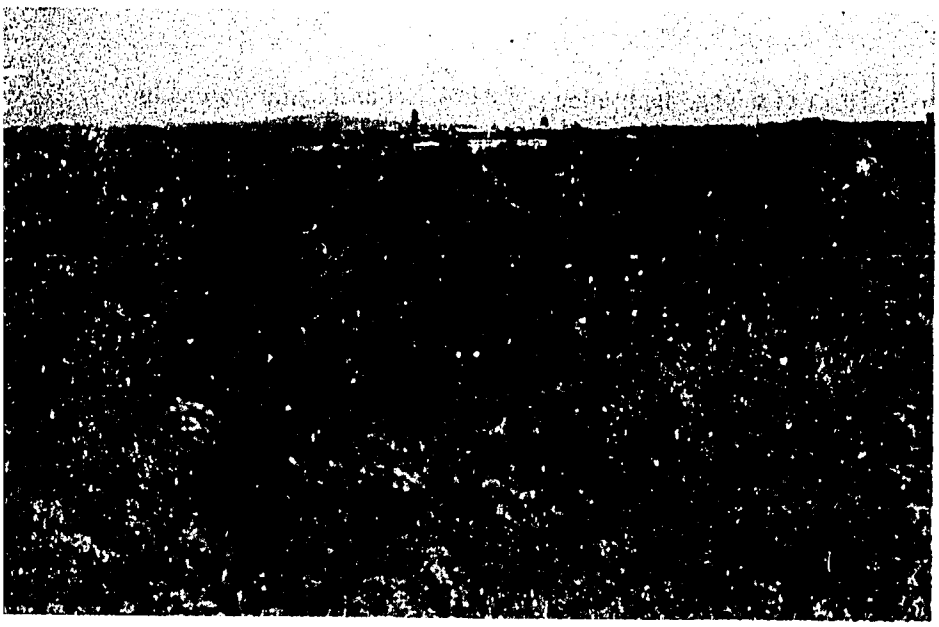
Cane and sugar yield from different sugarcane varieties

Variety	Cane yield (t/ha)	CCS (%)	Sugar yield (t/ha)
'BL-10'	88.91	6.96	6.19
'IM-61'	72.98	8.61	6.28
'L-62/95'	62.05	10.04	6.23
'BL-4' (Punjab)	61.10	8.85	5.41
'TRITAN'	60.16	8.57	5.16
'CP-43-33'	56.88	9.64	5.48
'L-118'	55.94	6.43	3.60
'CP-48-103'	51.22	10.80	5.16
'BL-4' (Sind)	49.78	7.90	3.93
'CP-65-357'	48.78	10.67	5.20
'CP-51-21'	48.28	10.18	4.91
'Z. mex. 54-138'	45.78	9.34	4.28
'B-4360'	44.67	7.58	3.83
'L-116'	40.68	8.64	3.51
'L-113'	38.68	8.42	3.25
'BF-129'	38.07	7.82	2.98
'PR-1000'	33.07	8.51	2.81
'CP-44-101'	29.69	9.87	2.93



Oilseed Crops

OBJECTIVES OF RESEARCH PROGRAMME

1. To introduce and develop, improved varieties of currently sown oilseed crops and evaluate introduction of new oilseed crops.
2. To improve production practices, including both soil and water management.
3. To monitor major insect pests and diseases and to identify the potential sources of resistance for incorporating resistance into high yielding but susceptible varieties.
4. To test improved varieties using production technology and to demonstrate the full potential of oilseed crops.
5. To improve procedures to increase, maintain purity and distribute seeds of improved varieties.
6. To integrate research and extension of the oilseed processing industry particularly in oilseed development schemes in better way.
7. To explore new oilseed crops to lead country to self sufficiency in edible oils.
8. To improve oil extraction and meal processing techniques.

DETAIL OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Rape and Mustard

1. *National Uniform Yield Trial (NUYT):* Out of 16 promising cultivars, selected on the basis of their performance in the previous year, in National Uniform Yield Trial at NARC, three lines belonging to Ethopian mustard *(B. carinata)* gave more than twice the seed yield over the checks (1500 kg/ ha). Two lines, CS-1300' and 'CS-1283', have shown very encouraging performance.

2. *Seed Yield Trial:* This trial consisted of eight varieties which were received from Oilseeds Research Institute, Faisalabad *B. carinata* again gave maximum yield as compared to other test varieties (Table 1).

3. *Fodder and Seed Yield Trial:* Rapeseed and mustard provide fodder both in 'pure stand' and in 'mixed stand' with other fodder crops like berseem and shaftal during *rabi* season. An experiment was repeated this year to compare the fodder yield of various varieties at flowering stage and also their seed bearing potential. All test varieties were cultivated in the second week of October 1982. Data obtained for fodder and seed yield are given in Table 2. Strain, 'K-426' gave maximum fodder yield of 4800 kg/ha. Yield data obtained in this trial conform with the evaluations made in the previous years. It is evident from the results of last two years, that 'K-426' can be recommended for use as a fodder variety.

Table 1. Seed yield trial

Variety/ cult	Seed yield (kg/ha)
Regent'	1055
'RL-18'	518
'Torch'	1231
'Carinata' (check)	3055
'Midas'	1328
'Tower'	1259
'Span'	842
'Candle'	1046

Table 2. Fodder and seed yield trial of selected rape and mustard varieties

Variety/ strain	Fodder yield (kg/ha)	Seed yield (kg/ha)
'3035-5'	3500	833
'K-426'	4800	833
'3036-5'	3600	944
'2081-1'	4000	898
'1007-14'	3900	962

4. *Preliminary Seed Yield Trial:* This trial was carried out on 25 entries originating from promising lines of previous years, or from better performing exotic varieties imported recently. Strain, '77-1320' *(B. carinata)* gave maximum yield of 2055 kg/ha.

5. *Brassica juncea Germplasm Nursery:* The nursery of 85 *B. juncea* entries resulted in several cultivars with yields of more than 1400 kg/ha. Maximum yield of 2000 kg/ha, was obtained from strain,'682-2'.

6. *Brassica campestris Germplasm Nursery:* Forty four entries were evaluated. Maximum yield of 1555 kg/ha was given by line,'K-879'.

7. *Brassica napus Germplasm Nursery:* Seed yield data of the 34 entries show that chinese varieties, 'Gan You 4' and 'Gan You 5' gave highest yields of 2222 kg/ha.

8. *Brassica carinata Germplasm Nursery:* Seed yield data of 29 entries were obtained from this trial. No entry gave seed yield less than 1444 kg/ha. Highest yield was obtained from line, '77-1321' (3333 kg/ha). Results from previous year trials and reports from other countries show that *B. carinata* bears a yield potential of 4000 kg/ha, and that average seed yield of rapeseed and mustard can possibly be increased in *barani* areas if *Eruca sativa (Taramira* with average yield, 250 kg/ha) is replaced by *B. carinata* lines.

9. *Evaluation of New Varieties:* Ten lines of rapeseed and mustard such as 'Tobin', 'Altex', 'Westar', 'Regent', 'Zim-1', 'Zim-2' which have been recently evolved and possess the characters, like high seed yield, and yellow seed colour have been introduced from Canada and Australia. Seeds of these varieties will be increased at Summer Nursery in Kaghan and will be put in seed yield trials next year.

10. *Fertility and Population Studies on Brassica carinata:* A high yielding *B. carinata* line, 77-1283' was selected to investigate optimum fertilizer application rate and spacing. Five fertilizer levels [(62.5 N, 62.5 P), (93 N, 62.5 P), (93 N, 93 P), (125 N, 125 P), (0 N, 0 P = Control) kg/ha] were applied in main plots of Split Plot Design with four spacings, 30, 45, 60 and 75 cm, randomised in a main plot.

A random sample of five plants was taken for recording seed yield and number of pods per plant. Maximum yield was obtained in plots having rows (45 cm apart) with fertilizer dose of 62.5 N and 62.5 P kg/ha.

11. *Effect of Sulphur Application on Yield of Brassica carinata:* Sulphur application on brassica has been reported in other countries to markedly increase seed yield of rape and mustard. To test whether mustard response to sulphur was likely at NARC, farm sulphur was variously applied to varieties, 'RL-18', 'B.S.A.' and 'Tower' (Table 3).

12. *Resistance to Disease:* Of the 66 varieties evaluated for their resistance to white rust and downy mildew disease complex, varieties, 'Altex', 'Gan You-5', 'Oro', 'Regent', 'Tower' and 'Domo' were found to be resistant.

Table 3. Effect of sulphur application on the yield rape and mustard

Sulphur application (kg/ha)	Seed yield (kg/ha)		
	'RL-18'	'B.S.A.'	'Tower'
0	1093	1049	1249
5	1107	1075	1138
10	1520	1360	1400
15	1258	1035	1209
20	1422	1209	1275

Groundnut

1. *National Uniform Yield Trial:* A trial consisting of 12 entries was conducted to identify promising lines for different agro-ecological regions. The trial was planted during the second week of April, 1982. Variety, 'NC-FIA 14' gave maximum yield of 2767 kg/ha (Table 4).

2. *Vareital Trial (Erect Type):* Eight promising lines (erect type) for rainfed areas were tested. Variety, 'Early Banki' gave maximum yield (2300 kg/ha) in this trial.

3. *Optimal Seed Rate Evaluation:* Two promising varieties, 'Banki' and 'No. 334' were planted in April 1982.

Table 4. National uniform groundnut yield trial

Variety	Seed yield (kg/ha)	Pods/plant
'Sudan'	1567	12
'NC-7'	2658	13
'NC-6'	1958	12
'PI-13'	1700	13
'NC-5'	2308	15
'NC-17'	2375	14
'No. 334'	3025	18
'Alkita'	2150	15
'Virginia'	1875	10
'Banki'	1092	19
'UF-439-16'	2317	20
'NC-FIA-14'	2767	16

to determine the effect of seed rate on yield. Data given in Table 5 indicate a general trend of decreased pod number/plant with increase of seeds/hill although yield/ha was not adversely affected by increased seed number/hill.

4. *Comparison of Different Cultivation Practices:* The effect of four common cultivation practices (ridge sowing, flat sowing, furrow sowing, two-row ridge sowing) on yield were studied in *kharif* 1982. Different varieties may vary in their requirement of optimal cultivation practices. For instance, variety, 'Banki' gave highest yield when planted by 'flat sowing'

Table 5. Optimal seed rate for 'Banki' and 'No. 334' varieties

Seed rate	Banki'		'No. 334'	
	Seed yield (kg/ha)	Pods/plant	Seed yield (kg/ha)	Pods/plant
1 seed/hill	584	10	942	13
2 seeds/hill	1254	11	1838	12
3 seeds/hill	1145	10	1517	11
4 seeds/hill	1329	7	1867	8

Table 6. Groundnut yield as affected by different cultivation practices

Cultivation method	No. 334'		'Banki'	
	Seed yield (kg/ha)	Pods/plant	Seed yield (kg/ha)	Pods/plant
Flat	2208	13	1833	16
Ridge	2633	13	1217	12
Furrow	2121	19	1467	18
2 row ridge	2246	19	1592	15

whereas variety, 'No. 334' produced its maximum in ridge sowing (Table 6). Greater number of pods produced in furrow sowing may be largely due to better moisture storage and availability.

5. *Resistance to Cercospora:* Varieties 'NC-2', 'NC-5' and 'No. 334' were tolerant to *Cercospora* leaf spots diseases and received the rating of 5 on a 9 point field scale.

Improved production technology for groundnut has been developed for *barani* (rainfed) as well as irrigated areas.

Sunflower

1. *FAO Sunflower Yield Trial:* Sixteen varieties/hybrids were tested. Highest yield (1406 kg/ha) was obtained from 'Inra H9P2', a French hybrid. Local variety, 'Noor' gave a matching yield in this trial.

2. *Comparison of Open Pollinated Hybrid Varieties:* Two Italian open pollinated varieties, 'Ala' and 'Argentario' and three USA hybrids, 'NK-212', 'Cargill IS-894' and 'IS-894' were compared. Higher yields were obtained in hybrids than in open pollinated varieties, though statistically not significant (Table 7). Both the open pollinated varieties and hybrids took the same period in reaching maturity. One drawback of great plant height variation was noticed in these open pollinated varieties. As yields of hybrids are not significantly higher than those of open pollinated varieties, it suggests that open pollinated varieties may be used after selection for uniform plant size and maturity, until indigenous hybrids are developed.

Table 7. Comparative study on open pollinated and hybrid varieties

Variety	Plant height (cm)	Head diameter (cm)	Seed yield (kg/ha)
'Ala'	91	7	867
'Argentario'	82	7	900
'NK-212'	88	6	867
'Cargill IS-894'	88	7	933
'IS-894'	86	7	1050

3. *Disease Resistance:* Of the 17 FAO sunflower cultivars evaluated none was found resistant to wilt disease complex.

Table 8. AVRDC soybean varietal yield trial

Variety	Plant height (cm)	Days to flowering	No. of pods per plant	100-grain weight (g)	Seed yield (kg/ha)
'AGS-66'	50.0	44	28	11.0	1175
'AGS-62'	50.5	39	32	14.5	1556
'AGS-2'	70.8	60	20	8.2	804
'AGS-17'	51.0	53	25	13.2	825
'G-9645'	59.0	51	24	14.5	1140
'G-9946' (entry 11)	62.4	51	18	15.5	712
'AGS-129'	49.0	55	35	15.1	930
'AGS-130'	53.6	55	16	14.5	709
'AGS-135'	63.4	53	23	10.8	1016
'G-2261'	46.2	54	36	12.5	1040
'G-9925'	60.4	54	24	10.8	1108
'G-9946' (entry 10)	62.0	51	27	17.5	912
'Bragg' (local)	68.8	54	27	10.1	1051

Soybean

1. *Soybean Varietal Trials:* Varieties like 'Bragg', 'William', 'Forrest', 'Mitchell', 'Lee', 'Davis' and 'Pickett-71' have been identified as high yielding.

2. *AVRDC Soybean Varietal Yield Trial:* Thirteen varieties from AVRDC were evaluated. Variety, 'AGS-62' gave highest yield (1556 kg/ha). Data of all varieties, on plant height, days to flowering, pods per plant, 100 grain weight and yield (kg/ha) are given in Table 8.

3. *Agronomic Characters of Soybean:* Out of 16 entries, highest yield was obtained from variety, Bay.

4. *Resistance to Charcoal Rot:* Of the 16 soybean varieties tested for their resistance to charcoal rot, two varieties, 'Centennial' and 'Celest' were resistant.

THRUSTS FOR NEXT YEAR

1. Collection and evaluation of germplasm will be continued for traditional as well as non-traditional oilseed crops in order to strengthen available gene source for yield, quality and disease resistance. The work will be further streamlined through developing and maintaining purity in the germplasm entries by selfing. The germplasm entries will also be catalogued as per their outstanding characters.

2. In breeding, priority will be given to obtain potential yields and suitability to specific environmental conditions and agro-climatic zones. Production practices will be further improved in consideration to the particular requirement of the particular variety for particular areas like irrigated, *barani* (rainfed) and *sailaba* (flooded), etc.

3. Research on evolving suitable control measures for insect pests and diseases will be intensified.

4. Development/improvement of equipment used for harvesting and threshing with particular stress on sunflower thresher and groundnut digger, picker and sheller.

5. On-farm testing of improved varieties and cultural practices through applied research programme will be continued.

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Pulse Crops

OBJECTIVES OF RESEARCH PROGRAMME

1. To select and breed for high yield, yield stability and resistance to diseases.
2. To develop and standardize appropriate production technology suitable for *barani* (rainfed) and irrigated conditions, with special emphasis on small farms, in different agro-ecological zones of the country.
3. To develop various cropping systems for legumes including mixed-cropping, intercropping and sequential cropping.
4. To undertake economic evaluation of the on-farm trials, including chemical methods of crop protection, and base-line surveys of production, marketing and utilization in comparison with other major food crops.
5. To strengthen the national pulses research programme by arranging local and regional training for the research staff.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS / ACHIEVEMENTS

Chickpea

1. *Screening of Germplasm Against Ascochyta Blight:* About 4000 exotic and 300 indigenous lines were evaluated under artificial as well as natural epiphytotic conditions, to assess their disease reaction to *Ascochyta* blight. As given in the following table seven exotic lines persistently showed resistance against the disease. No indigenous variety was found to survive *Ascochyta* blight.

Chickpea germplasm evaluation against *Ascochyta* blight

Entry	Original No.	Last scoring*	Seed colour
'51852'	8522	2	Black
'51859'	8536	2	Black
'51860'	8539	2	Brown
'51880'	8560	2	Black
'51884'	8564	2	Black
'51885'	8565	2	Black
'51886'	8566	2	Black

*Blight resistant standard score (scale 1–9)

2. *Chickpea International F_3 Trial:* About 15 F_3 population and one local check, 'C-235' were included in this trial. Highest yield of 235.42 kg/ha was recorded in cross 81,123 followed by cross 81, 171 (214.58 kg/ha). In general yield performance was poor due to lack of adaptability at NARC.

3. *International Chickpea Screening Nursery (Desi Long-duration):* About 100 entries including 'C-44' as local check, used after every 12 entries, were evaluated for blight resistance under artificial and natural diseased conditions. All entries were found highly susceptible to *Ascochyta* blight, with no survivals.

4. *International Chickpea Screening Nursery (Desi Medium-duration):* About 20 cultivars were evaluated and screened against blight. All the entries showed high susceptibility.

5. *Chickpea International Yield Trial (Large Seeded):* About 20 cultivars were evaluated and screened against blight. All the entries showed high susceptibility.

6. *Chickpea International Yield Trial:* About 24 exotic lines were evaluated and screened against blight. No line could escape.

7. *International Chickpea Cooperative Trial (Desi Long-duration):* About 14 cultivars were evaluated and screened against blight at both vegetative and podding stage. Two brown seeded *desi* type lines with good plants ('HG-202-6-1' and 'ICC-1154') were found tolerant to blight at vegetative and podding stage, producing 301 and 395 kg/ha, respectively. Rest of the lines were completely destroyed.

8. *International Chickpea Early Generation Segregating Bulk Test Multilocational Trial:* About 14 cultivars were studied for blight tolerance. No entry could escape.

9. *Chickpea Varietal Yield Trial:* About 10 *desi* chickpea cultivars from AARI, Faisalabad were tested at NARC. Highest yields of 196.30 and 193.05 kg/ha were recorded in 'AUG-480' and 'No. 149', respectively. Blight scoring on these cultivars were 7 and 8, respectively, and days to maturity were 197 and 200, respectively.

Eight chickpea cultivars obtained from Agricultural University, Faisalabad, were also studied at NARC. Highest yield of 31 kg/ha was recorded in cultivar, '918'. Rest of the cultivars showed poor adaptability and high susceptibility to disease.

10. *Chickpea Genotype x Seed Rate Interaction:* Three cultivars, ('CM-72', 'C-44', 'ILC-195') and three seed rates (40,50 and 60 kg/ha) were used in the experiment. Highest yield of 518.33 kg/ha, followed by 503.12 kg/ha were recorded in 'ILC-195',

at 40 and 60 kg/ha seed rate, respectively.

11. *Chickpea National Uniform Yield Trial:* The trial comprised nine promising cultivars contributed by the pulses breeders of the country. The trial was planted at 20 locations throughout the country. 'CM-72' ranked first at NIAB, producing 1942 kg/ha, followed by 'C-141' which produced 1914 kg/ha. In Bahawalpur 'CM-72' ranked second both at ARS and farmers' fields producing 1036 and 910 kg/ha, respectively, while 'E-1289 topped the list at ARS and local check, 'C-235' at farmers' fields.

At ARI Sariab cultivar, 'NEC 138-2' produced the highest yield of 1016 kg/ha, followed by 'CM-72' which produced 834 kg/ha. At the experimental field of Technical Services Association, Agricultural Projects (TSAAP), line, 'C-141' (black seeded) was the top yielder producing 941 kg/ha.

12. *Chickpea Fertility-cum-inoculation Trial:* Out of eight treatments, highest yield of 1113 kg/ha was recorded in T_7 (inoculation + 50 kg/ha P_2O_5, 60 kg/ha K_2O) followed by T_5 (K_2O 60 kg/ha) with a yield of 572.1 kg/ha. Maximum number of nodules (28) were also found in T_7.

13. *Chickpea Seed Grading Trial:* Three chickpea cultivars, 'ILC-195', 'C-235' and 'C-44' were graded into three groups (G1 = healthy and vigorous seeds; G2=diseased and shrivelled seed and C= control with healthy and diseased seeds). Highest yield per plant 14.97 and 5.37 and 4.41 g, respectively, were found in all three cultivars where healthy and vigorous seeds were used. Interaction between varieties and grading did not show significant difference except for 100-seed weight.

14. *Chickpea Date of Planting and Plant Population:* Three sowing dates and four inter-row spacings viz., 30, 40, 50 and 60 cm were used in the experiment. 'CM-68' was the cultivar under study. Highest yields of 621 kg/ha, followed by 557 kg/ha were found in crops sown on November 22, with 30 and 50 cm row spacings, respectively. Therefore, planting can be delayed upto 3rd week of November without much loss in yield.

Lentil

1. *Screening of Germplasm:* About 120 exotic and 52 indigenous lines were evaluated for yield and screened against *Ascochyta* blight, *Botrytis* attack and lodging. Highest yield of 326 g/2m row was recorded in exotic accession, '1930'. Five entries giving yield more than 200 g/2m row are '1687', '1686', '1684', '1701' and '1761'. Entries '1930', '1687' '1761' and '1684' were found resistant to *Botrytis* and tolerant to blight. Entry '1701' was susceptible to blight and lodging.

Among the indigenous lines significant yields of 313.8, 280.5, 247.5, 213.3, 222.7, 212.5, 212.0, 210.5 g/5m row were recorded in 'Pak-40386', 'Pak-40365', 'Pak-40386', 'Pak-40377', 'Pak-40398', 'Pak-40368', Pak-40400' and 'Pak-40376', respectively. Days to maturity ranged between 140 and 160 days. All the entries showed suceptibility to *Botrytis* but accessions, 'Pak-40368', 'Pak-40400', 'Pak-40401' were resistant to *Ascochyta* blight.

2. *Lentil International Screening Nursery (Early):* Eighty exotic lines were planted at NARC. Thirteen lines, namely, 'EL-19' (Ethopia), '76 TA', '66-05' (Jordan), 'ILL-203', 'GIZA-9', 'F-130', 'EL-31', 'EL-70' (Ethopia), 'L-1327', 'EL-39' (Ethopia), 'EL-53' (Ethopia) check, '2L-830' and 'LG 46' were tolerant to lodging. About 7 lines were resistant to *Botrytis* while 46 lines showed tolerance to *Ascochyta* blight and 11 lines were resistant to blight. Yields of 94, 78, 75, 64, 63 g/4m row were recorded from lines, 'EL-65' (blight resistant), 'EL-76' (blight tolerant), '80-S-54151' (suceptible to *Ascochyta* blight, *Botrytis* and lodging) 'check-2', (blight tolerant) and '80-S-42162 (blight tolerant), respectively.

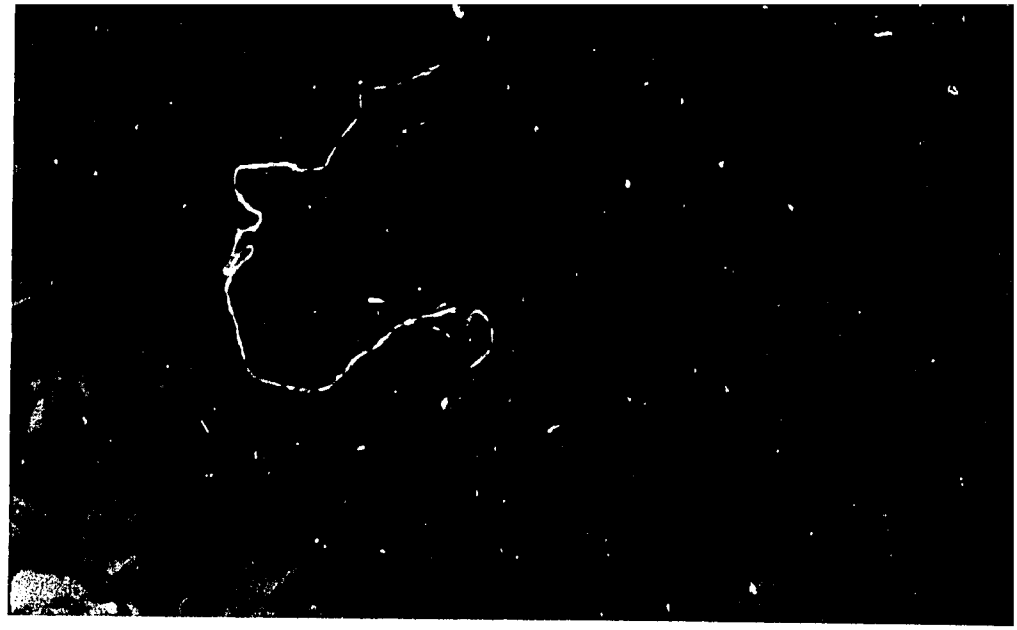
3. *Lentil International Screening Nursery (Large Seed):* Experimental material comprising 52 lines were planted at NARC and evaluated for *Ascochyta* blight, *Botrytis* and yield per 4m row. 'ILL-39', (Syria), 'ILL-101', (Morocco) 'ILL-4400', 'ILL-3524', 'ILL-780' and 'X-76-TA-71' gave higher yields of 78.4, 104.1, 86.1, 74.6, 71.5 and 78.5 g/4m row, respectively. Six lines were *Botrytis* and blight resistant.

4. *Lentil International Screening Nursery (Small Seeded):* Experimental material contained 105 entries, out of which 11 lines were *Botrytis* tolerant (local check, 'ILL-124', 'ILL-2116', '2194-19', 'X-75-TA-28', 'X-75-TA-28', 'ILL-4401' and 4 unidentified, 85 were blight tolerant and 7 were lodging tolerant. Highest yields of 13 to 140 g/4m row were recorded in 45 lines.

5. *Lentil International Screening Nursery (Tall):* About 79 lines were tested, out of which 10 lines were *Botrytis* resistant, 31 lines *Botrytis* tolerant, 33 lines blight resistant, 32 lines blight tolerant and 27 lines lodging tolerant. Highest yields of 26.7, 23.9, 24.2, 28.6 and 20.7 g/4m row were recorded in 'ILL-1939', 'X-TA-1', 'X-76-TA-81', 'X-76-TA-179', and 'X-77-TA-67', respectively.

Mung

1. *Germplasm Evaluation:* Six hundred and thirty six exotic and indigenous lines of germplasm were screened at NARC, for resistance to yellow mosaic, *Cercospora* leaf spot



Mungbean is an important pulse for meeting protein requirements of low-income community in Pakistan

and yield. Forty lines were selected on the basis of adaptability, resistance to diseases, days to maturity and yield potential. Out of these 14 lines are being tested again for their yield potential and others are being used in the hybridization programme.

2. *AVRDC Mung Evaluation Trial:* Twenty two varieties of mung obtained from AVRDC were evaluated. The variety, 'VC-1647' gave the highest yield of 1527 kg/ha and some varieties have shown consistent and highest yield potential for the last three years at NARC. The variety, 'VC-1562' also gave good yield, i.e., 1324 kg/ha.

3. *Mung Coordinated Yield Trial (Kharif 1982):* In this trial 12 varieties were tested with respect to days to 50 percent flowering and maturity and yield potential. However, late sowing and rains during the maturity phase have severely affected the crop and no significant yield was recorded in any of the varieties.

4. *Mung Varietal Trial:* In this trial 12 cultivars were tested to select the physiologically most efficient genotypes, i.e., with highest harvest index under rainfed conditions for their use in future breeding programme. The cultivar, 'M-133-100', gave the highest harvest index percentage of 25.56 with second highest economic yield (83.72 g/m^2), followed by cultivar, 'M-3854' with harvest index percentage of 25.10 and 89.42 g/m^2 economic yield.

5. *National Uniform Yield Trial:* The National Uniform Yield Trial was planted at NARC to test the performance of various cultivars. The results revealed that the cultivar, 'M-20-21' gave the highest yield of 1490 kg/ha. The varieties, 'M-121-25', 'E-115', 'E-54' and 'M-131-37' also showed better yield potential.

6. *Optimum Fertilizer Treatment:* An experiment was carried out to determine the effect of rhizobium inoculation and NPK treatment on yield. Highest yield of 716.43 kg/ha was expressed in T3 (no nitrogen and rhizobium inoculation) and T4 (no nitrogen, no inoculation, P = 100 kg/ha and K=40 kg/ha).

Pigeonpea

Pigeonpea Varietal Yield Trial: Ten cultivars were tested for their yield potential. Highest yields of 1245 and 1032 kg/ha were recorded from 'ICPL-89' and 'ICPL-1', respectively.

2. *Optimum Sowing Dates and Row Spacings:* Sowing date-cum-row spacing studies were carried out using six sowing dates with 20 days interval from April 5 to July 15, 1982 and two inter-row spacings of 75 and 60 cm. Highest yield of 720.62 kg/ha was obtained in fifth sowing date (25-6-82) and 60 cm row spacing followed by 75 cm spacing (681.71 kg/ha) with first sowing (5-4-82).

Cowpea

Cowpea Varietal Yield Trial: Ten cowpea cultivars were evaluated in this trial. The cultivars namely, 'VITA-6', 'VITA-5' and 'TVX 3368–03K' proved to be highest yielding with 774, 771 and 726 kg/ha yield, respectively.

THRUSTS FOR NEXT YEAR

1. Collection, maintenance and distribution of germpasm will be continued.
2. In breeding and selection priority will be given to identification and evaluation of high yielding cultivars responding to new level of management.
3. Agronomical studies will be undertaken to determine sowing time, population density, moisture and fertilizer requirements, weed control through chemical, biological and cultural means and seed quality.
4. Developing effective screening techniques, race spectrum, host pathogen relationship and preventive measures.
5. Identification of resistant lines and their incorporation into high yielding varieties.
6. Establishing existing farm production practices and socio-economical constraints to production, to evaluate marketing pattern.
7. Enhancing rhizobium technology, development and production system of efficient local strain and its distribution among pulse growers.
8. Cooking quality and status of anti-nutritional factors especially in materials arising through hybridization between inter- and intra-species will be determined.
9. Studies on seed germination, seed-bed preparation and seed production under sanitary measures will be ensued.

SCIENTIFIC STAFF

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Fruits

OBJECTIVES OF RESEARCH PROGRAMME

1. To select and introduce high yielding and good quality varieties for different ecological zones.
2. To undertake agronomic studies for improving the quantity and quality of yield.
3. To develop suitable plant protection measures for the control of pests and diseases.
4. To expand availability period of stone fruits.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Date-palm

Initial work was started at Dera Ismail Khan and different experiments on pollination, fruit thinning, optimum cultural practices and varietal collection are in progress. For undertaking comprehensive research of high quality PARC is transforming Turbat Date Farm into National Date-palm Research Institute by properly equipping and upgrading its research facilities

Banana

In Basrai banana a fertilizer dose of 8:4:4 NPK gave better growth and higher yields but was not significantly different from lower three treatments.

The variety, 'William Hybrid-I' proved to be high yielding when spaced at 2.74m x 1.82m. The number of followers did not show significant effect but one follower with mother plant produced better graded branches. In the complex fertilizer trials treatment 6.5 + 8.0 + 8.0 bags of urea, DAP and SOP gave better growth and yield.

A set of three multifactor experiments have been started. The following main qualities have been found prominent in 'William Hybrid-I'.

- It is bit resistant to cold which is lacking in 'Basrai'.
- It gives about 1.5 times more yield over 'Basrai'
- Keeping quality is better.

Coconut

Plants gave better growth in terms of linear length and number of leaves, where a fertilizer dose of 400g of urea and 100 g triple super phosphate (TSP) has been applied closely followed by plants given a dose of 190 g TSP and potassium sulphate, followed by a dose of 200 g potassium sulphate alone. Application of farm yard manure also helped to accelerate the plant growth and nutrient uptake.

Data recorded show that 'Early dwarf' variety has given better growth in terms of linear length, circumference of plants and number of leaves closely followed by variety, 'Kings coconut'. About seven percent plants of 'Early dwarf' variety have flowered.

Stone Fruits

Seven varieties of peaches have been selected for commercial plantation. The varieties are 'Flordasun', 'Spring dust' (early), 'NJ-238', 'Halford', 'Summer set' and 'Sentinel' (medium) and 'NJ-240' (late). Variety, 'Summer set' has given highest yield followed by 'NJ-238', 'Flordasun' and 'Sentinel', respectively.

In apricot varieties, imported from New Jersey, USA, 'NJA-13' has given very encouraging results. This variety came into fruiting after one year and was noted for good fruit set and no fruit drop. Among the nectarine varieties, 'Nectared' is promising.

For chemical control of weeds in peaches an experiment was carried out using Afolan-S and Dacthal @ 2 and 11 kg/ha, respectively, four weeks before germination. Afolan-S completely supressed all common weeds.

Side furrow irrigation system proved useful to prevent plant mortality in stone fruit orchards.

Root stock of peach red leaf and Myrobalam have been imported for strengthening rootstock studies.

Budded plants numbering 40 of peach, 13 of plum, 2 of apricot and 8 of nectarine were received from Texas, USA in January 1982, and were planted at ARI, Tarnab, Peshawar. The material is being multiplied for testing at various locations. Budwood of four apricot varieties; 'Caslin', Cattel', 'Glengerry' and 'Morocco' and plum rootstocks, 'Buck' and 'Mariana were received from New South Wales, Australia and were successfully propagated.

Pome and Nut Fruits

In these experiments 25 apple,

5 almond, 7 walnut and 6 pear cultivars are under trials at Swat, Dir, Hazara and Kurram Agency. At Peshawar, 2 low chilling apple, 5 almond, 6 pear and pecan nut cultivars are under observation. In sub-tropical apple, cultivars, 'Anna' gained popularity among growers due to its early bearing and maturity, heavy production and attractive reddish colour. The pecan nut is a new fruit for Pakistan and cultivar, 'Staurt' is gaining popularity due to its thin shell and good bearing. In pear cultivars, 'Moonglow' gave maximum yield with attractive red colour. In persimon, 5 Japanese and 17 Italian cultivars were introduced and successfully grafted at ARI, Tarnab.

THRUSTS FOR NEXT YEAR

Date-palm

1. Reducing the higher rate of mortality in the planting of date suckers and transfering package of improved technology for date and palms production and protection.
2. Encouragement of date processing industry by providing research facilities in the potential areas of production.

Banana

1. Work on agronomical and nutritional requirements and trials under different ecological zones will be carried out.
2. Studies will be continued to ensure the accelerated introduction of potential variety, "William Hybrid-I' to replace Basrai banana.
3. The types of weeds and their density per unit area will be studied alongwith the effect of weedicides on particular weeds.

Coconut

1. About 50000 ha land in the districts of Thatta, Badin and part of Karachi is suitable for coconut plantations. Efforts will be made to increase both area and production.
2. Studies on the insect pests of coconut will be carried out and effective control measure will be recommended for growers' benefits.

Stone Fruits

1. Evaluation of recently imported rootstock from USA and Australia will be continued.
2. Selection of varieties of different stone fruits based on growth, yield performance and maturity behaviour will be continued.
3. Improvement in budding techniques to reduce mortality.

Pome and Nut Fruits

1. Recording incidence of pests, diseases and their effective control.
2. Evaluation of dwarfing apple rootstock for yield and quality.
3. Spacing trials in apple nursery will be continued.

Banana, coconut and stone fruits remained the main areas of research during 1982-83

Vegetable Crops

OBJECTIVES OF RESEARCH PROGRAMME

1. To collect germplasm from local and foreign sources; evaluate them to select promising lines for further breeding programmes to evolve suitable cultivars.
2. To develop systems for year round production of vegetables.
3. To develop and/or introduce low cost farm machinery/tools and equipment which can be gainfully used by small farmers for intensive cultivation.
4. To coordinate and integrate research activities at the national level to avoid wasteful duplication of research.
5. To identify and recommend suitable persons for training locally and abroad.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Radish

Four cultivars of radish, 'Shamura', 'Minoochali', 'Korea No. 4' and 'Desi' were evaluated. 'Shamura' gave the highest yield of 73.15 t/ha at NARC while 'Minoochali' with a yield of 61.47 t/ha out-yielded Chinese radish yielding, 40.45 t/ha. However, the root/shoot ratio of 'Korea No. 4' was the best (Table 1).

Table 1. Yield of selected radish varieties (1982-83)

Variety	Yield (kg/ha)	Root/ shoot ratio	Seed yield (kg/ha)
'Shamura'	73.15	2.38	1083
'Minoochali'	69.37	2.34	592
'Korea No. 4'	38.38	3.96	–
'Desi'	58.76	2.25	700

Turnip

Four cultivars namely, 'Purple Top', 'Golden Ball', 'Milan Red Top' and 'Desi Red' were evaluated for yield at NARC. Cultivar, 'Desi Red' had the highest yield of 48.78 t/ha, while 'Milan Red Top' gave the least yield of 30.08 t/ha. However, the root/shoot ratio of 'Milan Red Top' was the highest.

Cabbage

Seventeen cultivars were tested at different locations in the country. Cultivars namely, 'Golden Acre No. 84', 'Sinjar F_1 Hybrid', 'Marner Julico' and 'Marner Allfruh' showed low mortality percentage, comparatively short maturity period, more head weight and optimum yield under Faisalabad conditions. At Sariab (Quetta), cultivars, 'Early Jersey', 'Weibkhol Wram', 'Diener Fruchrotkhol' have performed well in relation to head weight and yield.

Cauliflower

The germplasm of 17 cultivars was screened. The cultivar, 'Chiniot' (late) gave maximum yield of 22.23 t/ha and the lowest of 9.41 t/ha was recorded in 'S-192'. 'Chiniot' (late), 'Danova' and 'Tuckerman' exhibited low mortality at the time of transplantation and buttoning at maturity.

Peas

Comparative studies were carried out between the local and seven exotic cultivars in different agro-ecological zones of Pakistan. The cultivar, 'American' gave maximum fresh pod yield of 6.13 t/ha and minimum of 1.87 t/ha was recorded in 'Velvex' at Swat, while 'Arkel' was top yielder (1.50 t/ha) at Faisalabad.

Tomato

Seventeen heat tolerant cultivars were screened in relation to mortality at transplantation time, yield and insect pest resistance at NARC and Faisalabad. 'PARC-HT-1' and 'PARC-HT-2' which were top yielders in 1981-82 again gave the highest yield. Besides this, high yielding lines and heat tolerant cultivars were, 'PARC-HT-9', 'PARC-HT-13', 'PARC-11', 'PARC-HT-14', 'PARC-HT-12', 'PARC-HT-5', and 'PARC-HT-10'. The insect pest resistance studies showed that the cultivars, 'PARC-HT-3', 'PARC-HT-9', 'PARC-HT-7', 'PARC-HT-14', 'PARC-HT-16', and 'PARC-HT-17' were found least infested by tomato fruit borer (*Heliothis* spp.).

Muskmelon

Eight cultivars were evaluated for yield, disease resistance and total soluble solids (TSS). Cultivars, 'PARC-1' and 'Hales Best Jambo' gave the maximum yield of 6.68 and 6.64 t/ha, respectively. The cultivars, 'Polymra Special' and 'PARC-1' were

resistant to downy mildew. Highest TSS were recorded in the cultivar, 'Honey Gold', (10–12 percent) followed by 'PARC-1', (7–11 percent) and the minimum, (6–8 percent) were found in 'PARC-2' and 'PARC-3'. Sugar percentage of 'PARC-2' and 'PARC-3' was below acceptable level.

Cucumber

Five cultivars namely, 'Baby Lone F_1', 'Byblos F_1', 'Market More', 'PARC-1' and local were tested for yield and powdery mildew resistance. Local cultivar out-yielded all other varieties by giving 56 t/ha while 'PARC-1' was found to be tolerant to powdery mildew.

Watermelon

The exotic cultivars namely, 'Congo', 'Charleston Grey', 'Black Diamond' and 'Sugarbaby' were planted at NARC for evaluation. The maximum fruit weight was recorded in 'Black Diamond' followed by 'Charleston Grey' and 'Congo' (Table 2).

Table 2. Fruit yield of tested watermelon cultivars

Variety	Average fruit weight (kg)
'Black Diamond'	14
'Charleston Grey'	12
'Congo'	10
'Sugarbaby'	3

Okra

A varietal trial consisting of four cultivars, namely, 'PARC-1', 'PARC-2' (red), 'Pusa Green' and 'T-13' was conducted. 'PARC-2' exhibited the highest fruit yield of 10.1 t/ha while 'T-13' gave the lowest yield of 9.6 t/ha. Cultivar, 'PARC-2' was found high yielder, least infested by pod borer and comparatively having better cooking quality.

Onion

Six cultivars were tested. 'PARC-5' exhibited the highest yield of 8.60 t/ha followed by 'Campbellpur Red' (6.64 t/ha), 'PARC-4' (6.25 t/ha) and the lowest yield was given by 'PARC-1' (2.72 t/ha).

Seed Production

Promising cultivars were planted in order to increase their seed and to record possible yield of seeds per hectare. The yield obtained is given in Table 3.

Table 3. Seed production in vegetables

Species	Cultivar	Yield (kg/ha)
Radish	'Shamura'	1083.33
Turnip	'Purple Top'	707.07
Cauliflower	'Snow Drift'	200.00

The seeds of different cultivars of peas, spinach, okra, watermelon, tomato, squashes have also been multiplied at NARC and Sariab, Quetta for further coordinated research experiments.

THRUSTS FOR NEXT YEAR

1. Screening of heat tolerant tomato lines for yield, resistance to other abiotic and biotic factors.
2. Cross combination studies on tomato heat tolerant lines for hybrid tomato production.
3. Evaluation of exotic and local germplasm of melon, cucumber, onion, pepper, eggplant, watermelon squash, carrot, cabbage, cauliflower and lettuce.
4. Screening of pea germplasm for powdery mildew and root rot resistance.
5. Seed production studies on cabbage.
6. National uniform cultivar trials on various vegetable crops of economic importance.
7. Studies on vegetable production under *barani* conditions.

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Potato

OBJECTIVES OF RESEARCH PROGRAMME

1. To screen new germplasm against diseases, pests, salt and cold as well as drought and temperature stresses.
2. To study aphid dynamics in relation to seed production.
3. To produce basic/foundation seed of selected potato varieties through clonal selection and other techniques.
4. To study possibilities of raising early summer potato seed crop in the hills as to eliminate spring seed crop in the plains where due to high aphid population the rate of degeneration is very high.
5. To standardize seed management practices.
6. To study chemical weed control to avoid post-germination interculture in the seed crop.
7. To standardize seed storage practices and study their comparatives economics.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Screening Potato Varieties Against Low Temperatures (Autumn 1982)

There is a need to develop varieties which perform well during three main potato growing seasons in Pakistan. To identify better yielding, disease resistant and frost tolerant varieties, suited to varying local conditions, exotic germplasm comprising 30 varieties was screened at NARC. The clones, 'FB-8500-A/1','FB-9003-3' and 'FB-9469-13' were from USA and 'Kufri Sindhuri was from India while the rest of the varieties were received from the Netherlands.

Due to limited seed material, only one row of 10m, for each variety could be planted. All the rows were given standard application of fertilizers, water and other crop management practices. The sowing was done on October 4, 1982 and harvested on January 12, 1983.

The following rating scale for assessing frost damage and cold injury was adopted

Rating number		Amount of foliage/ tuber injury
0	=	Plant dead to seed piece and some tubers or seed pieces frozen.
1	=	Plant dead to soil line; tubers uninjured; plants regenerate from seed pieces.
2	=	90 percent of leaves severely injured; lower stem alive and regenerates axillary buds no tuber injury.
3	=	60 percent of leaves severely injured; upper 1/3 of stem frozen; axillary buds develop.
4	=	25 percent of leaves severely injured, stem tip frozen axillary buds develop.
5	=	10 percent of leaves severely injured; stem tips injured axillary buds develop.
6	=	10 percent of leaves damaged, stem tips water-soaked in spots; axillary buds develop.
7	=	10 percent of leaves slightly damaged; stem tips uninjured; plants continue to grow.
8	=	10 percent of leaves bronzed without necrotic spots on leaf tips and edges.
9	=	No injury.

There was a severe frost on January 10, 1983 and the temperature went as low as–2°C. Thus all the varieties were badly affected and killed. However, this time Indian variety, 'Kufri Sindhuri showed comparatively better tolerance than other entries. It was followed by the US clone, 'FB 9003-3'. No apparent recovery from the damage of frost was observed.

Though all the varieties were badly injured by frost but due to low temperature the tuberization took place in time and some yield could be obtained. The bulking period was reduced by the frost which badly affected the yields. This year also the US clone, 'FB 9003-3' out-yielded all other entries, with tubers of comparatively better size and colour (Table 1). 'Ajax' and 'Spunta' were second and third highest yielders, respectively. 'Kufri Sindhuri' produced large number of small size tubers of less attractive colour. Though it was less damaged by the frost but the yield was low due to smaller size of tubers. It appeared to be late in maturity. High yield could be obtained if it was harvested late.

Table 1. Yield data and frost injury and rating in imported potato clone

Cultivars	Frost injury (2.1.1983)	Frost injury (6.1.1983)	Yield (kg)	Calculated yield (t/ha)
'FB-8500-A/1'	6	2	4.0	5.71
'Ajax'	6	5	8.3	11.85
'Arkula'	7	6	7.3	10.42
'Cleoptra'	5	3	6.4	9.14
'King Edward'	8	7	5.4	7.71
'FB-9003-3'	9	7	8.7	12.42
'Arran Banner'	7	3	6.9	9.85
'Spunta'	9	6	8.2	11.71
'Granola'	2	2	3.3	4.71
'Nicola'	7	5	5.0	7.14
'Vakon'	7	5	5.1	7.28
'Theresa'	5	3	4.8	6.85
'Alwin'	6	5	6.8	9.71
'Murillo'	5	3	4.0	5.71
'Patrones'	2	2	3.9	5.57
'Ilona'	8	5	4.8	5.71
'Jessica'	6	4	5.7	8.14
'Desiree'	2	2	4.0	5.71
'Konder'	3	2	4.1	5.85
'Sante'	7	5	5.1	7.28
'Romanze'	7	5	5.3	7.57
'FB-9469-13'	6	5	6.9	9.85
'Cardinal'	6	4	6.3	9.00
'Kufri Sindhuri'	9	8	7.0	10.00
'Diamant'	7	6	8.1	11.57
'Wilja'	2	2	4.0	5.71
'Mansour'	8	6	4.0	5.71
'Universe'	6	4	5.6	8.00
'11385-5'	7	5	6.5	9.28
'Redepipo'	2	2	3.8	5.42

Table 2. Comparative performance of leading potato varieties (average of four replications)

Cultivars	Total yield (kg)	Average yield (kg)	Yield (t/ha)
'Iris'	51.05	12.76	9.71
'FB-9003-3'	60.70	15.17	11.55
'Patrones'	51.65	12.91	9.82
'FB-9469-13'	50.25	12.56	9.56
'Diamant'	45.02	11.03	8.58
'Ajax'	40.09	10.22	7.78
'Spunta'	43.03	10.82	8.23
'Universe'	52.15	13.03	9.92
'Kufri Sindhuri'	72.43	18.10	13.78
'Atlantic'	47.25	11.88	8.99

Comparative Performance of Ten Leading Varieties of Potato (Autumn 1982)

The autumn is the main potato growing season in the Punjab. However, spring season is also important to grow potatoes to maintain availability of fresh potatoes in the markets. Thus varieties which equally perform well under a wide range of agro-climatic conditions are needed. Therefore, a trial with the ten leading varieties was conducted at NARC for conforming their performance in respect of yield and other characteristics (Table 2). The experiment was laid in Randomised Complete Block Design with four replications and plot size of 6.25 m x 2.10 m. The crop was sown on October 4, 1982 and harvested on January 9, 1983.

All the plots were given recommended doses of fertilizer before planting and at the time of earthing up. Irrigation and other cultural practices were given whenever needed.

'Kufri', 'Sindhuri' out-yielded all other varieties, followed by US clone, 'FB-9003-3' and 'Universe.' No doubt 'Kufri Sinduri' gave higher yield but the tubers were of smaller size with deep eyes and less attractive colour as compared to red varieties, 'Desiree', 'Cardinal' and 'Ultimus'. This defect may adversely affect the consumers acceptability. Colour of US clone, 'FB 9003-3' was quite attractive but it has also deeper eyes than 'Desiree' and 'Cardinal'.

Evaluation of Potato Seed from Different Sources (Spring 1983)

The certified seeds imported from the Netherlands gave good yield but were very expensive. So they were compared with seeds produced at Kaghan valley and seed stock locally available.

The experiment was laid at NARC in Randomised Complete Block Design with four replications. The sowing was done on January 20, 1983 and harvested in May 1983.

The commercial varieties, 'Desiree', 'Cardinal' and 'Patrones' were included in the trial.

The main purpose of the study was to compare the viability, stand and health status of the crop raised from the seed obtained from various sources. The germination in case of imported stock was very quick and uniform because of proper storage conditions and breaking of dormancy. The Kaghan produced seed was stored at higher altitude and was brought down to the plains at the time of planting. It sprouted late but later gave vigorous plants and attained good stand (Table 3).

Data in respect of potato leaf roll viruses were recorded in early stages. The seed obtained from the market showed great leaf roll infection

Table 3. Germination percentage of seed from different sources

Seed source	germination percentage	
	March 2, 1983	March 20, 1983
Imported seed	82.91	91.41
Kaghan seed	4	91.25
Market seed	38.25	88.75

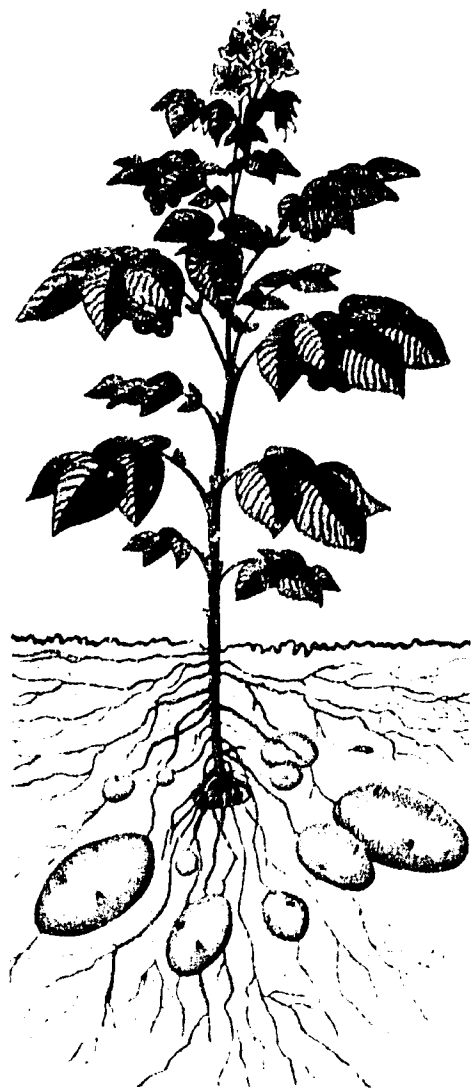
as compared to Kaghan and the imported seed stocks. The Kaghan produced seed was found as good as the imported stock in respect of healthy status and no significant difference was visible.

THRUSTS FOR NEXT YEAR

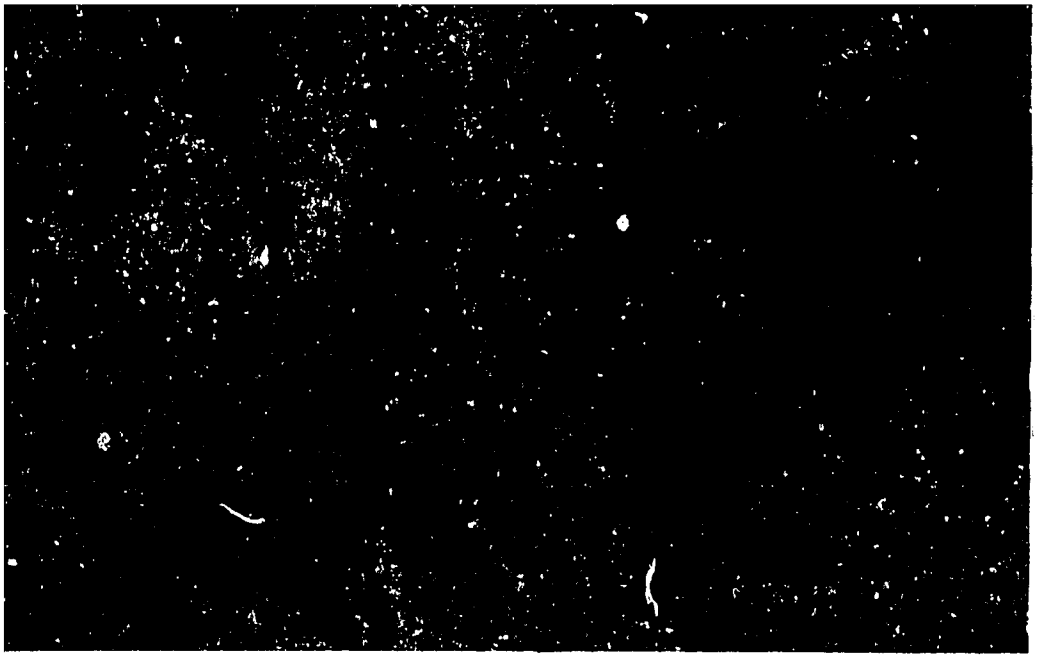
1. Testing, evaluation of new germplasm against biotic and abiotic stress, especially cold tolerance.
2. Evaluation of potato seed from various sources to develop appropriate technology for producing quality seeds locally.
3. Aphid population dynamics.
4. Development of production technology based on low cost inputs.
5. Transfer of technology to farm level through on-farm trials.
6. Study of consumption patterns and marketing systems to improve the present food situation and ensure outlet of farmers' produce.
7. Investigating methods for increased consumption and industrial uses of fresh potatoes.

SCIENTIFIC STAFF

1.	Syed Mahfooz Ali Shah	Coordinator
2.	Mr. Amjad Hussain	Senior Scientific Officer
3.	Mr. Nasrullah Jan	Senior Scientific Officer
4.	Mr. Mohammad Banaras	Senior Scientific Officer
5.	Mr. Mohammad Masud Mahmood	Scientific Officer
6.	Mr. Najeebullah Khan	Scientific Officer
7.	Mr. Bismillah Khan	Scientific Officer
8.	Mr. Khalid Farooq	Scientific Officer
9.	Mr. Allah Wadhayo	Scientific Officer
10.	Mr. Javed Anwar	Scientific Officer



Raising virus free plants was the major area of research on potatoes



Jute

OBJECTIVES OF RESEARCH PROGRAMME

1. To screen the most suitable high yielding and quality fibre strains through introduction, selection and hybridization.
2. To standardize various aspects of jute cultivation under varied climatic conditions in the country.
3. To find out the most suitable retting techniques under local conditions:the microbiological and chemical aspects of retting.
4. To disseminate the knowledge acquired through research experimentation and demonstration regarding the use of improved technology in jute production.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

1. *Hybridization:* The recombination of genetic factors lead to production of new and desirable characters not found in either parent.

Following 625 crosses were made with the aid of indole acetic acid and linolin paste.

'JRO-212' x 'D-154'	125
'TJ-1' x 'JRO-212'	100
'TJ-1' x 'JRO-321'	100
'TJ-2' x 'Nepal-2'	75
'TJ-2' x 'CG-38'	125
'TJ-3' x 'PARO-78'	100
Total	625

2. *Single Plant Selection Studies:* The material grown with check and was compared with the standard plants, looking on morphology and quality. Those plants which show superiority were selected for further multiplication. Fifty selections were made from single plant on the basis of plant height and diameter in non-replicated progeny row trial.

3. *Varietal Yield Trial for Fibre:* Six varieties were tried with four replications at ARI, Tandojam in Randomised Block Design at a plot of 14.5 m x 1.85 m for fibre and seed yield. Variety, 'TJ-2' gave the best results. While at ARSs Seria, Naurang (Bannu) trial was made on 12 varieties, sown at 5 m x 3 m plot on April 5, 1982 and harvested on October 2, 1982. Out of which 'Nepal-III' and 'Nepal-IV' out-yielded by producing 2166.66 and 2124.99 kg/ha, respectively (Table 1).

Table 1. Varietal trial at ARSs, Bannu

Variety	Height (cm)	Girth (cm)	Fibre yield (kg/ha)
'Nepal-I'	222.25	7.15	1842.00
'Nepal-II'	230.00	6.50	1308.33
'Nepal-III'	250.00	7.25	2166.66
'Nepal-IV'	253.75	7.25	2124.99
'Nepal-V'	245.00	7.15	1183.32
'C.G.'	255.00	7.38	1777.77
Corchorus olitorius	270.00	7.62	1833.33
'Yue-Yuan'	260.00	7.50	1674.99
'C-6'	260.00	7.62	1540.16
'D-154'	255.00	7.50	1508.33
C. capsularis	245.00	7.12	1449.99
'Wild Jute'	242.25	6.87	1408.33

A similar trial was made at ARS, D.I.Khan on 12 varieties but here sowing was done on April 4, 1982 and harvested on September 5, 1982. The study showed 'Nepal-IV' as highest yielder although 'Nepal-V' has shown the highest plant height and maximum basal girth (Table 2).

4. *Zonal Varietal Trial:* This trial was made on three varieties, 'TJ-1', 'TJ-2' and 'TJ-3' in Tandojam, Naudero and Kotdiji using six replications with Randomised Complete Block Design. Variety, 'TJ-2' gave highest fibre yield at all the locations while 'TJ-3' gave highest yield of seeds at Tandojam and Naudero and 'TJ-2' at Kotdiji.

5. *Effect of Topping on Yield of Seed:* At ARI, Tandojam the experiment was performed under Split Plot Design of 5.5m x 4.6m with two varieties 'TJ-1' and 'TJ-2'. The topping (cutting of the upper growing portion of jute plant) was done at height of 30, 60

and 90 cm. The seed yield js increased by this treatment.

A similar trial was performed on *Corchorus capsularis* at Serai Naurang, (Bannu) in Randomised Complete Block Design in plot size of 5m x 3m in four replications. The sowing was done on April 4, 1982 and harvested on November 19, 1982. Topping treatment was given at the height of 0, 30, 60 and 90 cm. The results obtained so far reveal that the seed yield from untopped plants is higher but topping did affect the branching.

6. *Rotational Trials:* To work out the economics of different crop rotations with jute varieties, *C. capsularis* and *C. olitorius* trials were performed at ARS, D. I. Khan in a Split Plot Design with two replications and a plot size of 3m x 5 m. Jute varieties were sown on April 6, 1982 and harvested on September 10, 1982. The results reveal that Jute–Wheat–Jute rotation gives the highest fibre yield (Table 3).

7. *Spacing Trials:* At ARI, Tandojam variety, 'TJ-2' was ploted in Randomised Block Design (3m x 2m) with four replications and four plant to plant spacings, i.e., 10, 12.5, 15 and 17.5 cm and three row to row spacings (22, 30, and 37.5 cm) in 12 combinations. The highest yield was obtained when planted at a spacing of 22cm x 15cm. Using different cultural practices yield was maximum with two dry ploughings and two cultivators.

At ARSs Serai, Naurang (Bannu) *C. olitorius* was tried under similar conditions, 5m x 3m plot and four row to row distances (20, 30, 40 and 50 cm). The crop was sown on April 4, and harvested on October 9, 1982. The highest fibre yield was 1332 kg/ha.

8. *Fibre Yield:* Variety, *C. capsularis* gave maximum fibre yield when 4–6 kg/ha of seed were sown at ARSs Serai, Naurang (Bannu) while 'TJ-2' gave highest yield when seed rate was kept as 7.5 kg/ha at ARI, Tandojam. The irrigation when applied at an interval of seven days to seeds of 'TJ-2', planted at a depth of seven centimetres gave maximum yield of 1332 kg/ha at 20 cm spacing.

9. *Sowing and Harvesting Time: C. capsularis* at ARSs, Serai Naurang (Bannu) gave the highest yield when sown on April 30 and harvested after 120 days (when the plant had attained full height) and had a fertilizer treatment of 12:5:5 NPK, as compared to sowing done on April 15, May 15 and May 30. However, 'TJ-2' at ARI, Tandojam gave highest yield when sown on April 15 than on March 15, and 30.

THRUSTS FOR NEXT YEAR

1. Jute development studies to increase the production of local jute fibre with respect to yield and quality.
2. Research on retting and microbiological techniques of jute fibre.

SCIENTIFIC STAFF

1.	Dr. M. Munir Nayyar	Senior Scientific Officer
2.	Mr. Karam Khan Kaleri	Scientific Officer
3.	Mr. Farooq Ahmad Qureshi	Scientific Officer

Table 2. Varietal trial at ARS, D. I. Khan

Variety	Height (cm)	Girth (cm)	Yield (kg/ha)
'Nepal-I'	482	5.52	1836.25
'Nepal-II'	470	5.28	1692.79
'Nepal-III'	440	5.27	1606.72
'Nepal-IV'	501	6.27	1900.81
'Nepal-V'	508	6.29	1484.78
'CG (Toosa)'	445	5.28	1513.47
'C-6'	455	5.04	1962.79
'Yue-Yuan'	493	5.31	1821.91
'D-4'	469	5.52	1606.72
'D-154'	407	5.30	1671.28
C. capsularis	485	6.01	1821.91
Kenaf	463	5.53	2001.23

Table 3. Rotation trials in jute

Treatment	Germination (%)	Height (cm)	Girth (cm)	Fibre yield (kg/ha)
R1 V1	72.05	499	6.25	1886.46
R2 V1	77.05	454	5.05	1886.46
R3 V1	75.00	469	6.25	1628.22
R4 V1	77.05	484	6.05	1886.46
R1 V2	77.05	499	6.75	2080.11
R2 V2	72.05	515	6.75	2051.42
R3 V2	85.00	469	6.00	1886.46
R4 V2	82.05	499	6.25	1951.00

R1 = Jute-Wheat-Jute
R2 = Jute-Linseed-Jute
R3 = Jute-Sarson-Jute
R4 = Jute-Fallow-Jute
V1 = *C. capsularis*
V2 = *C. olitorius*

Tea

OBJECTIVES OF RESEARCH PROGRAMME

1. To explore areas in the mountainous and sub-mountainous tracts of the northern regions having potentials for tea production.
2. To establish and standardize the clonal propagation techniques and screen suitable germplasm.
3. To set up a National Tea Research Station.
4. To develop and disseminate production and processing technology.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS / ACHIEVEMENTS

1. *Germination and Growth Studies in Srilankan Variety:* The 'High Grown' (collected above, 1800 m altitude) Srilankan tea seeds sown at the Experimental Tea Nursery, Mansehra in November, 1982 started germinating in May, 1983. The germination recorded was about 30 percent, whereas in the later stages of growth the survival rate was 17.2 percent.

2. *Applied Tea Research Trials at Daively:* About 33 kanals land at village Daively near Battal was taken on lease during February, 1983 to establish experimental Tea Garden as part of the applied tea research trials, initiated by tea project. Approximately 19000 Chinese tea saplings raised at the Experimental Tea Nursery, Mansehra in 15 cm x 22 cm black polyethylene sleeves, were shifted to the site at Daively and transplanted in the field during March–April, 1983.

3 *Soil Amendments and Plant Improvement:* The chemical conditions (pH value) of the soil at Mansehra tea nursery are marginal for tea growing. In order to bring the pH value of the soil to a desired level, i.e., from 6.8 to 6.0, one percent solution of aluminium sulphate was applied at three-month interval. Growth data recorded showed slight improvement of treated saplings over the control ones. This application enhances the acidity of soil which ultimately helps the plant in uptaking the aluminium, iron and manganese.

Two percent application of zinc sulphate in the form of spray on shoots did not improve the apparent physical symptoms, i.e. chlorosis and rolling of leaves.

The slight improvement in plant growth in response to one percent aluminium sulphate indicates that the soil is the limiting factor in case of tea crop. Therefore, the soil pH value must be below 6.5. The poor response of tea saplings to two percent zinc sulphate solution reveals that the abnormal physical symptoms in plant have not been occurred due to zinc deficiencies, rather the plants seemed liable to disease incidences.

4. *Soil Testing of the Prospective Tea Areas:* A series of soil testings of the prospective tea areas for their pH values and calcium status have been done. The results of these tests show that the soils of the areas are suitable for introducing tea due to their desired pH values and the physical characteristics.

5. *Feasibility Report on Tea Cultivation:* This was under taken by a four member team of Chinese tea experts during May–June, 1982. The Feasibility Report submitted by them indicates that there is a considerable potential for tea production in Pakistan. As a first step, they proposed establishment of a National Tea Research Station at village Bedadi. Based on the recommendations of the Chinese team, the PARC, through the Provincial Government has moved to acquire 20 ha for its establishment. New PC-I of the scheme from 1983-84 to 1987-88, costing Rs. 19.998 million has been developed which is under submission to CDWP for approval.

THRUSTS FOR NEXT YEAR

1. Tea seeds will be procured from the countries having the soil and climatic conditions identical to Pakistan. Most of tea growing districts in China have almost similar growing conditions as existing in Pakistan. Approximately 3000 kg of 'Qi-Men and 'Jeu-Keng' tea seeds will be imported from China for sowing at various locations in the areas identified by the Pak-China team of tea experts.
2. Applied Tea Research Trials on microplots at various locations will be extended to Swat and Azad Kashmir.

SCIENTIFIC STAFF

1.	Dr. Abdur Rauf Khan	Principal Investigator
2.	Mr. Abdul Aziz	Agric. Chemist
3.	Mr. Naeemullah	Scientific Officer

Minor Crops

OBJECTIVES OF RESEARCH PROGRAMME

1. To introduce and poopularise crops like ginger, saffron, spices, condiments, and mushrooms.
2. To select cultivars most suited to different agro-ecological zones from imported and local germplasm.
3. To standardize packages of production technologies for different crops and regions.
4. To study methods of preservation and marketing and to explore export potentials.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Ginger

Performance of demonstration-cum-research plots showed that ginger can be successfully grown in Shakargarh, Bajwat, Gujaranwala, Rawalpindi and Lahore under partial shade of mango, guava, apple, loquat, *ber, amla and hareer* which is very important for their survival after germination, in well drained acidic soils, where irrigation facilities are adequately available. Saw-dust application just after planting gives better results.

Seed source studies indicated that ginger seeds imported from China proved high yielder as compared with local and the one imported from Sri Lanka, Indonesia and Malaysia. In manurial experiments, a combination of 1:1:1 NPK gave higher yield, plant height and number of tillers per plant.

From the studies on the effect of soil amendments on the yield 13.34 t/ha yield was obtained where 15 t/ha gypsum was applied and this was followed by sulphur, applied @ 2 t/ha.

Saffron

A spacing of 7.5cm x 30 cm gave more flowers and corms per unit area when planted at 10 and 15 cm depth and gave better sprouting and less rot.

Corms bigger than 2.5 cm in diameter gave maximum number of flowers and there was no significant difference in ridge planting versus flat bed planting.

There was a favourable response from fertilizer application 1:1 for P_2O_5 and K_2O.

The great problem faced was of corm rottening which affected the corm multiplication as well as the experimental results. The causal organism was identified to be *Fusarium oxysporum* and the available material of Iranian, Italian and Spanish varieties were susceptible to it.

Kenaf

Thirteen seed samples from Mardan, Bannu and D.I. Khan districts were collected and planted at ARSs, Serai Naurang, Bannu and D.I. Khan for screening and identification of kenaf cultivars already under cultivation in NWFP. Seed samples were also supplied to Jute Agronomist, Faisalabad and Jute Botanist, Tandojam, Hyderabad for testing their performance. To test the kenaf at various locations with different ecological conditions ten demonstration plots were planted in Bannu and D.I. Khan at farmers' fields.

Kenaf seed available in the markets of NWFP is admixture of different varieties/types. Seed collected during the comprehensive survey of the kenaf growing areas was planted to test and select plants of various types possessing desirable characters. Results have revealed that types, 'Sun Kukra-I' and 'Sun Kukra-II' which belong to *Hibiscus sabdariffa,* have shown good adaptability to local conditions, hardness to adverse weather and quick growing habit.

Condiments and Spices

Cultivation and yield trials on various condiment and spice crops, i.e., *Carum copticum* (bishop's weed), *Sesamum indicum* (sesame), *Curcuma domestica* (turmeric) *Plantago ovato* (ispagol), *Foeniculum vulgare* (fennel), *Coriandrum sativum* (coriander) and *Ammonum subulatum* (large cardamon) were carried out successfully at PFI, Peshawar and AARI, Faisalabad. Efforts to procure propagation material and seeds of exotic spice crops such as, black pepper *(Pipex nigium), A. subulatum* and clove *(Eugenia caryophyllus)* were continued during the period.

Efforts were made to introduce and acclimatize some exotic spices like aniseed, chamomile, cardamom and

Japanese mint *(Mentha arvensis). Pimpinella anisum, M. arvensis* and *Matricaria chamomilla* performed well, got acclimitized under Peshawar climatic conditions and showed good potential to develop as a minor cash crop which can be easily adjusted in the present cropping pattern of the province. Due to some technical reasons the project has been terminated during 1983.

Mushrooms

Ninety one species of mushrooms were collected from different parts of the country. The isolates of two strains of oyster mushroom collected from Changa Manga forests and Swat were studied for temperature requirement. New substrates for spawn preparation and cultivation of oyster mushrooms were identified and demonstrated successfully. Oyster mushrooms were cultivated on the logs of *Populus nigra, Erythena suberous,* horse dung and synthetic compost at Faisalabad. An attempt was also made to cultivate mushrooms on paddy straw, barley straw, sorghum heads and corn cobs hulls. Cane bagasse was also successfully tried for the growth of oyster mushrooms for single cell protein.

Experiment on the effect of the addition of spent compost of Chinese mushrooms on the yield of barley and wheat crop is in progress, since spent compost added in the soil for the cultivation of fodder crops produced better results. Mycoflora of mushroom beds and insect pests of mushrooms were also studied. Out of the six fungicides tried to control the saprophytic fungi of mushrooms, Nenlate and Daconil produced good results. Paddy straw and rye straw produced better quality Chinese mushrooms. Gram straw mixed in cotton waste also produced better results. *Pleurotus ostreatus* strain, '467' and *Phellorina inquinans* were analysed for amino acid composition. Paddy straw proved better waste for the preparation of the compost for the cultivation of button mushroom.

Oyster mushroom was successfully grown on wood shaving, saw dust, logs of some soft woods, straws of wheat, paddy, barley and crucifers and corn cobs and wild grass in the Swat valley. Four species of Quercus (oak wood) were tried for the cultivation of Shiitake mushroom in the forests of Swat and Murree hills.

Sucessful cultivation of saffron can fetch sizeable income to the farmers

THRUSTS FOR NEXT YEAR

Ginger

1. Further studies to screen out the most suitable seed source for our environmental conditions will be carried out.
2. Regular trials will be conducted to find out suitable fungicide for controlling soft rot, which has been noticed in every field.

Saffron

1. Demonstration of production technology to the interested farmers alongwith the standardization of different cultural practices.
2. Introduction of varieties resistant to *Fusarium oxysporum* besides devising control measures.

Kenaf

1. Efforts will be made to introduce the best suited varieties among the progressive farmers.
2. Mechanization of cultivation and processing to reduce the cost of the product.

Condiments and Spices

1. Exploration and exploitation of drug and spice crops by introducing new varieties of better performance.

Mushrooms

1. Collection of wild growing mushrooms and their cultivation under artificial conditions as well as to explore the possibility for commercial cultivation.
2. Studies on the pests and diseases to devise their control measures.
3. Processing and preservation of mushrooms.
4. Arrangement of training courses to disseminate the knowledge to the farmers and interested growers.

Tissue Culture

OBJECTIVES OF RESEARCH PROGRAMME

1. To undertake mass clonal multiplication studies.
2. To purify various plant materials from viral and fungal diseases by meristem tip culture.
3. To evolve new varieties through tissue culture techniques.
4. To isolate stress tolerant lines.
5. To increase the quantity of secondary metabolites.
6. To make use of protoplast culture technique and hybridization studies which provide research tools for genetic engineering.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Potato

1. *Meristem Tip Culture:* It has been observed that the size of the meristem plays a crucial role in plantlets initiation. A series of experiments have, therefore, been designed to determine the optimum meristem size for plantlet regeneration on a favourable medium. The length of the meristem ranged from 2 to 5 mm. A linear relationship has been observed between the size of the explant and its regenseration potential.

Besides, the size of the meristem, success of technique depends upon the composition of the culture medium particularly the hormonal combinations, light and temperature. All these conditions have been perfectly monitored in the tissue culture laboratory at NARC and about 400 potato plantlets of popular cultivars like, 'Cardinal', 'Desiree', 'Jose', and 'FB' clones have been successfully raised.

Plants thus produced are not immune and they may be re-infected. A continuous stock of the *in vitro* shoots have to be maintained in the laboratory for supply to farmers at appropriate times. In addition to the *in vitro* fragmentation of nodes for vegetative multiplication, horizontal layering technique has been successfully implemented. This involves the use of a cytokinin which releases the axillary buds from apical dominance. It is advantageous in the sense that the new shoots produced are equally vigorous; in nodal fragmentation on the other hand the vigour of the shoots decline over the course of successive re-implantations.

2. *Transplantation Techniques:* The most critical step in tissue culture studies is the transference of plantlets from test tubes to pots under more or less similar conditions as the ones maintained during the test tube stage, before final transfer to the fields. Two types of soils were used; peat soil in jiffy pots and ordinary soil in polythene bags. Encouraging results were noted in jiffy pots, and more than 50 percent plants transferred to the fields at Murree grew happily. These plants have been tested and found to be virus-free.

Rice

1. *Optimization of the Medium for Callus Induction:* 8P medium and N6 medium were compared for callogenesis in 'Basmati-370', 'IR-6' and 'KS-282' seeds. The sugar contents of the media were also manipulated and an optimum concentration of sugar as well as an optimum combination of macro, micro and organic components of the medium for callogenesis from the mature seeds of the three varieties was determined. Explants from roots were also used for the purpose.

2. *Optimization of Medium for Organogenesis:* This is an essential pre-requisite for screening purposes. Emphasis was given to this work and the conditions were standardized for organogenesis in the seed-derived calli of 'Basmati-370' and 'IR-6'. An optimum medium for direct regeneration from nodal explants and stem parts was also improved.

3. *Screening of the Callus Against Various Levels of Salinity:* A stress of NaCl and $CaCl_2$ ranging from 0 to 250 mm in each case was applied to the media on which the seeds were grown and their effect on callus induction was observed. Both the salts in lower concentrations favour callus induction but retard the growth. However, at higher concentrations they reduce callus induction too. A prolonged effect of the stresses in higher concentration resulted in the death of explants. Some calli were screened at certain level of stress and after one month when they were transferred to organogenetic medium, with same amount of salt stress, the small embryonic shoots died within a few weeks.

4. *Albinism in Rice:* There is a high

percentage of albino plants produced *in vitro* cultures. Some experiments were therefore, designed to study albinism in rice. It was observed that the albinism was caused by different factors and it is also of different types. It appears that there was a feedback inhibition in plastid genes caused by high percentage of sucrose, which can also be reproduced if the causing factor is reduced. There also seems to be a multiple effect of hormones, salts and sucrose which is not reproducible. It is thus, concluded that high concentration of sucrose in the medium plays a major role besides other factors in causing albinism in rice.

Date-palm

Conventionally, date-palm is propagated through suckers or offshoots which are limited in number (10–15) and are produced during the first 10–15 years of the palm life. Date-palm is dioecious producing a greater percentage of female plants. Propagation through seeds produces great genetic variability which is not desirable. Tissue culture is a tool which can ensure rapid clonal propagation of date varieties and may also speed up the rate of seed multiplication.

1. *Direct Regeneration Through Tissue Culture Technique:* Explants used were basal portions, lateral buds, shoot tips, inflorescence including rachilla tissues, and embryos. Among these only basal portions obtained from the young date-palm seedlings that were collected from the Barri Imam area, Islamabad showed direct regeneration. Callus was formed from the basal portions, lateral bud and embryos, that were cultured in Murashige and Skoog medium as well as in Heller's medium (table).

2. *Transfer of Plantlets to Free-living Conditions:* Few plantlets with distinct roots and shoots were transplanted in free-living conditions, in jiffy pots containing a mixture of equal portion of peat moss and vermiculite soil. At the time of transplantation the shoot was 8cm in size. The plantlet showed speedy growth implying that it is advisable to transfer the plantlet (with root and shoot) to free-living conditions when their shoots have assumed a size of 6–10 cms, with well developed root system. In order to sustain the pace of growth the plantlet was watered with Hoagland's solution (one-fourth strength) once a week, with ordinary water being given every alternate day. Out of few plants only one survived for well over two months, after which it also died. This indicates that more perfection in transplantation techniques is required.

Direct regeneration of explants

Explants	Heller's medium	Murashige and Skoog medium	Regeneration
Basal portions	–	NAA 8mg/l and Adenine 5mg/l	Initiation of shoot and root
Embryos	Adenine 5 mg/l, 2, 4-D 50 mg/l, kinetin 1 mg/l and NAA 5 mg/l	–	Callus formation
Lateral buds	NAA 40 mg/l 2, 4-D 100mg/l	–	Callus formation
Plantlets from embryos	Gibberellin 1mg/l, Kinetin 5mg/l NAA 3 mg/l and Adenine sulphate 50 mg/l	–	Root formation
	Gibberellin 1mg/l, Kinetin 5mg/l NAA 3 mg/l and Adenine sulphate 5 mg/l	–	Shoot formation

THRUSTS FOR NEXT YEAR

1. Field multiplication of virus-free potato tubers and purification of other cultivars, like 'Ultimus', 'Desiree', 'FB' clones, 'Spunta' etc.
2. Large scale production of date-palm plantlets from the vegetative parts of the plant both with and without callus formation.
3. Production of haploid plants through anther/pollen culture techniques.

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Plant Genetic Resources

OBJECTIVES OF RESEARCH PROGRAMME

1. To explore different areas in the country for collection of germplasm of different crops.
2. To evaluate germplasm for different characters.
3. To document germplasm at the Genebank – Genetic Resources Centre.
4. To preserve/conserve germplasm and its distribution.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Exploration and Collection

1. ***Mung and Maash:*** They are the major summer food legumes of Pakistan and are important source of proteins, especially for the low income people. Their major cultivation is in the province of Punjab. Most of the *Vigna* species like *mung, maash* and moth bean are considered to have been originated in the sub-continent but their representation in the World's collection is very limited. Therefore, the Plant Genetic Resources Unit of PARC, organized and undertook a *Vigna* species collecting expedition in the Punjab, an important centre of diversity. The collection mission lasted for 21 days during September 1982; travelled almost 4000 km and collected 419 samples of 12 different crops from 160 sites. The collection areas were Rawalpindi, Attock, Jhelum, Gujrat, Multan, Bahawalpur and Mianwali districts covering different agro-ecological zones.

2. ***Fruit Germplasm from Northern Pakistan:*** The area including the valleys of Gilgit, Hunza, Ishkomen, Yasin, Astore, Chillas, and Sinkiang in China and Waahan in Afghanistan have the richest resources in the fruit germplasm. These are being wiped out due to cutting of trees by the local inhabitants for firewood and other purposes, and replacement with improved varieties by the agriculture department.

To safeguard this precious material from being eroded, a 15-day fruit plant collecting expedition was undertaken during January 1983; travelled about 3000 km and collected 227 samples of 14 different species from 27 sites at an altitude ranging from 1350 to 2439 metres.

The material collected has been grafted onto the rootstock nursery at NARC, Fruit Development Project, Quetta and ARI, Mingora (Swat), which would be available to fruit breeders for utilization in their breeding programmes for fruit improvement in the country.

3. ***Lentil Germplasm from Punjab:*** A 15-day lentil collecting expedition to the Punjab province was organized during April 1983 which travelled over 4000 km and explored the districts of Gujrat, Sialkot, Lahore, Kasur, Sheikhupura, Gujranwala, Sahiwal, Multan, Muzaffargarh, Jhang, Faisalabad and Attock. Collections were made from field, farm storage, village and grain markets depending upon the availability of the material. A total of 212 samples of 16 different crops from 75 sites were collected from altitude ranging between 190 and 459 metres. The material was threshed, cleaned, documented and conserved in the genebank for further evaluation and utilization.

Evaluation and Characterisation

Ninety three accessions of oat germplasm were grown at NARC during 1982-83 for its multiplication and distribution. The material was sown in a 5m row using the augmented design, with one metre distance between each accession, according to the IBPGR rules. The material was threshed, cleaned, dried and is being preserved in the genebank.

Seven hundred and fifty accessions of wheat germplasm comprising the entire collection, 'PNE-1976', '1981', collected from Northern areas, Baluchistan and other parts of the country, were sown at NARC and ARI, Sariab, Quetta during 1982-83. Data were recorded for 22 different morphological, botanical and genetic characters. Some of the wheat accessions having desirable traits would be utilized for wheat improvement programme. The data and results are being disseminated to the breeders at different research institutes in the country and abroad.

Similarly, 2100 accessions of chickpea, and 80 accessions of barley germplasm were grown at NARC during the report period and were multiplied/rejuvenated for further utilization.

Documentation and Preservation

The material collected through expeditions and other sources was documented at NARC, where the genetic resources information was maintained on specified format, "Accession Record List and Stock Record List" that can easily be computerized.

In case of fruit germplasm, the scion wood, collected during expedition, were grafted on the rootstock nursery for their preservation as "Clonal Repository" at NARC; ARI, Sariab, Quetta, and ARI,Swat.

The germplasm collected through expeditions was threshed, processed, cleaned and packed in screw top tins and finally conserved in the genebank at 0°C (Table 1).

Table 1. Germplasm accessions of different crops in genebank at NARC

Crop	Accessions
Chickpea	2312
Rice	2693
Wheat	1205
Aegilops	10
Maize	171
Rape and mustard	480
Mung	627
Maash	437
Lentil	829
Barley	261
Sorghum	90
Medicago	79
Millet	38
Groundnut	145
Sunflower	67
Vegetables	159
Primrose	68
Spices	47
Cowpea	86
Soybean	7
Peas	12
Tobacco	10
Artimesia	1
Safflower	2
Setaria	1
Misc. (oilseeds)	14
Other misc. crops	77
Fruit crops	323
Oat	98
Total	10349

Germplasm Distribution

A large number of germplasm has been distributed to different research organizations within and outside the country. The details of the germplasm distributed are given in Table 2.

THRUSTS FOR NEXT YEAR

1. Exploration and collection of cereals from different parts of the country and along the borders with Afghanistan and Iran.
2. Characterization of wheat germplasm for salt tolerance, drought resistance and its utilization in different breeding programmes.
3. Multiplication and rejuvenation of *maash (Vigna mungo)* and *mung (Vigna radiata)* collected during the expedition, for its further utilization and distribution to various research institutes in and outside the country.

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4.	Mr. M. Afzal	Scientific Officer

Table 2. Distribution of germplasm of different crops from genebank at NARC

Crop	Accessions	Distributed to
Maize	516	Dr. George A. White, ARS USDA, Beltsville, MD, USA
Onion	21	Dr. P. Hanlet, DDR, East Germany
Mung	22	Dr. Changsoon, AVRDC, Taiwan, China
Wheat	23	Dr. Lorenzo, Rome, Italy
Wheat	285	Dr. M. Qazi, CIMMYT, Mexico
Wheat	120	Dr. A. R. Rao, UA, Faisalabad
Wheat	104	Dr. H. R. Hanes, USA
Barley	20	Dr. Kausar Malik, PSO, NIAB, Faisalabad
Barley	45	Dr. A. R. Rao UA, Faisalabad
Maize	53	Dr. Rchard N., CIMMYT, Mexico
Vegetable	81	Coordinator (Vegetable), NARC
Vitis	37	Dr. A. C. Goheen, USDA, California, USA
Juglans regia	24	Dr. L. W. Shreve, Texas, USA
Punica	66	Dr. B. D. Horon, Georgia, USA
Prunus, Pyrus	150	USDA, Maryland, USA
Misc. fruits	27	Dr. M. Saeed Fruit Development Project, Sariab Quetta
Misc. fruits	227	Mr. Faridullah Khan ARI, Mingora, Swat

Plant Introduction

OBJECTIVES OF RESEARCH PROGRAMME

1. To increase the understanding of the taxonomic relationships, geographical and ecological distribution and centres of diversity of crop plants and their wild relatives, and to help promote their systematic assembly for crop improvement.
2. To expand plant germplasm collections with local and exotic material.
3. To distribute plant germplasm to scientists and collect data on its performance and use for crop improvement and in preventing genetic vulnerability.
4. To gain knowledge and document new and improved chemical, biological and agronomic potentials of selected plant species as new crop sources of oil, waxes, gums, fibre, food and feed proteins as well as medicinal products.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS / ACHIEVEMENTS

The research work was mainly concentrated on the introduction of new plant material and its evaluation. In total 273 varieties/cultivars of 45 different plants were imported from various countries were either evaluated at plant introduction centres (P.I.C s) or distributed to different research organizations.

P.I.C., NARC, Islamabad

Kangroo Apple (*Solanum aviculare*)

It is native to Australia and a proven source of steroids. Imported seeds were sown at NARC in pots in November 1982. The seedlings were transplanted in the field during March and May to know the best time for transplantation. The best time for the transplantation of the seedlings was found to be the first week of March. If it is delayed, the growth of the plants including height and number of leaves is reduced.

Apple

Seventeen varieties imported from USA were planted at NARC during 1979 for low chilling requirements. Out of these only nine fruited 'Fasse Pamac' showed higher bearing while 'Lebanani' and 'Dr. 102T116' were intermediate.

Performance of strawberry varieties

Variety	Yield	Fruit size	Remarks
'Aliso'	Very productive	Large, red irregular shape	Suitable for warm areas
'Sequoia'	Very productive	Large, soft flesh, tender skin	Everbearer in mild climates
'Tufts'	Very productive	Large, red	Suitable for citrus pruning areas
'Salmi'	Fruit large, red flesh, vigorous growth	Large, dark red medium firm skin	Suitable for mild climates
'Pishwari'	Very productive	Large, medium firm dark red	Resistant to wilt
'Mishnery'	Less productive	Medium, red flesh	–
'Block mother'	Very productive	Medium, red flesh	–
'Fiction'	Less yielding	Medium, red flesh	–

Buffalo Gourd (*Cucurbita foetidissima*)

It grows wild on wastelands and is highly drought tolerant. On barren land, it may match the performance of traditional protein and oil sources such as peanut and sunflower, which require more water. Its enormous root can weigh as much as 30 kg after just two growing seasons.

Its seeds were imported from USA and sown at NARC on March 8, 1983. The growth is excellent but the yield data has to be recorded when the plants flower.

Strawberry

Eight varieties were planted on ridges to study their comparative yield

which is given in the table.

Macroptilium lathyroides

It is tropical legume and is supposed to be tolerant to water-logging and salinity. Seeds received from FAO, Rome were sown at NARC during April and June, 1982. Plant growth was vigorous and attained a height of 0.85–1 m with lot of secondary branches within two months.

Grape Vine

Four varieties (three from Italy and one from USA) have been planted in the field and are growing well.

Guayule

It is a substitute of rubber tree for arid and dry areas. Five accessions were received from USA. The seedlings have been transplanted in the field and are growing well.

Bamboo

One hundred and forty four plants of bamboo *(Bambusa arundicacae)* are already growing in the field. The seedlings received from Dera Dun, India of species ***Dendrocalamus strictus*** have been planted in the field. The suckers of two more varieties (yellow and tall) have also been planted.

Sesamum

Thirty six cultivars (world collection) from FAO, Rome were evaluated for 14 morphological characters and wilt reaction. All the cultivars were found susceptible to wilt.

Evaluation of Exotic Legumes

Six accessions of rice bean, three of winged bean, two of sword bean, two of bambara groundnut, three of tepary bean have been sown in the field. Rice bean and tepary bean proved very high yielding while lablab bean and winged bean proved very low yielding as there was very poor pod formation. Due to low temperature in November, only a few pods with seeds were formed.

P.I.C., Karachi

Coffee *(Coffea arabica)*

Seedlings of Mexican varieties were transplanted in open field under full shade and also under partial shade at P.I.C., Karachi during April 1978, but they could not survive and all perished away.

At present a total of 22 plants are growing. Seven under full shade of Ranimewa, six under partial and three under partial shade of ***Azadrista indica (nsem),*** respectively, and remaining six were under chicku. It has been observed that plants under full shade of Ranimewa from where water course passes showed vigorous growth and free from tip-buring in comparison to other plants.

Only two full ripened berries were collected from the plants under full shade of Ranimewa during mid-January, 1983, whereas all other berries developed, perished away due to hot winds and rise of temperature during May–June, 1982. Pericarp and pulps were removed from berries and two gelatinous seeds of grey colour were obtained from each berry.

Seeds were washed to remove gelatinous matters, dried in the sun and sown in pots on January 17, 1983 This method of sowing was suggested by Dr. U. Pethiya Agoda formerly Director, Coconut Research Institute, Srilanka, during his visit to P.I.C., Karachi.

Flower buds appeared on the five plants under full shade, plants under chicku did not bear any bud. It was observed that plants under full shade bore flower buds earlier and in larger number than plants under partial shade. Older shoot of plant bore earlier flower buds than new shoot. Developed berries are green and progressing very well in comparison to last year, since, hot winds and rise of temperature during May-June, 1983 were not so severe as compared to last year.

Coconut *(Cocos nucifera)*

Seeds of dwarf variety imported from Srilanka were sown on April 28, 1980 in the nursery bed which showed 60 percent germination. Seedlings were transplanted in the field during February–March, 1981. Seven percent mortality was observed after transplanting till June, 1983. Plants are growing very well and at present 158 plants are surviving.

During November, 1982 to March, 1983, plants suffered very much by ***Alternaria*** blight, and borer. However, these were controlled by applying Bordeux mixture, (5:5:50), Dithan M-45, and Bidrin.

Fifty five nuts of 17 Indonesian varieties were sown during March, 1981 in nursery bed, showed 64 percent germination. Twenty five seedlings were transplanted in the field, during September, 1981. Eight percent mortality was observed after transplanting till June, 1983. At present 23 plants are progressing very well.

Oil Palm *(Elaeis guineensis)*

Three varieties from Malaysia were sown in January, 1981, which showed on average ten percent germination.

Five varieties from Indonesia; sown on April 27, 1981 showed 43 percent germination.

Seedlings progressed very well in earthen pots, kept under shed. However, all seedlings were transplanted in open field during October, 1982 and February, 1983.

It was observed that growth of the plants, new sprouting of leaves and branches remained checked after transplanting throughout winter season, i.e., from November, 1982 to March, 1983. When temperature started rising from April, 1983, new sprouting of leaves were recorded. Malaysian variety showed 23 percent mortality whereas no mortality in Indonesian varieties was observed.

Custard Apple *(Annona reticulata)*

Twenty one plants of variety, 'bullock heart' are growing very well. These plants were propagated by cuttings imported from Australia during 1975. Most of the plants bore flowers during May-June, 1983, which were partially developed into fruit having normal size and taste.

Seeds of a well known variety of India, 'Bhopal Selection' were sown in the nursery bed, which gave 68 percent germination. Seedlings were transplanted in the field/on the border of water course during April, 1981. It progressed very well and few plants started fruiting in May-June, 1983. It is expected that in following two years all plants will bear fruit. At present 23 plants are growing very successfully.

Bamboo *(Bambusa* **sp.)**

Twenty seven bunches of thin variety raised by seedlings, obtained from D.F.O., Lahore during February, 1980 are growing very well. Plants produced number of rhizomes during the last two years, which were established as new plants. It is planned that rhizomes obtained from plants during the current year will be distributed to the promising growers for propagation purposes.

Tamarind *(Tamarindus indica)*

Fifty three plants of local

variety raised by seedlings during September and October, 1978 are growing in the field. Most of the plants are green and healthy. Few plants have attained a height of 3–4 m with dense crown. Few trees bore flowers and set fruit during 1982-83.

Ipil-Ipil *(Leucaena leucocephala)*

Eighteen plants of giant variety are growing very well. Seeds of this variety are being collected from the mature pods and are available for distribution.

Areca Nut *(Areca catechu)*

Twenty seedlings from Srilanka were transplanted on the water course line. These are growing well but sprouting of leaves is very poor.

Betel Leaf *(Piper betle)*

Few vine cuttings of Bangkok/ Indian varieties from mature vine creepers were obtained from local growers during February, 1982, and transplanted in shed. A number of plants have been propagated by layering its vines.

Mulberry *(Morus rubra)*

Seedlings of Korean variety were transplanted in the field during July–August, 1982, which are growing very well. Seven more seedlings have been transplanted during July 1983. At present a total of 18 plants are growing in the field.

Passion Fruit *(Passiflora sp.)*

Few seedlings/seeds were obtained from Srilanka at the end of July, 1982. Seedlings raised from seeds were transplanted in the field during October, 1982 and July, 1983. At present all 19 plants are growing very well. Plants are creepers and a number of vines have been produced by the existing ones.

Chinese Guava *(Psidium guajava)*

Five seedlings obtained from Srilanka by the end of July, 1982 and transplanted in the field, which are growing very well.

Avacado

Five seedlings obtained from Srilanka were transplanted by the end of July, 1982 in the open field. One seedling perished away while the rest are growing with poor performance. It is doubtful that these seedlings may survive in future.

Buffalo Gourd *(Cucurbita foetidissima)*

Few seeds were obtained from Islamabad and sown on May 9, 1983 in the open field which showed 77 percent germination. Vines are propagating very fast. Plants are healthy and green. It is a drought tolerant crop, which can be grown on barren lands. Seed contains 30–35 percent protein and 34 percent oil.

Rice Beans *(Vigna umbellata)*

Few seeds were obtained from Islamabad and sown in the field on May 9, 1983 which showed 30 percent germination. After germination none could survive in the field, while seeds sown in the shed are growing very well.

The plants can be adopted to high temperature and humidities and can be grown in the rice field for improving nitrogen and humus contents. Seeds are rich in protein, calcium, iron, phosphorus, vitamins, thiamin and riboflavin. Plants can be used as forage due to its nutritional quality.

Tepary Bean *(Phaseolus acutifolius)*

Few seeds, obtained from Islamabad were sown in field and shed with 66 and 44 percent germination, respectively. After germination, most of the seedlings perished away at both the places. Few are growing with poor progress.

It is drought tolerant crop and can thrive in arid/semi-arid regions withstanding heat and dry atmosphere. Seeds have high protein content (23–25 percent); can be used as vegetable while leaves/young pods as forage for livestock.

Honey Locust *(Gleditsia triacanthos)*

Few seeds from Islamabad sown in the field and shed which showed 35 and 20 percent germination, respectively. Seedlings in the field after germination could not survive whereas only two seedlings are surviving in the shed. It is a good forage crop with hard and woody stem which has uses in timber industry.

Macroptilium lathyroides

Seeds obtained from Islamabad were sown in the field on May 5, 1983 which showed very good germination. Seedlings started flowering after three weeks of germination and pods matured after one week. Seeds have been collected for further sowing. Plants are growing very well. It can be adopted to a wide range of climate. It can be used as forage and also as a green manure.

Cassava *(Manihot esculenta)*

Few cuttings from Zambia were planted in the field in July, 1981. The plants matured after 6–12 months and tubers became ready for consumption purposes. Its cuttings were planted in open field, which sprouted and grew very successfully. It is rich in starch.

Chicku *(Achras sapota)*

One hundred and nine plants are growing very well. All the plants bore fruit during 1982-83.

THRUSTS FOR NEXT YEAR

1. Identification of neglected but seemingly useful plants, both wild and domesticated, that have economic potentials.
2. To indicate requirements and avenues for research to ensure that selected plants reach their fullest potentials.
3. Large scale experimental plantation of Kangroo apple, Buffalo gourd, Jerusalum artickoke, Guayule, Rice bean, Coconut, Cashewnut, Passion fruit, etc. in different agro-ecological zones of the country.

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Entomology

OBJECTIVES OF RESEARCH PROGRAMME

1. To survey different ecological zones of Pakistan for recording pests and determine the losses caused by them.
2. To study seasonal and annual fluctuations in population of important pests and develop preventive and curative measures for their control.
3. To study possibilities of introducing natural enemies from abroad and to determine their efficiency for pest control.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Melon Fruit Fly

Three species of fruit flies occur in three different ecological zones of D.I. Khan. *Myiopardalis pardalina* infests melons in Kulachi and Tank area; *Dacus cucurbitae* in D. I. Khan tehsil and *Atherigona orientalis* in the Indus river delta. Four to five generations of *M. pardalina* were recorded in the melon crop during the season and no alternate host was found. In further varietal trials 'Danish' was found most resistant followed by 'Sarda'. 'Bokhara' was the most susceptible variety which is mostly grown in Kulachi, Tank and some other areas of D.I. Khan. In the chemical control, Tamaron EC and Diptrex gave good control of the pest followed by Supracide and Dimilan. In granular application Furadan 3G proved effective as compared to other granules. No predator or parasite of any species was recorded.

Leaf Hoppers

The leaf hopper species infesting okra was mainly *Amrasca devastans* with occasional specimens of *Empoasca punjabensis* and *E. signata*. The leaf hopper population varied a lot. Azodrin sprays brought about drastic reduction in it. The periods taken for maturity of individual fruits was 7 to 12 days in unsprayed plots and 6–9 days in the treated plots. In plants, plotted week-wise, the rise and fall of yield curve followed inversely with the rise and fall of leaf hopper numbers during the 13 weeks of crop age.

Termites

Among the five insecticides tested in the laboratory, Oftanol (Isofenphos) gave promising results and in the field 10 and 20 percent concentrations of this insecticide gave complete protection of wood from termite. Exotic strains of *Bacillus thuringiensis* obtained from WHO and the local ones obtained from Department of Microbiology, Karachi University and another bacterium, *Pseudomonas aeruginosa* obtained from NIAB, Faisalabad for controlling termites gave very encouraging results.

Coccids

They infest almonds, grapes, pistachio, mulberry, etc. Almond scales and grapes mealy bugs caused heavy damage to their respective hosts. Sumicidin and Supracide controlled almond scale very effectively when applied at nympha' swarming and leathery stages. A few parasites and predators were recorded. The grapes mealy bug infested about 45 percent vine yards of Quetta and Pishin districts. It overwinters as mature females under the flaxes of bark at the lower part of main trunk. Chemical control of grapes mealy bug with Folidol and Hostathion gave encouraging results. Application of pesticides on espellier system of grape training was easier and more effective than the conventional one.

Aphids of Crucifers

Aphids were collected from 90 locations in the Punjab and Sind. *Brevycoryne brassica; Rhopalosiphum erysimi, Aphis nerii; A. medicagenasis* and *Myzus persicae* being in abundance in warmer regions of Punjab and Sind having more infestation while the northern Punjab had very little attack of aphids not reaching economic threshold.

The preference / non-preference host was determined by recording data on initial settling of winged aphids on twelve selected varieties of brassica. Varieties, 'K-295-S', 'Cr-168/565' of *Brassica juncea* which have bright green leaves attracted very small number. The studies on apterous aphids reproduction and population, build up under natural conditions, showed that the aphid development on varieties, 'K-295-S', 'CR-168/565' and 'Zero erucic' was very slow as the number per plant on these varieties remained less than 10. The leaves of these varieties are shiny, glossy and

devoid of any hair, whereas the varieties having larger aphid populations possess dark green, dull and hairy leaves. Aphid colonization by forced feeding under muslin cloth field cages revealed that the encaged inoculated plants of varieties, 'K-295-S', 'RL-16', 'CR-168/565' and 'Zero erucic' were not liked by aphids and the sizes of colonies on them were very small.

The application of Disulfoton with first irrigation gave better aphid control. Seven predators and two parasites were recorded which affected the population to some extent.

Sawflies

A survey for sawflies and their natural enemies was carried out in the northern forests of Pakistan. *Gilpinia pindrowi* was recorded from 1600 to 2800 m on *Pinus wallichiana, G. polytoma* (Htg.) from 2100 to 2800 m and *G. ghanii* Smith from 2000 to 2300 m on *Picea smithiana* and *G. indica* (Cameron) from 2000 to 2200 m on *Cedrus deodara.* These sawflies were attacked by 24 parasites and 5 predators. Detailed studies on biology, phenology, temperature tolerance, host suitability, etc. were carried out on the important natural enemies. The important parasites were *Agrothereutes* sp. *Dibrachys* sp. nr. *boarmiae, Dibrachys* sp. nr. *cavus, Monodontomerus dentipes, Drino discreta* and *D. gilpiniae. Rosa* spp. were attacked by *Cladius pectinicornis, Arge nigrinodosa* and *A. annulitarsis.* These were parasitised by three ichneumonids, two eulophids and one tachinid. *Nematus melanspis* attacked willow and was parasitised by *Endasys* sp. and *Vibrissina turrita. Trichiocampus ulmi* and *A. praesternalis* were collected from elm. *T. ulmi* was parasitised by three ichneumonida, and one species each of pteromalid, tachinid and mermithid.

Epilachna **spp.**

As a result of survey in different ecological regions of Pakistan seven species of Epilachninae, *Epilachna sparsa, Epilachna* sp., *E.* sp. nr. *ocellata, E. dodecastigma, Henosepilachna elaterii* sp. *orientalis, Afidentula manderstjernae* and *Afidenta mimetica simplex;* seven of their parasites *Pediobius foveolatus, Tetrastichus epilachnae, T. appannai, T.* sp nr. *ovulorum* and *Tetrastichus* spp. and three species of predators *Geocoris tricolor, Dalpada eremica* and *Derareocoris* sp. were recorded. Detailed studies were made on ecology, biology,and behaviour of *Epilachna* spp. and their parasite, *Pediobius foveolatus.* Parasitism was extremely low on *E. sparsa* infesting economic crops. Results of redistribution of *P. foveslatus* were promising.

Cone Borers

Dioryctria abietella and *Eucosma pylonitis* cause serious damage to the cones mainly of *Pinus grifithii.* Infestations of *D. abietella* were higher in sunny areas and that of *E. pylonitis* in shady areas suggesting that *D. abietella* prefers warmer localities. In light traps maximum adults were caught in May and August suggesting the peak emergence periods of first and second generations of *D. abietella* and in May for *E. pylonitis.* Sixteen parasites, 16 predators and 8 pathogens from *D. abietella* and 8 parasites, 8 predators and 2 pathogens from *E. pylonitis* were recorded. Biologies of *Trichogrammatoidea* sp. *Telenomus* sp., *Liotryphon* sp., *Lissonota* sp. nr. *deversor, Campoplex* sp., *Dolichomitus* sp., *Zemiotes* sp., *Bracon piger* and *Dibrachys* sp. nr. *affinis* were studied. Systemic insecticides, Metasystox and Tamaron were tried against these borers. Metasystox gave higher mortality than Tamaron. Mortality of the pests was higher than their parasites due to Metasystox. Further, the insecticides also gave promoting effect on the larval mortality due to pathogenic micro-organisms.

Cutworms

Telenomus remus which was released at Peshawar, Hyderabad and Multan during 1980-81 seems to be well established at these localities. It was recovered from Warsak 10 km away from the release site, parasitising upto 57 percent egg-masses of *Spodoptera litura* on sugarcane and 4.7 percent on cauliflower. At Hyderabad it was recovered from *S. litura* egg-masses on castor (parasitism 20 percent), cauliflower (15.3 percent) and spinach (5.8 percent) at Latifabad about 12 km away from the release site. At Multan it parasitised 18.1 percent egg-masses of *S. litura* on cotton. Studies were made on host suitability, temperature tolerance, overwintering and host plant preference of *T. remus* and *E. platyhypenae.* Parasitism of *T. remus* was higher on castor followed by cotton and tobacco. At Peshawar *Trichogrammachilonis* was reared for the first time from *S. litura* egg-masses which were also parasitised by *T. remus.* Releases of *E. platyhypenae* were also made at Hyderabad, Lahore, Multan, Rawalpindi and Peshawar on cauliflower, maize, cotton, etc. This was recovered once from *Mythimna separata* larvae feeding on maize at Rawalpindi.

Lepidopterous Pests of Crucifers

Diadegma pierisae which was redistributed at Sialkot from Haripur in February 1981 against *Pieris brassicae* was recovered later with 2.1 percent parasitism in January, 2.5 percent in February and 3 percent in March. *Apanteles glomeratus* was not found at Quetta. Therefore, 2500 adults were released during April-May against *P. brassicae.* At Rawalpindi, in life table studies, 3.4 percent eggs of *P. brassicae* failed to hatch, 3.9 percent were predated upon by *Coccinella septempunctata* and an unidentified syrphid, 1.8 percent larvae were washed by rains, 84.3 percent were killed by *Bacillus thuringiensis,* 0.4 percent were parasitised by *D. pierisae,* 0.4 percent by *A. glomeratus,* and 4.9 percent were missing. About 0.5 percent pupae were parasitised by *Pteromalus puparum* and only 0.4 percent adults of *P. brassicae* emerged. Bactospeine, a microbial pesticide was effective against larvae of *P. brassicae* and *Plutella xylostella* and 1,0.5; 0.2, 0.1, 0.05 percent solution gave 100 percent mortality of young larvae of *P. xylostella* in 1, 1, 3, 4 and 6 days, respectively. It was not lethal to parasites, *A. plutellae, D. semiclausam* and *Tetrastichus sokolowski* of *P. xylostella* and *D. pierisae, A. glomeratus* and *Pteromalus puparum* of *P. brassicae.*

Apanteles flavipes

Extraction of kairomones from mandibular glands of *Chilo partellus* was carried out for attraction of *A. flavipes* to sugarcane. Augmentation of *A. flavipes* (reared for a number of generations on sugarcane borers) was done at Mandi Bahauddin. Parasitism increased at release site and upto 5 percent *Acigona steniellus* larvae were parasitised during October-November and 2 percent in December as compared with 0.5 percent in October in the control. A strain of *A. flavipes,* imported from Indonesia, was found

effective against sugarcane borers. The exotic parasite *Allorhogas* sp. nov. was mass-bred and about 21000 adults were released against graminaceous borers at ten different localities in the NWFP, Punjab and Sind.

Pink Bollworm of Cotton

The imported parasite, *Chelonus blackburni* was mass-reared and 12500 adults were released in a cotton field at Multan from June to October. It was recovered from infested bolls in November from the release site and 0.5 km away. About 21000 adults of *Bracon greeni* were released during July-October reducing infestation in square-blooms to 2.5 percent and bolls to 14.3 percent and increasing parasitism to 21.5 and 6 percent respectively. As compared with the control, where square-blooms infestation was 13.5 percent and in bolls 25 percent and parasitism was 6 percent. *Achroia grisella* proved suitable laboratory host for rearing two indigenous parasites, *Chelonus (Microchelonus)* sp. and *Brachymeria tachardiae. Chelonus* sp. at 22°C completed development in 43 days on *Earias vitella* as compared with 86 days on *A. grisella.* Predators used insects infesting lucern, maize, sorghum and vegetables as intermediary hosts from June to August before shifting to cotton.

Mites

Work on their collection from crops, vegetables, plain and hill fruit plants and wild vegetation remained in progress in 51 different localities of Pakistan. The phytophagous mites thus collected belong to the families Tenuipalpidae, Tetranychidae, and Tarsonemidae, whereas the predatory mites belong to the families Cheyletidae, Cunaxidae, Phytoseiidae, Raphignathidae and Stigmaeidae; total genera being 41. Eight new species of mites of the genus *Cenopapus,* family Tenuipaidae were recorded. Biology of *Brevipalpus dosis* Chaudhri, a common species of phytophagous mites, was studied under laboratory conditions. Two insecticides/acaricides, Omite and Metasystox in the concentrations of 0.05 and 0.1 percent were tried against white sugarcane mite, *Schizotetranychus mustafii.*

THRUSTS FOR NEXT YEAR

1. Extensive survey to find out additional natural enemies of insect pests.
2. Detailed studies on promising natural enemies with special emphasis on their efficacy for the suppression of target species..
3. Develop techniques for mass multiplication of major parasites and predators of important pests and their release in the field to control target pests.
4. Introduction of promising exotic natural enemies to study their efficacy under conditions in Pakistan.

Pink bollworm poses the most serious threat to cotton crop in Pakistan. Experiments on biological control of this pest have yielded encouraging results

Plant Pathology

OBJECTIVES OF RESEARCH PROGRAMME

1. To investigate into host-parasite genetic relationship and monitor changes in virulence in parasites causing rusts in wheat.
2. To assay varietal resistance, determine the mode of inheritance of resistance to the disease and identify pathogenic variation in the parasite.
3. To carry out seed health testing of some cereal and legume crops for detection of seed-borne diseases.
4. To identify new source of tolerance to the prevalent and new virulence of rusts that are resistant to parent stock and can be used in National Breeding Programme.
5. To diagnose and control important diseases through chemical, cultural and biological methods.
6. To evaluate agro-chemicals for safe economics and effective seed treatment.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Wheat

1. *Stripe Rust (Puccinia striiformis):* During 1982-83 a total of 157 samples were collected from the high infestation areas of northern Punjab (north of Faisalabad), northern NWFP and uplands of Baluchistan during the survey of the wheat growing areas of the country for the commercial varieties, 'Punjab-81', 'LU-26', 'Blue Silver' and 'Lyallpur-73'. The intensity of infection ranged from traces to 80 percent from field to field. Out of the 52 samples analysed, physiological race '6E16' was most prevalent with 91 percent frequency. Other variants prevalent in national population were '38E16' and '6(38) E16'.

A severe epidemic of stripe rust (90–100 percent) in wheat crop in the uplands of Baluchistan was observed where 90 percent area was planted under old local type varieties. Known susceptible varieties like 'Punjab-81', 'LU-26', 'Pavon' and 'Blue Silver' were found free of stripe rust infection. It indicated that the races prevalent in Baluchistan are different from those in other provinces of the country. The stripe rust samples from Baluchistan are being analysed.

Regional Disease Trap Nurseries were planted at Islamabad, Faisalabad, Mardan, Tarnab and Kaghan to see the development of stripe rust in high intensity areas. Infections on *Yr* genes (yellow rust resistant genes) were noted which indicated that genes *Yr1, Yr2, Yr6* and *Yr7* for resistance to *P. striiformis* west., were attacked by the prevalent natural populations of the pathogen. Few isolates of *P. striiformis* were virulent on *Yr3* and SW 92/Omar. However, field reactions on the remaining near isogenic lines indicated that *Yr4, Yr5, Yr9* and *Yr10* were free from rust.

2. *Yellow Rust:* A total of 713 breeders' advanced lines, candidate varieties and existing commercial varieties of wheat under National Wheat Diseases Screening Nursery (NWDSN) were planted at different agro-ecological regions, including Karachi, Tandojam, Dokri, Quetta, Sialkot, Chakwal, NARC (Islamabad), Pirsabak, Mardan, Tarnab, and Kaghan. This nursery was screened in adult stage against stripe and leaf rust, the two major diseases of wheat.

The stripe rust reactions data was considered from Faisalabad, NARC, Kaghan and Pirsabak while leaf rust data was considered from all the locations. The data for Chakwal, Dokri and Mardan was not considered because of erratic development of rusts.

From the results a total of 282 lines / varieties were found resistant to leaf rust at all locations while 293 lines/varieties had good resistance to stripe rust. The results of these tests were passed on to the breeders for further use in the wheat breeding programme.

3. *Stem Rust (Puccinia graminis tritici):* Thirty field cultures on 26 back cross lines, each with a single gene for resistance, were analysed. The results revealed that 23 percent isolates are virulent on a combination of eight host genes. Near isogenic lines, *Sr26, Sr 27* and *SrGt,* were resistant to all isolates while only one isolate could attack *Sr24.* Wheat lines with genes *Sr5, 9e, 10, 11, 22, 24, 26, 27, 29Tt* and *Gt* were resistant to most of the isolates and provide the best protection against stem rust. Association of virulence for gene *Sr9d* with *Sr6, Sr9a, Sr9b* and *Sr15* was observed.

Wheat cultivars, 'C-271', 'C-273',

'C-518' possessed gene *Sr9d;* '9D' contained genes *Sr7b* and *Sr9d;* 'C-248' possessed *Sr7a, Sr9a* and *Sr15;* 'Punjab-76' contained *Sr-30;* 'WL-711' contained *Sr7b, Sr9d* and *Sr30* while 'Yecora-70' possessed gene *Sr 9d.*

4. *Leaf Rust (Puccinia recondita tritici):* Research work on the genetics of host parasite interactions between *Triticum aestivum* and *P. recondita* revealed that among the old and present day wheat cultivars grown in the country, 'C-269' possessed probable genotype *Lr2a* and *Lr18;* 'Pavon-76' contained *Lr2b;* 'Torim-73', *Lr 2b;* 'SA-75' possessed *Lr 2b* or *2c, Lr 18* and *Lr20;* '8A' possessed *Lr14a;* 'Local Red' contained *Lr14a* and *Lr18.* Moreover, old cultivars carried resistance on *Lr2* and *Lr14* loci besides *Lr17, Lr18, Lr20,* and *Lr23.* 'PARC-73' was found to contain *Lr18* for seedling resistance to *P. recondita.* No culture was found to attack 'Pak-81' possibly due to several seedling genes, present in it. Narrow based resistance was observed in most of the spring wheat cultivars presently grown in the country.

Comparing the development of leaf rust in wheat varieties at Karachi, Tandojam and Quetta, it was evident that maximum rust was recorded from Karachi followed by Tandojam, because of favourable climatic conditions.

5. *Complete Bunt:* Of the 11 varieties tested, 4 susceptible and 3 intermediate were selected. They were crossed reciprocally and F_1 seeds were collected. Half of them were planted at Summer Nursery Kaghan and half retained for next *rabi* sowing.

For varietal screening, 715 varieties/lines of NWDSN were treated with the mixture of chlamydospores of the bunt fungus collected from different sources and were sown in November 1983. Out of these 190 gave susceptible reaction, 48 intermediate reaction and the rest were found free from the disease.

6. *Partial Bunt (Tilletia indica)* Seven hundred and thirteen lines included in NWDSN and 64 additional commercial varieties were inoculated hypodermically with sporidial cultures of *T. indica* at the boot stage. Data showed following varieties / lines to be susceptible to the partial bunt diseases.

1. 'LU-26'
2. 'ARZ'
3. 'V-1207'
4. 'V-1262', 6134, C-271 X Cno "S" No/6134-C-272 Pak. 15387-17a-ca'
5. 'V-81579 CNo "S" – HD 832'
6. 'V-79391 Fury x KAL-BB CM 37138-48a-M-5y-IM-0a'
7. 'V-1299 (cc-INIA x BB INIA) CNo-HD 832-Pk. 15523-oa'
8. 'V-80067. Lyp-63 x 6134-C271 PK-15377-48-1a-1a-1a-oa'

7. *Seed-borne Fungi:* Seed samples of wheat, rice, sorghum and maize, collected from farmers' fields and seed processing agencies, were tested by the standard blotter and petri plate methods.

Frequency of various fungi, isolated from seeds of wheat, rice, sorghum and maize, is given in Table 1.

Drechslera rostrata and *D. longirostrata* were isolated from rice seed samples collected from Nawabshah district in Sind. They are new records on this host plant. *Curvularia leonenses* was also recorded for the first time from sorghum seeds collected from Dadu district.

Fungi such as *Alternaria alternata* and *A. tenuissima* were predominant in wheat seed samples particularly collected from rain affected areas in Punjab. These fungi cause seed rot.

At Karachi, Sorghum Nursery was tested against grain smut *(Sphacelotheca sorghi).* Out of 25 varieties, 11 showed grain smut ranging between 1.2 percent in 'Red Jamper' and 12.5 percent in 'BR-123'. Four varieties were found resistant.

Broadbeans

Plots are being planted with this crop at Agricultural Research Farms. It has been observed that almost all the diseases prevalent on this crop were present in the fields. The diseases, probably, have been introduced alongwith the seeds imported from various countries. This is because the imported seeds are not subjected to post entry quarantine seed health tests.

Ascochyta fabae, causes leaf spots of brown to dark brown colour on leaves, stem and pods, while *A. alternata* causes dark brown lesions on the leaves and pods. *Sclerotinia sclerotiorum* was isolated from stems showing stalk rot symptoms.These pathogens were re-isolated successfully. *S. sclerotiorum* also proved to be pathogenic.

Broadbean seeds were subjected to the seed health test on potato dextrose agar (PDA) (Table 2). Important pathogens like *A. fabae, A. alternata, Fusarium* sp. and *Macrophomina phaseoli* were isolated from seeds.

Lentil

The crop was relatively free of diseases in the previous years, but later severe blight symptoms appeared in NARC fields. The crop was heavily damaged by the disease especially after the heavy seasonal rains.

Disease specimens were collected for disease diagnosis. Leaves, stems and pods showing round to irregular brown spots with many pycnidia in the lesions were cultured on PDA for the isolation of the pathogen. *A. lentis* was isolated from the infected plant parts.

Table 1. Seed-borne fungi of wheat, rice, sorghum and maize

(percent)

Fungi isolated	Wheat	Rice	Sorghum	Maize
Alternaria alternata	10–20	2–5	1–2	–
A. tenuissima	10–20	2–5	1–2	–
Ascochyta tritici	10	–	–	–
Curvularia iuncata	2–5	2–3	1–2	–
C. pallesceps	1–2	1–2	1	–
C. leonenses	–	–	–	–
Fusarium semitectum	1–2	2–3	–	–
F. moniliforme	1–2	2–3	–	–
Drechslera tetramera	2–3	2–3	1–2	–
D. hawaiiensis	2–3	2–3	1–2	–
D. rostrata	–	–	1	–
D. longirostrata	1	–	–	–
Phoma glomerata	1	–	–	–

It was suspected that the fungus was seed-borne in nature. Therefore, seeds were subjected to seed health test (Table 3). Frequency of occurrence of *A. lentis* was high in the samples tested, showing thereby, that a lot of initial inoculum is present with seeds. Such seed lot used for planting purposes will produce diseased crop under favourable climatic conditions. This also established that the lentil blight fungus is seed-borne.

Seasame

One sample obtained from Oilseed Programme NARC was tested for its health. It was found that *Chaetomium* sp. infestation was four percent while that of *Curvularia* sp. and *Phoma* sp. was only one percent.

Tapery Beans

Seed samples, obtained from Food Legume Programme NARC, were subjected to seed health test. The percentage incidence of *Macrophomina phaseoli* was 16.3 to 44.0 and of *Alternaria* sp. was upto 1.25.

Rice

Studies on *Xanthomonas oryzae*, a causal organism of leaf blight of rice were undertaken. Different media were used to find out the most suitable medium for getting good colonies of the bacterium, *X. oryzae*. Among the media tested, tryptone-soya-agar which contains tryptone, soya, peptone, sodium chloride and agar has been found most useful and best for cultivating and maintaining the organism under viable conditions.

Maize

One hundred and fifty two samples showing symptoms of stalk rot disease collected from NARC, CCRI, Pirsabak and MMRI, Yousafwala were analysed. *Fusarium moniliforme, F. graminearum, Hypochus* sp. and *M. phaseolina* were isolated in varying frequencies. Studies on the role of these organisms in the causation of stalk rot disease are in progress. So far none of the approved commercial varieties has shown resistance to *Fusarium* stalk rot under artificial inoculation.

Table 3. Percentage incidence of fungi in lentil seed

Fungi	incidence (%)
Ascochyta lentis	34.5
Alternaria alternata	2.5
Fusarium spp.	9.3
Phoma sp.	0.75
Chaetomium sp.	0.25
Penicillium sp.	0.25

Tahle 2. Percentage incidence of fungi in broadbean seeds

Fungi	Incidence on 3 samples (%)		
Ascochyta fabae	1.1	0.0	5.05
Aspergillus niger	7.9	1.0	2.5
Alternaria alternata	11.4	8.0	4.0
Chaetomium sp.	1.1	0.0	1.05
Fusarium sp.	1.1	1.1	2.5
Drechslera sp.	0.6	0.0	0.0
Macrophomina phaseoli	0.0	3.75	0.0
Penicillium sp.	0.0	1.0	1.0
Phoma sp.	5.0	0.0	1.0

Peas

A trial on eight varieties revealed that losses in yield of peas due to powdery mildew in different varieties varied from 11.2 to 22.0 percent at plant disease index (PDI) varying from 54 to 76. Of the four varieties, 'Alaska', 'PN 25', 'Alderman' and 'American'. The last being more tolerant gave highest yield.

Varieties, 'NP-25', 'Alderman', 'H-57', 'No.26', 'Pep. 326', 'PV-774', 'P-8', 'Indian', 'FC-3954', 'Lanat', 'Arkel', 'Juwel', 'WV-Kelvedon Kelvex', 'Velga', 'American' and 'Alaska' are highly susceptible under natural field infection while 'Groch Zescielygedeniany' was found susceptible and varieties, 'Groch Nefryl' and 'Groch Delisail' were found moderately susceptible to powdery mildew. Two varieties, 'Groch Benjamanek' and 'Groch Kehredonu' exhibited moderate resistance to disease while only one variety, 'Groch Leser' was found resistant. Out of the three chemicals, Afugan, Captan and Saprol, Afugan proved to be the most effective.

THRUSTS FOR NEXT YEAR

1. Investigations into host-parasite genetic relationship and monitoring changes in virulence in parasites, causing rusts in wheat will continue.
2. Analysis of parameters in epidemiology of *P. recondita*.
3. Assay of pathogenicity in populations of *Erysiphe graminis* and assay of resistance to powdery mildew in wheat.
4. Assay of varietal resistance to Septoria and detection of pathogenic variation in the parasite.
5. Identification in wheat of the components of horizontal resistance to leaf rust.
6. Assay of pathogenic variation in *Pyricularia oryzae* and assay of varietal resistance to blast in rice.

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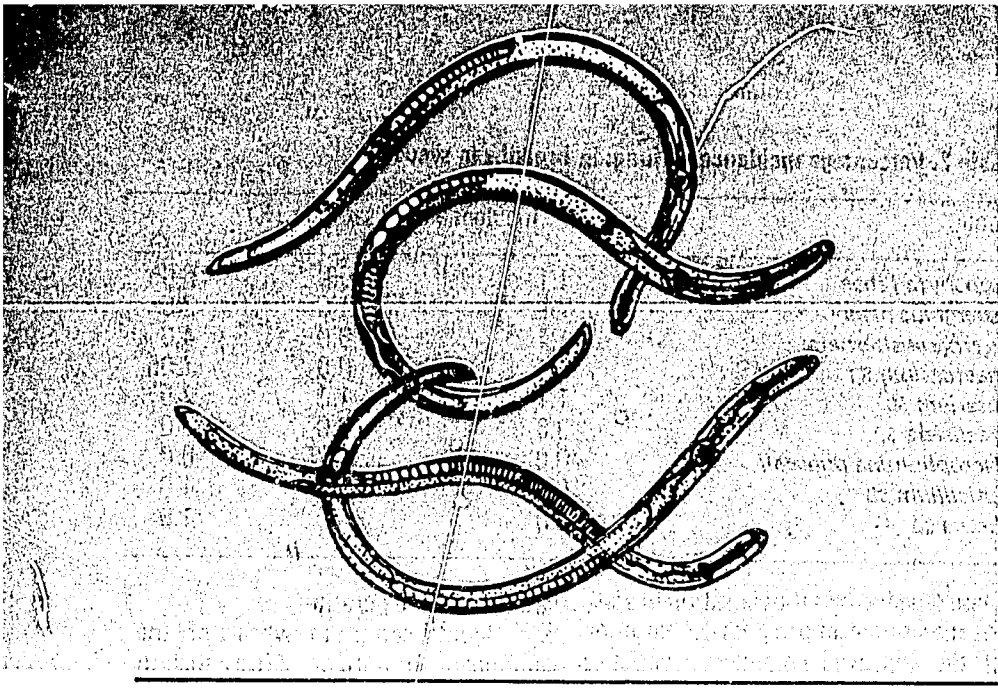

Nematology

OBJECTIVES OF RESEARCH PROGRAMME

1. To identify the nematode problem of various crops in different regions.
2. To determine the extent of damage, to upgrade crop protection capabilities against nematode pests so as to increase the production of economic crops.
3. To develop manpower in the field of nematology in the country.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Survey of Nematodes

Extensive survey of various citrus growing areas of Punjab have indicated the presence of nematodes. The survey was also necessary to carry out control experiments. Detailed survey was also undertaken in some parts of Baluchistan to study the nematode infestation in peach, almonds, apple, pinus, pear, plum, wheat, onion and apricot. A total of over 500 soil and root samples were collected from 105 localities of Sind, Punjab and Baluchistan. Samples were processed in the laboratory and over 800 slides of the parasitic nematodes were prepared. Besides studying frequency of infestation these nematodes were identified upto species level. As a result some new species were recorded. In Punjab citrus orchards were found heavily infested with citrus nematodes besides other parasitic nematodes.

Five nematodes *Qinisubieus curvus, Meloidogyne* sp. *Helicotylenchus indicus, Aphelenchus avenue* and *Pratylenchus scribneria* were studied for the influence of moisture contents at different soil depths and population densities. It was observed that the highest population was at the root zone (0–30 cm) and no nematode was recorded beyond 63 cm in soil.

Taxonomy of Plant Nematodes

Nematodes found associated with different crops during this period are as follows:

a. Genus and Species New to Science

1. *Aglenchus mardanensis* n. sp.
2. *Basiroides citri* n. sp.
3. *B. sindhicus* n. sp.
4. *Leipotylenchus amiri* n. sp.
5. *Merlinium niazae* n. sp.
6. *Neopsilenchus vulgaris* n. sp.
7. *Orientylus karachiensis* n. sp.
8. *Tylenchorhynchus quaidi* n. sp.

b. Parasitic Nematode Species Recorded for the First Time in Pakistan

1. *Basiria indica*
2. *B. minor*
3. *Hemicriconemoides strictathecatus*
4. *Hoplolaimus californicus*
5. *H. stephanus*
6. *Malenchus andrassyi*
7. *M. platycephalus*
8. *Merlinius microdorus*
9. *Paratylenchus nainianus*
10. *P. salubris*
11. *Pratylenchus brachyurus*
12. *P. similis*
13. *P. pseudopratensis*
14. *Rotylenchus buxophilus*
15. *Tylenchus butteus*
16. *Tylenchorhynchus claytoni*
17. *T. goffarti*
18. *T. parvus*
19. *T. clavicaudatus*
20. *Xiphinema pratensis*
21. *X. radicicola*

Control Experiments

Besides survey, morphology and taxonomy experiments were carried out in green house. Chemical control experiments in the fields were set in different localities of Punjab. The chemicals were applied against nematodes which were heavily populated around citrus roots.

Aldicarb and Carbofuran used in granular form, were found effective in reducing the citrus nematodes in the soil. In Sargodha, Bhalwal, Faisalabad, Sahiwal and Multan, where the nematode infestation was heavy, Aldicarb and Carbofuran @ 25 and 30 g ai/tree were applied twice a year. Large areas were included in the experiment. The two nematicides reduced nematode population markedly and as a result yield increased and better quality of fruit was obtained.

Among the organic fertilizer, poultry manure was found most toxic in eliminating population of *Pratylenchus scribneria* and *Ditylenchus* sp. Whereas urea and superphosphate were less toxic and farm yard manure was the least effective against these nematodes.

Age of Egg Plant Seedling in Relation to Root-knot Development

To see the effect of root-knot nematode infestation on seedlings of different age such as 2, 3, 4, 5 and 6 weeks, were inoculated with *Meloidogyne javanica*. At maturity whole

plants were uprooted, top and root lengths were measured and weighed separately. Infection rate was measured according to scale of Taylor and Sasser (1974). The infection rate decreased with an increase in the age of seedling.

Resistance in Some Wheat Varieties Against *Anguina tritici*

Out of many commercial varieties released for cultivation to the farmers in Pakistan, five varieties 'Zamindar', 'WL-711', 'Local White', 'Pak-70', 'Veerys' were selected for resistance against *A. tritici*. Experiments were carried out in green house using 12" dia pots. Results showed 100 percent germination in variety 'WL-711' followed by 'Local White', 'Zamindar', 'Pak-70' and 'Veerys'. Earcockle disease caused by *A. tritici* was recorded in highest frequency in the variety, 'WL-711' (93 percent) followed by 'Veerys' (71.2 percent), 'Pak-70' (65.6 percent) while in 'Zamindar' and 'Local White' no infestation was recorded.

Effects of Latex Extract on the Activity of *Meloidogyne larvae* in vitro

In order to evaluate new chemicals that could work as a chemical nematicides several plant extracts were tested against nematodes in vitro. Four concentrations, i.e., 0.005, 0.05, 0.5 and 10 percent of the plant extract of papaya, euphorbia, dhatura and cactus were tested. Out of these higher concentrations of euphorbia were found most effective followed by dhatura while papaya and cactus were not.

Sugarcane Nematode Control

Nematicide treatment was made with Temik 10G and Furadan 3G in infested sugarcane field. Soil samples were collected monthly for nematode population till harvesting. A marked decrease in nematode population in treated fields resulted in an increased sugarcane yield.

THRUSTS FOR NEXT YEAR

1. To carry out extensive survey extending to more crops to record and describe new nematode species.
2. Evaluation of more nematicides for achieving desired contol of nematodes.

SCIENTIFIC STAFF

1.	Mr. M.A. Maqbool	Nematologist/ Principal Investigator
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Plant Virology

OBJECTIVES OF RESEARCH PROGRAMME

1. To carry out surveys of incidence, intensity and distribution of virus diseases in Pakistan.
2. To identify and characterise viruses infecting host plants of economic importance on the basis of host range, symptomatology, serology and physicochemical properties and undertake transmission tests of virus diseases with seed, soil, dodder, insect and other vectors.
3. To produce virus-free material of potato, sugarcane, citrus and tomato.
4. To screen crop varieties for their resistance against virus diseases and find out control measures of important and serious virus diseases.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Surveys of Virus Diseases

A 10m x 10m area was selected at random and incidence of virus or virus-like diseases was recorded as percentages by actual counts. Diseased specimens were collected in polythene bags and stored at 4°C until processed. Occasionally, whole plant, systemically infected, was removed and planted in the pot which served as source of inoculum.

Diseased leaves were chopped by means of a sharp razor blade and put in a screw-capped glass tube containing anhydrous calcium chloride under a pad of muslin cloth. The tubes were placed at 4°C until the inoculum was required for inoculation.

Virus diseases are widely distributed in all crop plants of economic importance. So far 45 diseased samples have been collected on 27 host species, with tentative identifications pending and their complete characterisation High disease incidence, ranging between 10 and 15 percent was encountered in solanaceous hosts, sugarcane, legurninous crops and papaya, but in other crops it was low. The collection includes three new records of virus diseases of turmeric, arum and lassori.

Epidemiology of Virus Diseases: Virus diseases collected so far fall in five symptom groups, i.e., mosaic, streaks, yellows, leaf roll, and leaf curl. Mosaic and streaks are generally mild and do not cause appreciable loss except in potato and sugarcane. These diseases are also influenced by the weather conditions. Mixed virus infections appear to be common in leguminous and solanaceous hosts. Epidemiologically, yellow and leaf curl viruses, transmitted by a common vector, white fly, *Bemisia tabaci* are predominantly present in Pakistan and infect a wide range of host plants including weeds. The vector is present throughout the year on a number of hosts which accounts for wide spread occurrence of these viruses.

Yellow Mosaic of Mung and Urd Beans

Mung bean *(Phaseolus radiata)* and Urd bean *(P. mungo)* at NARC showed high infection (25–40 percent) of yellow mosaic virus. Investigations were initiated on the identification and properties of this virus.

1. *Symptomatology:* Infected plants showed mild to severe yellow flecks which were scattered on the leaves, turning them completely yellow and occasionally puckering and curling were also noticed. Infected plants produced few small and deformed pods which contained few seeds. Early infection appeared to be quite serious.

2. *Sap Transmission:* Inoculum was prepared by grinding the infected material in 0.02 M phosphate buffer, pH 7.0 containing 0.15 percent thioglycollic acid (1:1 w/v). Test plants were lightly dusted with 400-mesh carborundum and inoculated mechanically with infective sap by forefingers. Plants were then rinsed with tap water to remove excess inoculum and placed in an insect-free environment for symptom development and were observed for one month. No disease appeared indicating that the yellow mosaic virus is not sap or mechanically transmissible.

3. *Seed Transmission:* One hundred seeds were collected from infected bean plants and planted in pots which were kept in a protective place. Germination was quite satisfactory (90 percent), but no symptoms of mosaic appeared indicating that virus is not seed-borne.

Potato Viruses

Potato crop is susceptible to a very large number of virus diseases. Surveys have indicated that atleast six viruses viz., potato virus X(PVX), virus S (PVS), virus A (PVA) virus Y(PVY), leaf roll virus (PLRV) and alfalfa mosaic virus (AMV) are preva-

lent in Pakistan. Two viruses, PVY and PLRV, are very serious and involved in degeneration of varieties and reduction in yield. Studies were made with PVY.

1. *Testing of Tissue-cultured Material:* Tissue-cultured material of four potato varieties viz., 'Wilja', 'Spunta', 'Desiree' and 'Ultimus', prepared by the tissue culture laboratory, NARC, was tested for detecting virus. Tube precipition technique was employed to note the reaction between antigens and antibodies. Test antigen was prepared by homogenizing the infected tissue in 0.02 M phosphate buffer, pH 7.0 containing 0.15 percent thioglycollic acid and emulsifying it with chloroform (1:1:1 w/v). The emulsion was broken by centrifugation at 5000 rpm for five minutes and the clear supernatants were collected and used as antigen. It was titrated against imported viral antisera with unknown homologous titers. The antiserum was diluted in 0.14 M sodium chloride in 0.02 M phosphate buffer pH 7.0. Antigen and antiserum were mixed (1:1) in small serological tubes which were incubated at room temperature (32°C) for 24 hours and antigen – antibody reactions were noted. Appropriate controls were also included.

The results of serological detection in Table 1 indicated that the tissue-cultured potato was free from infection of PVX, PVS, PVA and PVY. Infected material on the other hand, reacted positively with antiserum to PVX and PVY, confirming the presence of two viruses only.

In control experiments, infection of PVY and PVX was, however, confirmed. The above studies suggest that these methods can be used for the identification of viruses, and the potato varieties can be freed from virus diseases.

Table 1. Purity tests on different potato cultivars

Antiserum	Tissue-cultured material	Infected	Healthy
PVX	–	+	–
PVS	–	–	–
PVA	–	–	–
PVY	–	+	–
Normal	–	–	–
Host serum	+	+	+

2. *Characterisation of PVY:* It has many strains which differ in symptom expression, serological relationship and other properties. Attempts were made to identify strain of PVY infecting 'Ultimus' variety. It infected *Chenopodium album, C. murale, C. amaranticolor, Nicotiana tabacum, N. glutinosa, Nicotiana* sp., and 'A-6' plants of *Solanum* sp. It did not infect *Phaseolus* sp., *Datura* and *Gomphrena.* Reactions on these host included chlorotic local lesions, severe mosaic and mottling. In tobacco it caused leaf drop streaks. Serological tests with three samples of antiserum to PVY gave positive reactions with titres ranging between 16 and 64. It was found to be a severe strain of PVY and closely resembling to PVY^N.

3. *Varietal Resistance of Potato:* Ten potato varieties were screened against PVY and PLRV under natural field conditions (Table 2).

Table 2. Reaction of potato varieties against PVY and PLRV

Variety	Infection of PVY (%)	Infection of PLRV (%)
'Ultimus'	10	15
'Multa'	15	25
'Vekaro'	2	5
'Cardinal'	10	10
'Patrones'	7	15
'Desiree'	3	10
'Kufri' Sindhuri'	2	5
'Spunta'	3	10
'Wilja'	5	15
'Diamant'	5	10
Average	6.2	12

These observations were recorded on a protracted period at different places. Incidence of PLRV was higher than PVY. No variety was free from viruses. Two varieties, 'Vekaro' and 'Kufri Sindhuri' were found to be less affected.

Sugarcane Mosaic Virus (SCMV)

1. *Occurrence and Incidence:* It is distributed throughout Pakistan with an incidence ranging between 30 and 98 percent. Symptoms are generally mild in Sind and the Punjab but very severe on varieties grown in Peshawar region. Affected plants develop clear mosaic pattern which can be easily distinguished in the young leaves. Electron micrographs have shown that the particles of SCMV are flexuous rods measuring about 750 nm.

2. *Varietal Resistance:* Twenty sugarcane varieties were screened against SCMV under natural field conditions. No variety appeared to be immune or highly resistant to SCMV. Highest disease intensity was recorded in varieties, 'PR-1000', 'BL-4', 'BL-13', 'BL-16', 'NCO-310' 'Triton', and 'Pondia'.

THRUSTS FOR NEXT YEAR

1. General surveys, collection, preservation and identification of virus diseases of crop plants of economic importance with special emphasis on those infecting potato, sugarcane, tomato and citrus.

2. Production of virus-free sugarcane setts of varieties, 'PR-1000', 'BL-4', 'Triton' and 'Pondia' by serial heat treatment and screening varieties resistant against SCMV

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Stored Grain Protection

OBJECTIVES OF RESEARCH PROGRAMME

1. To estimate the extent of quantitative and economic losses associated with physical, biological and socio-economic environments at the farm and the market locations in different agro-ecological zones of Pakistan.
2. To conduct field experiments to improve the current storage practices and to evolve new techniques to prevent storage losses at the farm and market levels.
3. To estimate grain losses in different types of government godowns, and to advise the government on future policy and programme for developing suitable storage facilities.
4. To disseminate available information and organize regular training courses for extension workers and the officials involved in grain storage.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Use of Organic Insecticides as Grain Protectants

Lindane, applied as dispensers to *mung* seeds @ 240, 160, 120, 80 and 60 ppm, was evaluated for its toxicity to pulse beetle for one year. Twenty five insects (adults, mixed sexes) were released in glass jars, each containing 250 g *mung* grains. The dispensers were prepared in April 1982 and tested upto 12 months to find out their effective persistance. Their effectiveness upto three months has already been reported.

The dispensers were most effective when placed in jars at top position. Dispensers kept at middle and bottom positions were less effective as they took longer for complete killing of the pest. The number of F_1 and F_2 adults were significantly lower than their respective controls after six months. The adults which emerged in F_1 generation in 240, 160 and 120 ppm doses at top and middle positions could not multiply normally. Therefore, their number decreased significantly in F_2 generation. This phenomenon shows that these treatments are good enough to create an insecticidal pressure under which the pulse beetle population did not progress in a normal way. However, after 12 months their effect on emergence of F_1 and F_2 generations was significantly reduced. The doses of 240 and 160 ppm only at the top position could check the insect to develop further from F_1 and F_2 generations. The rest of the doses and positions could not stop population build-up of the pest.

Thus Lindane in the form of dispenser at these dose rates when kept at the top layer of *mung* remains effective against *Callosobruchus analis* infestation for at least one year.

Effect of Ambush, Sumithion, Sumicidin and Reldane, each in concentration of 200, 100 and 40 ppm against *Trogoderma granarium, Rhizopertha dominica* and *Sithphillus oryzae* by liberating ten insects at intervals of 24 to 48 h for 192 h revealed that Sumithion was the most effective insecticide against *S. oryzae*. None of the insecticides proved effective against *T. granarium*. Mortality rate was directly proportional to the concentrations of the insecticides and decreases with the passage of time. Sumithion also proved to be the best insecticide for adults of *R. dominica* liberated at 24 h interval, giving mortality of 99.4, 94.2 and 75.1 percent with 200, 100 and 40 ppm, respectively.

Use of Local Plant Materials as Grain Protectants

Various storage practices known for their effectiveness against insect pests were studied.

In the areas around Hyderabad foodgrains are mostly stored in gunny bags and *Bharolas* in which farmers add dried *neem* leaves (*Azadirachta indica*). Sometimes fresh leaves of *neem* are rubbed against the inside walls of *Bharola* before filling grains in it.

In the districts of Nawabshah and Khairpur *Palli* is commonly used. It is made up of dried leaves of dates, woven together. Sometimes the outer side of its walls and top are plastered with mud. Besides *neem* leaves, chilli (*Capsicum frutescens* L.) dust (the left over after taking out whole chillies) is placed in between grain layers in the *Palli*.

In the lower Punjab, i.e., Rahim Yar Khan and Sadiqabad areas *Palli* made up of *Sarkanda* leaves, held together in small but long bundles forming a thick circular structure is used. The whole structure is laid on wooden planks. Before filling grains, wheat straw is packed at the base on

which extract of *neem* leaves is sprinkled. Sometimes the whole structure is treated with this extract. The top is again packed with wheat straw and plastered with mud and cowdung. The farmers who store foodgrains in bags mostly mix mercury in the grains.

In dry areas of southern Punjab, i.e., Bahawalpur and Bahawalnagar, due to low relative humidity, farmers do not give any treatment to stored foodgrains and insect infestation generally does not develop. Most of the farmers disinfest the grain by sun-drying. *Neem* leaves are rarely used.

In central Punjab, in addition to *neem* leaves farmers use two other plants, *krund* and *lana (Haloxylon multiflorum).* The fresh shoot portions of these plants are rubbed on inside walls of *Bharola* or *Kothi* before storing foodgrains. *Neem* leaves are frequently used in different ways. Some farmers mix water extract of *neem, krund* or *lana,* with mud and plaster the structure. Gunny bags are also impregnated with *neem* extract and then dried before use for storage purpose. Farmers of east Punjab, (Lahore, Kasur, Sheikhupura and Gujranwala) sometimes mix *methi* leaves *(Trigonella foenum-graecum)* with wheat or rice, especially during rainy season.

In the rice growing areas of Punjab people apply turmeric powder *(Curcuma longa)* alongwith a little amount of mustard oil and common salt to rice in general and to Basmati variety in particular for protection against insects and diseases and to improve its quality.

In *barani* areas (Jhelum and Rawalpindi) no plant material is usually used for grain preservation. However, some plants which are said to be effective against insects grow there. *Bhekar (Adhatoda vasika)* and Ipil Ipil *(Leucaena leucocephala)* and *Bhang (Canabis sativa)* are being traditionally used as protectants for foodgrains.

A survey of Azad Kashmir, Swat valley and Murree hills revealed 14 plants to possess repellence against stored grain insects. Extracts from 12 plants were obtained and tested for their repellent properties. *Acorus calamus* and *Xanthoxylum armatum* had maximum repellency against *Tribolium castaneum* the repellent contents being present in the rhizomes of *A. calamus* and in fruits of *X. armatum, Eucalyptus citriodora, Ailanthus excelsa, Chenopodium ambrosioides,* unidentified leaves (Mircholia), *Jasminum humile* and *J. officianale* have considerable repelling properties against *T. castaneum.*

Plant Extracts as Repellents

The plant materials tested were roots of *Mushkbala (Valariana officianalis)* and *Kuth (Saussurea lappa),* rhizomes of *Batchgandi (A. calamus)* and kernel of *neem (Azadirachta indica).*

Table 1 indicates that all the plants show some degree of repellency at all dose rates. The average percent repellency of all the plants mostly at higher dose rate (600 $\mu g/cm^2$) has a higher value than 40 percent. Any treatment showing more than 40 percent average repellency is a promising repellent.

Insecticidal Activity of Plant Powders

Toxicity of 21 plant materials and 3 synthetic plant products was studied in the laboratory against pulse beetle, *C. analis* on *mung.* The plant material or synthetic products were ground to a fine powder. The plant powders were mixed with clean *mung* @ 1.0, 0.5 and 0.25 percent and synthetic plant products were applied @ 0.075, 0.050 and 0.025 percent (w/w) of *mung.* Twenty five grams of treated or untreated *mung* was added to glass petri dishes alongwith ten freshly emerged adults of *C. analis.* Each experiment was replicated five times.

Insect mortality was recorded daily till 100 percent mortality was achieved in control. The promising insecticidal plant materials and synthetic plant products were further studied for their effect on emergence of F_1 and F_2 generations and the corresponding weight loss to *mung.*

One of the promising plant materials, i.e., *A. calamus* was also

Table 1. Repellency of hexane extract of various plant materials against adult red flour beetle *(Tribolium castaneum)*

Plant material	Dose ($\mu g/cm^2$)	Percent mean repellency/week				Overall average repellency
		1st week	2nd week	4th week	8th week	
Valariana officianalis (roots)	600	66.3	59.2	38.7	14.2	44.6*
	300	46.3	61.3	32.1	−17.5	30.6
	150	58.3	60.0	20.8	−15.7	21.9
Acorus calamus (rhizomes)	600	74.6	90.0	53.8	25.4	61.0*
	300	67.9	76.3	31.3	−6.3	42.3*
	150	53.3	82.5	42.9	23.7	50.6*
Saussurea lappa (roots)	600	94.6	92.5	54.2	−43.8	49.4*
	300	89.6	78.3	40.0	−19.2	47.2*
	150	86.7	66.7	1.3	−46.7	29.5
Azadirachta indica (seed kernel)	600	80.0	67.1	64.2	39.6	62.9*
	300	84.2	62.5	57.1	18.3	55.5*
	150	66.7	50.4	54.6	20.8	48.2*
Control	–	13.5	15.4	11.7	6.6	11.8

* Promising repellent treatments

studied for its action in the form of dispensers (powder or extract) and found to be the most toxic material as it caused 100 percent mortality in three days at one percent dose rate. It was also very effective at lower doses of 0.5 and 0.25 percent where it took four days. In case of control, complete mortality of the pest was achieved in 18 days. *Soya (Peucedanum graveolens)* followed and took 8, 9 and 9 days for complete kill of the pest at 1.0, 0.5 and 0.25 percent dose rates, respectively, whereas the comparable control took 13 days. The remaining ones did not indicate any appreciable toxicity when compared with their respective controls. Both *Batchgandi* and *Soya* were considered as promising insecticides against pulse beetle and were therefore selected for further detailed studies.

Table 2 indicates that both the promising insecticidal plant materials have visible effect on the emergence of F_1 and F_2 generations and corresponding weight loss in *mung*.

These studies indicated that *A. calamus* in the form of loose powder gave complete mortality of *C. analis* in three or four days at different doses in *mung* and there appeared no offsprings of the pest. However, direct mixing of this powder in *mung* may not be desirable. Therefore, the material was tested in the form of dispensers made from the powder as well as from the n-hexane extract of the powder. The treatment in the form of powder (loose) was the most effective as it took only 3, 4 and 4 days for complete death of the pest at 1.0, 0.5 and 0.25 percent dose rates, respectively, as against 18 days in control. Dispenser of extract was the next in order of effectiveness showing 100 percent mortality in 5 days at all 3 doses against 14 days in control. In case of dispenser made of powder the effect was somewhat delayed requiring 6 to 7 days for complete mortality. This difference in the effectiveness of *A. calamus* can be attributed to the differences in the availability and distribution of toxic vapours in the treated media.

Table 2. Mean progeny of ten adults (mixed sexes) of *Callosobruchus analis*

Plant material	Dose (% w/w)	No. of adults emerged		Percent weight loss	
		F_1	F_2	F_1	F_2
Acorus calamus	1.0	–	–	–	–
	0.5	–	–	–	–
	0.25	–	–	–	–
Peucedanum graveolens	1.0	–	–	–	–
	0.5	6	129	2.12	11.20
	0.25	12	253	6.56	30.82
Untreated		305	396	44.80	59.14

Table 3. Toxicity of some synthetic plant products against adults of the pulse beetle *(Callosobruchus analis)*

Plant product	Days for 100 percent mortality			
	75 ppm	50 ppm	25 ppm	Control
Camphor	2	2	2	13
Menthol	4	3	6	12
Thymol	3	3	3	12

Insecticidal Activity of Synthetic Plant Products

Toxicity of three synthetic plant products, viz., camphor, thymol and menthol against pulse beetle at different dose rates is given in Table 3.

No progeny of pulse beetle emerged in *mung* treated with camphor, menthol and thymol and thus there was no weight loss recorded. However, in control, 202 and 503 adults emerged in F_1 and F_2 generation which caused 34.4 and 54.9 percent weight losses, respectively.

Assessment of Post-harvest Losses in Wheat

Fallen ears were collected from 1m x 1m plots selected at random at various sites throughout the Punjab province.

If the area under wheat crop in the province is 4.9 million hectares, average yield is 1677.4 kg/ha and market price of wheat is Rs. 1600/t. It was seen that about 2.67 percent of the harvest is left over in the field while harvesting. The total quantity of the wheat thus lost in the province is 0.22 million tonnes which worths about 357 million rupees.

THRUSTS FOR NEXT YEAR

1. Research on the development of grain protectants involving both organic and local plant materials will continue.
2. Efforts will be made to assess post-harvest losses in major food-grains.
3. The effect of temperature, relative humidity and grain moisture content on the biology of major storage insect pests will be studied.

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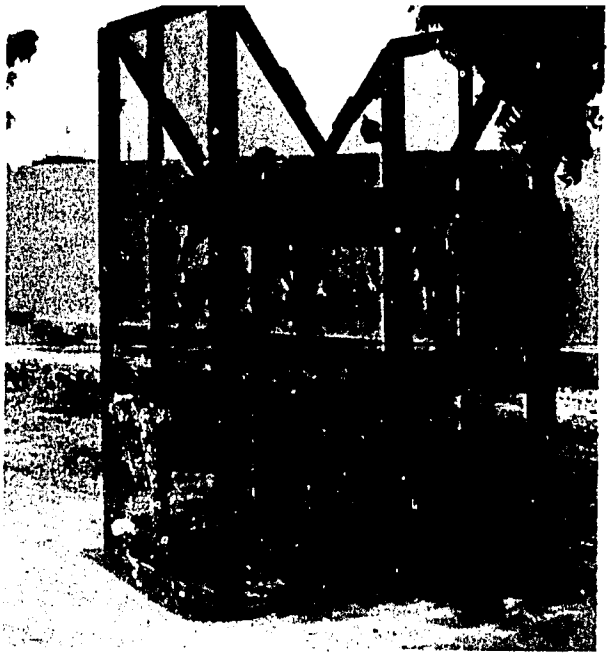

Vertebrate Pest Control

OBJECTIVES OF RESEARCH PROGRAMME

1. To identify some important ecological parameters of rodent pests and their control.
2. To screen out chemical compounds for bird pest control.
3. To investigate rodent-borne diseases in relation to human and livestock health and to develop control measures suitable for application at the small farmers level.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Screening of Avitrol, Against House Sparrow

Avitrol, also known as 4-Aminopyridine, is a bird frightening agent which affects the nervous system. They produce distress or alarm calls and the bird flocks leave the feeding area. It has been successfully used in some countries for the control of bird pests in crops such as cereals, sunflower and peanuts. Its evaluation was carried against house sparrow to find a suitable concentration where maximum alarm calls are produced. Three concentrations; 0.5, 0.75 and 1 percent were used with millet grains and given to 20 birds (with equal sex numbers) orally.

The results (Table 1) showed that the difference among the three concentrations is significant ($P<0.05$) in the time from dosing to abnormality and first call. Birds which were dosed at 0.5 percent concentration took longer duration from dosing to first call than at 0.75 and 1 percent. The number of vocal distress calls and the duration of calls were not significant ($P > 0.05$) between the three concentrations. Males produced more calls than females. The LD_{50} value was calculated as 5.9 mg/kg (4.5–7.7 mg/kg) at 95 percent confidence limits.

From these studies it can be suggested that baits prepared from Avitrol in 0.75 and 1 percent concentrations could be affective if used against house sparrow in the fields.

Assessment of Parakeet Damage to Citrus Fruits in Punjab

In Punjab many varieties of citrus fruits are widely cultivated among which sweet orange and kinno varieties are highly susceptible to bird damage. Parakeet is the major bird pest damaging these fruits. As these fruits are of high economic importance particularly in respect of exports to Middle East countries, a survey in 11 districts of Punjab was carried to assess the economic losses (Table 2).

Highest damage was recorded on the top branches of the trees (28.64 percent) while it was 5.85 and 0.34 percent on the middle and lower branches, respectively. Overall damage ranged between 0.02 and 58.39 percent per tree. The losses estimated in terms of value were 30.15 and 18.87 million rupees in local and foreign trade, respectively.

Formulation of Suitable Rat Bait

The rat baits prepared for their use in temperate areas mostly meet failure in tropical and sub-tropical climates because of less acceptance and choice for other food materials. To evaluate the acceptance and palatability of indigenous agro-based materials for their use as a bait for commensal rat control, three meals were selected viz., sunflower, corn and soybean. Initially corn meal with 20 and 30 percent protein contents was offered to *Rattus rattus* and *R. norvegicus* individually caged. Later on 1,2 and 5 percent fish meal was added to know if there was enhanced consumption.

These preliminary food intake studies revealed that there was not much difference in the intake of 20 and 30 percent corn meals. However, when 2 and 5 percent (w/w) fish meal was added the acceptability increased in both species.

Rodent Control in Rice Maximization Area

In the project area of about 800 ha two registered rodenticide baits, zinc phosphide and Racumin were provided to the farmers. The training in respect of their formulation and application was imparted to the PARC project staff and also to farmers. Before the start of rodent control operation, the damage and population index were calculated at 2.65 percent and 44.55 percent, respectively, which reduced by 80–85 percent at the end of experiments.

Chemosterilant Effect of Epibloc Against Field Rats

Epibloc or Alpha chlorohydrin is

Table 1. Response of caged house sparrows to dosing with 4-Aminopyridine (4–AP)

Treatment (percent) mg	Bird (N)	Average body weight (gm)	Amount of 4-AP received mg/kg $\bar{X} \pm SE$	Time from dosing to abnormality (min)	Time from dosing to first call $\bar{X} \pm SE$	N birds emitting vocal distress calls 0–20 (min)	21–40 (min)	41–60 (min)	60–120 (min)	Distress calls Average N	length (sec)	Deaths
(0.5)												
6	10 ♂	19.13	1.598 ± 0.076		– –	–	–	–	–	–	–	1
6	10 ♀	20.19	1.479 ± 0.020	–	– –	–	–	–	–	–	–	–
18	10 ♂	19.68	4.628 ± 0.174	35.28	60.4 ± 30.28	2	1	2	–	10	20.59	2
18	10 ♀	19.75	4.569 ± 0.088	49.50	58.0 ± 12.63	4	1	3	–	8	5.77	2
30	10 ♂	19.53	7.782 ± 0.307	28.33	36.77 ± 6.14	5	1	–	3	21	7.89	7
30	10 ♀	18.24	8.249 ± 0.16	28.20	38.8 ± 6.71	6	3	–	1	14	5.87	9
(0.75)												
6	10 ♂	19.41	2.327 ± 0.060	79.6	68.33 ± 8.76	–	2	1	–	8	2.12	2
6	10 ♀	19.83	2.271 ± 0.039	31.75	*	–	–	–	–	–	–	2
18	10 ♂	20.39	6.641 ± 0.131	29.2	38.3 ± 6.01	3	5	1	1	23	8.35	
18	10 ♀	18.98	7.129 ± 0.130	23.8	38.0 ± 3.77	6	2	1	1	8	6.06	9
30	10 ♂	19.72	11.46 ± 0.269	19.8	25.4 ± 2.03	8	2	–	–	13	5.69	10
30	10 ♀	19.60	11.497 ± 0.163	18.6	27.6 ± 2.16	9	1	–	–	18	5.19	10
(1.0)												
6	10 ♂	20.89	2.88 ± 0.071	42.9	53.5 ± 2.65	2	3	1	–	9	5.29	4
6	10 ♀	18.73	3.22 ± 0.088	32.66	47.85 ± 6.20	4	–	1	2	15	6.55	2
18	10 ♂	19.03	9.574 ± 0.368	16.4	25.3 ± 3.74	7	1	2	–	17	9.59	10
18	10 ♀	19.41	9.306 ± 0.202	23.8	34.7 ± 4.97	8	2	–	–	16	7.08	10
30	10 ♂	19.21	15.66 ± 0.298	12.4	23.7 ± 6.42	8	2	–	–	19	8.35	10
30	10 ♀	19.33	15.59 ± 0.380	12.1	19.4 ± 1.49	9	1	–	–	9	6.01	10

* Single bird displayed vocal distress calls

Table 2. Details of parakeet damage to citrus fruits in Punjab

District	Number of orchards surveyed	Total area of orchards (ha)	Area surveyed (ha)	Damage (%) Top	Middle	Lower	Cumulative
Lahore	1	8	1	7.21	1.77	0.24	9.22
Kasur	4	16	2	10.81	2.37	0.37	13.55
Okara	4	27	3	19.78	5.86	0.89	26.53
Sahiwal	7	35	4	23.48	5.09	0.25	28.82
Multan	9	36	4	30.64	7.86	0.26	38.76
Vehari	5	20	2	41.57	11.33	1.14	54.04
Jhang	4	21	2	31.34	4.34	0.49	36.17
Tobatek Singh	5	14	1.5	33.67	8.37	0.16	42.20
Faisalabad	2	14	1.5	58.39	9.17	0.17	67.73
Sargodha	10	40	10	28.60	5.28	0.02	33.90
Gujrat	3	28	3	37.99	7.10	0.34	45.43
Total:	54	259	34	323.48	68.54	4.3	396.35

a new kind of chemical compound which is toxic and sterilant against rats. This causes indirect male sterility and brings down the population to 5 percent. Studies were carried in the laboratory against soft furred field rat which is a pest on wheat and rice crops. As a first part of the study the males were offered epibloc bait for 1–5 days and then put on normal food for 5 days. The males were then autopsied, testes and epididymis were removed to record the sterility effects and it was observed that:

- Number of sperms taken from the distal end of epididymis were less than at the proximal end.
- Weight of the testes and epididymis was less as compared to the normal male rat but the treated testes were swollen.
- Lesions produced on epididymis by epibloc prevent the flow of sperms to exterior, similarly some seminiferous tubules stop functioning due to degeneration of epithelial cells.
- No mortality was recorded.

Development of *Millardia meltada* (Soft Furred Field Rat)

During the period under report post-natal development, growth of young ones was studied and standard

taxonomic measurements were taken from the day of birth, daily, upto 28 days; thereafter at weekly intervals till 20 weeks. The technique adopted for recording data on the behavioural development of the young ones was experimental rather than observational and it was revealed that this species breed throughout the year.

Ecto-and Endo-parasites of Rodents and other Vertebrates

The collection of parasites was made both from the commensal and field rats. The former being trapped from the residential areas of Karachi and were *R. rattus, R. norvegicus* and *Mus* spp. while from the fields the rats were *Bandicota bengalensis* and *Tatera indica.* As a result of these investigations many new species of ecto-parasites were discovered and identified.

Taxonomic Studies of Fleas (Siphonoptera)

The fleas of medical and veterinary importance received very little attention in Pakistan, particularly from the systematic point of view. Studies were made on the natural classification, host association, geographical distribution and their relation to man. Fleas act as intermediate host, a vector of various protozoan, bacterial, rickettsial, viral and helminth parasites to men and animals. Besides, rodents act as reservoir particularly, the gerbils in the desert areas.

The fleas which were collected from different species of rodents include five species, *Xenopsylla bantorum* (a new record), *X. cheopis, X. astia, Synosternus coleoptrae* and *Ischnopsyllus octactenus.* The hosts are *R. rattus, R. norvegicus, Meriones hurrianae, Golunda ellioti, Tatera indica, Gerbillus gleadowi* and *Suncus murinus.*

THRUSTS FOR NEXT YEAR

1. Pilot rodent control trials near Rawat, Islamabad capital territory, in groundnut crop and survey of bird pests damage to maize crop in Punjab and NWFP will be undertaken.
2. Development and evaluation of suitable indigenous agro-based materials for rat bait formulation.
3. Studies on the laboratory evaluation of Epibloc will continue.
4. Studies on the population dynamics of wild boar and development of a suitable pig trap will be carried out.
5. Studies will be made on rodent-borne diseases, the effects of poisons against rodents and birds and screening of newly developed rodenticide, Biomethelin, against field rats.
6. Imparting training in vertebrate pest control for the agricultural extension officers of the provincial governments.

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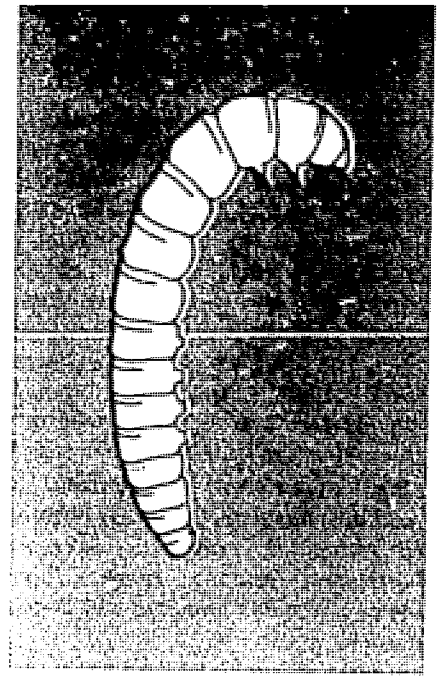

Integrated Pest Management

OBJECTIVES OF THE RESEARCH PROGRAMME

1. To determine economic thresholds for different pests.
2. To evaluate different varieties for resistance to pests.
3. To determine population dynamics of primary insect pests in sugarcane and paddy crops in the different agro-ecological areas of Pakistan.
4. To evaluate different cultural schemes for insect control.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Insects of Paddy

An attempt was made to determine economic threshold of borers on the basis of number of egg-masses per unit of earmarked area in 'IRRI-6' and 'Basmati-370' at Kala Shah Kaku. The treatment comprised one egg-mass per 5, 10, 15 and 20 $.m^2$. Only one egg-mass was found during the second week of September, to help decide the application of Furadan-3G @ 25 kg/ha. Because of insignificant attack of hoppers and borers this year, very little difference in yield was found between treated and untreated fields.

Plant spacings of 30 and 20 cm did not show significant difference in population of insects. The population of *Scirpophaga furcifera* was higher during first fortnight of September and second fortnight of October. In general it appeared that high temperature and low humidity under natural conditions put a check on the population of plant and leaf hoppers this year.

The experiments with insecticides like Hitox 6-4G, Advantage-20 EC, Elstar 50 EC, and Furadan-3G, against borers were conducted with two treatments at 25 and 50 days of transplanting. With these treatments the egg-masses were found only during second fortnight of September, however, Furadan-3G gave better results than others.

Among alternate host plants of plant and leaf hoppers *Nephotettix nigropictus* was highest in January on *Triticum vulgare* but one third on *Cynodon dactylon* plus rice stubbles in January. The population of this insect dwindled after March. However, *Cofana spectra* remained throughout the growing season upto May. It appears that out of the various alternate host plants *T. vulgare* could be preferred by *N. nigropictus.*

The population of predators was probably the lowest in March. The spiders showed highest population in January and staphylinids in February whereas coccinellids in January on *Trifolium alexandrium. T. vulgare* was harbouring the minimum number of predators in May. The population of predators on *C. dactylon, Medicago sativa* and rice stubbles was lower. These natural enemies may possibly hasten the decline in the pest population in conjunction with other environmental factors. This will amplify the role of alternate hosts.

The rice stem borers, *Tryporyza incertulas, Sesamia inferens, Chilo suppressalis* and *Scirpophaga aurifroa* appeared at Tandojam during July and reached their maximum in sweep net, larval and light trap sampling during September and October. Attack being severe on 'IRRI-6' than on other varieties.

Insects of Sugarcane

Cicaduline sp. attacked the seedling stage of crop while weeds were also in considerable number. Highest number of 14.6 leaf hoppers per leaf were recorded during June. Weeding of the field helped in checking the number of adults. After August population gradually dropped due to rains and low temperature. *Scirpophaga nivella,* top borer was observed in June for the first time and was maximum in mid-July when it infested the crop severely. The population gradually dropped due to rains and could not recover due to fall in temperature.

Stem borer infestation started in July and gradually increased to 38.5 percent in November and remained so till June.

Pre-harvest infestation of borers revealed that 'BJ-6223', 'BJ-6456', 'D-72292' and 'BJ-63108' varieties were infested 40, 33.3, 33.3 and 20 percent, respectively. 'BNS-1128', 'BNS-688' were not infested at all. Thus weeding and treatment with systemic insecticides at the seedling stage in June will help a lot to save sugarcane from leaf hoppers and borers.

To discern the varietal susceptibility, the occurrence of stem borer, top borer, pyrilla, and white fly were recorded at Mardan. It was found that none of the varieties, i.e., 'CP-44', 'CP-48' 'IM-61' 'CP-51/21' and NCO-310' was resistant. The infestation

range of stem borer was 25 to 35 percent. The population of white fly on these varieties ranged between 20 and 35 per leaf. 'NCO-310' showed the maximum infestation of stem borer and white fly.

At Tandojam (Sind) top borer, *Scirpophaga nivella,* stem borer, *Chilo infuscatellus* and root borer, *Emmalocera depressella* were found active in April. Infestation increased gradually upto 36 percent in ratoon crop and 20 percent in crop planted in August. Pyrilla appeared late in March and reached its peak population of 132 individuals per leaf in May causing 45 percent infestation to the crop. *Tetrastichus pyrillae* parasitized 58 percent eggs in August and helped in checking the population. White fly, *Aleurolobus barodensis* was found in highest density during November and December.

Insects of Grapes

Survey studies in the northern parts of Baluchistan revealed that 'Khalchini' is the only variety least damaged by grape mealy bug. 'Haitha', a late variety, is severely attacked. All the varieties are equally susceptible to powdery mildew. Chemical control trials against both the diseases at various localities gave positive response. Trials for modification of existing system of training of grapes and chemical repellents of birds showed encouraging results.

THRUSTS FOR NEXT YEAR

1. Working out of economic thresholds and integrating various control methods for borers of paddy and sugarcane will be made.
2. Population dynamics, economic losses and economics of control operations for borers, plant and leaf hoppers in rice and pyrilla in sugarcane will be studied.

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Pesticides

OBJECTIVES OF RESEARCH PROGRAMME

1. To investigate the causes of deterioration of pesticides in storage under country's conditions and to evolve methods of reconditioning the deteriorated pesticides.
2. To find out the possibility of using local diluents and carriers in the formulation of pesticides.
3. To undertake quality control of pesticides on samples of formulations referred by various public/private agencies and individuals.
4. To find new techniques for the analysis of pesticide formulations.
5. To determine the fate and residues of various pesticides commonly used in crop protection.
6. To conduct toxicological investigations using insect pests to determine species specificity, causes of resistance to pesticides and their genetic effects on selected insect and mammalian media.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Residual Effects

1. *Fruits and Vegetables:* Survey of fruits and vegetables available at the wholesale market, Karachi for organochlorine pesticide residues was conducted to assess their level of contamination. The samples were extracted for pesticides with suitable solvents, cleaned-up to remove undesirable and interfering substances and finally assayed by GLC using an electron capture (EC) detector system. Of the fruits and vegetables studied, eight have been found to contain varying amounts of different pesticides, viz., heptacholor, DDT, BHC or their metabolites.

2. *Thimet and Disyston Residues in Cotton:* Studies on the persistence and fate of Thimet and Disyston residues in foliar extracts after their granular applications to cotton crop have been completed. Pye Unicam series 204 GLC equipped with a Nickel source EC detector was employed to monitor metabolites of both the parent compounds.

Investigations indicate that both insecticides are taken up by cotton plants to reach peak level within one week of application. Significant levels of residues of both the products were available upto six weeks after initial application.

3. *Termite Control:* An experiment was designed in collaboration with PCSIR, Karachi, to study the persistence of Dieldrin when applied to sugarcane crop for termite control.

Samples of soil, sugarcane, its juice and roots, alongwith plants with leaves were collected from treated fields, drawn and screened for pesticides residues. Results indicate that Dieldrin is not translocated to the sugarcane juice although upto 0.03 ppm residues were found in sugarcane roots. The study also showed that more than 30 percent Dieldrin was available in the soil even after nine months of application.

4. *Dissipation of DDT from Paddy Field:* An experiment was designed to check whether DDT is actually translocated through plant system or its residues are deposited on plant surface following evaporation from soil surface.

Storage Stability

During the period under report, four batches comprising 220 samples of organochlorine and organophosphate insecticides stored under field conditions, were drawn from Karachi, Mirpurkhas, Multan and Peshawar and subjected to physicochemical analyses. No remarkable change in the characteristics of organochlorine compounds have been observed while increase in acidity and decrease in active ingredient were observed in samples of certain organophosphorus pesticides.

Some of the containers in which pesticides are being marketted by private firms do not appear suitable for their packaging. Comparatively, aluminium containers, though costly and not in use, were found more suitable for shelf-life.

Genotoxicity

A new unit of genetic toxicology has been created in the laboratory, which is first of its kind in the country. It is intended that initially genetic media of Mediterranean fruit fly, *(Drosophila melanogaster)* would be employed in these investigations, concentrating on few selected pesticides being used in Pakistan. For this purpose, cultures of the fly have been obtained from Institute of Toxicology

Zurich, Switzerland, (through the courtesy of Dr. Wurgler). Initial efforts were concentrated on rearing the flies on different artificial diets and protecting them against development of mould. Out of five strains of *Drosophila* obtained, four have survived and are producing progenies. The Swiss scientist is cooperating whole heartedly by providing insect cultures and relevant literature. He has been requested for a second supply of the strain of *Drosophila* which has not survived.

The stock is being maintained at constant temperature. Local strains of the fly have also been collected for comparative studies. Presently these flies are being reared on their natural diet. Efforts are in progress to rear these insects as well on artificial diet.

THRUSTS FOR NEXT YEAR

1. Studies on residual life of pesticides under Pakistan conditions and evaluation of conventional pesticides with newly introduced ones will be made.
2. Development of new analytical techniques and stabilising pesticide formulation according to our requirement.
3. Undertaking genetic toxicology of pesticides and their effect on beneficial microflora of paddy ecosystem.
4. Monitoring for resistance to pesticides in crop pests and their biomagnification in cotton ecosystem.
5. Survey of environments of Sind and Baluchistan for pollution with organochlorine insecticides.

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9.	Mr. M. Shariff Khan	Scientific Officer
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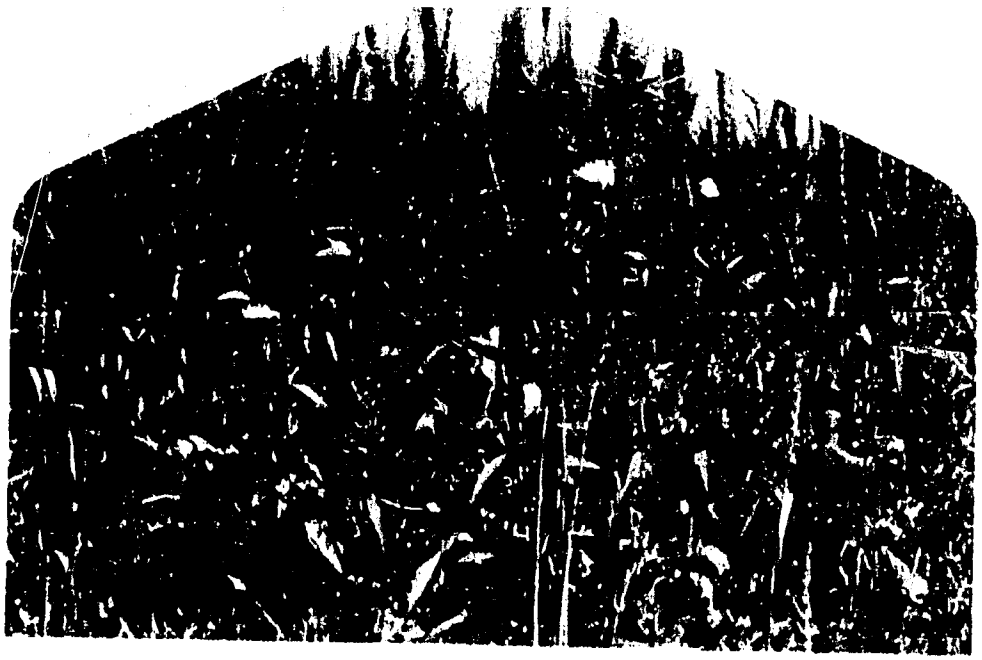

Weeds

OBJECTIVES OF RESEARCH PROGRAMME

1. To find out yield depression effect of weeds on various crops.
2. To find out economic threshold of dominant weeds.
3. To develop an integrated weed control for different crops.
4. To identify and preserve weeds for reference purposes.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Wheat

1. *Weed Spectrum and Density:* There were at least 20 and 18 weeds competing in 'Sonalika' and 'Pak-81', varieties, respectively. Usually weed density remained higher in 'Pak-81' than 'Sonalika'. Highest density was recorded during February and lowest during May (Table 1).

Though most of the weeds were similar in the two varieties, some were different. *Anagallis arvensis* was dominant in 'Sonalika' whereas *Medicago polymorpha* in 'Pak-81' *A. arvensis* was most abundant (62.8 percent) during February while *M. polymorpha* in April (66.9 percent).

2. *Yield Affected by Weeds:* Ratio of the fresh weight of wheat and weeds in 'Pak-81' was 15:1 whereas in 'Sonalika' it was 3:1. When weedy and weed free plots were compared in both the varieties there was 66 and 10 percent increase in wheat weight, respectively. The impact of weeds in 'Pak-81' was more than 'Sonalika'.

3. *Sowing Date Effect in 'Sonalika':* Weed density was higher in field that was sown in November than that sown in December. The peak of weed density in early sown 'Sonalika' reached in March and declining thereafter. While the highest density was recorded in January in late sown wheat (Table 2).

4. *Effect of Wheat Plant Densities:* Observations made in fields having different plant densities of 'Sonalika' revealed that ratio of wheat to weed plants was 1:1 and 5:1 in 75/m^2 and 130/m^2 wheat densities, respectively. The high crop plant density results in lesser weeds and more yield.

'Sonalika' sown in November, having different plant densities also showed the same trend. Approximate ratios of wheat plants and weeds for 40, 160, 225 and 275 wheat plants/m^2 were 2:1, 8:1, 10:1 and 13:1, respectively (Table 3).

5. *Effect of Weeding Time on the Yield of 'Pak-81':* Experimental studies indicated that number of spikes/m^2 was highest in plots, kept weed free throughout the growing season.

Table 1. Number of weeds ('000') per hectare in 'Sonalika' and 'Pak-81'

Month	Variety	
	'Sonalika'	'Pak-81'
January	770	715
February	1195	3145
March	674	2759
April	650	1200
May	607	585

Table 2. Weed density in 'Sonalika' sown on different dates (per m^2)

Weed	January		February		March		April	
	I	II	I	II	I	II	I	II
Fumaria parviflora	21.5	20.5	2.0	11.5	2.6	26.5	5.0	0
Circium arvensis	8.0	3.5	0	0	0	0	0	0.6
Convolvulus arvensis	9.5	15.5	4.0	0	4.3	0	0.6	0.3
Vicia sativa	31.5	28.5	0	0	0	30.0	2.6	2.3
Melilotus indica	9.5	0	0.5	14.0	0	58.0	0	0
Anagallis arvensis	0	2.0	5.5	75.0	4.3	34.6	10.3	12.3

I = Sown in December
II = Sown in November

Table 3. Weed density in different wheat plant densities

(per m^2)

Weed	Wheat plants			
	40	160	225	275
Coronopus didymus	6.3	3.0	6.0	5.0
Fumaria parviflora	3.6	5.5	8.0	0
Medicago polymorpha	5.6	12.0	9.0	7.0
Cynodon dactylon	0	0	0	9.0
Unidentified	0.6	0	0	0
Total	16.1	20.5	23.0	21.0

Spikelets/spikes were more in plots kept weed free for four months after emergence of the crop. While grains/spike were more in weed free plots. However, 1000-grain weight revealed that the best treatment was to keep weed free for three and a half months followed by that kept for four months after emergence of the crop.

6. *Chemical and Mechanical Control:* Efficacy of five herbicides (Tribunil, 2, 4–D, Dicuran–MA. Graminon and Buctril-M) were tested and compared with hand, *rumba* and *kasola* weeding.

Weed density/m^2 recorded during the growing period (Table 4) revealed that maximum effect of the chemicals was apparent during March. Hand-weeding controlled weeds only after weeding was done and increase in population occurred thereafter. Dicuran treated plots always had the lowest weed population.

The results obtained after harvest indicate that fresh weight of weeds was lowest in Graminon treated plots (62.7 kg/ha), followed by Dicuran treated plots (111.1 kg/ha). Fresh weight of wheat was highest in hand-weeded plots, followed by *rumba* weeded and 2, 4-D and Dicuran treated plots. When spikes/ha, spikelets/spike and 1000-grain weight were considered 2, 4-D appeared to be the best. However, grain weight/ha was more in hand-weeded plots (6666.6 kg/ha), followed by Buctril treated plots (6000 kg/ha).

Observations after the field was harvested indicated that summer grasses/sedges were dominant. *Cyperus rotundus* was approximately 50 percent of the total weeds, followed by *Brachiaria* sp.

Tribunil and Arelon (dispenser) followed by Banvel-P applied at post-emergence gave the excellent weed control in wheat crop.

7. *Efficacy of Herbicides on Potted Weeds:* Different herbicides were sprayed on potted weeds and observed for the number of plants that died. Results indicate that Buctril–M, efficiently controls *Fumaria parviflora, Asphodelus tenuifolius* and *Centaurea* sp.; Graminon, controls *F. parviflora, P. minor, Melilotus indica* and *Euphorbia helioscopia;* Dicuran, controls *F. parviflora* and *E. helioscopia;* Tribunil, controls *E. helioscopia* and *Centaurea* sp.; 2, 4–D controls *F. parviflora* and *Centaurea* sp. and Galex, controls *E. helioscopia.*

Sugarcane

1. *Planting Time Affects Weeds:* Sugarcane planted during spring had a higher weed density as compared to that planted in autumn. The ratio of total weed density/m^2 in spring and autumn plantings was 4:1, 3:1, 1:1, 1:1, 2:1 and 4:1 from July through December, respectively.

2. *Weed Flora in Different Varieties:* Weeds recorded from the rows of different varieties revealed that 'L-75-19' had a highest number of weeds followed by 'L-75-33', 'L-75-20', 'L-75-40' and 'Iran'. The lowest number was in 'CP-75-328' and 'Triton'. *Brachiaria* sp. and *Echinochloa* sp. were the dominant weeds.

In Sind, varieties, 'L-54', 'L-119', 'CO-321', 'L-116', 'BL-4', 'L-113', 'PR-1000', 'CO-672', 'NCO-310' and 'BL-19' were highly populated with *Cynodon dactylon* except 'L-116' and 'BL-4' having highest density (average 30 plants/m^2) in 'L-54', Second in density was *Cyperus rotundus* (average 16 plants/m^2) in 'L-54', 'L-119' and 'PR-1000'. *Convolvulus arvensis* and *Euphorbia helioscopia* were very scarce in all the varieties.

A survey of sugarcane varieties, viz., 'CP-44', 'CP-48', 'IM-61', 'CP-51/21' and 'NCO-310' at Mardan revealed that out of 19 weeds, *M. sativa* and *Trianthema monogyna* had high densities.

Intercropping sugarcane with onion and *teenda* lowers the weed density to 10:1 as against 14:1 with clover and 30:1 alone.

At NARC studies on 22 varieties showed that from January to April the serious weed was *Anagallis arvensis* from May through August, *Echinochloa* spp., and in June only *Cyperus rotundus.*

3. *Efficacy of Herbicides:* Herbicides used were Sencor 70WP and Diuron 80WP separately, and together. The results indicate that at the time of harvest total weed control was highest in Sencor + Diuron treated plots. However, considering the control of broad-leaved and grasses/sedges weeds separately, 94.7 and 100 percent control was obtained by Diuron treated and hand-weeded plots, respectively.

Table 4, Weed density in different treatments and periods

(per m^2)

Treatment	Month			
	February	March	April	May
Weed control	12.0	12.2	13.0	7.9
Hand-weeding.	3.5	9.5	9.8	5.6
Tribunil	9.0	7.5	9.6	7.2
2, 4–D	7.0	4.2	16.4	9.4
Dicuran-MA	10.0	0.3	1.4	3.2
Graminon	14.0	0.9	1.6	8.3
Buctril-M	20.5	5.2	5.9	8.2
Kasola weeding	8.0	2.2	3.1	6.9
Rumba weeding	7.5	5.8	1.9	8.4

The length of sugarcane plants was highest in Sencor and Diuron sprayed plots (3.7m) and weight/plant was more in Sencor treated plots (2.6 kg).

Rice

1. *Weed Flora in Different Varieties:* 'Basmati-6141' had the highest number of different species. *Cynodon dactylon* was dominant being present in 22 out of 24 rice varieties. The ratio of weeds to rice plants in 'Basmati-4001' was 1:3 while in 'IRRI-6' it was 1:1.

Echinochloa spp. were dominant in July, *Cyperus rotundus* and *Fimbristylus dichotoma* in August and *Sphenochlea zylanica* in September. Total weed density/m^2 during these three months was in the ratio 1:4:9.

2. *Control of Weeds:* Application of pre-emergence weedicides, Aviroson @ 27.17 kg/ha and Saturn @ 3.36 l/ha, five days after transplantation of 'Basmati-370' and a post-emergence weedicides 'DMA-6 @ 2 l/ha, two months after transplanting at Kala Shah Kaku, controlled most of the weeds. Aviroson, Saturn and DMA-6 gave 29.5, 26.2 and 12 precent increase in paddy yields, respectively.

Highest density of weeds was of *Ipomea acquatica* (average 11.6 plants/m^2 followed by *Cyperus rotundus* (average 4 plants/m^2. Application of herbicides, Machete and Herbit, respectively, enhanced the grain yield from 27.2 to 40.5 in Naudero and from 26.9 to 38.6 in Tandojam while mechanical control enhanced the yield by 50 percent on average.

Brassica

There was a high weed density being 206–228/m^2. *Poa annua* was dominant in January being 208/m^2

Peas

Total weed density was 121/m^2. *Malva* sp., *Anagallis arvensis* and *Polygonum plebejum* were the dominant species having 26, 23 and 22/m^2 density, respectively.

Maize

Mainly grasses were present. Total weed density was 22.6/m^2. *Cyperus rotundus* was dominant, being 91.1 percent. *Sorghum halepense* (1.6/m^2), *Digera arvensis* (1.0/m^2) and *Brachiaria* sp. (0.6/m^2) were some of the other weeds present. Ratio of weeds to maize plants was 4:1 and that of broad-leaved to grasses was 1:4.

Insects Associated with Weeds

Insect enemies recorded included a curculionid, *Baris scolopacea* and a momphid, *Mompha* sp. from *Chenopodium* spp., curculionids, *Elasmobaris balassogloi, Leptomias* sp., *Macrotarrhus* sp. *M. altaicus,* and aphid, *Apis (Perganosida)* sp. thrips. *Thrips* sp., *T. carthami, Aeolothrips* sp. buprested, *Sphenoptera* sp. and cicadellid, *Agallia robusta* from *Kochia* spp. and a coleophorid, *Coleophora caliacrealla* and a curculionid, *Bulaea lachatschovi* on *Atriplex* spp.

Biology and host specificity of *Baris scolopacea, Mompha* sp., *Hayhurstia atriplicis, Xerobion eriosomatinum* and *Coleophora caliacrealla* were studied. Of these *Mompha* sp. and *H. eriosomatinum* appeared specific to *Chenopodium* spp. *X. eriosomatinum* to *Atriplex* spp.

Aphid attack was recorded on *Vicia sativa, Malva neglecta, Rumex dentatus* and *Cepsella bursa-pectoris.* Adult noctuids were observed feeding on Medicago flowers. Lace wings and *Apis florea* were also present in large numbers.

Diseases Associated with Weeds

Loose smut *(Ustilago cynodontis)* was recorded from *Cynodon dactylon* in sugarcane fields. Rust-*Melampsora* sp. *euphorbii* was recorded from *Euphorbia helioscopia* and *Cercospora* sp. from *Rumex dentatus.*

Losses Due to Weed

In a field experiment at NARC, Islamabad *Chenopodium* reduced green weight of wheat by 52.7 percent when *Chenopodium* and wheat plants ratio was 1:4. *Trioza chenopodii* when released @ 2 pairs per plant reduced green weight of *C. album* by 69.2 percent while the green weight of wheat increased by 48.7 percent.

THRUSTS FOR NEXT YEAR

1. Evaluation of different cropping patterns and cultural practices for weed control.
2. Determination of efficacy of new weedicides.
3. Developing long term crop rotation experiments for the control of weeds and providing recommendations and services for herbicidal control.

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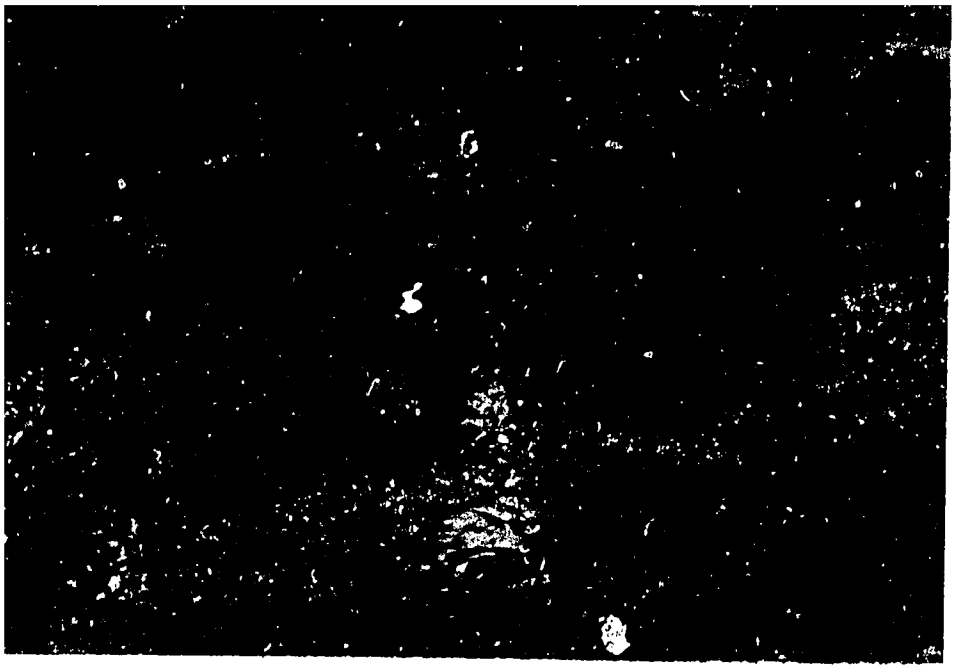
Part II

Natural Resources

Technical



Fodder and Forage Crops

OBJECTIVES OF RESEARCH PROGRAMME

1. To collect and introduce superior exotic and indigenous fodder and forage crop species/varieties and their screening and selection.
2. To conduct agronomic and other cultural experiments for evaluation of high fodder yielding multicut, nutritious and disease and insect resistant varieties of fodder crops.
3. To undertake biochemical analysis and digestibility trials on different fodders and forages.
4. To undertake breeding and hybridization of fodder crops to produce nutritive and high yielding varieties.
5. To demonstrate improved fodder varieties on farmers' fields.
6. To carry out seed multiplication of selected, improved fodder and forage crop varieties and their distribution.
7. To develop and apply suitable improvement practices for pasture development.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Berseem *(Trifolium alexandrinum)*

Variety, '4/11', has been selected and recommended for cultivation in the Punjab and Sind provinces. New berseem selection, viz., 'Synthetic I/79' and 'L-64+13' have also shown good performance in fodder production. Fertilizer dose of 20-90-0 kg/ha NPK is most suitable for these varieties. Variety, 'Multifoliate' has been recommended for NWFP.

Lucern *(Medicago sativa)*

Varieties, 'Synthetic' and 'Snora' are recommended for the Punjab and Sind provinces. 'Mesasirsa' has given better performance in the uplands of Baluchistan. Varieties, 'Mesasirsa' and 'Kandhari' are highly desirable for green fodder production in Baluchistan where 50-100-50 kg/ha NPK was found most suitable. However, at Sargodha 60-150-0 kg/ha NPK gave highest forage yield. At Tarnab, variety, 'Punjab Selection' gave the highest fodder production.

Cowpeas *(Vigna unguiculata)*

An exotic variety, 'P-518' from Australia out-yielded all the other varieties in forage yield trials conducted at different research stations and on farmers' fields. This variety is recommended for the Punjab area, while for Sind 'Barsati', 'Dofasly' and local varieties have been found better for forage production.

Sorghum *(Sorghum bicolor)* :

Varieties, 'Hegari', 'No. 94', 'No. 132' and 'No. 1' were found high forage yielding in the Punjab. 'Turi', 'Achokartuho' gave better performance in Sind. 'Baghdar' was selected for Baluchistan and in NWFP variety, 'Atlas' gave highest green fodder yield of 20 t/ha. Studies at University of Agriculture, Faisalabad showed that forage yield of 'Sadabahar' was significantly higher than local variety and its protein content is also five times that of other available varieties. Yield depression occurred from F_1 to F_2 was only 4 percent whereas in F_3 it was upto 43 percent. Sweet sorghum, Sudan grass hybrid, viz, 'RLAx S.G. Sweet' and 'RLA x S.G. 523' developed at Sargodha gave better performance giving green fodder yield of 155.62–170.68 t/ha for 4 cuttings.

Varieties, 'Avon', 'PD-2-LV-65' and 'Sargodha-81' were recommended for Punjab. 'Fulgrain' and 'Algerian' varieties gave better performance in Sind and Baluchistan. 'Avon', 'Swan' and 'DN-8' were better for NWFP. 'Sargodha-81' and 'PD-2-LV-65' gave the highest yield under dryland conditions at NARC.

Millets *(Pennisetum typhoides)*

Varieties, 'Synthetic', 'DG-Bajra' and '18-BY' were selected for Punjab. In Sind, 'No. 347' performed better and 'DB-2' was selected for NWFP. 'Giant Bajra' proved to be highly desirable for green fodder production in the irrigated plains of Baluchistan.

Barley *(Hordeum vulgare)*

Varieties, 'Min-126', and local were found good for uplands of Baluchistan. In Sind, 'TA-17' and 'Arid-8' performed better and were selected for fodder production.

Elephant Grass *(Pennisetum purpureum)*

Variety, 'A-146' introduced at NARC gave forage yield of 50 t/ha under dryland conditions, however, intercropping of *P. purpureum* with

annual legumes increased green fodder yield by 10 t/ha. This variety has been recommended for large scale pasture establishments in the dryland areas of Potwar sub-tract.

Buffel Grass *(Cenchrus ciliaris)*

Package of technology has been developed for seeding buffel grass under dryland conditions in Thal and Tharparkar and Potwar rangelands. Dry matter yield of 4.8 t/ha has been recorded at NARC.

Blue Panic *(Panicum antidotale)*

It is very nutritious forage grass with a dry matter yield of 5.5 t/ha under dryland conditions. The grass is recommended for Potwar tract and sub-tropical, sub-humid ecological zones. *Chloris gayana, Digitaria decumbens, Eragrostis curvula, Chrysopogon aucheri* and *P. maximum* have been selected for large scale seeding in the dryland areas after several years of introduction trials at NARC.

Annual Medics

Seventy five Australian varieties were introduced at NARC, of which variety, 'Jemalong', 'Herbinger' 'Barrel' and 'Snail' gave better performance and are being introduced at other ecological zones also.

Pastures

The pastures have been established on 5 ha at NARC with the improved varieties of *Cenchrus ciliaris, Panicum antidotale, Pennisetum purpureum,* and *Chloris gayana* for developing a package of technology. The pasture will also be used for large scale seed multiplication. Ten hectare area has been sown with *C. ciliaris* at Dhabeji for seed multiplication and different grasses and legumes have been sown at Jamrud over 10 ha for conducting various range improvement practices.

Moreover, grass legume nurseries have been maintained at all the cooperating units where exotic and indigenous species are introduced and selected for large scale seed multiplication.

Vicia sativa

It gave forage dry matter yield of 4 t/ha at Jaba Sheep Farm and is recommended for dryland winter cropping. Various sowing and planting technique trials at Thal indicated that tuft planting after removing existing vegetation during rain was the most successful method. Buffel grass sown in mixture with Karera grass gave better performance than single stand. Double disc-ploughing followed by broadcasting of buffel grass at the seed rate of 3 kg/ha was most suitable sowing method.

Spineless Prickly Pears

Fodder cactus from Tunisia at Dhabeji gave good performance. It is successfully propagated over 2 ha under dryland conditions.. *Atriplex canesens* have been grown over 0.5 ha at Mastung and 1000 kg seeds were procured. Plants of various winter grasses and legumes are being introduced at Mastung to study their performance.

Guar (Cyamopsis tetragonoloba)

As a result of selection and testing at AARI, Faisalabad an exotic variety, 'Mills' has been introduced. Substantial quantity of the seed of forage crops were collected at all cooperative institutions.

Out-reach Programme

It has successfully been carried out in Islamabad district, the Punjab and Sind provinces. Seeds of improved varieties were distributed to the farmers. Substantial quantities were reseeded at Livestock Production Research Institute, Bahadarnagar, Okara. AARI, Faisalabad provided seeds of berseem and 'Sadabahar' to Punjab Seed Corporation for large scale seed multiplication.

THRUSTS FOR NEXT YEAR

1. Carry out uniform national yield trials by including the varieties tested and selected at various institutes starting with *kharif* fodder crops under irrigated and *barani* conditions separately.
2. Establishment of demonstration-cum-seed multiplication plots at farmers' fields to test the technology under farmers' conditions.
3. Carry out crop rotation trials to see how the fodder and other crops fit into the farming system.
4. Studies on hay and silage making and preservation of fodder.
5. Studies on requirements of irrigation water for fodder crops.
6. Arrange parent lines of existing high yielding hybrid crops like 'Sada bahar' to produce hybrid seed in sufficient quantity.
7. Seed multiplication of improved and tested varieties of fodder crops, grasses and legumes at government and experimental farms.
8. Reseeding techniques for various ecological regions.
9. Emphasis on nutritive quality of forage and fodder species by biochemical analyses and digestion trials.
10. Plan introduction, testing and selection of fodder shrubs and trees on a wider scale.

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Forestry and Range Management

OBJECTIVES OF RESEARCH PROGRAMME

1. To introduce, test, select and propagate fast growing forest species of industrial value by producing genetically superior planting stock and quality seeds.
2. To improve management of the forests through cultural practices and controlling forest pests and diseases.
3. To preserve and manage important wildlife species.
4. To increase production of rangelands and get maximum livestock production through planned grazing.
5. To study genetic improvement and breeding of poplars.
6. To test and identify species and develop techniques for utilizing arid and semi-arid areas.
7. To utilize poor quality woods for the manufacture of panel products.
8. To determine physical and mechanical properties of important timber species.
9. To study the effects of tree rows on the yield of agricultural crops in the major crop production tracts of the country.
10. To assess farm energy requirements and reduce farmers' dependence on commercial energy sources using appropriate alternate technologies in a coordinated system.
11. To undertake eco-physiological studies for degradation of vegetation in scrub areas.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Tree Improvement

About 0.21 million plants of important tree species raised from genetically superior selected parent stock were distributed for field planting in the provinces. About 2700 candidate trees of various conifers and broad-leaved species were selected for various ecological zones, of which nine were established for genetic improvement. A total of 1243 kg seed of various species was collected and distributed to field officers.

Out of 46 coniferous species and their seed sources none of the exotic pines performed better than *Pinus roxburghii* in sub-tropical regions. While, in the temperate region *P. pseudostrobus* has been found to be the most promising.

Provenance trials and progeny test-cum-seed orchards of *Dalbergia sissoo. Eucalyptus camaldulensis, E. tereticornis, E. grandis* and *E. europhylla* were established.

Results of four-year old experiment at Peshawar indicate that annual wood production per hectare under irrigated conditions is upto 30.2 m^3 in *E. tereticornis,* 27.4 m^3 in *E. grandis* and 25.8 m^3 in *Leucaena leucocephala.*

To determine methods of vegetative reproduction of ornamental species about 25000 cuttings of 82 ornamental species were planted.

Poplar Nurseries

It is recommended that seeds of *Populus ciliata* and *P. euphratica* should be collected in July and August and sown either in flat beds or in *kundas* (flat earthern pots) in pure sand and seedlings of *P. ciliata* may be transplanted in polythene tubes when 2–3 weeks old but direct field planting of *P. euphratica* seedlings gives good results. The seeds of *Populus* species loose their viability in a couple of days. Therefore, sowing should be accomplished soon after seed collection which may result in 90 percent germination.

Forest Management

To find out the optimum spacing for poplars for various and uses the experiment was laid out in Changa Manga. One year old nursery grown stock of *P. euramericana* 'CV-I-214' was planted at 1.8m x 1.8m, 2.4m x 2.4m, 3.0m x 3.0m, 3.6m x 3.6m, 4.3m x 4.3m, 4.9m x 4.9m and 5.5m x 5.5 m spacing in 49 plots. It has been established that if the poplar plantations are desired to be worked on a six year rotation 1.8m x 1.8m spacing gives the maximum volume of wood (136 m^3/ha), followed by 2.4m x 2.4m spacing (134 m^3/ha). Least volume (50 m^3/ha) was given by 5.5m x 5.5m spacing.

Water Requirements

In experiments, laid out at Chichawatni and Sarhad plantations, to find out the optimum delta required for irrigation, it was found that the optimum delta for various species is as follows:

Species	Delta (m)	Yield (m^3)
Salmalia malabarica	1.37	67.57
Eucalyptus camaldulensis	1.82	45.91
Hybrid poplar	1.82	39.82
Morus alba	1.37	17.90

Effect of Fertilizer

Twenty six experiments on 12 tree species, viz., *D. sissoo, E. camaldulensis, Juglans regia, Cedrus deodara, Pinus roxburghii, P. wallichiana, Acacia arabica, Morus alba, Quercus dilatata, Aesculus indica, Bauhinia variegata* and Hybrid poplar were maintained at 20 different locations throughout the country.

Results revealed that in *M. alba* application of 200 N kg/ha increases the foliage yield by 85 percent as compared to control. In case of *A. arabica* application of NP results in 10 percent more diameter growth at breast height as compared to control resulting in 23 percent increase in volume.

Arid Zone Afforestation

Experiments to find out afforestation, planting and sowing techniques, survival and rate of growth of different tree species under dry conditions and on rain water harvesting have been laid out at Rakh Dagar Kotli (Thal), Babbarbandh (Sind), Jamrud and Kotal.

The following species have been found suitable for arid and semi-arid parts of the country.

Acacia aneura, A. modesta, A. tortilis, A. victoriae, Prosopis cineraria, Tecoma undulata, Ziziphus mauritiana, Dalbergia sissoo, Eucalyptus camaldulensis, E. citriodora, E. grandis, Atriplex canescens, Ephedra nebrodensis, Cenclrus ciliaris, C. setigerus and *Panicum antidotale.*

Interdunal flats have proved the best site for planting, followed by dune tops while dune slopes are the poorest for the establishment of tree species. For the establishment and growth of plants plastic apron mulch has proved to be the best moisture conservation technique.

Mud plaster (wheat and husk) has been found to be the best and cheapest material for rain water harvesting. The average height gained by *E. camaldulensis* and *A. modesta* was 99 and 76 cm and survival 93 and 80 percent in mud plaster and 86 and 76 cm, and 100 and 93 percent in mechanical stabilization, respectively.

Wildlife Management

The birds population of Haleji, Khinjer, Manchar, Chuch, Hadero, Garro, Serani lakes and Marshy areas of Drigh Dhand, Kanadhani Dhand, Luka Forest, Sonda Forest and natural forest divisions of Sind was studied. In all, 124 species of birds have been studied and detailed biology of 79 species has been described. Community and habitat stratification of birds in the wetlands of the province has also been studied. The distribution and concentration of birds in various districts especially in relation to vegetation type has been investigated.

Vegetation mapping of Margalla hills has been done at a scale of 1:30000 and vegetation delineated into five communities. To determine the population status of various birds and animals in Margalla Hills, Bannigala and Rawal Lake survey has been conducted. Forty two avian and eight mammalian species have been described with relation to their vegetation types, habitat and number.

Forest Pests

1. *Mistletoes:* The forest areas of Mirpur and Dir Forest Divisions were surveyed to study the incidence infestation, abundance of inoculum and host range of the parasites attacking different tree species. The infestation was recorded in 14 forest compartments covering an area of about 20558 hectares.

The average incidence of attack on blue pine was 62.9 percent. The infection rating was 2.7 and the frequency of the parasite was related to the diameter of the trees. The warmer faces were more favourable for the development of the parasite. Similarly, older trees were more susceptible to the attack of the parasite. The general effects of the parasite include dieback, reduced vigour and sparse foliage of the attacked plants.

2. *Natural Enemies of Poplar Borers:* Collection of infested billets was made from Peshawar, Islamabad and Parachinar to recover their parasities, predators and diseases. The following natural enemies have been recorded and are being studied for use against these pests to develop biological methods of control:

- *Alaus* spp., and elaterid predator of the larvae of *Apriona cinerea* and *Aeolesthes sarta.*
- Pathogenic fungus *Beauveria bassiana* attacking the larvae of *Indarbela quadrinotata.*
- Mite, *Proctotaelaps* spp., attacking the larvae of *Apriona cinerea* and *Aeolesthes sarta.*
- Hymenopterous parasites on various stages of poplar borers.
- Nematode, probably *Neoaplactana* group attacking the larvae of *Apriona cinerea.*

Shelterbelts – Farm Forestry

Studies were undertaken at Mirpurkhas (irrigated) and Babbarbandh (arid zone–unirrigated) to find out the effects of shelterbelts on crops. Shelterbelts running from north to south have been planted over 66 ha. About 10000 plants of *E. camaldulensis* planted at five shelterbelts in 1980 at Mirpurkhas have given 100 percent survival and have grown to average height of 7–10m. The quantity of wood available in November, 1982 from these belts was estimated to be 822 m^3. Starting with an initial growth of 72 m recorded in April, 1981 an increase of 198, 296, 256 m^3 was observed at an interval of every six months.

It has been found that tree windbreaks are comparatively non-functional during winter and highly functinal during summer.

The work started on experimental scale at Peshawar and Mirpurkhas, has attracted the attention of the farmers and the agro-forestry programme has received a big boost. The trees being grown by the farmers, will bridge the gap between demand and supply of wood in the country as well as improve the economic lot of the farmers.

Experiments to study the effect of shade of trees on agricultural crops and to identify suitable species that can grow in conjunction with agricultural crops have been laid out at Daphar, Mastung, Hyderabad and NARC.

Nitrogen Fixing Trees

The importance of actinorhizal

plants and recommendations for the cultivation of species of *Alnus, Casuarina, Coriaria* and *Elaeagnus* in various ecosystems of the country have already been made. The successful isolation of the *Frankia* endophyte from *Alnus nitida* nodules opens up the ways for the manipulation of this symbiosis (like rhizobium – legume symbiosis) for greater nitrogen fixation, growth and yields.

Range Management

Studies have revealed that 50 percent over-storey cover yields maximum forage production of 181 kg/ha of desirable species followed by 25 and 75 percent cover yielding 139 and 103 kg/ha of desirable species, respectively.

Results obtained from the study on optimum level of utilization of vegetation indicate that maximum production of air dry forage (1069 kg/ha) is obtained by 50 percent utilization followed by 1007 kg/ha for 60 and 70 percent utilization. *Olea cuspidata, Acacia modesta, A. aneura* and *Ceratonia siliqua* are promising species of fodder value in the scrub zone.

About five hectares of land has been reseeded with improved and promising grass species including. *Panicum antidotale, Cenchrus ciliaris, Pennisetum purpureum, Digitaria decumbens* and Bajra Hapier Hybrid grass. Among all these grasses, *C. ciliaris* is the most adapted species, yielding an air dry forage of 2697 kg/ha.

Ten thousand plants of *Leucaena leucocephala* have been planted to improve the productivity of the range, yielding 413 kg/ha green forage and 549 kg/ha fresh wood in 1½ years. However , the average forage production of native grasses has shown a 16 percent increase.

Social Survey

A detailed social survey of village population was conducted. A total of 682 persons of 93 families from eight villages were surveyed. Level of literacy was 22 percent and average income of a family was Rs. 2585/month while average expenditure was Rs. 1129. The total number of livestock in and around the range was 838. Out of these 8.33 percent were buffaloes, 38.58 percent cows, 1 percent sheep, 35 percent goats, 14 percent oxen and 4 percent assess. The cropping pattern of the population in *kharif* season is that 30 percent area is under grain legumes and 70 percent under coarse cereals. During the *rabi* season 92 percent of the cultivated area is under cereals and 8 percent under oilseed crops.

THRUSTS FOR NEXT YEAR

1. Classification of public and private rangelands according to their condition and trend.
2. Integrated range resource surveys and analyses and determine their grazing potential.
3. Introduction of scientific grazing management and testing of grazing systems with different kinds of range livestock to maximise sustained production of forage, livestock and their products.
4. Introduction, testing, selection and propagation of fast growing forest species of industrial value in various ecological regions.
5. Finding fast growing tree species for chipboard, plywood manufacture, pulp and paper making, and in other industries.
6. Developing the agro-forestry systems for raising trees in conjunction with crops and selecting suitable trees for growing in farms and shelterbelts.
7. Increasing the production of minor forest produce like resin and medicinal plants.
8. Utilizing the poor quality woods for manufacture of panel products.
9. Pest management, pest forecast and critical population studies.
10. Investigations on honey-bees and their management.
11. Devising management plan for the conservation and propagation of wildlife species.
12. Developing sericulture on scientific lines as cottage industry.

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Land and Water Management

OBJECTIVES OF RESEARCH PROGRAMME

1. To estimate runoff and soil losses from *barani* lands and develop and evaluate methods for cultivation and land forming to improve the rain moisture conservation and management.
2. To develop simplified methods for measurement of irrigation water for different crops and estimate soil moisture status for proper irrigation.
3. To classify and develop map for different soils of Pakistan on the basis of total/available micronutrient status.
4. To formulate guidelines regarding the production of various crops based on the experimental results achieved and replenishment of trace elements for stabilising increased crop production in the deficient areas.
5. To design and install high efficiency low-cost irrigation system viz., sprinkler and trickle.
6. To develop the plan for strengthening/establishing of agro-meteorological stations and provide reliable data for agricultural purposes under different climatic regions.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Water Management and Conservation

The studies were conducted in the farmers' fields (100 km) around Islamabad to estimate the runoff and soil losses from agricultural lands. The results indicated that the runoff in the high rainfall areas ranges between 50 and 60 percent of the total rainfall, whereas, the soil losses range from 2 to 3 t/ha annually.

Maize, soybean and sorghum crops were sown during *kharif* 1982 but unfortunately the season remained dry abnormally. Consequently, the crops failed to give the desired results. Water being the main constraint in *barani* areas, the unevenly distributed rainfall amounting to 426 mm during the season could not fulfil the water requirements of the crops.

The results also revealed that the average grain yields upto 4.5 t/ha of wheat and maize, can be obtained under 200 percent cropping intensity. The studies were also conducted to evaluate the effect of deep tillage on moisture conservation and utilization. Further deep tillage to 45 cm increased the moisture conservation and utilization alongwith 10–25 percent increase in crop yields.

Water Measurement and Control System

At NARC the newly earmarked area for the Directorate of Land and Water Resources have been surveyed and topographic maps have been prepared. The water measuring devices such as flumes, notches and weirs have been developed and fabricated through local manufacturers. The development of electrical resistance blocks for the measurement of soil moisture contents is in progress.

The construction work of water courses and installation of water control structures at other three co-operating institutions namely, CCRI, Pirsabak AZRSs, D. I. Khan; and RRI, Kala Shah Kaku, is near completion.

Techno-economic Studies for Optimizing Land Use Under Gully Eroded Lands

A site was selected at Mangial (Fatehjang). The boundary was marked and the map was prepared using plain table techniques. One gully was selected to develop the optimum land use aspects using management of rain water under different land shapping techniques. Before land development operations, soil survey was carried out. The area under this gully is about 3.02 ha. The detailed topographic maps of the area were developed and contour lines drawn. Moreover, the designing for various land shapping techniques was made, taking into consideration the economics of land development.

The area under second gully was not suitable for crop production. Therefore, it was developed for afforestation and range management. The area in between these two gullies was already under cultivation. The area developed under different land shapping techniques and land use alongwith development cost is given in Table 1.

Estimation and Monitoring of Surface Runoff and Soil Losses from Gully Eroded Lands

The gully area which was not suitable for crop production was divided into six dependent sub

Table 1. Gullied eroded area under specific use

Specification of area	Area (ha)	Total cost (Rs.)	Cost (Rs./ha)
Area improved for crop production	2.475	1450	585.85
Area developed for crop production	1.062	2170	2043.31
Area developed under R.S. Terraces	0.193	1300	6735.00
Conservation catchment area	0.250	255	1020.00
Area developed for grasses	0.511	540	1056.00
Area developed under eyebrow terraces	1.872	3458	1847.22
Area under grassed water way	0.049 (275 running metre)	2800	10.18/m
Area under gully bed	0.220	–	–
Area under pond/ reservoir	0.018	2700	–
Total	6.65		

catchments. The catchment area contributing the runoff in each case have been staked, measured and mapped. For the measurement of runoff 'H' type flumes have been designed and fabricated through local manufacturers. These have been installed at the runoff concentration points. To measure the rainfall, one non-recording rain gauge has been installed in each sub-catchment and stakes were installed at a distance of 7m x 7m to estimate soil losses. Different plant species were planted in catchments (Table 2). The detailed topographic survey of each such catchment was done to know the configuration of the catchment area.

Table 2. Plant species in different catchments

Area (ha)	No. of plants	Plant species
0.200	412	Eucalyptus
0.175	Control	--
0.106	175	Alianthus
0.058	150	Mulbery
0.171	349	Leucaena
0.167	300	Vitex

Development of Conservation Structures

Conservation structures of different designs were made using different construction material. The designs were drop structure, step drop structure and pipe structure. The construction material included stones, bricks, sand, cement and RCC pipes. The expenditure on the RCC pipe structure is minimum.

The area developed for crop production was sown under maize, and soybean but the crop stand was not so good due to new developments. The wheat crop was planted during *rabi* season. The crop conditions were very good, it has been harvested and data are being processed.

Micronutrient Status of Soils

Soil samples collection was started in the respective areas of the three cooperating units, i.e., PARC, NIAB, and NWFP Agriculture University, Peshawar. Two hundred and forty two samples were collected from different soil series in the district of Islamabad and Rawalpindi only.

Micronutrient status maps have been prepared showing the adequate, low or excess status of zinc, copper, manganese, iron, boron and molybdenum, based on the previous work done at different locations in Pakistan, supported by the analytical data of FAO bulletin No. 48 on micronutrients. The results provide enough guidance to streamline research work on different crops and establish their micronutrient requirements in different areas.

At NIAB, 800 soil samples have been collected from different soil series in the district of Sheikhupura and Faisalabad and prepared for physicochemical and micronutrient analysis.

Development of Low Cost High Efficiency Irrigation System

The work is in progress taking into consideration the development of flow and pressure regulating procedures through various types of tubing, land slope and layout of orchards.

A survey was conducted during August, 1982 to find out the available types of synthetic and rubber tubings in the local market. Based on the available materials in the market the low pressure nylon, high pressure nylon, rubber, and double line rubber and canvas tubings were selected for testing.

In the market the nylon tubing is available in different sizes ranging between 0.16 and 3.81 cm. However, there are certain tubes which are not available in smaller sizes.

The connections were designed and the patterns were developed for Tee, Cross, Elbows and Joints. In the beginning these materials were casted with aluminium. However, after the field test these connections can be developed using hard plastic or PVC materials to reduce the cost. This can only be done after finalising the design of the proto-type connections.

The studies are in progress in order to develop data-base regarding discharge, friction losses and working of various components on a lateral line of 60 m. The area for the installation of a small scale trickle system for 0.1 and 0.2 ha is under developmental stages.

The survey work for the fruit orchard at AZRI, Quetta is in progress to develop the trickle system for fruit orchards.

Agro-meteorological Stations

The project is aimed to develop agro-met stations under different agro-ecological zones and to develop capabilities for the collection, analysis and reporting of data on national basis. In order to evaluate the existing status of agro-met stations at various ARIs, a survey was conducted from August to October, 1982. The question-

naires received from various institutions were analysed and the brief status of the existing agro-met facilities were reported in the form of a status report.

On the basis of the existing status of agro-met observations at various research institutions as well as the future requirements, the agro-met observatories are classified into A, B and C categories.

During the first year of the project (1982-83), seven institutions included for the development of B type observatory were NARC, ARI. Tarnab, SAU, Tandojam; AZRI, Quetta, RRI, Kala Shah Kaku; MMRI, Yousafwala and University of Agriculture, Faisalabad.

Some institutions already have most of the instruments regarding agro-met stations and they only require assistance for the installation of equipments, collection of data and reporting procedures. For this purpose facilities will be extended to CCRI, Pirsabak and AEARC, Tandojam.

THRUSTS FOR NEXT YEAR

1. Study the effect of tillage depth, spacing and contour strip cropping on the yield components of crops and rain moisture conservation.
2. Electrical resistance block will be developed and installed in the field to estimate soil moisture status.
3. Basins, borders and furrow irrigation systems will be developed to provide facility for field evaluation of irrigation techniques.
4. The total volume of water and percentage of rain water losses will be estimated under different plant species in relation to soil losses.
5. Field trials on different crops will be planned in micronutrient deficient areas to find out optimum dose and best source of respective nutrient.
6. Development of weather models for agro-met zones to provide guidelines for land use, planning, irrigation scheduling, erosion control (wind/water), climatic effects on crop production and post-harvest operations and weather forecasting.

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Soil Productivity

OBJECTIVES OF RESEARCH PROGRAMME

1. To survey the availability of different organic materials such as crop residues, animal droppings, urban wastes and factory by-products in different regions of the country.
2. To standardize the method of composting for the production of organic manures of high quality.
3. To study the synergistic effects of organic materials on the efficiency of mineral fertilizers.
4. To popularise the production and use of organic manures among farming community through out-reach programmes.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Cowdung Affects the Availability of Phosphorus

Fresh cowdung was taken in plastic pots and 100 and 200 mesh, rock phosphate was mixed in it separately at the rate of one percent. There were three replications of each, i.e., control, one percent 100 mesh and one percent 200 mesh rock phosphate. The material in the pots was stirred and moisture loss was made up weekly. Five samples, original cowdung, just after the addition of rock phosphate, and after one, two, and three months were taken. These samples were analyzed for available (water soluble) phosphorus.

The addition of cowdung showed gradual increase in available phosphorus percentage with the passage of time. The time period in the control affected the phosphorus availability by 0.01 percent. The availability of phosphorus (water soluble) in 100 and 200 mesh was 0.10 percent and 0.12 percent higher, respectively, than control.

Composting of Wastes

In Pakistan there is a large amount of organic wastes in the form of agricultural wastes (crop residues etc), animal wastes, forest wastes and municipal wastes. These wastes, after their composting, can be used as organic manures and the consumption of expensive mineral fertilizer can be reduced.

To compost waste organic materials available at NARC such as weeds collected from different crops, *Cannabis sativa (bhung)* and hydrilla collected from Rawal Lake were used separately. These materials were mixed with composting agents and buried in pits of size 1m x 1m x 0.5 m. The composting agents used were, DAP, urea, rock phosphate, single super phosphate (SSP) and dung. Samples were taken after 3, 6 and 9 months for analysis. With the help of this analysis, the best compost will be determined on the basis of greater nutrient potential. Then the compost will be used as organic manure in field trials and its effects on crop yield and soil properties will be determined.

Comparative Effects of Pre-mixed and Fresh-mixed SSP and Rock Phosphate with Farm Yard Manure

Farm yard manure (FYM) loses nitrogen and manurial value if it is not properly preserved. But if stored in pits after mixing with SSP and rock phosphate; nitrogen losses will be reduced which ultimately results in nitrogen rich manures. Moreover, during composting phosphorus of rock phosphate is in available form.

Hence FYM was collected and SSP and rock phosphate were mixed @ 1.5, 3.0 and 6.0 kg/t of FYM and buried in pits. After three months it was used for field trial. In addition, this was compared to FYM to which SSP and rock phosphate were mixed at the time of application in the field.

The results of total plant yield of maize fodder indicated negative results. The composted FYM in comparison to fresh mixing of FYM with SSP and rock phosphate could not perform well whereas, composting of FYM served both the purposes.

Effect of Farm Yard and Green Manures on Efficiency of Mineral Fertilizers

Green manuring or the addition of FYM improves soil physical health and also adds nutrients to the soil which thus gives more crop yield.

To see the effects of green manuring on the efficiency of mineral fertilizer, a plot was green manured with *Sesbania* which was grown and ploughed in that field two months before conducting this trial. Wheat crop was sown in the plot. A similar plot (non-green manured) with the

same treatment was also maintained. The treatments given to both the plots were in a combination of mineral N (fertilizer) and organic N (FYM) in ratio of 0:100, 25: 75, 50: 50, 75: 25 and 100: 0.

Grain and straw data of wheat were taken with the same treatments of manured soil, giving an overall greater yield than non-green manured soil in each plot.

Spacing Effect on Ipil Ipil Growth

Ipil ipil *(Leucaena leucocephala)* is a fast-growing plant and can be used as timber, fodder and forage, firewood and rich organic fertilizer. It also improves soil productivity by increasing nitrogen contents, organic matter contents, rebuilding tilth and surface texture. Ipil ipil nursery was grown. After some weeks seedlings were transplanted in plots with inter-plant and inter-row distances of 0.76m x 1.5m, 1.5m x 1.5m and 1.5m x 3m, respectively. Average plant height after 19 months was 3.53m in 0.76m x 1.5m plot which was slightly more than in 1.5 m x 1.5 m plot. Average plant girth in 1.5m x 1.5 m plot is 4.3cm which is slightly more than 4.0 cm of plot 0.76 m x 1.5 m. However, the number of plants is significantly different in the two plots. The plot with 1.5m x 1.5m spacing has 169 plants while the number was almost double (325 plants) in 0.76 m x 1.5 m plot. Therefore, for maximum biomass production of ipil ipil, the inter-plant and inter-row distances of 0.76m x 1.5 m is recommended.

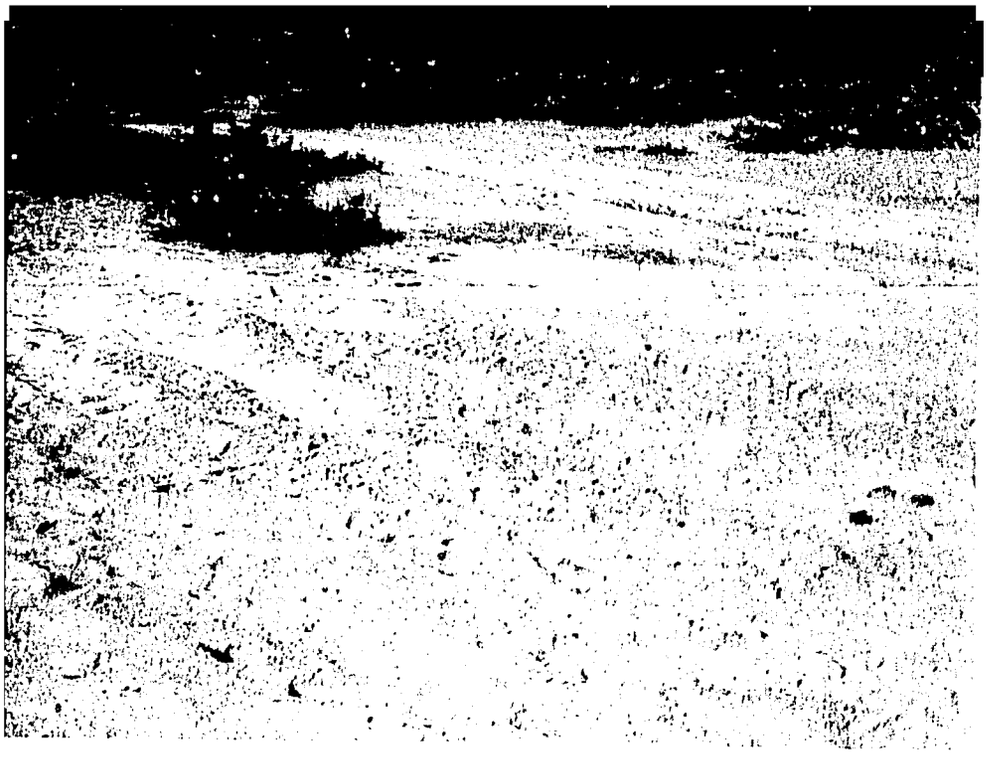
THRUSTS FOR NEXT YEAR

1. Composting of commonly available organic substrate by pit and heap method will be conducted.
2. Compost will be applied to the field for manurial assessment and to observe its synergistic effect on the efficiency of mineral fertilizer.
3. The possibility of leaves of fast growing trees for ration formulation of poultry birds will be evalutated.

SCIENTIFIC STAFF

1.	Dr. G. R. Sandhu	Coordinator
2.	Mr. M. Yousaf Hayat Khan	Scientific Officer
3.	Mr. Mohammad Aslam	Scientific Officer

Ipil ipil: new sucessful introduction which improves the soil productivity by nitrogen fixation. Foliage being rich in protein serves as excellent feed for animals



Saline Agriculture

OBJECTIVES OF RESEARCH PROGRAMME

1. To undertake phyto-ecological survey and select salt tolerant plant species from both inland and coastal areas.
2. To screen out collected genestock for their limits of salt tolerance.
3. To develop and improve cultivation practices and planting techniques under salt affected conditions in coastal and inland areas.
4. To carry out economic utilization of dense, saline sodic soils, and brackish ground waters.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Salt Tolerance Studies

The experiment was conducted on four noded cuttings of two grasses namely, *Cynodon dactylon* and *Paspalum distichum*, in test tubes using half strength Hoagland solution as a medium for growth. Later, they were subjected to the following treatments:

T_1 = Control (½ strength Hoagland solution)
T_2 = EC 5.0 mmhos/cm
T_3 = EC 10.0 mmhos/cm
T_4 = EC 15.0 mmhos/cm
T_5 = EC 20.0 mmhos/cm
T_6 = EC 25.0 mmhos/cm

Fifty replicates were tried. EC levels were maintained with NaCl. Solutions were changed on alternate days.

It was noted that leaf tip burn started at higher EC levels, 4–5 days after introduction to the saline solutions. The experiment was terminated after 50 days and survival percentage of grasses was noted. Both the grasses gave satisfactory survival upto an EC of 15 and 20 mmhos/cm, respectively. However, 50 percent yield reduction occurred beyond 15 mmhos/cm. The higher tolerance of *P. distichum* might be due to more favourable conditions for this grass as it has adapted to grow under submerged conditions. The surviving plants were transferred to soil for multiplication and further studies.

In field experiment for determining the salt tolerance of economic tree species at Mirpurkhas *Prosopis juliflora* gave the highest survival of 86 percent followed by *Casurina equisetifolia* and *Pithocelobium dulce* with 60 and 51 percent survival, respectively. Another experiment was put up at Jauharabad, which suffered badly due to heavy rains and flood water. Whole area was replanted.

One hundred and ten soil samples were collected from the Peshawar salinity parameters. The saline experimental areas were levelled thoroughly to receive uniform irrigation.

A phyto-sociological survey of coastal vegetation extending from Karachi to Gawadar was undertaken for primary selection of economically valuable plants growing under saline environments. Thirty stands of vegetation were surveyed at various locations using point centered quarter method. Soil and sub-soil samples were collected and analysed physically and/or chemically. The leading dominant technique revealed the ecological affinities among the dominant species and their relationship to edaphic variables.

P. juliflora was the most wide spread species and exhibited wide range of tolerance to many edaphic characteristics including salinity and sodicity. *Anthrocnemum indicum* was much restricted in its distribution only to highly saline sodic and calcareous soils. *Tamarix indica* and *T. aphyla* were also associated with saline, highly saline and waterlogged soils. Density was maximum for *T. indica* followed by *Acacia senegal, A. nilotica, P. juliflora* and *P. cineraria.*

Objective classification of vegetation disclosed 11 plant communities. Their soil reaction is alkaline and community delimitation is predominantly influenced by soil salinity, sodicity, K content and Na: K ratio prevailing in these habitats.

An experimental station on Sonminani coast is being set up for testing selected salt tolerant plants for growth on sand dune using saline water for irrigation.

Salt tolerance studies on 14 varieties of sunflower and 52 varieties of cotton were completed at University of Agriculture, Faisalabad.

Analysis of soil and water samples, collected from different experimental sites, was completed. A total of 120 sites were bored and were classified into different salinity levels. In all, 36 locations were selected covering all the salinity ranges. Salt tolerance studies on 'Qalandri' and 'NT' varieties of cotton showed that

former was better. In case of sorghum, germination of 'Sorokartuhu' was better than 'Red Janpur' and other tested varieties under saline conditions.

Amelioration of Saline Sodic Soils by Using HCl as a Chemical Amendment

The experiment was conducted in PVC plastic pipes with inner polythene linings to study the effect of different dilutions of HCl under restricted leaching conditions. The columns were filled with 4 kg saline sodic soil and soil was ground to pass through 2 mm sieve before filling into these columns. The percolating solutions were added equivalant to 80 percent. Following dilutions of HCl were used for leaching through these columns.

T_1 = Control (irrigation water)
T_2 = 1:100 dilution
T_3 = 1:200 dilution
T_4 = 1:300 dilution

Experiment was conducted in triplicate. These solutions were passed through the columns @ 950 ml per column. After adding the solutions, columns were sectioned into 4 equal portions after 24 hours. The soil was dried and processed for physico-chemical analysis.

Different salinity parameters for the top layer are presented in Table 1.

The data indicates that EC of the soil decreased with canal water and acid solution but the effect was lesser in later. The salts removed from the upper layers were deposited at the bottom of the column.

Moreover, the pH of the soil decreased to safe limits (less than 8.5) with all HCl dilutions. Effect of canal water alone was not satisfactory as the pH was reduced only to 9.70 from 10.30 noted in case of original soil.

Soluble Ca^{++} + Mg^{++} increased considerably in the top layer with HCl dilutions. However, effect of 1:100 dilution was maximum and of canal water was negligible. Soluble Na^+ decreased significantly by leaching with all the solutions. Moreover, the effect of 1:100 and 1:200 dilutions were better than the other treatments. Soluble K^+ was reduced considerably from the upper layer and was deposited in the lower depths.

Chloride removal was found to be maximum with canal water. With HCl dilutions, amount of chloride was more in case of 1:100 dilutions. CO_3^{--} + HCO_3^- were removed to a greater extent with acid dilutions as compared to leaching with simple water.

Rate of water leaching was faster in case of acid solutions as compared with canal water. As the leaching solutions were used upto 80 percent of saturation percentage, the leached ions from the upper layers were deposited in the lower portions of the soil column.

Table 1. Soil analysis after treatment with acid solution

Estimation	Original soil	Control	HCl dilution 1:100	1:200	1:300
EC x 10^3	56.00	3.96	9.43	7.90	4.97
pH	10.30	9.70	7.58	7.63	8.13
Soluble Ca^{++} + Mg^{++} meq/100g	0.14	0.10	3.35	1.65	0.58
Soluble Na^+ meq/100g	37.66	1.39	0.45	0.56	1.42
Soluble K^+ meq/100g	0.64	0.05	0.18	0.12	0.09
Chlorides meq/100g	8.74	0.99	4.26	3.42	2.40
CO_3 + HCO_3 meq/100g	18.40	2.48	1.59	1.31	1.59

Comparison of HCl and Gypsum as a Reclament for Non-saline Sodic Soil

The soil was non-saline sodic with pH of 9.8 and EC of 1.40 mmhos/cm. The yield data of the rice test crop is presented in Table 2.

Table 2. Paddy yield (average of three replications)

(kg/ha)

Treatment	Average
T_1 (100% HCl of GR)	2280
T_2 (50% HCl of GR)	1930
T_3 (Gypsum 100% of GR)	1886
T_4 (Control)	456

GR: Gypsum requirements

It is clear from the data that all the treatments have increased the yield of rice significantly over that of control. Yield given by T_1 and T_2 are statistically alike but T_1 is significantly superior to that of T_3.

Data regarding productive tillers/hill, plant establishment/m^2 and plant height also gave similar results.

THRUSTS FOR NEXT YEAR

1. The promising salt tolerant plants, shrubs and trees will be further studied and the economics of putting salt affected areas under these will be worked out.

2. Screening of varieties against salinity and sodicity will be continued.

3. Development of cultivation methodology with amended and unamended sea water will also be carried out.

4. About 45 ha affected land has been acquired at Sadhoke (Gujranwala–Lahore road) for conducting research on saline agriculture. Development of this area will be completed.

5. A soil-plant-animal complex will also be set up at the place.

SCIENTIFIC STAFF

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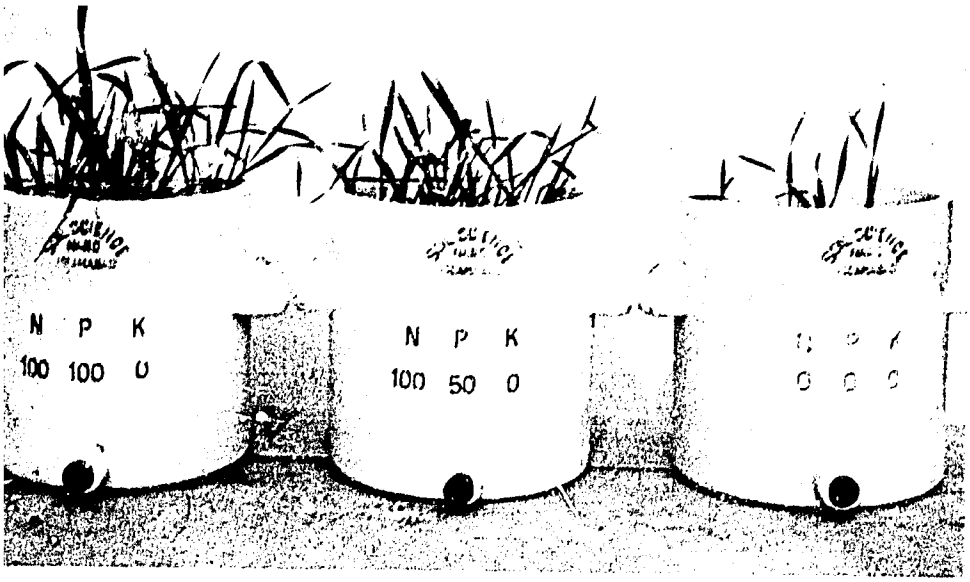

Soil Fertility

OBJECTIVES OF RESEARCH PROGRAMME

1. To assess the role of fertilizers for increasing crop yields.
2. To increase efficiency of fertilizers by mixing Farm Yard Manure (FYM) and study their residual effects.
3. To study fertilizer – moisture interaction under rainfed *(barani)* conditions for optimizing crop yields.
4. To determine fertilizer and micronutrient requirements of major crops.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Response of Fertilizers

The experiment was designed in Randomised Complete Block on 100m^2 plots in three replications under four fertilizers namely, urea, DAP, nitrophos and SOP.

In experiment on maize laid at Tarnab, Malakand and Mansehra in NWFP all P,K and ½ N was incorporated at sowing and the remaining N top-dressed at knee height stage. In rice experiment, laid at nine locations in Punjab, NWFP and Sind ½ N and all P and K were mixed with soil at puddling and the remaining N dose top-dressed eight weeks after transplanting.

The application of fertilizer in general increased yields of all the maize varieties at all the locations. The dose 180:90:60 gave the highest yield. Increase in P and K doses resulted in appreciable yield increases.

Fertilizer application increased significantly, the rice yields over the controls at all the locations. The highest yields were obtained at the highest NPK dose of 120:90:60. Increasing doses of N and P resulted in significant yield increases, but effect of K was less evident at two locations in Sind.

Efficiency of Different Methods of Fertilizer Application

A methodology similar to previous experiment was adopted. The fertilizer doses were 120:90:60 kg NPK/ ha tested for broadcasting plus incorporation, banding and strip application on maize, rice and cotton.

It is evident from Table 1 that strip method was the best for fertilizer application, followed by banding and broadcasting in maize.

In rice varieties, banding proved superior to broadcasting; strip application was not attempted (Table 2).

While in cotton, strip application was the best method, closely followed by banding and broadcasting except for one location (Bahawalpur) where this trend was reversed (Table 3).

Calibration of Yield Response to Phosphorus

In maize the fertilizer treatment 120:80:90 of NPK out-yielded all other treatments. However, increasing doses of P beyond 80 kg/ha had depressing effect on yield.

Rice at Peshawar gave highest yield with 120 kg N plus 90 kg K_2O without P.Phosphorus application here also revealed yield depression. At three locations of Hyderabad the highest yields were recorded with 120:60:90 NPK. However, further P increase either had none or depressing effect on yield.

At the four locations in Sind highest yield of cotton was obtained with 100:60:0 NPK treatment. Increasing P application upto 60 kg resulted

Table 1. Effect of fertilizer application on maize yield (kg/ha)

Treatment \ Location	Tarnab	Mardan	Malakand	Mansehra	Sahiwal	Sahiwal	Sahiwal
Treatment \ Variety	'Sarhad White'	'Sarhad White'	'Sarhad White'	'Sarhad Yellow'	Neelum'	'Neelum'	'Neelum'
Broadcasting	1652	3703	2442	3223	4428	3724	4426
Banding	2035	3153	2221	3089	4626	3875	4623
Strip application	2049	3483	2535	3490	4772	4055	4742

in significant yield increases, but beyond this its nil or depressing effect was noticeable.

At Tandojam, however, the best combination was 100:90:60 NPK and increasing P doses resulted in corresponding increments in yield.

Residual Effects of Phosphorus and Potassium

In Punjab, application of NPK in the ratio of 100:75:50 gave the highest yield in maize. In NWFP, 100:75:50 was the best combination at Tarnab, Mardan and Peshawar, while 100:75:100 NPK dose was the best at other locations. In general, yield at Tarnab was comparatively lower than other locations. Response to K application is evident at Mardan, Malakand and Mansehra. Increasing P from 75 to 100 kg/ha rather depressed yields except at Mansehra.

In rice, at Punjab the best combinations of NPK were 100:50:50 and 100:50:100 for Kasur, and 100:50:0 and 100:75:50 for Gujranwala, in two sets of experiments, while in NWFP the best combination appeared to be 100:75:50.

Highest yield for cotton was noticed with 75:50:50 NPK treatment at Tando Allahyar, Mirpurkhas and Tandojam, while with the 75:50:0 at Hala and Matli in Sind.

Therefore, fertilizer application increased yield of the three crops and they responded to P and K application. The experiment would continue for three years on the same sites for the assessment of residual effect of the added fertilizers.

Fertilizers and Moisture Interaction in *Barani* Areas

The experiment was conducted on maize, sorghum and groundnut in three replications on 100m^2 plots in a Split Plot Design with 75:50:25 NPK kg/ha. The treatments given were, deep tillage (T_1) using chisel plough and conventional tillage (T_2). Mulching was done by the application of straw, organic matter/or by loosening/compacting the soil with appropriate implements (M_1). Controls were not given any mulching treatment (M_2).

Table 4 indicates that the combination of fertilizer application, conventional tillage and no mulching resulted in the highest yield of the three crops at both the locations and in all the trials conducted.

Table 2. Effect of fertilizer application on rice yield (kg/ha)

	NWFP			Punjab	
Location	Malakand	Swat	Mansehra	Sheikhupura	Kasur
Variety	'Basmati'	'JP-5'	'JP-5'	'IRRI-6'	'IRRI-6'
Treatment					
Broadcasting	3602	3813	2634	4700	4458
Banding	4110	4660	2879	4910	4623

Application of farm yard manure (FYM) enhances the efficiency of mineral fertilizers

Effect of FYM on Efficiency of Different Phosphate Fertilizers

The experiment was laid in Randomised Complete Block Design

Table 3. Effect of fertilizer application on cotton yield (kg/ha)

	NWFP		Punjab		Sind			
Location	D. I. Khan	D. I. Khan	Bahawalpur	Multan	Tando Allahyar	Hala	Matli	Mirpurkhas
Variety	'B-557	'B-557'	'B-557'	'B-557'	'NT'	'NT'	'NT'	'NT'
Treatment								
Broadcasting	1618	1159	1977	1053	2833	2167	2183	3317
Banding	1740	1218	1791	1159	3117	2250	2317	3464
Strip application	1786	1364	1584	1134	3433	2317	2383	3483

with three replicates on maize and cotton under the following treatment regimens.

Treatment (dose) N : P : K	Sources
T_1 120:60:60	All P as DAP, N as urea and K as SOP
T_2 120:60:60	T_1 + FYM, 300 kg/ha
T_3 120:60:60	All P as nitrophos, K as SOP, remaining N as urea
T_4 120:60:60	T_3 + FYM, 300 kg/ha
T_5 120:60:60	All P as SSP, N as urea, K as SOP
T_6 120:60:60	T_5 + FYM, 300 kg/ha
T_7 Control	–

Well-rotten FYM was thoroughly mixed with phosphatic fertilizer before its application to field.

Results are evident from Tables 5 and 6. In maize the highest grain and stalk yields were obtained where SSP, urea and SOP were applied in combination with FYM (T_6). Thousand-grain weight was, however, greater in T_4 where nitrophos replaced SSP as P source.

The highest yields of cotton at three locations, Tandojam, Tando Allayar and Hala were noted with T_2 where DAP, urea and SOP were mixed with FYM. Although this treatment gave appreciable yield increase over most of the treatments but did not seem to differ drastically from T_4 and T_6. At Matli and Mirpurkhas the highest yields were obtained with T_6, i.e., when SSP, urea, SOP and FYM were applied together.

The results, therefore, clearly indicate that application of FYM can enhance the efficiency of mineral fertilizers.

Effect of Trace Elements on Yield

The experiment was laid on a 10m x 5m plots in three replications in a Randomised Complete Block Design. The fertilizers used were, urea, SSP, SOP, $ZnSO_4$, $CuSO_4$, $FeSO_4$, $MnSO_4$ in doses of 120 N; 60 and 90 P, 60 K; 5 Zn, 5 Cu; 2.5 Fe and 2.5 Mn kg/ha, respectively.

To maize crops all P,K, ½N and micronutrients were applied at sowing and the remaining ½N was topdressed at knee height stage while in rice all P, K, ½N and micronutrients were mixed with soil during puddling and the remaining N dose wastopdressed eight weeks after transplanting. Whereas for cotton the recommended practices of fertilizer application were utilized.

Table 4. Effect of moisture and fertilizer on yield of maize, sorghum and groundnut

Maize (kg/ha)

Location	Attock				Rawalpindi			
Tillage	T_1		T_2		T_1		T_2	
Mulching	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2
N P:K 0:0:0	665	736	810	944	622	788	877	870
75:50:25	1055	1186	1371	1769	1656	1843	1962	2011

Sorghum (kg/ha)

Location	Attock				Gujrat			
Tillage	T_1		T_2		T_1		T_2	
Mulching	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2
N:P:K 0:0:0	499	558	558	687	247	319	341	403
75:50:25	764	840	929	1008	670	914	838	1011

Groundnut (kg/ha)

Location	Attock				Rawalpindi			
Tillage	T_1		T_2		T_1		T_2	
Mulching	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2
N:P:K 0:0:0	1934	1539	1510	1732	1431	1673	1606	1858
75:50:25	2036	2360	2446	2602	2167	2553	2852	3081

Table 5. Effect of FYM on agronomic characters of maize in NWFP

Treatment	Grain yield (kg/ha)	1000-grain weight (g)	Stalk yield (kg/ha)
T_1	2392	207	11555
T_2	2648	203	14222
T_3	1885	203	11259
T_4	2372	227	12074
T_5	2586	212	15259
T_6	2937	213	15852
T_7	1144	180	77556

Significant increase in yield of maize was noticed at Malakand, Jarma, Tarnab and Tandojam, with NPK application. Zinc application, alongwith NPK further increased the yield particularly at Tarnab. The effects of Cu, Mn and Fe addition to

NPK when supplemented singly also enhanced the yield, however, Cu and Zn in combination with NPK resulted in dramatic yield increase in NWFP. The positive effects of combination of Fe and Mn with NPK were noticed. Application of all the four micronutrients alongwith NPK surprisingly was not promising except at Tandojam where it was slightly better than the Zn treatment.

In case of rice, NPK supplementation gave significant yield increases. In D. I. Khan (NWFP), application of micronutrients either had no effect or caused depression in yield. At other locations viz., Lahore, Gujranwala in Punjab and Tandojam and Tando Muhammad Khan in Sind, the application of Zn produced dramatic yield increases. Application of other three micronutrients did not appear profitable.

NPK application greatly also increased cotton yields at all the three locations. However, at Sakrand, response to Mn and B were very revealing; at Matli and Mirpurkhas application of the four micronutrients singly or in combination did not show significant positive affects on cotton yield.

Table 6. Effect of FYM on yield of cotton in Sind

Location	Tandojam	Tando Allahyar	Hala	Matli	Mirpurkhas
Variety / Treatment	'Sarmast'	'NT'	'NT'	'NT'	'NT'
T_1	1294	2517	2150	1667	2717
T_2	1660	2733	2317	1817	2950
T_3	1160	2567	2133	1767	2900
T_4	1480	1733	2264	1983	3117
T_5	1200	2417	2100	1967	3233
T_6	1540	2567	2267	2133	3416
T_7	686	800	867	700	917

THRUSTS FOR NEXT YEAR

1. Correlation of yield and fertilizer response with soil test values and devising rapid and simple soil testing procedures for predicting fertilizer needs on wide variety of soils will be undertaken.
2. Mineralogical make-up and variability among soils will be studied.
3. Adsorption and desorption, fixation and defixation characteristics of soils for computing fertilizer doses will be investigated.
4. Experiments on crop rotations with legumes to harvest natural atmospheric N reserves will be arranged.
5. Long-term K fertility experiments to evaluate precisely future K fertilizing requirement will be laid.
6. Effect of fertilization on insect pests, diseases and weeds, and agrometeorological observations during the experimentation will be considered.

SCIENTIFIC STAFF

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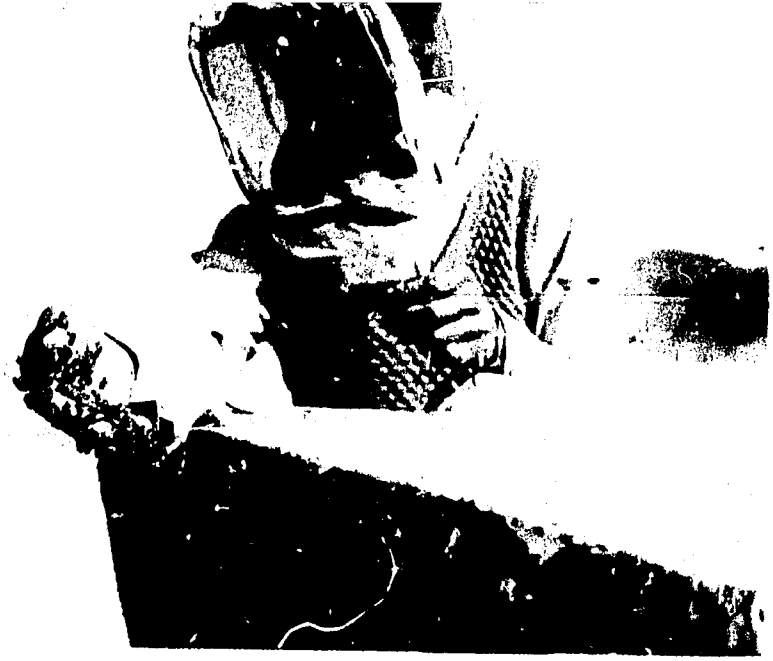

Honey-bee Management

OBJECTIVES OF RESEARCH PROGRAMME

1. To devleop honey-bee management technology, improving their strains for development of apiculture in different ecological areas.
2. To conduct studies on pollination potential of various honey-bee species in different varieties of insect-pollinated crops.
3. To transfer modern honey-bee management technology to the bee-keepers and introduce higher nectar and pollen yielding plants.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Apis mellifera

The apiary of Baluchistan was migrated to Dadar and Quetta and that of Sind remained at Hyderabad throughout the year. Therefore, some of the colonies suffered from dearth of flora but the bees in Baluchistan flourished very well.

Sarson, mesquite, citrus, berseem, *Acacia, ber,* mulberry, banana, cotton and lucerne constituted important honey-bee flora and were fairly abundant in parts of Hyderabad, Mirpurkhas, Thatta and Karachi. Similarly, apple, peach, almond, apricot, cherry, pear, guava, melons, sunflower, clovers, mesquite, citrus, *Ain-ul-asl* and *Asl-e-amir* occurred in Quetta, Ziarat, Dadar, Sibi, Zohb, Nasirabad and Loralai. Although these flora are abundant in some situations but none provides flora throughout the year.

The drone production was late in May-June when weather was very hot. Accordingly the queens were produced during summer (May-August). A fairly large proportion of queens did not mate. Failure of mating in queens adversely affected the strength of apiary.

Apis cerana

1. *Improvement of Colonies:* Four colonies producing 15–20 kg honey per annum were selected and placed 5 km away from the apiary. Three of them were provided drone combs for stimulating production of drone brood while the fourth was used for queen production and its drone brood was removed to avoid inbreeding. Only 9 queens out of 20 mated normally and started laying a fairly large number of eggs.

2. *Winter Migration of Wild Colonies: Apis cerana* migrated from the hills (Murree) to foot-hills (Rawalpindi and Islamabad) due to low temperature and dearth of flora in winter. These swarms create restlessness in the wild colonies maintained in Langstroth hives.

Observations were made in an apiary comprising 23 hives placed on *sarson* at Islamabad in early November. Some single or multiple-queen swarms settled near the apiary on a tree and sometimes entered in empty hives and also inside those having bees in them. The bees of 1 to 5 or more hives, left their brood and food reserves to unite with the winter swarms and form larger colony. The wings of queens in all the hives (wild colonies) in the apiary were, therefore, clipped to check absconding. However, the incoming colonies continued to induce the bees of most of the hives to leave their clipped queens and unite in the main swarm. Such colonies were dislodged and put back in the hive providing one queen each in a queen cage. The bees, because of mixing, had lost identity of their own queen. Many winged queens located in the swarms were also clipped and supplied to queenless colonies. However, 17 queens died in or near their hives owing to their desertion by bees, many of which had flown away with the wild swarm.

Thus the colonies suffered appreciably not only because of mortality of queens but also due to union of the bees of the hive with the swarms. Studies will be made to find out the causes of this behaviour apparently helpful for overwintering of some weak and wild colonies and for maintaining better colony characteristics for the future generation.

3. *Effect of Migration of Honey-bee Colonies on Honey Yield:* Twenty hill bee colonies, with 10- frame bees were selected for studies on honey yield in different floral belts. They were placed in 4 sets of 5 colonies each. Honey was extracted a few days before the expiry of blooming period of major honey plant species. The colonies of the first set were migrated to Rawalpindi, Islamabad, Swat and Haripur; second set to Rawalpindi, Islamabad and Haripur; and third and fourth sets were placed, respectively, at Swat and Islamabad.

The colonies migrated to Rawal-

pindi, Islamabad, Swat and Haripur remained in fairly good conditions and gave high honey yield (average 16.08 kg per colony). The honey-bees shifted to Gujar Khan, Islamabad, Rawalpindi and Haripur gave comparatively low honey yield (4.7 kg per colony) due to high mortality. The non-migrated colonies produced less honey in Swat (3.3 kg per colony) and Islamabad (2.8 kg per colony) and 60 percent of the colonies expired due to dearth of flora in late summer, autumn and winter.

Natural Enemies

1. *Mites:* In Gujrat, Sialkot, Lahore, Rawalpindi, Islamabad, Haripur, Khanpur, Peshawar, Mardan, Hasanabdal and Swat valley incidence of *Acarapis woodi* was surveyed. Infestation was higher in Swat valley where several beekeepers had migrated the hill bees on 'shain' *Plectranthus rugosus*. The epidemic appeared to have resulted owing to assemblage of colonies in Swat where the infested bees have played a major role in spreading *A. wocdi* to a large number of colonies.

Besides *A. woodi, Tropilaelaps clareae* mite was detected from brood combs of *Apis dorsata* at Shakargarh during November and from *A. cerana* colonies during February–June. *Neocypholaeps* sp. being a pollen mite was recorded for the first time from *A. cerana.*

Examination of 13 apiaries comprising 1197 *A. cerana* colonies in Swat indicated that 40 colonies suffered from acarine disease while varroasis was detected in only three colonies.

Six severely infested *A. cerana* colonies comprising 5-to 10-frame bees were kept under observation to study the effect of disease on colony development and for giving different control treatments to the acarine Some of the bees had slowed down their foraging activities while others had stopped it. The bees were found clustered on frames or walls of hives.

Folbex smoke-strip treatment was applied 4 times for 30 minutes at four-day interval during October-November. One strip was used per colony each time. In order to maintain vitality of the bees, supplemental feeding of sugar syrup (sugar and water 1:1) was given at weekly intervals. An antibiotic, Neo Terra (Tm-25) was also fed (one teaspoonful of Tm-25 in one litre of sugar syrup) three times to get rid of bacterial infection. This treatment was applied at six-day interval. One colony was cured completely while populations of the other five colonies dwindled appreciably in four to five weeks. Examination of the infected bees revealed that their prothoracic tracheae had all stages of acarine mites (eggs, nymphs and adults).

The beekeepers of different areas were given demonstrations to control acarine disease in early stages by smoke-strip treatment with Folbex. In order to check further spread of the disease, the infected colonies were got isolated from the apiaries. Some of the dying/ diseased colonies were taken from the owners for further experiments by PARC staff. These were treated and returned.

A. mellifera and *A. cerana* colonies were placed together in many apiaries, no disease was found in colonies of the former species except in a few hives at Peshawar. It seemed that *A. mellifera* is somewhat resistant to the local strains of the acarine mite.

2. *Birds:* The oriental bee-eaters *(Merops orientalis* and *Dicrurus aster)* were fairly common at Haripur and some other situations. Explosions made with scare crow machine at 3-4 hours intervals proved very useful to drive these away.

3. *Hornets:* Five species of hornets namely, *Vespa velutina pruthii, V. basalis, V. tropica haematodes, V. orientalis* and *Vespula germanica* were found at Hasanabdal, Haripur, Peshawar, Rawalpindi, Islamabad, Gujrat, Mandi-Bahauddin and Swat valley. These brought about fairly heavy losses to honey-bee colonies when their population was at peak in August-September.

V. velutina pruthii remained active by first week of November while only a few individuals of *V. orientalis* were caught as incidental visitors in apiaries by the second week of November. However, *V. basalis* and *V. tropica* were not encountered after last week of October. The hornet, *V. velutina pruthii* was the most destructive pest of *A. mellifera* at Islamabad and Haripur while *V. orientalis* was less damaging.

The hornet *V. orientalis* and *V. tropica* were usually fought back and defended upon by the worker bees of *A. cerana* and *A. mellifera.* However, *V. velutina pruthii* and *V. basalis* were more prompt and swift and were mostly seen waiting on wing in front of the hive. They overpowered the bees during their foraging flight and carried them to their nests for feeding their young ones.

The bees of *A. mellifera* repelled these wasps only outside the hive as the guard bees clustered both inside and outside the entrance with some bees lying upward near the entrance wall. They continuously rocked their heads and antennae, but these bees could not effectively repel the hornets and finally fell prey to them. The bees of *A. cerana* defended themselves within the hive and also exhibited strong defence in groups of 15–70 individuals at the entrance. They rocked their body, opened their wings and swung in the direction of the hornet in an organized manner. Thus they occasionally defied the efforts of the hornets for capturing them.

Pyemotes ventricosus (Pyemotidae) is a cosmopolitan mite and is known to attack 139 insect hosts. During the present studies, it was found attacking less than one percent larvae of *V. velutina pruthii* which after becoming sluggish gradually perished. The mite also exhibited a pronounced sexual dimorphism. Studies are being made on the potential of this mite as a biocontrol agent against *Vespa* spp., on its mass rearing technique and on the possibilities of its being a future pest of honey-bees.

The use of bee guards or fixing of a wire-gauze tube, 1.5cm x 17 cm as bee passage at entrance of the hive reduced the frequent entry of *V. basalis, V. orientalis* and *V. velutina,* but did not lessen losses because bees were caught and killed by them during their foraging flights.

Searching of hornet nest was difficult. The ability of some of the wasps to use general visual stimuli in searching of baits has been demonstrated by various scientists. Sugar baits were used keeping in view the attraction of hornets to sweet secretions of sugarcane leaf hopper, *Pyrilla aberrans* and also to honeydew excreted by the aphids. A bait was prepared by pouring 50 percent sugar solution placed on a coarse cloth in a tray on the top cover of an empty hive. The sugar solution attracted *V. basalis* and *V. velutina* adults

(ratio 1:3). These were killed with fly flappers during their feeding.

Minced meat (spleen or liver) was also readily fed upon by the hornets, *V. basalis* and *V. velutina*. The hornets assembled on meat were caught with hand nets and killed. The relative attractiveness of meat was almost 60–80 percent less than sugar solution. Furthermore, some birds also lifted away the minced meat reducing the effectiveness of this bait. The sugar solution bait also had some limitations because of its being a food of bees.

Six plastic jars each of 12, 16 and 20 cm length and 5, 7.5 and 10 cm diameter at mouth with a small quantity of 50 percent sugar solution (2 cm depth) were kept at different places in the apiary. A large number of hornet adults were trapped alive in sugar solution. These were counted at 24 h interval. The data on average relative trap-capture of different hornet species (five replicates) indicated that the number of hornets captured in plastic jars of 12 cm x 5 cm size at mouth was highest possibly due to its narrow mouth which inhibited the hornets from flying out. A considerable number of hornets were caught in sugar solution traps at very low cost. Thus this method seems to be promising in controlling these enemies of honey-bees.

Pollination of Apple

An experiment was conducted on five apple varieties namely, 'Sky Spur', 'Red Delicious', 'Kashmiri Amri', 'Nuggot' and 'McIntosh' in two fields at Murree. Four *A. cerana* colonies were used for pollination. Two colonies were placed in the centre of each field. Four plants of each variety were selected. Three branches of uniform size and age bearing equal number of flower buds were selected on each plant. One of the branches was covered with muslin cloth bag, (no insects visited), the other with net cloth bag of 3.5 mm mesh size, (insects smaller than bees visited) and the third was left open and tagged, (bees and other insects visited). The number of flowers and fruit set on each branch were counted. The data indicate that fruit setting was 0–3 percent in muslin covered bags, 1.6–9.1 percent in net cloth covers and 28.3–34.1 percent in open twigs indicating a marked effect of honey-bee and other insect pollinators on fruit setting of apple.

Honey-bee Flora

Thirty thousand plants of *Robinia pseudoacacia* and *Vitex negundo* were raised in the nursery at NARC. These are known to produce more than 500 kg/ha honey under optimum conditions. Fifteen thousand plants of *V. negundo* and 600 of *R. pseudoacacia* were distributed to interested persons for growing on government and private lands.

Seeds of some important honey producing species of *Eucalyptus* were imported from Australia and were sown at NARC

THRUSTS FOR NEXT YEAR

1. Studies on improvement of honey-bees for high honey yield will be continued.

2. Investigations on the development of management technology for increasing honey production and its transfer to beekeepers and other interested persons will be carried out.

3. Studies on the control of pests and diseases of honey-bees will be undertaken.

4. Investigations on pollination potential of honey-bee species on different crops and fruit plants will be made.

5. Propagation and growing of plants for development of permanent honey-bee floral pockets in co-operation with other departments will be enhanced.

SCIENTIFIC STAFF

1.	Dr. Rafiq Ahmad	Coordinator
2.	Miss Nasreen Muzaffar	Senior Scientific Officer
3.	Mrs. Elizbeth Stephen Waghchoure	Scientific Officer
4.	Mrs. Mumtaz Qazi	Scientific Officer

Flora of Pakistan

OBJECTIVES OF RESEARCH PROGRAMME

1. To compile the Flora of Pakistan, so as to exploit the plant wealth of our country.
2. To undertake thorough investigation of the plant material available (both fresh and dried) to ascertain new taxa if any.
3. To add continually plant collection to the herbarium to make it more useful and comprehensive source of reference.
4. To publish the resear h results for the scientists, institutions, libraries both in and out of the cour ry.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Field trips to any particular area, depending on the availability of a particular plant were made. General collection is also done when flora is prominent viz., in spring (February to April) and in the monsoon season (July to September). However, the plant specimens were collected in duplicates and triplicates from the field alongwith field data and observations. Plants once collected are then pressed, dried, preserved mounted, accessioned and finally filed in the herbarium cabinets after identifications.

During 1982-83, approximately 4000 specimens have been collected from Jaboi, Taxila, Islamabad, Broha, Rawal Lake, Talor, Margalla, Lahore Pir Sohawa, Tret, Perilla, Karot, Kotla and Patriata.

Research workers for a taxonomic study of the group, work on a particular family. Herbarium specimens are required, but which are not available are loaned from herbaria within or outside the country. This includes description with key to the genera and species. This is followed by a more detailed description to the species, citations, distribution and short notes on the economic uses, vernacular name(s) and flowering periods. These are accompanied by profuse illustrations. The manuscript is then sent to taxonomists abroad for their comments/suggestions.

Plant collection trips in the area of Rawalpindi and Islamabad districts (i.e., Margalla, Panjar, Lehtrar, etc.) yielded at least 35 new plant records which have not been reported previously. They are:

1. *Acer oblongum*
2. *Arisaema tortuosum* var. *curvatum*
3. *Ceropegia macrantha*
4. *Impatiens scabrida*
5. *Cyanotis cristata*
6. *Suene colorata*
7. *Spergula fallax*
8. *Tragapogon gracile*
9. *Merrimia palmata*
10. *Dioscorea melanophryma*
11. *Bridelia verrucosa*
12. *Frankenia pulverulenta*
13. *Myriophyllum verticellatum*
14. *Urginea indica*
15. *Loranthus pulverulentus*
16. *Ammania verticillata*
17. *Eulophia dabia*
18. *Polygonum chinensis*
19. *Meliosma simplicifolia*
20. *Striga lutea*
21. *Tamarix dioica*
22. *Oreocnide frutescens*
23. *Valerianella muricata*
24. *Vitis cf. capreolata*
25. Ten taxa of family Poaceae

To study the representative specimens of the families Geraniacae, Anacardiaceae and Adoxaceae for the flora of Pakistan, trips to Botany Department, University of Karachi were arranged.

Finally the manuscript of a particular family after corrections and additions is sent to the press. One thousand copies of each family are printed. Out of which about 450 copies are distributed to various institutions/universities and libraries.

THRUSTS FOR NEXT YEAR

1. The following plant families will be described and published during 1983-84 : Agavaceae, Anacardiaceae, Santalaceae, Orchidaceae, Solanaceae, Campanulaceae, Caryophyllaceae and Primulaceae.

2. Different field trips will be undertaken in order to collect plant material for research purposes and for the herbarium.

SCIENTIFIC STAFF

1.	Prof. E. Nasir	Principal Investigator
2.	Dr. S.A. Ghazanfar	Senior Scientific Officer
3.	Mr. Jasin J. Nasir	Co-Principal Investigator
4.	Miss Rubina Akhter	Scientific Officer

Part II

Animal Sciences

Technical

Animal Breeding

OBJECTIVES OF RESEARCH PROGRAMME

1. To study factors contributing to variation in reproductive efficiency in cattle and buffalo.
2. To study the causes of infertility in male Nili/Ravi buffaloes.
3. To conduct research on reproductive physiology of buffalo.
4. To identify buffalo bull mothers for the production of progeny tested bulls to improve the performance of buffaloes.
5. To develop cross-breeding schemes of indigenous cattle with exotic blood for increased milk and meat production.
6. To evolve suitable breeds of sheep in selected areas for fine and carpet wool production.
7. To study the quality of milk at different time intervals during its distribution.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Production Performance and Adaptability of Cross-bred Cows under the Sub-tropical Environmental Conditions of the Punjab

Productive and Reproductive Performance of 62.5 Percent Cross-bred at Livestock Production Research Institute (LPRI), Bahadurnagar, Okara

1. *Growth Rate:* The body weights at birth and 3, 6, 9, 12, and 15 months of age in Holstein Friesian (HF) x Sahiwal (S), females were 25.5 ± 1.0, 63.6 ± 2.74, 94.4 ± 4.13, 131. 87 ± 7.8, 176.1 ± 7.85 and 217.0 ± 8.60 kg, respectively, while in Jersey (J) x S (62.5 percent) these were 25.0 ± 1.75, 76.66 ± 9.22, 94.66 ± 10.21, 132.33 ± 12.14, 175.33 ± 6.74 and 212.0 ± 4.73 kg, respectively. The growth rate at 15 months of age in HF x S and J x S was 0.420 and 0.416 kg, respectively. The differences in the mean body weights of the two were, however, statistically non-significant at all the ages, studied.

2. *Skeletal Measurements:* The skeletal measurements like height at withers, body length and heart girth were recorded in cross-bred females. The HF x S females had significantly ($P < 0.05$) longer body at 12 and 15 months of age; more height at withers at 9, 12 and 15 months of age and larger girth at 15 months of age than J x S females. All other differences in the means of skeletal measurements of these two genetic groups were statistically non-significant.

3. *Productive and Reproductive Performance:* The age and weight at maturity in HF x S was 484.0 ± 27.33 days and 224.7 ± 9.92 kg, respectively, while in J x S the same values were 485.0 ± 29.13 days and 221.67 ± 7.27 kg, respectively. The age and weight at first calving in HF x S was 949.27 ± 27.81 days and 337.55 ± 19.86 kg and in J x S it was 961.0 ± 111.85 days and 338.33 ± 195.57 kg, respectively. In HF x S the 305 days estimated milk yield, fat contents and solids (non fat contents) were 2150.28 ± 227.34 kg, 4.09 ± 0.10 and 7.95 ± 0.09 percent, respectively while in J x S it was 1945.0 ± 177.86 kg, 4.6 ± 0.2 and 8.1 ± 0.2 percent, respectively.

Productive and Reproductive Performance of 25 Percent Cross-breds at LPRI, Bahadurnagar, Okara

1. *Body Weight and Growth Rate:* The body weights at birth and 3, 6, 9, 12, and 15 months of age in HF x S females were 19.8 ± 0.42, 49.31 ± 1.54, 78.62 ± 2.77, 111.55 ± 3.82, 149.67 ± 4.16 and 189.24 ± 4.51 kg, respectively. In J x S the body weights were 19.36 ± 47.0, 48.9 ± 1.97, 70.93 ± 3.25, 105.92 ± 8.25, 139.3 ± 4.16 and 178.4 ± 5.17 kg, respectively. The daily growth rates at 15 months of age in HF x S and J x S were 0.372 ± 0.008 and 0.35 ± 0.01 kg, respectively. The HF x S female calves were significantly heavier than J x S at 6, 9, 12 and 15 months of age while the differences at birth and weaning weight were statistically non-significant.

2. *Productive and Reproductive Performance:* The age and weight at maturity in HF x S were 569.25 ± 5.6 days and 231.25 ± 14.35 kg. In J x S these values were 646.78 ± 29.85 days and 238.0 ± 8.91 kg, respectively. The age and weight at first calving in HF x S was 1092.79 ± 29.26 days and 359.10 ± 9.39 kg while in J x S these values were 1081.9 ± 30.82 days and 329.3 ± 14.34 kg, respectively. In HF x S, 305 days estimated milk yield, fat and solids (non fat contents) were 1741.46 ±

111.83 kg, 4.32 ± 0.09 and 7.98 ± 0.06 percent, respectively. In J x S these values were 1460.2 ± 83.36 kg, 4.9 ± 0.22 and 8.3 ± 0.08 percent, respectively. The HF x S and J x S females consumed 528.8 ± 24.58 and 509.7 ± 13.28 kg of concentrate ration, respectively, from 4 to 15 months of age. The cost of this concentrate ration was Rs. 555.24 in HF x S and Rs. 535.19 in J x S.

Productive and Reproductive Performance of 37.5 Percent Cross-breds at LPRI, Bahadurnagar, Okara

1. *Growth Rate:* The average body weights at birth and 3, 6, 9, 12 and 15 months of age in HF x S females were 21.1 ± 1.25, 49.38 ± 3.79, 71.9 ± 4.55, 94.5 ± 2.34, 135.6 ± 9.77 and 162.0 ± 7.92 kg, respectively, while in J x S females these values were 23.3 ± 0.91, 57.6 ± 7.14, 79.17 ± 9.27, 102.8 ± 9.6, 133.2 ± 15.96 and 177.4 ± 12.61 kg. The differences in the body weights of HF x S and J x S at all ages were statistically non-significant. The daily growth rates at 15 months of age in HF x S and J x S females were 0.31 ± 0.02 and 0.34 ± 0.03 kg, respectively. The differences between means of growth rate were statistically non-significant. It may be noted that in general J x S females were heavier than the HF x S but these differences were statistically non-significant at all the ages. The heavier body weights of J x S females calves than HF x S may be due to small number of animals and effect of season.

2. *Productive and Reproductive Performance:* The average age and weight at maturity was 737.13 ± 23.38 days and 246.13 ± 7.32 kg in HF x S and 720.33 ± 33.41 days and 264.5 ± 7.59 kg in J x S, respectively. At first calving it was 989.8 ± 18.25 days and 289.6 ± 9.54 kg in HF x S and 998.75 ± 30.96 days and 330.75 ± 11.66 kg in J x S, respectively. The estimated 305 days milk yield was 2029.32 ± 274.00 kg in HF x S and 1972.8 ± 297.49 kg in J x S.

Productive and Reproductive Performance of F_2, Interse 50 Percent HF x S Cross-breds at LPRI, Bahadurnagar, Okara

The results of these studies have been summarised in Table 1.

Table 1. Growth rate, productive and reproductive performance of F_2 (50%) interse cross-bred females at LPRI, Bahadurnagar, Okara

Particulars	No.	Mean ± S.E.
Birth weight (kg)	61	23.39±0.433
Weaning weight at 3 months (kg)	61	56.8±1.42
Weight at 6 months (kg)	59	86.8±2.45
Weight at 9 months (kg)	54	116.3±3.78
Weight at 12 months (kg)	49	151.9±5.42
Weight at 15 months (kg)	47	193.45±4.96
Daily growth rate at 15 months (kg)	47	0.37±0.01
Age at maturity (days)	44	669.98±24.54
Weight at maturity (kg)	44	264.30±6.98
Age at first calving (days)	28	997.61±26.64
Weight at first calving (kg)	28	357.61±13.59
305 days estimated milk yield (kg)	17	2190.24±61.57
Fat contents (percent)	17	4.16±0.04
Solids – non fat contents (percent)	17	7.81±0.06
No. of services per conception	36	2.36±0.22

Cross-breeding of the Australian Illawara Shorthorn with Sahiwal Breed

During the period under report the data on various traits, were analysed for cross-bred progeny. The brief results are as follow.

1. *Age at First Successful Service:* On the basis of 16 record this age for F_1 progeny was 584 ± 127 days.

2. *Age at First Calving:* On the basis of 26 records this age was observed to be 843 ± 142 days.

3. *Service Period:* The average length of this period on the basis of 35 records of cross-bred F_1 cows was 85 ± 3 days.

4. *Dry Period:* The average length of this period subsequent to different lactation was calculated as 128 ± 69 days on basis of 42 records.

5. *Calving Interval:* It is another economic trait in dairy cattle. Shorter calving interval is always desirable. The average calving interval among cross-bred F_1 cows was 335 ± 72 days on the basis of 46 available records.

Reproductive Ability of Male Nili/Ravi Buffalo

Due to absence of data on normal values previously a study was initiated on normal buffalo bulls of different ages. All normal bulls were subjected to detailed clinical examinations including recording of their body weights at regular intervals. Semen samples, collected from them in routine use were also subjected to detailed evaluation for estimating the normal semen production ability of this breed.

On the basis of regularity in semen production and expression of libido, 56 buffalo bulls were found to be normal. The body weights of these animals at six months interval from 6 to 78 months were 215, 305, 359, 454, 492, 528, 571, 625, 666, 708, 762, 783 and 790 kg, respectively, which decreased to 762 kg at the age of 162 months.

The data indicated that definite variations existed between bulls in the attainment of different weights at the same age. It also revealed a definite pattern of growth. The growth curve thus prepared has become available for comparative evaluation future.

A positive correlation (r = +0.97) was observed between age and body weight increment upto 5 years of age. The body weights ranged from 395 to 685 kg. The scrotal circumference of these animals ranged from 23.5 to 34.5 cm.

These values for bulls over 5 years of age, ranging from 65 to 108 months, were from 550 to 825 kg for body weights and 28.5 to 35.0 cm for scrotal circumference. In a group of mature bulls ranging in age from 83 to 164 months, the average body weights and scrotal circumference were 767 ± 61 kg and 34.1 ± 2.05 cm, respectively.

Under a routine semen collection programme, average annual value for the production and quality of semen for normal young and mature buffalo bulls are given in Table 2.

The age of 45 normal bulls at first ejaculation ranged from 14 to 58 months, the average being 36.23

Table 2. Quantity and quality of semens produced by young and mature buffalo bulls

No. of ejaculates	Volume (ml)	Mass activity	% Motility	Conc. (million/ml)
Young bulls (N = 38)				
60	2.3	+ + (+)	71	902
Mature bulls (N = 32)				
100	2.7	+ + (+)	70	1063

months. Their body weights then varied from 310 to 690 kg with an average of 519.84 kg.

The following normal values of testes and accessory sex glands were recorded in two groups of bulls studied.

Average age (months)		63.7	118
N		31	11
Average body weight (kg)		651.8	772.8
Gland		Dimension	(cm)
Testes	Right	9.3x5.9	9.8x6.6
	Left	9.3x5.9	10.3x6.9
Scrotal circumference		30.6	34.1
	Right	8.9x5.1	10.6x6.5
Seminal vesicles	Left	9.4x7.8	11.0x6.4
Ampulla	Right	13.6	15.3
	Left	13.6	15.4

Physiology of Post-partum Buffaloes

The experiments were planned on two groups of animals. The first group included buffaloes, calving from April to September while the second included all buffaloes calving from October to March. The study periods thus represented two different parts of the year.

Part of results of first group, i.e., on buffaloes calving during April–September have been obtained and are given as follows while those of second group, i.e., on buffaloes calving during November–March are being collected and will be analysed on completion of data.

1. *Hematocrit:* Overall means of hematocrit value on day 0 (day of calving) and day 7, 14 and 21 post-partum were 33.39 ± 3.8, 24.82 ± 4.5, 36.71 ± 4.71 and 35.32 ± 5.34, respectively. The values on day 0 differed ($P < 0.01$) from those on day 7, 14 or 21 post-partum. Month of calving and month x post-partum interval interaction had significant effect on hematocrit values on day 7 and 21 post-partum but not on day 0 or 14. Hematocrit values on day 7 post-partum were correlated positively with 60 days milk production ($r = 0.32$, $P < 0.01$).

2. *Involution of Uterus:* The period required for uterine involution was 25.6 ± 7.3 days and this was not affected by age of the buffalo, month of calving or parity. This was, however, related to development of follicles ($r = 0.21$ $P < 0.01$). regression of corpus luteum ($r = 0.40$, $P < 0.05$) and observation of first post-partum estrus ($r = 0.45$, $P < 0.01$). Cervical diameter on day 14 post-partum was affected by month of calving (smaller for April, $P < 0.05$) and parity of the buffalo, $P < 0.01$) but was not affected by the age of buffalo. Average affected by the age of buffalo. Average decreases in cervical and pregnant horn diameters from day 14 to complete involution were not affected by months of calving or age of the buffalo but were greater ($P < 0.01$) for cows in first lactation than those in second or higher number of lactations. Sex and birth weight of the calf, however, has no effect on involution rate.

3. *Appearance of First Observable Estrus:* This was observed at 56.44 ± 27.8 days and was not affected by age, parity of the buffalo or by the month of calving. It was not significantly correlated with 60 days milk production, or interval to first follicular development. However, there was a positive correlation between period of uterine involution and interval to first estrus ($r = 0.45$, $P < 0.001$).

4. *First Post-partum Estrus:* The duration of first post-partum estrus was 19.3 ± 10.8 hours. Age and parity of the buffalo and month of calving has no effect on duration of first post-partum estrus. There was negative correlation between first 60 days milk production and estrus duration ($r = 0.23$, $P < 0.1$). The appearance of first estrus had no relationship with its duration. There was a positive correlation of 0.27 ($P < 0.05$) between time of termination with duration of estrus (duration of estrus was longer in buffaloes in which estrus ended at 1800 or 2200 hours, than those in which estrus ended at 0200, 0600 or 1200 hours).

The remaining results like, progesterone hormone assay, percentage of fertility, etc , are being evaluated.

Causes of Sterility in Male Nili/Ravi Buffalo Bulls

Three types of problem buffalo bulls identified at Semen Production Unit (S.P.U), Qadirabad were, bulls suffering from complete sterility (36 percent); bulls which had given poor quality semen from the very beginning (38 percent); and the bulls which started well but developed problem of producing semen of poor quality (26 percent). Twenty two bulls belonging to various types of infertility were slaughtered and detailed post-mortem examinations were made. This included biometry of the reproductive organs and some other endocrine glands. Tissues from these organs were preserved for histological examination. Specimens were also collected from these animals for microbiological studies. Later studies revealed the absence of any type of specific infections, like brucellosis, vibriosis tuberculosis and mycoplasmosis. Histological preparations of samples is in progress.

Reproductive Traits of Kundi Buffaloes

Buffaloes are on top in the production of livestock products. Their population in Sind province is approximately two million heads. This fraction of animal husbandry constitutes a major bulk of the dairy industry in the province. Buffaloes has been so far the most neglected animals as far as research on its productive and reproductive capabilities is concerned. Therefore, it, needs thorough investigation for exploiting the maximum potentials, it has for improving the national economy in the form of more milk, beef, skin etc.

Age-wise groups were made to launch a proper sexual health control programme at Kundi Buffalo Farm. The animals were divided in three groups.

1. *Group I (Buffaloes in Various Lactations):* The total number of buffaloes in various lactation periods, i.e., 1st, 2nd, 3rd, 4th or 5th were classified. All these animals were divided in two sub-groups, i.e., one sub-group included buffaloes which

were within 60 days of parturition. The other sub-group was comprising buffaloes with more than 60 days post-partum. These sub-groups were checked from records if these animals had shown estrus and whether they were bred or not. All animals as a result of service were becoming pregnant/and were allowed to continue with their progressive gestation. The day of parturition and weights of the newborns were recorded. Other animals found to be non-pregnant and not have shown to come into heat were checked with the help of teaser bulls for detection of estrus so that they could be bred at the shortest possible intervals. These animals were utilized to calculate the various reproductive parameters.

2. *Group II (Pregnant Heifers):* These were identified and divided into three sub-groups on the basis of late, mid and early pregnancy. All late pregnant heifers and late pregnant buffaloes were kept in separate paddock for proper care and feeding besides proper recording of timing of parturition.

3. *Group III (Non-Pregnant Heifers):* The non-pregnant heifers were divided in the following three sub-groups on the basis of their age:

a) 2–3 years
b) 1–2 years
c) 0–1 years

The weight gain of all these animals was recorded at intervals of three month to calculate the weight gain pattern . The heifers coming in heat for the first time were weighed on that day to calculate the weight and age at puberty and served to calculate the fertility level.

Data regarding male and female Kundi buffaloes are given as follows:

	Male	Female
1. Liveweight(kg)	625	500
2. Height at withers (cm)	134	132
3. Length from point of shoulder to pinbone (cm)	127	118
4. Average milk capacity in lactation of 9 to 10 months (l)	–	3000
5. Age at first calving (yr)	–	4.5 to 5
6. Lactation period (day)	–	305
7. Calving interval (day)	–	650 range (400–855)
8. Liveweight at birth (kg)	35	30
9. Breeding season	75% medium	July–Oct. Feb.–May

Un scrutinizing the present status of farm animals it was observed that out of 55 buffaloes, 6 had recently parturated, 29 were found pregnant and 20 animals were found having more than 60 days post-partum interval. All these animals were subjected to clinical examination.

All pregnant heifers were identified (10) and were divided into three groups on the basis of late, mid, and early pregnancy. All late pregnant (5) heifers were kept separately, so that timings of parturition could be properly recorded.

All non-pregnant heifers were also divided into four groups on the basis of their age.

1. Above 3 years age – 19 heifers
2. 2–3 years – 13 heifers
3. 1–2 years – 12 heifers
4. 0–1 year – 13 heifers

Quality of Milk at Different Time Intervals During its Distribution

Samples were collected at different intervals during the distribution of milk, and were analysed in the laboratory for total titrable acidity immediately after distribution of milk is over.

The results of study completed so far are tabulated as follows:

Kind of samples	No. of samples	Acidity as lactic acid (%)	
		Minimum	Maximum
Buffalo	143	0.1044	0.1674
Cows	215	0.0930	0.1350

Estimation of Milk Fat Contents of Lactating Animals at Animal Sciences Institute, NARC

The milk samples from individual animal are analysed fortnightly. Since July 1982, 1500 samples have been analysed and average fat contents for cow and buffalo milk were 3.97 and 7.56 percent, respectively.

THRUSTS FOR NEXT YEAR

1. Studies on reproductive triats of economic importance of dairy animals will be continued to boost up milk and meat production in the country.
2. Studies on reproductive physiology of buffaloes will be continued.
3. Evaluation of fine wool sheep through the introduction of exotic germplasm in NWFP.
4. Evaluation and selection of sires based on progeny tests for genetic improvement of livestock.
5. Improvement in the quality and quantity of carpet wool through selective breeding and better management.
6. Cross-breeding of local breeds of cattle with exotic breeds for increased milk production.
7. Fattening potential of different indigenous breeds for mutton production.
8. Studies on the production performance of Cholistani cows.
9. Studies on the impaired reproductive efficacy in dairy animals.

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Animal Health

OBJECTIVES OF RESEARCH PROGRAMME

1. To take adequate safeguards to ensure proper disease control.
2. To study the anthelmintic evaluation of indigenous medicinal plants for veterinary usage
3. To evolve better vaccines for Foot and Mouth disease, Newcastle disease, Rinderpest and other highly contagious diseases of economic importance in livestock and poultry.
4. To study calf mortality in buffaloes.
5. To free the animals from parasitic diseases.
6. To study epidemiology of major livestock diseases.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS / ACHIEVEMENTS

Salmonella in Poultry, Poultry Products, Poultry Feeds and Feed Ingredients

Out of 46907 samples cultured, Salmonella organisms were recovered from 3805 samples. In these isolated organisms, 622 were *Salmonella pullorum,* 2877 *S. gallinarum,* and 307 *S. paratyphoid.* Of these *S. paratyphoid* organisms, 160 were recovered from poultry tissues out of which 29 belonged to serogroup B, 112 to serogroup C_1, 7 to serogroup C_2, 12 to serogroup K. Out of 13, recovered from poultry feed, 3 belonged to serogroup C_1, 4 to serogroup C_2, 1 to serogroup E_2, and 5 to serogroup C_1, Out of 34 recovered from feed ingredients 1 belonged to serogroup B, 8 to serogroup C_1, 2 to serogroup C_2, 6 to serogroup E_1, 1 to serogroup E_2, 3 to serogroup E_4, 12 to serogroup C_1 and 1 to serogroup K. Out of 25 recovered from Hatcher fluff 17 belonged to serogroup B, 4 to serogroup C_1, 2 to serogroup E_1, 2 to serogroup H. All 9 recovered from unhatched embryonated egg, belonged to serogroup C_1. Out of 8 recovered from egg shell, 2 belonged to serogroup C_1, 5 to serogroup E_1, and 1 to serogroup H. Two were recovered from litter of which 1 belonged to serogroup C_1 and 1 to serogroup E_2. Out of 55 recovered from table eggs, 20 belonged to serogroup B and 35 to serogroup C_1. One recovered from water belonged to serogroup D.

All 102 *S. paratyphoid* isolates have been completely serotyped. The results indicate that 5 were *S. typhimurium;* 4,*S. debry,* 1, *S. stanley;* 2, *S. paratyphis* B; 1, *S.texas;* 7, *S. infantis;* 9, *S. richmond;* 3, *S. daytona;* 6, *S. galiema;* 10, *S. baiboukoum;* 2, *S. bareilly;* 1, *S. gatow* 2, *S. thompson;* 2, *S. virchow:* 1, *S. albany;* 3, *S. kentucky* 2, *S. emek* 2, *S. carvallis;* 2, *S. muenster;* 1, *S. regent;* 4, *S. coquilhatville;* 1, *S. amager;* 1, *S. journal;* 2, *S. manilla;* 1, *S. binza;* 1, *S. lanka;* 1, *S. pankow;* 1, *S. cannstall;* 1, *S. yalding;* 4, *S. krefeld;* 14, *S. goodwood* and 5, *S. bristol.*

Results of sensitivity test indicate that all cultures were sensitive to Furazolidine, Gentamycin and Neomycin. Most cultures were sensitive to Oxytetracycline and Chloramphenicol. Whereas all cultures were resistant to Penicillin and Erythromycin. Ten fowls, were identified as typhoid reactors and they were kept under observation. Results were noted upto 6 weeks. Upto 3 weeks there was no mortality but in 4th week 1 bird died and in 5th and 6th week 1 and 2 birds died, respectively. Liver, spleen, heart, ovaries and intestinal content of all dead birds were cultured but *S. gallinarum* was recovered from 1 bird only. Weekly egg production was noted. Pullorum testing of all birds was done weekly and it was found positive. Cloacal swabs, littre samples and eggs were cultured but *S. gallinarum* was not isolated. After 6 weeks all alive birds were slaughtered. Liver, spleen, heart, ovaries and intestinal contents were cultured but *S. gallinarum* was only recovered from one bird.

Salmonella group B was recovered from fluff samples. To test the pathogenecity, 24 hours old culture was inoculated to 3 days old chicks but no mortality was observed upto 5 weeks. After 5 weeks all chicks were slaughtered and post-mortem lesions were recorded and tissues were cultured. No Salmonella was detected from any sample of liver, spleen, and heart after culturing.

For pathogenecity, 40 isolates of group C_1 Salmonella were tested. To begin with 0.5 ml of each culture was inoculated in one day-old chicks; 20 chicks for each culture were used. The chicks were observed upto 5 weeks. Out of 40 isolates, only 3 isolates were pathogenic, viz., *S. bareilly, S. gatow,*

S. thompson, while the remaining had caused variable mortality. Cloacal swabs were cultured weekly and were found positive in Ist week only. Droppings of chicks were also cultured daily. The healthy laying birds which were artificially infected with *S. bareilly, S. thompson* and *S. gatow* showed great depression, in-appetence and diarrhoea, a week after infection. The four groups which were treated with different drugs showed rapid improvement in their clinical condition as compared to the positive control group which was not treated with any drug. The results recorded showed that the groups which were treated with Gentamycin and Furazolidone showed better effects than Gentamycin alone. *S. bareilly, S. thompson* and *S. gatow* were isolated from cloacal swabs and droppings during the first week after inoculation and one week after treatment but not after that. No clinical signs and symptoms of the disease were observed after the treatment period.

The egg production after inoculation with *S. bareilly, S. thompson* and *S. gatow* was 20, 9, and 7 percent, respectively. The feed consumption and water intake reduced suddenly after the inoculation. The birds which were infected with *S. bareilly* showed less intake of feed and water than others. The positive control group showed 25, 19.5 and 21 percent decrease in egg production by the end of experiment in *S. bareilly, S. thompson* and *S. gatow,* respectively.

Birds were treated four weeks after inoculation with four drugs, i.e., Furazolidone, Gentamycin, Streptomycin and Neomycin at 30th and 31st week of age. Furazolidone was found to be more effective than Gentamycin. Salmonella were recovered from the cloacal swabs and droppings, upto one week after inoculation and one week after treatment. Streptomycin and Neomycin showed encouraging results but were less effective than Furazolidone and Gentamycin. Salmonella were recovered from the cloacal swabs and droppings, one week after inoculation and 3 weeks after treatment. The birds which were inoculated with Salmonella regained the egg production after treatment. Negative control groups did not show any symptoms of the disease till the end of the experiment.

The post-mortem examination of the birds, which were treated with drugs and the negative control birds showed no changes in the visceral organs. However, mottling and enlargement of the liver, kidneys and distention of the gall bladder was observed in the positive control birds. Congestion of the lining of duodenum and upper small intestine was noted. Abnormality of the ovarian follicles was also recorded.

Bacteriological examination of the egg shell, egg yolk, and tissues of all groups was carried out during the experiment. *S. bareilly* and *S. gatow* was not isolated from any sample. *S. thompson* was isolated from the egg shell and yolk of 25 percent infected birds before treatment. However, none was isolated from the tissues of those birds treated with different drugs. *S. bareilly, S. thompson* and *S. gatow* were isolated from the spleen, ovary, caeca and liver of 40–50 percent positive control birds. The tissues of the negative control birds showed no sign and symptom of the disease. The post-mortem findings of the negative control birds did not reveal any lesion.

Rinderpest Like Disease

The possibility of other Rinderpest like disease such as infectious bovine rhinotracheitis, bovine viral diarrohea, and para influenza infections is recognised. Thus these diseases must be considered while diagnosing Rinderpest.

An out break of Rinderpest like disease occured at the Cattle Colony, Landhi, Karachi which lasted from November to mid-February, affecting a large number of buffaloes. During survey 517 sheds were visited, out of which 136 were suspected for Rinderpest. A total of 180 animals were recorded as really infected with Rinderpest from which 65 cases were recovered while rest were disposed off. Majority of the affected animals were fresh arrivals in the colony.

Blood samples were collected aseptically from four sick animals at the peak of the temperature. Various laboratory tests like agar gel diffusion, inoculation of cattle with material for virus isolation, inoculation of bovine. Kidney cultures revealed no Rinderpest virus.

Cultures from blood and other material gave bacterial growth. Material suspensions as well as bacterial cultures, killed mice, rabbits and cattle within 24 hours. Identification of bacteria revealed ***Pasteurella, Escherichia coli*** and ***Hafinea*** group. It is observed that material is negative for Rinderpest virus and the problem is due to intestinal form of pasteurellosis.

Agar gel precipitation test (AGPT) was conducted. Firstly antigen was prepared for which mesentric lymph nodes and prescapular lymph nodes were collected from animals slaughtered on the 5th to 9th day of fever. The nodes were trimmed of excess fat, minced with scissors and homogenized with an equal volume of phosphate buffer. The suspension was filtered through gauze and the filtrate used as the antigen. Test was performed using 1 percent Noble agar in borate buffer (pH 8.6) and the test was read after 24–48 h. Results indicate that out of 28 cases tested only one was positive. Details are given in the following table:

Days after onset of fever	No. of samples tested	Positive
3–5	5	Nil
6–8	11	1
9–15	12	Nil

Moreover, counterimmunoelectrophoresis (CIEP) test was performed according to the method of 1 percent agarose in barbital buffer (pH 8.6) and ionic strength 0.02 was used. The antigen was placed in the wells near the anode and the antiserum in wells near cathode. A current of 0.008 to 0.01 amp was passed through the gel for 30 to 40 minutes. Slides were read immediately after the electrophoretic run for the development of precipitation lines, and some were finally stained. Out of 20 samples tested only one was found positive for Rinderpest.

Complement fixation test was performed for block titration of Rinderpest antigen, prepared locally from lymph gland of suspected cases, with hyperimmune serum at $4^{o}C$ for 18 hours. Thus 11 lymph nodes were tested and according to our observations only antigen isolated from one lymph gland proved positive for complement fixation test to the dilution of reference hyperimmune serum, at a minimum dilution titre

upto 1:32. Details of experiment are given in the Table 1.

Clinical material from animals suspected of Rinderpest like disease were also tested for the presence of bacterial pathogens. Since a large number of sick animals responded to treatment by sulpha drugs, the possibility of bacterial infections or secondary complications could be ruled out.

Rinderpest specific precipitinogens were present in the lymph nodes of infected cattle. Diagnosis of Rinderpest could be made by testing lymph glands of suspected animals against hyperimmune serum made in rabbits. When collected during the febrile period of disease these glands contained significant levels of precipitinogens. Sixteen suspected lymph glands (collected 3 to 8 days after onset of infection) were tested for Rinderpest antigen, only. It gave a positive result. Eleven of these samples were tested for the Rinderpest antigen by complement fixation test. It was positive (positive for precipitinogen also).

The buffaloes from which these samples were collected, did not show the classical symptoms of disease (fever followed by diarrohea was reported in most of the cases). During the summer months the incidence of the disease was very low and few animals were available for biopsy and autopsy studies. Due to this reason it was not possible to examine a larger number of cases. Other Rinderpest like diseases had to be considered in making a diagnosis for Rinderpest. Bovine viral diarrohea, para influenza infections and Infectious Bovine Rhinotracheitis (IBR) were also being included in the investigations and suspected material was to be tested for these agents also.

Table 1. Complement fixation test of Rhinderpest antigen

Antigen Dilutions (lymph glands)	Reference Serum Dilutions 1:8	1:16	1:32	1:64	1:128	1:256	Antigen Control (no serum)
1:2	4	4	4	3	2	0	0
1:4	4	4	4	2	1	0	0
1:8	4	4	3	2	0	0	0
1:16	3	2	0	0	0	0	0
1:32	2	0	0	0	0	0	0
1:64	0	0	0	0	0	0	0
Serum control (no antigen)	0	0	0	0	0	0	0
Complement control (complement units)	0	0	2				
	5CH 50	2.5CH 50	1.25CH 50				

Effect of Parasitic Load (Haemonchosis) on Body Weight Gain and Wool Yield in Sheep

Haemonchosis, a round worm infestation in sheep inflicts heavy losses to livestock industry due to decreased mutton production and poor wool yield both quantitatively and qualitatively. To work out the extent of losses due to the parasitism in sheep, the present project has been started on 40 sheep.

The faecal examination of all the sheep was conducted to assess the present status of parasitic infestation. The incidence of different parasites was worked out. The most prevalent was the *Haemonchous contortus* (85 percent). Next in order were the *Trichostrongylus* species (22.5 percent), *Oesophagostomum columbianum* (20.0 percent), *Chabertia ovina,* (17.5 percent), *Oestertagia circumcincta* (10.0 percent) *Moniezia expansa* (5.0 percent).

All the experimental sheep have been rendered free both from external and internal parasites with treatment of Asuntol and Systemex.

The larvae of *H. contortus* are being grown experimentally in the laboratory. Their known number of third stage larvae will be fed to different groups of sheep by keeping control group to work out the effect on wool yield and growth rate of sheep.

Incidence of Parasitism in Sheep and Goat in Rawalpindi

During the period under report studies completed on animals (sheep and goats) revealed the incidence of different parasites as follows:

Parasite	Incidence (Percent)
H. contortus	75.55
Trichostrongylus spp.	52.51
O. circumcinacta	13.67
C. ovina	10.79
M. expansa	10.79
O. columbianum	5.04
Fasciola gignatica	2.15
Avetillina centripunctata	2.15
M. benedeni	0.72

Serological Survey of Bovine Brucellosis

Bovine brucellosis, a disease of great economic importance inflicts losses in animal production through abortion in animals at the pregancy, subsequently causing decrease milk production, infertility, prolonged calving interval in aborting animals, loss of calves and interference with breeding programmes.

In total 471 animals have been tested including the livestock at Animal Sciences Institute (ASI) Farm, NARC, and 7 villages around NARC. The serological tests employed were serum agglutination and milk ring tests. Dry herd at ASI was screened with serum agglutination test while lactating herd at ASI and at different villages were screened with milk ring test. Cases positive to later were confirmed with the former test. Standard antiserum was prepared for comparison in two chinchilla rabbits. The results of the study completed so far are given in Table 2.

Table 2. Incidence of brucellosis

Species	No. examined	No. positive	Incidence (percent)
Buffalo	296	7	2.36
Cattle	175	5	2.85

Immune Response of Buffalo and Cow Calves Following Foot and Mouth Disease (FMD) Vaccination

This project has been initiated to compare the immunological competency of cow and buffalo calves and pattern of immunity development in these two groups of animals.

Sixteen calves (8 of each species)

of about 4 months of age were selected. They were born to FMD vaccinated dams. Each of 12 calves received 5 ml FMD (cell culture) vaccine subcutaneously leaving 4 animals as non-vaccinated control (two calves in each group).

Pre-vaccinal serum samples were collected from all these calves to determine the initial titre of residue maternal immunity.

Bacteriology of Milk at Different Intervals During its Distribution

To investigate the current standard of raw milk being supplied to Islamabad consumers, total viable count of organisms is being made from the samples collected twice a week both from morning and evening supplies.

Studies have been completed on winter milk supplies. Samples were collected at hourly interval, from initial point till the supplies were over. Total 358 samples have been tested so far and the results are given in Table 3.

Incidence of Subclinical Mastitis Identification and Drug Susceptibility of Causative Organisms at ASI, NARC

Lactating herd at ASI, NARC was screened fortnightly using white side test. Positive cases were subjected to bacteriological techniques for isolation of causative organisms. Antibiotic sensitivity of these positive cases was also checked to find out the effective drug for the treatment before they develop into overt form. The incidence of subclinical mastitis in cows varied from 23.59 to 43.51 percent whereas among buffaloes it ranged from 10.0 to 23.07 percent. The organisms encountered were *Streptococcus agalactiae, S. pyogenese, Staphylococcus aureus, Corynebacterium pyogenese, Bacillus cereus, E. coli, Proteus vulgaris.*

Almost all the organisms were found sensitive to either Combiotin or Oxytetracycline and were treated successfully.

Table 3. Bacterial count of raw milk supplies

	Total count		Coliform count	
	Morning	Evening	Morning	Evening
Cow milk	1.6×10^4 – 1.3×10^8	1.8×10^4 – 1.9×10^8	2.1×10^4 – 3.0×10^5	4.2×10^3 – 7.5×10^6
Buffalo milk	8.0×10^4 – 7.2×10^8	4.0×10^5 – 2.1×10^9	2.0×10^3 – 1.7×10^8	5.0×10^3 – 4.0×10^7

THRUSTS FOR NEXT YEAR

1. Studies to take adequate safeguards to ensure proper disease control like Rinderpest, Mycoplasmosis, Newcastle disease, Haemoglobinurea and Mastitis.

2. Incidence, taxonomy and seasonal variation of gastro-intestinal parasites of economic importance in sheep and goats.

3. Effect of aflatoxins in poultry.

4. Studies on the epidemiology of major livestock diseases.

5. Studies on the comparative and seasonal incidence of Paramphistomiasis in cattle, buffalo, sheep and goat and its diagnosis through serological techniques.

6. Control of Warble fly in livestock.

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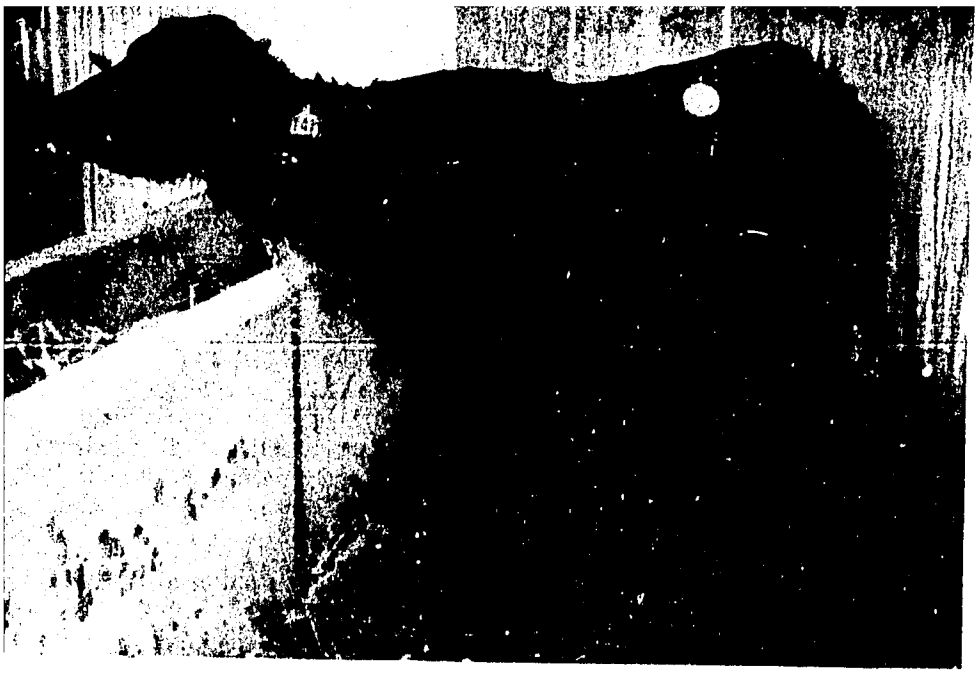


Animal Nutrition

OBJECTIVES OF RESEARCH PROGRAMME

1. To introduce a uniform official terminology for feeds, forages and other resources used for livestock feeding in Pakistan and to formulate national standards for methods of analysis and caloric value determination of feed resources.
2. To develop technologies for treatment of cellulosic wastes and their conversion into nutritionally valuable feeds.
3. To establish a fully equipped analytical laboratory for feeds.
4. To identify feasible systems for farmers, commercial feed millers, agro-industries and sugar-mills for the production of ruminant feeds.
5. To develop suitable feeding management systems according to the cropping patterns of individual provinces during the various seasons of the year.
6. To establish methods for converting livestock wastes, crop residues and industrial by-products into valuable feeds.
7. To provide least cost formula ration services to farmers and feed manufacturers.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS / ACHIEVEMENTS

Effects of Restricted Suckling on the Performance of Shorthorn and Sahiwal Cows and Calves

Twenty cows drawn from a mixed population of Australian Illawara Shorthorn (AIS), Sahiwal (S), their first crosses (F_1) and back crosses to AIS (B_1) were allocated to either artificial rearing (AR) or restricted suckling (RS) treatments.

The breed make up of the treatments was slightly confounded with AR and RS having S: 2, 6; F_1: 1, 1; B_1: 6, 2 and AIS: 1, 1 animals, respectively. During the first four days the calves stayed continuously with their dams to consume the maximum amount of colostrum. Calves under AR were separated permanently from their dams and were fed whole cow's milk from nipple bottle, whereas RS calves were allowed to suckle their dams for 30 minutes twice daily. After 30 days the freqency of nipple feeding and RS was reduced to once daily. All the calves were housed together and had free access to green fodder and a feed concentrate.

The cows were grazed on pastures but sometimes on crop residues. In addition, they were given 6.5 kg of feed concentrate based on cottonseed cake, 5 percent; wheat bran, 20 percent; maize gluten feed, 20 percent; rice polishing, 15 percent; molasses, 13 percent; urea, 0.25 percent; salt, 0.25 percent and mineral mixture, 1.0 percent.

The calves were weighed within 24 hours after calving and at weekly intervals. RS calves were weighed before and after suckling to determine their milk consumption. The amount of milk given to the AR calves was recorded daily. Composite samples of the milk were analysed on a weekly basis for fat (Gerber), protein (Kjeldahl) and total solids (drying at 60°C). Milk for the AR calves was taken from the total quantity given at milking. For the RS treatment; samples were taken from the dam during the suckling process (Table 1).

There were no apparent differences in the composition of the milk consumed by the calves on different treatments and in milk yield due to treatment in the AIS cows and their crosses. Cows on both treatments lost liveweight during the first 92 days of lactation and there was a slight tendency of weight loss in the RS treatment.

It can be concluded that RS calves compared with artificial fed ones from a nipple bottle not only leads to faster growth rates but in a much superior efficiency of utilization of the ingested milk for tissue growth. There appeared to be no difference in the response of the AIS and its crosses, and the Sahiwal breeds.

Feeding Value of Sugar Beet Pulp Silages

Fresh sugar beet pulp containing 93 percent moisture was ensiled in big polythene bags (3m x 1.8m) in the following combinations:

Ingredient (%).	Silages A	B	C
Fresh beet pulp	100	75	98
Wheat straw	–	25	–
Common salt (NaCl)	–	–	2
Total:	100	100	100

The bags were tightly sealed but

Table 1. Performance of cows and calves reared by restricted suckling (RS) or artificial rearing (AR)

	AR	RS
Calf Performance		
Birth weight (kg)	32.6	30.9
Weight at 92 days (kg)	64.6	83.1
Belly girth at 92 days (cm)	102	111
Condition score at 92 days*	63.3	74.0
Daily weight gain (g)	370	552
Increase in condition score	0.189	0.329
Milk intake (kg/d)	3.04	2.67
Milk conversion**	8.98	4.97
Composition of milk consumed by calf (%)		
Fat	4.09	4.22
Protein	3.55	3.62
Total solids	12.9	12.7
Cow Performance		
Total milk (kg/d) AIS + Crosses	13.0	11.7
Sahiwal	2.67	6.99
Saleable milk (kg/d)***		
AIS + Crosses	10.0	9.1
Sahiwal	−0.66	4.26
Liveweight change (kg/d)		
AIS + Crosses	−0.402	−0.299
Sahiwal	-0.226	−0.150

* Condition score = 100 [liveweight (kg) belly girth (cm)]
** Milk consumed (kg)/liveweight gain (kg)
*** Saleable after calf feeding

have a few holes for drainage and were kept inside a room. These were opened after 19 weeks and subjected to chemical analysis and digestibility studies. The digestion trials were conducted in a 3 x 3 latin square design on three growing calves. Silages mixed with 0.4 percent urea and 0.4 percent dicalcium phosphate were fed ad libitum to the calves. In addition 1 kg dried chopped maize fodder was given to each calf daily.

Table 2 indicates some differences in the chemical composition of silages, their VFA profiles and palatability and digestibility.

In another experiment, three different types of silages were prepared on large scale at a commercial buffalo farm in Mardan. The estimated composition of silages prepared are:

Ingredient (%)	Silo 1	Silo- 2/3
Beet pulp	72.0	55.2
Sugarcane pith	27.0	21.0
Sugarbeet leaves		23.0
Urea	1.0	0.8
Total:	100.0	100.0

The samples of silages were collected from the silos after a period of 6 weeks. Each silo was bored 0.6m deep for taking out the samples. They were then evaluated for their nutritional value.

These silages have successfully been tried on dairy buffaloes as a main source of feed in addition to the available forages, during various seasons of the year. The buffaloes consumed about 14 kg on DM basis per head per day.

Effect of Different Levels of Urea, Moisture and Treatment Time

Batches of 100 g of wheat straw were treated with 5, 6 and 7 g of urea. The urea was dissolved in sufficient amount of water to give a final moisture concentrations of 30, 50 and 70 percent with each urea level.

Wheat straw was put in wide mouth plastic bottles and urea solution was sprayed. Immediately after the addition of urea the bottles were shaken, closed tightly and were kept in open air under the sun. The samples were treated for four weeks. The samples were collected weekly and after an overnight drying in oven at 70°C they were subjected to analysis. The in vitro organic matter digestibility (INVOMD) was determined by Tilley and Terry method (1963).

The results (Table 3) indicated that the moisture of straw should not be above 50 percent, because samples with higher moisture content exhibited rancid odour and various degrees of decomposition of the organic matter. For this reason they were excluded from analyses.

Use of Soybean as a Source of Urease Activity

Dried sugarcane pith was treated with 6 g of urea dissolved in 50 g water per 100 g calculated on DM of pith. Ground soybean was added to the treated pith samples as a source of urease at 0, 0.5, 1.0 and 2.0 g per 100 g levels of sugarcane pith DM.

The treatment was carried out in plastic bottles which were immediately sealed. All the treatments were run in duplicate. The samples were thoroughly mixed. Two samples of sugarcane pith were also treated with 16 g of ammonium bicarbonate and 50 g of water per 100 g of pith DM (equivalent to 6 g of urea/100 g pith DM on N basis). After three weeks the samples were opened and analysed for their crude protein content and INVOMD (Table 4). The high crude protein content in the urea treated sample without soybean is due to the unhydrolysed urea, showing that there is no natural urease activity in cane pith.

Treatment of Wheat Straw with Urea at Farm Level

Five hundred kilogram wheat straw was treated with 30 kg urea and 250 kg water for a period of three weeks in a stack using a frame of four carts for storing straw. The urea solution was sprayed while compacting. The stack was then made airtight with wet mud. After three weeks, a strong ammonia smell was noticed which confirms the effectiveness of the technology applied. The treated straw samples were evaluated for their crude protein content and INVOMD.

The treatment with urea elevated the nutritional value of wheat straw to medium quality hay in terms of crude protein equivalent and the digestibility of organic matter.

Table 2. Chemical analysis, intake and digestibility of beet pulp silage

Parameters	Silage–A	Silage–B	Silage–C
Nutrients			
DM (%)	12.28	21.83	15.23
		Percent of DM*	
Ash	5.39	11.12	22.19
Crude protein	11.37	6.65	8.47
Crude fibre	27.48	37.61	20.24
Crude fat	0.98	1.12	0.87
Nitrogen free extract	54.78	43.50	48.23
Density (kg/m^3)	565.00	307.00	540.00
		Percent of VFA**	
Ammonia N	4.65	6.85	4.90
Acetic acid	8.49	1.80	2.25
	5.03	22.73	16.83
Butyric acid	0.87	5.93	0.73
	5.00	74.87	5.46
Lactic acid	6.65	0.19	10.39
	41.54	2.40	77.71
pH	3.87	4.43	3.48
Temperature (^0C)	19.00	17.00	17.00
Daily Dry Matter Intake			
Ration (kg)	2.74	2.63	2.79
Silage (kg)	1.87	1.76	1.92
Dry Matter Digestibility			
Ration (%)	67.26	57.02	72.51
*** Silage (%)	70.21	55.11	77.76
Organic Matter Digestibility			
Ration (%)	71.97	61.86	72.60
*** Silage (%)	75.84	60.80	77.71

* DM = Dry matter
** VFA = Volatile fatty acids
*** Calculated values

THRUSTS FOR NEXT YEAR

1. Production of experimental molasses blocks and feed blocks for various intake levels to meet requirements for different species of livestock and their production levels.
2. Testing the technical feasibility and economic viability of integrated recycling units, under construction, to be used as a demonstration model for small farmers in cooperation with extension services and Agricultural Development Bank of Pakistan.
3. Establish pilot processing plant for sugarcane pith to make a concentrated or complete ration using urea as a medium for treatment.
4. Technical backstopping of UNHCR project involving feed block and briquette production at Charsadda or other sugar-mill for livestock owned by Afghan refugees to reduce pressure of large number of livestock from Afghanistan on land and feed resources in NWFP.
5. Initiating development of dairy pilot plants in Peshawar valley designed for maximum utilization of ensiled sugar beet pulp and other waste resources deriving from the activities of sugarcane and other agro-industry.
6. In cooperation with UNHCR, PCSIR and Military Farm various complete or semi-complete rations for dairy animals and for fattening sheep will be prepared using briquetting machine to verify various forms of ammonia treatment through extrusion process.

SCIENTIFIC STAFF

1.	Dr. Amanat Ali	Senior Scientific Officer
2.	Miss Zarqa Naseer	Scientific Officer
3.	Mr. Amanullah Cheema	Scientific Officer
4.	Mr. Fatahullah Khan	Scientific Officer
5.	Mr. Farasat Abbas	Scientific Officer

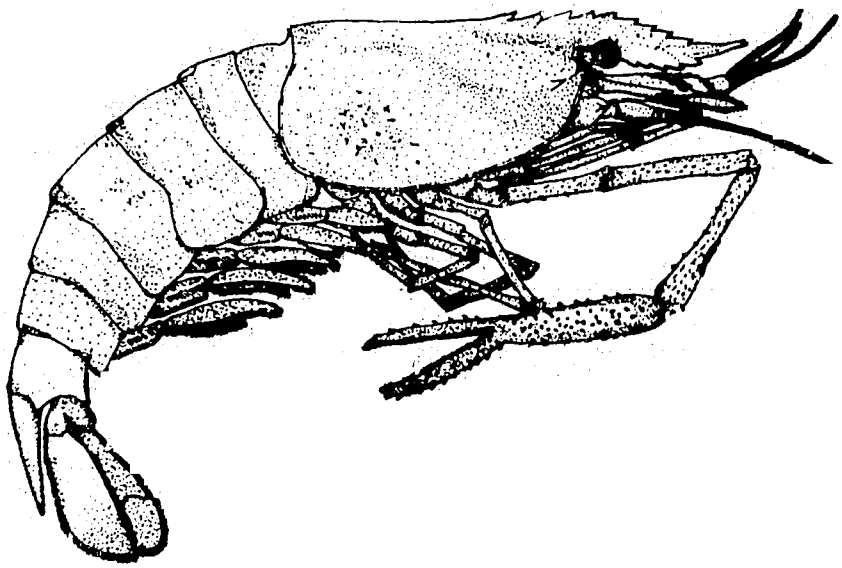
Table 3. In vitro organic matter digestibility of urea treated wheat straw (% DM basis)

Level of urea (g/100 straw DM)	30% moisture level (week)				Treatment time (week)			
	1	2	3	4	1	2	3	4
5	40.4	45.8	50.4	52.9	41.6	44.5	48.2	50.7
6	40.6	45.2	53.0	55.3	40.0	48.5	50.4	53.0
7	39.0	42.1	46.5	47.2	43.1	47.0	45.2	55.0

INVOMD of untreated wheat straw = 35.8

Table 4. Effect of adding soybean on the ammoniation of sugarcane pith with urea (on % DM)

Sugarcane pith	Crude protein	INVOMD
Untreated	2.19	43.0
Treated with 6% urea without soybean	15.56	43.1
Treated with 6% urea + 0.5% soybean	5.50	46.5
Treated with 6% urea + 1.0% soybean	6.06	48.7
Treated with 6% urea + 2.0% soybean	6.06	48.7
Treated with 16% of ammonium bicarbonate	7.19	50.7



Fisheries

OBJECTIVES OF RESEARCH PROGRAMME

1. To prepare and publish the carcinological fauna of Karachi (Sind) coast, viz., faunistic studies, some biological aspect of commercial and common species.
2. To undertake rearing work of the commercial species of prawn available in the freshwaters of Sind province and river Indus.
3. To evaluate various feed formulae and their effects on growth and survival rates, fecundity and rearing of trout fry.
4. To study the invertebrate fauna of mangrove swamps of Karachi coast.
5. To find out the effect of insecticide pollution on fish physiology.
6. To study the resources of fish/shellfish along Baluchistan coast, their dentification and distribution pattern.

DETAILS OF EXPERIMENTS SALIENT FINDINGS / ACHIEVEMENTS

Crustacea (Decapoda and Stomatopoda) of Pakistan

Regular collection trips (about 176) were made to different localities viz., (cape Monz) Buleji, Hawks Bay, Korangi Creck, Bunglow, Hub river delta, Monora, Mangrove Swamps, Sandspit, Gadiani, Pasni, Gawadar and from landing at Karachi Fish Harbour. A total of 5191 specimens were obtained. Many of these were collected by breaking the rocks, under the stone, during low tides.

The collections were sorted, preserved, identified and catalogued. Some were caught alive and brought to the laboratory in plastic bags. Live specimens and ovigerous females were kept in small aquaria or plastic bowls where they survived for a few days, and some even lived for several weeks at room temperature. Water was changed every 2–3 days; food was offered when available, and circulation was maintained.

Specimens were killed by chilling or freezing in a refrigerator and preserved in 70 percent alcohol for later studies. The preserved collection includes all representatives of class Crustacea.

Several specimens were collected for the first time from Pakistan waters; many afforded the first subsequent record of the species. Some species spawned in the laboratory and early larvae of many species were reared.

1. *Taxonomic Studies and Systematics:* Nineteen species of Stomatopoda and 250 of Decapoda have been obtained. They are housed in the Marine Invertebrate Reference Collection Centre (MIRCC), Karachi. The new records are adding considerably to the existing knowledge of the local fauna. Recently a project has been launched for exploring the Crustacean fauna of mangrove swamps near Karachi.

A fairly large collections of planktonic shrimps belonging to genus *Acetes,* earlier unrecorded from the marine waters of Pakistan were obtained. One very interesting and a fairly large section of anomurans. – the pagurids (hermit crabs) was thoroughly studied and the results were published.

2. *Larval Development and Juveniles:* A large collection of juveniles of penacid prawns is preserved. *Processa edulis, Periclimenes (harpilius) elegans* and *Macrophthalmus* sp., spawned in captivity and early larvae of these species were reared in the laboratory.

The Crustacean fauna of mangrove swamps of Karachi is absolutely unknown. Some collection trips (including planktonic collections) have revealed the presence of some common prawns (pencid and caridea) and several species of crabs, some of which are as yet unidentified. In all, 16 species of crabs have been collected. Some records are new.

Rearing Techniques of Fresh Water Prawns

Buried females of *Macrobrachium malcolmsonii* were collected from Khoris near Thatta. They were kept alive in large plastic bowls of 40 l, half filled with tap or brackish water of six percent salinity in the laboratory. After hatching larvae were separated in beakers containing brackish water with salinity ranging from 4 to 18 percent. The seawater was collected weekly from Clifton shore, Karachi, salinity of which varied from 37 to 37.5 percent. The larvae were fed on *Artemia nauplii* daily, supplemented with fish eggs, sieved boiled fish, plankton, fish slag, ground soybean and egg custard. Uneaten

food particles, wastes, and dead larvae were siphoned out daily and the water was changed on alternate days.

Rearing of *Macrobrachium malcolmsonii* through all larval stages is a difficult problem due to uncontrolled salinity and temperature, which fluctuates day by day due to lack of circulation and filteration of waters. Inspite of these limiting factors all the larval stages have been obtained. It is believed that if the rearing of this prawn is done under controlled conditions, excellent results can be achieved.

Study of Trout Feed at Madyan Trout Hatchery, Swat

An improved feed, F_6 was introduced to the fingerlings in April 1982. For comparing growth, random sampling was made from each trial and control stock. Total percentage gain reported is, 51 percent in feed F_1; 57 percent in feed F_5, 57 percent in control feed and 313 percent in feed, F_6. Mean conversion ratio of feed, F_5 and F_6 is the same, i.e., 5, while that of control feed is 6. The overall mortality is 3–5 percent in fingerlings and 29–40 and 49–62 percent in adult and brooder stages, respectively. The cost of different feeds has been calculated as Rs. 3.10, Rs. 2.99, Rs. 4.93 and Rs. 9.80 per kg for feeds, F_1, F_5, F_6 and control feed, respectively.

Toxic Effect of Pesticides on Fish Survival

The project under consideration was implemented in July 1982. The work included fabrication of specialised tanks for experimental analysis of effects of selected pollutants in a flow-through system. In addition to the above work, field trips were made to collect fish for breeding at the Departmental Fish Laboratory. Specimens of mahseer (*Tor putitora*) were collected for breeding work. As part of survey of pollutants, water samples were collected from Rawal Lake for chemical analysis.

Mangrove Fauna of Karachi Sind Coast

Collection work has recently started on the mangrove swamps. Regular trips are made to Jerry Creek, black water of Sandspit, Mangrove area of sides of Jelly bridge, P.N.S. Himalaya. It is found that fauna is rich, varied and absolutely unknown. Collections made so far have yielded species of all the major groups of economic importance.

Breeding and Reproductive Behaviour of the Carp, *Tor putitora* (Mahseer)

Fish were collected during January and March from Rawal Lake and its tributaries. Prior to killing animals for morphological studies of the gonads, blood was collected from common cardinal vein using heparinized syringes. Plasma was separated for androgen and estrogen estimations. Standard length and weight of fish were recorded.

For determination of seasonal variations in the gonads, the testes and ovaries were dissected out, weighed and immersed in Bouin's fixative. Subsequent to standard micro-techniques 8–10 μ thick sections were stained with hematoxylin-eosin.

Morphological examinations were carried out for observing seasonal changes in ovarian and testicular development. In addition, gonadosomatic index (GSI) was calculated using ovarian and testicular weights as a percentage of body weight.

The findings indicate that average testicular weight increased from 12.0 to 30.5 g during the period while GSI varied from 1.5 to 3.8. Morphometric observations on the testes for the three months revealed that seminiferous tubule diameter and the height of tubular epithelium increased with time. The nuclear diameters of interstitial cells also showed a gradual increase. Average plasma testosterone levels increased from 172 to 182 ng/100 ml while testicular testosterone increased from 0.6 to 1 ng/mg.

Comparable trends were noted with regard to ovarian development. The ovarian weight ranged from 19.0 g in January to 40.8 g in March. The GSI varied from 1.9 to 4.0 during same period. The average diameter of oocytes also showed a substantial increase from 110 to 17[illegible] μ. The estrogen levels in the ovarian tissue changed from 0.12 to 0.18 ng/mg, while plasma levels changed from 452 to 504 ng/100 ml during January and March.

THRUSTS FOR NEXT YEAR

1. Study on the effect of pesticides on fish development, growth and survival will be continued.
2. Further studies on invertebrate and vertebrate fauna of mangrove swamps will be done.
3. Survey, collection, cataloguing of fish landing at all fishing stations on the 720 miles long Baluchistan Coast, throughout the year, will be made.
4. Artificial breeding and propagation of *Tor pitutora* will be made.

SCIENTIFIC STAFF

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8.	Miss Humera Ehsan	Scientific Officer

Part II

Social Sciences

Technical

Crop Yield Constraints Research

OBJECTIVES OF RESEARCH PROGRAMME

1. To identify biological factors responsible for yield differential at the farm level as against the potential yields obtained with recommended technology at the farmers' fields and the socio-economic conditions restricting use of new inputs needed for high yields.
2. To measure the on-farm gap between potential and actual yields obtained under the prevailing socio-economic and physical environments.
3. To quantify the contribution of individual biological factors to the yield gap.
4. To make economic evaluation of the contribution of test factors to assess the added benefits of new farm technology *viz-a-viz* farm level practices.
5. To delineate the recommendation domain where it may be possible to alleviate existing physical and socio-economic constraints limiting farm yields by affecting farmers' adoption behaviour.
6. To suggest measures for removing yield constraints through an integrated institutional approach which would invariably involve the research, extension and other rural development institutions and policy makers/ planners.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS / ACHIEVEMENTS

The methodology for conducting experiments was same as used in the previous year (see PARC Annual Report 1981-82).

Field Experimentation

For various crops, 201 experiments in the Punjab, Sind, N.W.F.P. and Islamabad district were conducted with the cooperation of Cooperating Institutions detailed in Table 1.

The Cooperating Institutions included Rapid Soil Fertility and Soil Testing Institute, Lahore; Maize and Millet Research Institute, Yousafwala, Sahiwal; Soil Survey of Pakistan, Lahore Sind Agricultural University, Tandojam; Cereal Crops Research Institute, Pirsabak, Nowshera; Agric. Research Institute, Tarnab, Peshawar; and Technology Transfer Unit, NARC.

Table 1. Number of trials conducted for various crops

Crop\Province	Punjab	Sind	NWFP	Islamabad	Total
Wheat	27	19	20	32	98
Maize	14	–	22	–	36
Rice					
'IRRI-6'	7				
'Basmati'	17	–	–	–	24
Sugarcane	14	2	–	–	16
Cotton	–	3	–	–	3
Groundnut	10	0	–	–	10
Oilseed (Raya)	14	–	–	–	14
Total	103	24	42	32	201

Yield Gap and Contribution of Test Factors

The yield gap occurs because of different levels of inputs used by the farmers as against the recommended levels, test factors being tried under field conditions. Each factor has its contribution in enhancing yield on farmers' fields. Contribution of each factor in different crops in the Punjab, NWFP and Islamabad district is given in Table 2.

In Sind, two experiments were laid out on sugarcane with chiseling, gypsum and fertilizer as test factors. A gap of 24598 kg/ha was observed. Chiseling and fertilizer contribution were 59 and 48 percent, respectively, However, gypsum did not affect the yield significantly.

In three other experiments on cotton at Sind, plant density and weedicides were the test factors which showed a yield gap of 170 kg/ha. Plant population covered almost the whole gap while weedicide application did not show any positive effect.

In all, 19 experiments were laid out in Sind on wheat. Herbicides, different varieties and method of sowing were tested in 15 experiments

Table 2. Yield gap and contribution of test factors to yield gap

(kg/ha)

Province	Crop	Yield			Contribution of each factor* [%]		
		Farmers' practice	Recommended practice	Gap			
Punjab	Sugarcane	59164	96141	36977	23716 (F) [64]	5355 (I) [14]	7140 (S) [19]
	Rice						
	'Basmati-370'	2249	3200	951	365 (F) [38.4]	371 (PD) [39]	183 (PP) [19.2]
	'IRRI-6'	3573	5056	1483	704 (F) [47.5]	667 (PD) [45]	54 (PP) [3.6]
	Maize	2171	3463	1292	716 (F) [55.4]	259 (PD) [20]	358 (V) [27.7]
	Groundnut	1582	2448	866	435 (F) [50.2]	477 (W) [55.1]	61(V) [1.67]
	Oilseed (Raya)	763	1467	704	324 (F) [46]	197 (PP) [28]	176 (V) [25]
	Wheat						
	(Irrigated)	2729	3432	703	492 (F) [70]	33 (PT) [5]	176 (LP) [25]
	(Rainfed)	1620	3296	1676	1473 (F) [88]	180 (MF) [11]	135 (LP) [8]
NWFP	Maize	2218	4392	2175	915 (F) [42]	533 (PD) [24]	720 (V) [33]
	Wheat	1630	3893	2263	849 (F) [37]	338 (W) [15]	788 (V) [35]
Islamabad	Wheat	1775	3629	1855	906 (F) [49]	532 (W) [29]	392 (IC) [21]

*F = Fertilizer; I = Irrigation; S = Seed rate; PD = Plant density; PT = Planting time; PP = Plant protection; V = Variety; MF = Method for fertilization; LP = Land preparation; IC = Intercropping

and a yield gap of 711 kg/ha was recorded. In the remaining four experiments, chiseling, gypsum and fertilizers were the test parameters. A gap of 1223 kg/ha was observed over a yield of 2390 kg/ha of farmers practice.

Socio-economic Surveys

Socio-economic surveys were conducted for groundnut and wheat in Rawalpindi and Hyderabad districts, respectively. The results and main findings are tabulated as follows:

	Groundnut (1983)	Wheat (1982-83)
1. Fertilizer application		
i) Farmers using fertilizer	15.2%	100.0%
ii) Acreage fertilized	100.0%	--
iii) Dosage N/hectare	22.6 kg	97.9 kg
P/hectare	57.7 kg	57.33 kg
2. Reasons for low usage of fertilizer		
i) High price of fertilizer	68.0%	66.0%
ii) High use of fertilizer risky	23.6%	16.0%
iii) Think that soil does not require it	15.2%	18.0%
3. Percentage acreage under different varieties		
'Banki'	88.3	
'C-334'	16.6	
'Pawan'		74.5
'Z.A-77'		19.2
'Sonalika'		3.3
'LU-26'		2.9
4. Reasons for not using recommended varieties		
i) Lack of knowledge	–	56.0%
ii) Non-availability of recommended seeds in time	–	44.0%
5. Farmers practising weeding	20.8%	Nil
6. Reason for not weeding		
i) High cost of labour	22.2%	10.0%
ii) Using weeds as fodder	56.9%	26.0%
7. Farmers' perception of yield constraints		
i) Pest problem	94.4%	–
ii) Soil problem	44.4%	–
iii) Labour problem	79.1%	–
iv) Lack of funds for recommended level of inputs	–	28.0%
v) Lack of knowledge of improved cultivation	–	54.0%
vi) Tenurial status	–	18.0%
8. Credit use	2.7%	22.0%
Reasons for not using credit		
i) Complicated procedure	37.5%	12.8%
ii) Not available when needed	33.3%	7.7%
iii) High interest rate	11.1%	10.3%
iv) Use is risky	25.0%	23.1%
v) Tenurial status	–	46.1%
Sample size	72	50

THRUSTS FOR THE NEXT YEAR

1. Conducting 40 experiments on rice, maize, groundnut and cotton during *kharif*, 1983.
2. Conducting 30 experiments on wheat.
3. Conducting socio-economic survey in the Punjab and NWFP on rice, maize and wheat.
4. Preparation of technical reports on the field data of various crops.
5. Arranging training-cum-review programmes in all the provinces for field staff.

SCIENTIFIC STAFF

1. Mr. Manzoor Ali	Coordinator
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6. Mr. Nazir Hussain	Scientific Officer

Farm Management Research

OBJECTIVES OF RESEARCH PROGRAMME

1. To identify and analyse parameters of production cost of major crops.
2. To analyse relative profitability of various crops and enterprises.
3. To measure technical and economic efficiency in the production systems of crops and other enterprises.

The details of the findings at the two Cooperating Units are given as follows:

APPLIED ECONOMICS RESEARCH CENTRE, KARACHI

Data Collection

Data were collected with the help of "cluster- sampling". For this purpose three distributaries of Rohri canal, i.e., Setharki, Right Jahri and Left Jahri of Taluka Nawabshah were selected. Thirty water courses (cluster of farms) out of the total 92 were chosen on a proportionate random basis, from these distributaries. These covered 6268 ha of land, i.e., 29.45 percent of the total canal commanded area (20927 ha). Two hundred farm operators were interviewed and visited twice in 1982-83, which covered both *kharif* and *rabi* seasons. Most of these farm operators were small land holders and tenants.

These surveys covered various aspects of farm production, consumption, labour utilisation, marketing and capital investment.

Preliminary Results

Transcription of data to tape for final data analysis through computer will be completed in September, 1983 as per schedule. Therefore, only a few preliminary results relating to cropping intensity, gross value of products (per farm and per hectare), crops output and their yield per hectare were computed on farms located in the sample areas. These are analysed under various farm sizes and different tenurial arrangements.

1. *Cropping Intensity:* The use of land for crops is best reflected by the cropping intensity which is the proportion of total cropped area to cultivated area in a year. The cropping intensity recorded was highest on tenant-operated farms and small farms. These results are supported by other studies which used census and field survey data of Sind province.

It has been found that the cropping intensity falls with the large farm size and that it was lower on owner farms than tenant farms. The possible explanation of higher cropping intensity on tenant-operated farms (located in the sample areas) is that tenants (*haries*), having small parcels of land, are forced to use the same piece of land several times in a year than those who own the land. It is also possible (recent evidence on tractors use, supports this) that use of tractors for land preparation will result in increasing the cropping intensity of farms. This impact is more pronounced in case of tenant-operated farms.

2. *Gross Farm Income (GFI):* Difference in GFI per hectare between tenant and non-tenant farms shows that the former have relatively higher per hectare gross farm income than the latter. This difference may reflect their land use pattern. While comparing incomes raised on different farm sizes, it is found that small farms are having relatively greater cropping intensity whereas their farm incomes are comparatively low. One possible explanation for this is that they did not have access to the markets and mostly received relatively lower price for their farm products.

3. *Land Productivity:* The result indicate no significant difference in land productivity in cases of wheat and cotton among different farms located in the sample area. However, for sugarcane, tenants and medium farms seem to have relatively higher yield per hectare. The recent evidence on yield per hectare is mixed and shows that yield of all leading crops in Sind tends to fall with increasing farm size. But more recent evidence on yield differences showed no systematic differences in this respect. In conclusion, we may say that tenant-operated farms, using their land relatively to a greater extent, have relatively higher gross farm income per hectare.

AGRICULTURAL UNIVERSITY, TANDOJAM, SIND

Data Collection

Survey method is adopted to carry out the desired research. For

sample selection, as a first step, the preliminary surveys of Rohri canal in Sukkur barrage area and lined channel commonly known as Akramwah in Kotri barrage area were undertaken to select the sample water-courses and sample farms. Thereupon a list of all water courses situated on the Rohri canal within a distance of 50 km and 47 km on Akramwah, both in Hyderabad district was prepared to define the universe.

There were 37 water courses on the surveyed Rohri canal, 19 on Khisano minor and 18 on Nasirwah. These were randomised into 10 for sample selection purposes choosing 5 water courses from each of the two channels of the Rohri canal.

Similarly, on lined channel of Kotri barrage, Hassan Ali and Kumbh minors were taken up for sample selection. The preliminary survey of these two channels indicated 72 water courses feeding farms in Hyderabad Taluka which included 42 water courses on Kumbh minor and 30 water courses on Hassan Ali minor. Out of which 10 water courses, 5 from each minor, were selected for study, using random sampling techniques.

The total number of farm operators on each selected water course formed the universe. A sample of 10 farm operators from both sides of each water course was selected for study and that too by random sampling techniques. Thus, in all, 200 respondents were chosen for detailed study.

The data collection work for *kharif*, 1982 crops has so far been completed whereas the job of interviewing the selected respondents for *rabi*, 1982-83 crops is in progress.

Preliminary Results

So far, tenurial classes, farming classes, cropping patterns and cropping intensity have been determined for the selected farms.

1. *Tenurial Classes:* The most common tenurial classes in the area of study include tenants (share croppers), owner-tenants, owner cultivators (peasant proprietors), landlord and leasers.

2. *Farming Classes:* It was observed that share cropping system is very much popular. The share-croppers commonly known as tenants, generally contribute entire land inputs and share the yield enhancing inputs by 50 percent, whereas the land and capital inputs are contributed by the landlord. The produce is shared by both parties on fifty-fifty basis.

The second class is that of owner-tenants. They face lot of problems in operating their farming business. Due to shortage of irrigation water, they could not cultivate their own land and lease it out to others.

The third category was owner cultivators who were originally landlords or medium sized cultivating farmers. They had machinery, implements and cheap labour to operate the land.

3. *Cropping Pattern:* The data indicate that sugarcane and cotton were the main crops which shared 22.73 and 17.69 percent of total land, respectively, on shared cropped farms 16.98 and 37.74 percent, respectively, on owner-tenants class of farms, 7.45 and 28.53 percent or peasant proprietorship and 4.68 and 15.66 percent, respectively, with the landlords (owner cultivator plus landlords). The lease tenants devoted 73.33 and 26.67 percent of their holdings to vegetables and fodders, respectively.

Above fifty percent land was kept fallow by each farming class during *kharif* due to shortage of irrigation water. The fallow area constituted 53.33 percent of total land holding with tenants, 42.45 percent with owner-tenants, 52.28 percent with owner-cultivators, and 76.01 percent with owner cultivators plus landlords. The leasers cultivated the entire area.

4. *Cropping Intensity:* It was estimated as 46.67 percent on tenant farms, 57.55 percent on owner-tenants farms, and 47.72 percent on the farms of owner cultivators.

SCIENTIFIC STAFF

1.	Mr. Muhammad Inayat Khan	Scientific Officer

Economic Analysis of Small Animal Farming in Sind

OBJECTIVES OF RESEARCH PROGRAMME

1. To investigate the existing infrastructure and economic performance of sheep, goat and mixed farms in Sind.
2. To recommend policy measures to commercialize small animal farming.

METHODOLOGY

This research project is undertaken by the Sind Agriculture University, Tandojam, with the financial assistance from USDA.

The research is being carried out by survey method to generalize the findings. It involves the designing of representative sampling plan, preparation and pretesting of questionnaire, data collection, tabulation, analysis of data and interpretation of results in the technical reports. Universe of small ruminant farms was indefinite and widely scattered throughout the Sind province which created problems in the selection of representative sample.

In all 4128 commercial sheep farms were investigated in 742 *dehs* of which 56.15 percent were large farms. The universe spreads over five districts of upper zone. A sample of three percent proportionately from various categories of farms was selected for detailed study. Thus, 124 commercial sheep farms were chosen for survey. The farms which consist of a herd not less than 20 sheep were considered commercial farms. The sample was derived through stratified random sampling techniques.

ANALYTICAL APPROACHES

The study involved positive analysis because it entails descriptive appraisal of small ruminant farms as presently operated. It analyses the existing conditions on the basis of data, collected by interviewing selected number of entrepreneurs through conventional interview method.

The partial budgeting analysis was used to analyse financial aspects and selected sheep farms. A number of criteria were used to examine the economic efficiency of various sizes of farms.

Firstly, the data collected by recording interviews of sheep farmers were tabulated on the basis of size of farms. Weighted average was computed for different classes of farms. Secondly, the data was analysed to compute per farm gross income, cost of production, net returns, level of average investment, input-output ratios and production efficiency. Finally, analysis of correlation and regression was worked out to relate flock size with cost and income data to determine the best remunerative size of flock to be maintained by commercial sheep farms.

SALIENT FINDINGS

The results of business analysis of selected commercial sheep farms are summarised as follows:

It was investigated that herd maintained on selected farms averaged to 36 Small Stock Unit (SSU) on a small group of farms, 68 SSU on medium group of farms, 232 SSU on large group of farms, and 82 on all classes of farms. Capital investment averaged to Rs. 370.31 per SSU on small farms, Rs. 342.36 per SSU on all classes of farms, Net return averaged to Rs. 114.47 per SSU on small farms, Rs. 131.73 per SSU on medium farms, Rs. 190.40 per SSU on large farms and Rs. 162.05 per SSU on all classes of farms. Input-output ratios were on an average, calculated to be 1:1.50 on small farms, 1:1.64 on medium farms, 1: 1.45 on large farms and 1:1.95 on all classes of farms.

Rate of capital turn-over averaged to 47.33 percent annually on all classes of farms whereas large farms were efficient enough to recoup invested capital within two years with a capital turn-over rate of 58.74 percent annually. Female and children contributed 49.28 percent of total labour inputs in sheep farming. The regression analysis indicated that incremental income on medium and large group of farms were higher than the small farms. Thus the flock size between 68–232 SSU is efficient to be maintained on remunerative scale. Large farms were the most efficient because they yielded maximum return with minimised cost.

Developing Scientific Methodology for Estimation of Acreage and Yield of Major Crops in Punjab

PLOT SIZE ENQUIRY ON RICE CROP

To conduct this enquiry for 1982-83, an experimental 6.10 m x 4.57 m plot was located in 21 sample villages of Sialkot, Gujranwala, Sheikhupura, Kasur and Gujrat districts. This plot was sub-divided into 12 equal plots of 1.524m x 1.524 m each. The yield was obtained from each smallest unit and then pooled at various numbers (1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12) to frame various sizes and shapes of the plots. The yield obtained from various sizes were arranged in different series and for each series the standard deviation and co-efficients of variation were calculated. The summary of the results on perusal indicated that the average yield of a district remains almost the same for any size and shape of plot. Co-efficient of variation is, however, directly linked with the number/size of plots.

The number of observations generating various sizes of plots vary from 21 to 357. The maximum frequency is for smaller size of 0.46 m x 0.92 m.

The size of 0.74 m x 0.56 m seems to be the optimum because of its coefficient of variation. The data of at least next several years would have to be analysed for the confirmation of results.

FORECAST MODEL STUDY ON RICE CROP

For this purpose, three fields, one from each category of good, medium and poor rice crop were selected. The plots of circular shape, each having 0.28 m diameter were randomly located in each field. In each plot the number of plants, number of tillers and number of grains (mature and immature) were recorded regularly after an interval of 15 days. Therefore, about four observations were recorded.

The results of each observation were analysed separately to calculate the number of plants and tillers per hectare, number of tillers per plant and percentage of tillers failed. The regression and correlation co-efficients were also calculated.

The summary of the results are as follows:

a) Number of plants/hectare 147083–153619
b) Number of tillers/plant 11
c) Failure of tillers 4.89 to 6.83 percent
d) Total grains/plant 916
e) Failure of grains 9.29 percent
f) Matured grains/plant 830
g) Correlation coefficients
   i) Plants/tillers 0.36 to 0.62
      (I obs = 0.62
      II obs = 0.52
      III obs = 0.44
      Final obs = 0.37)
   ii) Plants/yield 0.1899
   iii) Tillers/yield 0.24
h) Regression coefficients
   i) Tillers in plants 6.28 to 11.65
      (I obs = 9.99
      II obs = 11.65
      III obs = 8.35
      Final obs = 6.28)
   ii) Yield in plants 5.91
   iii) Yield in tillers 0.43

Number of plants and tillers are likely to provide basic information on yield. A relationship would require supporting data for several years.

Long-run Demand and Supply of Major Agricultural Products

OBJECTIVES OF RESEARCH PROGRAMME

1. To analyse and project the supply of major agricultural commodities through alternative approaches.
2. To compare alternative projections in both the short- and long-runs.
3. To examine the implications of demand-supply imbalances over the project years.

METHODOLOGY

The demand forecasts have been made through sensitivity analysis using alternative benchmark growth rates for the independent variables. For comparative analysis, however, GNP is postulated to grow @ 4.5 percent, i.e., per capita income growing @ 1.5 percent, and prices are assumed to grow @ 7.5 percent. These rates conform to the actual performance of the economy in the recent past and can be realistically expected to obtain in the near future.

In the supply forecasts the growth rate of the independent variables is based on the average growth in the last five years. However, since the determining variables are policy oriented, projected supply is highly sensitive to policy decisions with respect to input and output prices, water availability, etc.

Wheat

The demand for wheat is stated to be a function of GNP and the consumer price of wheat which rise by 4.6 and 7.5 percent, respectively. The supply of wheat is stated to be a function of the wholesale price of wheat, price of fertilizer and availability of water. These are assumed to rise @ 7.5, 5.0 and 5.0 percent, respectively.

It is concluded from Table 1 that, given the uninterrupted continuation of concerted government support to the objective of wheat self-sufficiency, stable long-term wheat surpluses can be obtained in the 90's. The surplus is expected to be 0.68 million tonnes in 1990, 4.58 million

Table 1. Demand and supply forecast of wheat

(million tonnes)

Year	Demand	Supply	Deficit/surplus
1983-84	13.94	12.49	(–) 1.45
1984-85	14.55	13.27	(–) 1.28
1985-86	15.17	14.17	(–) 1.00
1986-87	15.83	15.16	(–) 0.67
1987-88	16.50	16.24	(–) 0.26
1988-89	17.21	17.39	(+) 0.18
1989-90	17.93	18.16	(+) 0.68
1990-91	18.68	19.91	(+) 1.23
1991-92	19.48	21.29	(+) 1.81
1992-93	20.30	22.75	(+) 2.45
1993-94	20.53	24.31	(+) 3.78
1994-95	21.38	25.96	(+) 4.58
1995-96	22.26	27.71	(+) 5.45
1996-97	23.88	29.57	(+) 5.69
1997-98	24.87	31.54	(+) 6.67
1998-99	25.90	33.63	(+) 7.73
1999-2000	26.96	35.86	(+) 8.90

Table 2. Demand and supply forecast of rice

(million tonnes)

Year	Demand	Supply	Surplus
1983-84	2.46	3.80	1.34
1984-85	2.54	4.12	1.58
1985-86	2.62	4.37	1.75
1986-87	2.71	4.57	1.86
1987-88	2.80	4.79	1.99
1988-89	2.89	5.04	2.15
1989-90	2.98	5.34	2.36
1990-91	3.08	5.67	2.59
1991-92	3.18	5.96	2.77
1992-93	3.29	6.26	2.97
1993-94	3.40	6.52	3.12
1994-95	3.49	6.86	3.37
1995-96	3.62	7.20	3.58
1996-97	3.74	7.56	3.82
1997-98	3.86	7.97	4.11
1998-99	2.99	8.37	4.38
1999-2000	4.12	8.81	4.69

tonnes in 1995 and 8.90 million tonnes in the year 2000.

Rice

The demand for rice is stated to be a function of GNP and the consumer price of rice, which are again assumed to rise by 4.5 and 7.5 percent, respectively. The supply of rice is stated to be a function of procurement price of rice, and sugarcane (completing crop), and water availability; which are assumed to grow by 10.0, 8.0, and 3.0 percent, respectively.

Table 2 shows a continuation of the rice surpluses for export rising from about 1.58 million tonnes in 1984-85 to 2.36 million tonnes in 1990, 3.37 million tonnes in 1995 and 4.69 million tonnes in the year 2000.

Transfer of Resources Between Agricultural and Non-agricultural Sectors

OBJECTIVES OF RESEARCH PROGRAMME

1. To determine the extent of transfer of resources between agricultural and non-agricultural sectors.
2. To investigate the causes and mechanism of these transfers.

Inter-sectoral transfer of resource has a great impact on the development of various sectors of the economy. It also affects income distribution amongst people and also between rural and urban area. An understanding of such transfers is necessary for the preparation of sectoral development programmes and the formulation of policies for income distribution. A study of the transfer of resources between agriculture and the rest of the economy is essential for the preparation of development programmes for agriculture.

The following are some of the principal means through which resources get transferred between agriculture and the rest of the economy:

i) public resource mobilization
ii) government non-development expenditure
iii) development expenditure
iv) terms for the exchange of goods and services between agriculture and the rest of the economy
v) rate of foreign exchange
vi) monetary and credit policies
vii) saving and investment policies
viii) pricing policies.

SALIENT FINDINGS

Most of the work of the study has been completed. Tentative estimates of the transfer of resources in some aspects of the economy are as follows:

- If all the direct and indirect taxes, as well as the public expenditure on current and capital accounts are considered, a transfer of resources to the agricultural sector during the period of the study is evident. Provincial estimates show that the net flow of resources increased from Rs. 1300 million in 1977-78 to Rs. 6900 million in 1982-83 while, net flow per capita increased from Rs. 30 to Rs. 141 during the same period. The net flow amounted to 6.86 percent in 1982-83.
- The per capita burden of taxes on agriculture, increased from Rs. 171 in 1977-78 to Rs. 307 in 1982-83.
- The burden of non-tax revenue on the current account has increased from Rs. 35 in 1977-78 to Rs. 62 per capita in 1982-83.
- The per capita benefits of public expenditure also increased from Rs. 236 in 1977-78 to Rs. 509 in 1982-83.
- The value of resource transfer from agricultural to non-agricultural sector through the transfer of principal agricultural commodities to the urban areas was Rs. 30595 million in 1978-79 which increased to Rs. 40383 million in 1980-81.
- The estimated net savings transferred from the agricultural sector was Rs. 15677 million which increased to Rs. 20570 million in 1980-81.
- In the case of foreign trade in agricultural commodities, it was found that the resource transfer from agricultural to non-agricultural sector was Rs. 5070 million in 1978-79 which increased to Rs. 13502 million in 1981-82.

Micro-level Research Studies

WHEAT SITUATION SURVEYS

This is a regular activity of Social Sciences Division.

The major objectives of these surveys are:

- To determine the adoption rate of improved wheat varieties, input level and practices by the farmers.
- To investigate the availability of key farming inputs including production credit and farm power and labour during wheat planting period.
- To study the condition of the standing wheat crop.

The salient findings of the 1982-83 wheat survey conducted in Sahiwal district of the Punjab province are as follows:

Crop Condition

Of 269 sample farmers, 60 percent reported that the condition of the standing crop was better than the previous year. Nearly 18 percent of the farmers rated the condition of crop as good as the previous year while 22 percent reported that the current crop was poorer.

The yield estimate for the current crop reported by the sample farmers averaged 2.65 t/ha.

Wheat Acreage

Wheat acreage on sample farms increased by three percent over the previous year. This increase was due to remunerative input-output prices fixed by the Government and favourable weather conditions at the time of planting.

Varietal Use

As many as 15 wheat varieties were observed in the field. 'WL-711' alone accounts for 33.1 percent of the wheat area sown during 1982-83. 'Yecora', the principal variety which accounted for 56.6 percent wheat area last year has dropped to 31.5 percent.

Six discarded wheat varieties, 'Pavon', 'Yecora', 'Chenab-70', 'WL-711', 'Mexi-Pak' and 'Desi' covered 67 percent of the wheat acreage compared to 85.0 percent last year, a decline of about 18 percent. Acreage under the recommended wheat varieties, however, increased from 15.2 percent in 1981-82 to 32.8 percent in 1982-83.

Fertilizer Application

Nearly 99 percent of total wheat area was fertilized during 1982-83. The proportion of fertilized wheat acreage was almost equal on small, medium and large farms. Despite increase in fertilizer prices, the average rate of fertilizer application increased from 146.08 – 156.12 nutrient kg per hectare during 1982-83, i.e., an increase of 7.5 percent over the previous year.

Availability of Production Loans

One-fourth of the sample farmers obtained production credit. Nearly 50 percent of the borrowers obtained loans from the institutional sources. The interest-free loans were obtained by 58 sample farmers.

Farm Power and Labour

Of the total sample farmers, 66.5 percent own bullocks, 17.1 percent own tractors, 4.8 percent own both while 12 percent have none and carry out their farming operations through hiring of tractors. More than 77 percent farmers hired tractors for wheat planting. It comprised 20 percent small farmers, 29 percent medium farmers and 51 percent large farmers.

Of the total respondents 31 percent employed casual labour during the wheat planting season for carrying out various farming operations. The farmers who hired casual labour planted wheat after cotton or maize.

Use of Wheat Threshers

Wheat threshers are owned by 51 respondents (19 percent). Of the remaining 218 sample farmers, 81 percent expressed their intention to hire wheat threshers during the current harvesting season. Sixty five percent of the sample farmers reported easy availability of threshers whereas the remaining 35 percent maintained that threshers were not easily available.

Extent of Disease Incidence on Wheat Crop

Nearly 80 percent respondents reported disease-free wheat crop in the area, while remaining 20 percent reported slight to moderate disease attack of loose smut. The major incidence of this disease was observed on 'Yecora' and 'WL-711' varieties.

FARMING SYSTEMS RESEARCH – AN EXPLORATORY SURVEY OF RAINFED AGRICULTURE IN NORTHERN PUNJAB

To increase the agricultural production levels in an area, problems

faced by its agricultural system must be solved by developing a new technology suitable to the target farmers. An exploratory survey was conducted in 20 different villages in Daultala IRDP Project area of Rawalpindi district during 1982-83, to find out key problems of agricultural system of the region. Following research opportunities were identified through the survey.

- Traditional tillage system was practised in the region which was not ideal for moisture conservation or utilisation. Therefore, deep tillage studies need to be undertaken.
- New implements available for efficient moisture conservation, weed control and surface mulching need to be tried and compared with traditional implements and methods.
- Fertilizer experiments need to be conducted to measure the response curves for N, P and K.
- Studies may be initiated to identify the major weeds that occur in the wheat crop of the area. Simple superimposed herbicide trials may also be used to determine the most effective and economic chemicals for the area.
- Varietal trials are needed for most of the crop grown in area particularly new varieties of chickpea, lentil and peanuts. Disease resistance is an important factor for these crops Improved *kharif* pulses should also be tested.
- Wheat sown was mixed with rape and mustard. This practice needs evaluation and economics of mixed versus sole planting also needs to be worked out.

RETURNS TO INVESTMENT BY MARKET INTERMEDIARIES IN RAWALPINDI–ISLAMABAD

The main objective of the investigation was to identify the major market intermediaries in the wholesale markets of agricultural products and to determine the extent, pattern and returns to their investment.

The study covered only 10 percent sample of all the categories of intermediaries. Due to manpower, time and resource constraints, a strict probability sampling scheme could not be followed. The analysis of the survey data reveals that the commission agents are getting the highest return as compared to *beoparies* and wholesalers. The rate of return to investment was estimated as 84 percent for the commission agents, 5.0 and 2.8 percent for the *beoparies* and wholesalers, respectively. It was observed that rate of return was inversely proportional to the size of the investment of the intermediaries. The wholesaler, who is an important intermediary, invested on the average Rs. 3.00 million annually with a very low rate of return of only 2.8 percent. One of the plausible reasons for getting high rate of return, by the commission agents is that they have organised themselves. The sales and purchases can hardly take place without the intervention of commission agents and price fluctuations least affect the earnings of the commission agents.

The research study provides the evidence that it is not possible to eliminate all the market intermediaries. They have to play a significant role in the transaction of agricultural products. It is, however, feasible to reduce their number and to improve efficiency through policy decisions and administrative measures.

ROLE OF WOMEN IN RICE FARMING IN PAKISTAN

To study the role of females in rice farming, a field survey of 110 farmers falling in 18 villages of Gujranwala district was undertaken to collect following information:

- Extent of family female participation in different rice farming operations and other household activities.
- Extent of hired female labour, participating in rice cultivation and their wage pattern.
- Work opportunities available to landless women in rice-based system and the income derived from various operations in production of rice.
- Source of knowledge available to and extension programmes working for transferring knowledge to rural women.
- Extent of female participation in decision process.

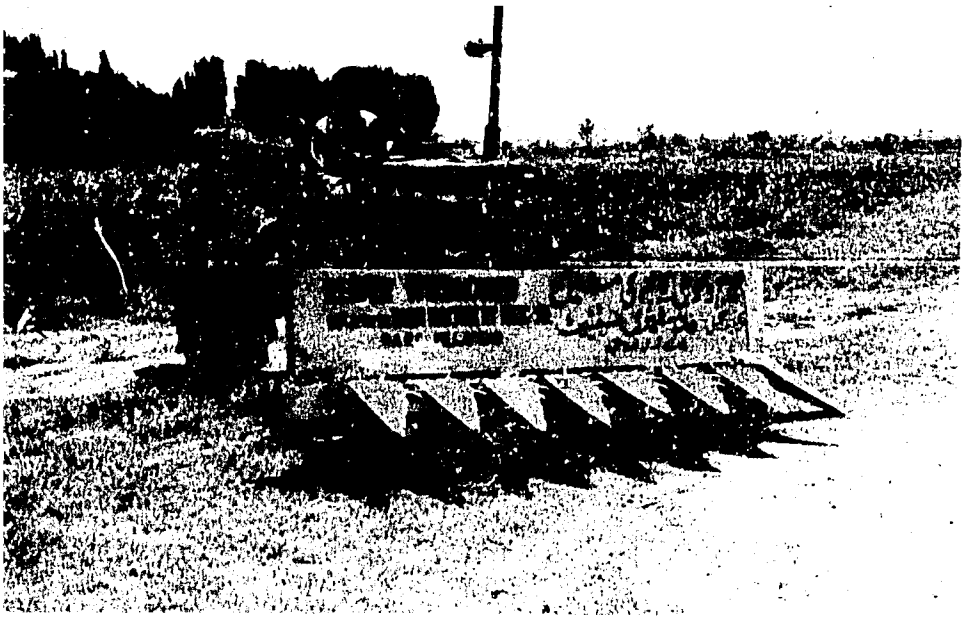
The results of the survey reveal that:

- Family labour participation is limited to a few rice farming operation; participation is mainly from small tenant families.
- Daily wages and seasonal income of hired labour are low.
- Predominant source of knowledge for female is household males.
- Mechanical technology development for rice farming is just in experimental stages in the country. No technology is available particularly designed to facilitate female rice farming work.
- Female participation in decision process is limited to a few relatively unimportant activities because of male dominance.
- The rice farming systems in the study area are partiarchal where females do not work independently and have little access to production resources. Any technology generated or transferred to females is less likely to have any direct welfare effect on rural women.

Part II

Farm Machinery Research
Arid Zone Research
Southern Zone Agricultural Research

Technical



Farm Machinery Research

OBJECTIVES OF RESEARCH PROGRAMME

1. To design, develop and adapt following farm machines:
   a. Groundnut digger
   b. Semi-automatic sugarcane planter
   c. Groundnut thresher
   d. Chain type tractor mounted 2.2-meter reaper-windrower.
2. To import potentially useful machines from other similar agro-climatic regions and evaluate their performance under local conditions.
3. To encourage local production of suitable agricultural machines by providing designs and other technical assistance to manufacturers.
4. To test and issue regular performance test reports on the popular locally manufactured agricultural machines to improve local production quality and to encourage healthy competition.
5. To undertake market research and product planning studies to establish specifications of demand oriented machines which need to be introduced in the country.
6. To coordinate agricultural machinery research and development activities among central, provincial and industrial organizations.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

Mechanization Research

1. *Mechanization Survey:* Amongst the farmers of Punjab, Sind and Baluchistan, the survey revealed that possession of tillage implements (M.B. plough, disc harrow, rotavator and sub-soiler) was linearly correlated ($r = 0.93$) to their knowledge about agricultural machinery. Majority of farmers (62 percent) indicated high price, lack of familiarity with operation, lack of extension efforts and of having never seen the implements as the major reasons for not having them. Spring loaded tine type cultivator was desirable by present 65 percent farmers, while poor mixing of soil, poor penetration and frequent breakage of springs were also been reported.

Analysis of data indicates, contrary to the currently held belief, small tractors will in future attract more attention from large farmers for their use in light farm operations, orchards and vegetable gardens. Other findings of the survey are as follows:

i. In Pakistan, 43 percent farmers knew about the reaper, 15 percent were familiar with it and 25 percent wanted to buy it.
ii. On the average, the farmers desired that prices of tractor mounted and self-propelled reapers to be Rs. 10000 and Rs. 16000, respectively.
iii. Demand of reapers and cutter-binders amongst the farmers increased with increase in size of land holdings.
iv. Demand for reapers was highest with the land owner-cum-tenants and was least with the tenants, while, the demand was higher amongst the tractor owners than amongst the non-tractor owners.

2. *Direct Seeding and Transplanting of Rice ('IRRI-6'):* The experiment on evaluation of different mechanized cultivation techniques revealed that broadcasting of pre-germinated seeds was a better treatment in terms of 1000-grain weight and grain yield as compared to others. Broadcasting gives 55 and 40 percent more yields than direct seeded and transplanted plots, respectively. However, transplanting gave better weed control.

3. *Wet and Dry Tillage Treatments in Rice ('IRRI-6'):* It was evident that wet rotavation of plots was more yielding than dry rotavation, M.B. ploughing and tine cultivation. Grain yield was 18 and 15 percent higher with wet rotary cultivation than deep ploughing and tine cultivation, respectively. Rotavator treatments produced more tillers. However, wet rotavation and deep ploughing resulted in better weed control.

4. *Wheat Tillage Studies:* During *rabi* 1982-83 an experiment on wheat for various tillage treatments was conducted at farmers' field in Sadhoke. The effect of shallow and deep tillage treatments were compared with the traditional bullock drawn practice (control). The results indicated that M.B. ploughing, followed by rotavation, gave the highest grain yield of 5720 kg/ha compared to 3950 kg/ha in control. These differences were highly significant. High yielding treatment was also better in tillering, giv-

ing 50 and 35 percent more tillers than chiseling followed by rotavation, and control, respectively. There were no differences found in plant population and weeds amongst various treatments.

Design and Development

1. *2.2-meter Reaper-windrower:* Hitching arrangements were developed for mounting reaper with maximum commonality of parts among all makes and models of tractors available in the country. The production drawings with provisions of available standard items in the market were prepared. Ultimately the cost of production was determined.

2. *2.2-meter Chain and Sprocket Type Reaper-windrower:* The field tests on wheat and paddy harvesting indicated that flat belts for conveying the crop stretched and needed frequent tensioning. This caused clogging problem and also affected the formation of proper windrows. To solve the problem, a chain and sprocket drive conveying system was incorporated in the design. Necessary changes were also made in the main frame structure to accommodate the new system. The star wheel thickness was increased to one inch and the vertical flat belt lugs were replaced with horizontal lugs riveted on the chain. Left hand header was redesigned by placing M.S. sheet cover on round bars similar to that on other headers.

3. *Multicrop Thresher:* For improvement of wheat *bhoosa* and reducing the grain losses through blowing threshing and cleaning mechanisms of tractor PTO operated multicrop thresher needed improvements. The threshing portion of the concave has been made from 0.95 cm square bars instead of round bars. The design of suction blower and oscillating tray is also being improved. The modified unit will be tested during the following wheat harvest and necessary changes in the production drawings will be made accordingly.

4. *Groundnut Digger:* Field testing of prototype fabricated indicated that following design changes need to be made:

   i. Top link connecting hole height was decreased from 75 to 50 cm for exerting maximum hydraulic pressure on blade during penetration in the soil.

   ii. The soil penetration resistance to the blade varies according to the soil types and moisture contents. The blade penetration angle can be changed by increasing or decreasing the length of top link upto some extent. The digger blade was also made adjustable for the required angle of penetration instead of welding it with main frame.

   iii. The coulter wheels were aiding plant detangling but were ineffective in controlling penetration depth. A pair of 700 mm long corrugated hubs with 220 mm dia were added to the coulter wheels to improve control on the working depth of the digger.

   iv. The blade length was increased from 1.52 m to 1.90 m for full utilization of 65 hp tractor power and for improving field capacity.

5. *Groundnut Thresher:* A prototype powered by 12 hp diesel engine was fabricated by incorporating the design principles of FMI multicrop axial flow thresher and KEM groundnut thresher. The preliminary tests indicated poor threshing, poor cleaning and high pod losses. The following changes were made for its improvement.

   i. The louvers on drum cover were made adjustable.

   ii. The concave threshing portion was made with spacing instead of two inches which improved the threshing and cleaning efficiency by 25 percent.

   iii. Grain deflector plate was made adjustable to avoid the flow of grain into blower housing.

6. *Semi-automatic Sugarcane Planter:* It was imported from India under the Mutual Exchange of Prototypes Programme of the Regional Network of Agricultural Machinery (RNAM). Its preliminary tests indicated that it needed a bigger size hopper to improve the field capacity of the machine. Similarly, with the original depth wheels, also used for metering fertilizer, the quantity of fertilizer applied was 1250 kg/ha as compared to 580 kg/ha needed in sugarcane production. Necessary changes were made in the machine by increasing hopper size from 70" x 15.25" x 10" to 84" x 15.25" x 15" and depth wheel dia from 14" to 20".

7. *1.2-meter Power Tiller Mounted Reaper-windrower:* 1.0-meter IRRI power tiller mounted reaper-windrower field tested on wheat crop indicated that the windrows made by this reaper overlap each other because of the crop being higher than the cutting width. Therefore, more labour was required to collect the harvested crop with this machine as compared to 2.2-meter reaper. To improve the performance, following design changes were suggested:

   i. Addition of one header to increase the cutting width from 1.0-meter to 1.2-meter.

   ii. Replacement of conveyor flat belts with chain and sprockets.

   iii. Replacement of vertical M.S. sheet lugs riveted on flat belts with horizontal flat bar lugs mounted on chain.

   iv. Fabrication of left hand header similar to 2.2-meter chain-and-sprocket type reaper.

Testing and Evaluation

1. *FMI Reaper-windrower:* Tractor mounted FMI reaper-windrower (Model FMI-RW-22) was field tested on paddy crop during November and December, 1982 in the paddy growing areas of the Punjab province. The results indicated average effective field capacity of 0.538 ha/h and average total machine loss of about one percent. Reaping by machine required only 9 man-hours/ha compared to 83 man-hours/ha required for hand reaping. Operating cost of reaper is Rs. 140.90/ha compared to Rs. 208.50/ ha for manual harvesting.

2. *Mughal Reaper-windrower:* It was designed by FMI and fabricated by M/S Mughal Farm Machinery Manufacturing Company, Daska. The effective field capacity of 0.291 ha/h was recorded with an average total loss of 1.96 percent. Reaping by machine required 15 man-hours/ha compared to 83 man-hours/ha for hand reaping.

3. *Technico Reaper-windrower:* It was manufactured by M/S Aerodynamical Technico Limited, Lahore, and

obtained for field testing on paddy crop in December, 1982. Average effective field capacity was 0.371 ha/h with a machine loss of 1.03 percent. Reaping by machine required only 10 man-hours/ha compared to 83 man-hours/ha required for hand reaping.

4. *Hold on Type 5-HP, Multicrop Thresher:* Diesel engine powered Korean multicrop thresher received under RNAM was tested on 'Basmati' and 'IRRI-6' varieties. The output of the thresher was found to be 350 to 400 kg/h. Farmers appreciated its performance and desired a bigger version of the machine.

5. *ASA Lift Groundnut Digger Windrower:* It was field tested at village Mangial, district Fatehjang in November 1982. An average field capacity of 0.115 ha/h was recorded when digging the semi-spreading variety 'Banki' with an average recoverable loss of 11 percent.

6. *Awan Groundnut Digger:* It was manufactured by New Awan Engineering Works, Dhudial and was field tested in January 1983. The tests indicated an average effective field capacity of 0.315 ha/h with recoverable loss of 10.27 percent. The operating cost of digger is Rs. 162.99/ha compared to Rs. 301.20/ha for manual digging.

7. *Semi-automatic Sugarcane Planter:* It was imported from India and tested by FMI at farmers' field in district Sahiwal and was found capable of performing four operations simultaneously; opening of furrows, placing cane sets (manually), placing fertilizer, and covering sets and fertilizer. The test results indicated field capacities of 0.46 and 0.26 ha/h with single and double set placement methods, respectively. The field efficiencies were observed as 80 and 86 percent, respectively. The total cost was Rs. 162.80 and Rs. 305.80 per hectare as against Rs. 326.30 and Rs. 417.30 per hectare for single and double set placements, respectively, compared with manual planting.

8. *Crown Maize-Sheller:* FMI conducted performance tests on a maize-sheller manufactured by New Crown Industries, Sarnmundari Road, Faisalabad for shelling two different maize varieties, i.e., 'Pir Sabaq-80' and 'Sarhad Tiller' at CCRI, Nowshera. The sheller encountered certain problems, e.g., low cleaning efficiency and entrance of grain into the blower housing. Consequently, it was modified and much better performance was achieved. Output of the sheller varied from 1500 to 2000 kg/h with an average cleaning efficiency of 95 percent.

Industrial Extension

1. *Technical Assistance to Manufacturers:* Bukhari Engineering Corporation, Karachi; Mughal Engineering, Larkana; ASH Engineering Works, Arifwala; Sayyed Machinery Limited, Lahore; Aerodynamical Technico Limited, Lahore; United Agro-Engineers, Daska; Mughal Farm Machinery Manufacturing Company, Daska; Mohammad Tufail – Noor Ahmad Engineering Works, Hafizabad, and Noor Wheat Thresher and Mechanical Works, Hafizabad were given prototypes for duplication. FMI engineers and mechanics were deputed to assist in the fabrication of the first prototypes to ensure that the machines were made strictly according to the specifications. Few manufacturers are able to follow technical drawings for fabrication purposes.

2. *Demonstrations:* To popularise the reaper-windrower amongst farmers and potential agricultural machinery manufacturers, several demonstrations were arranged in the four provinces. Proper mass media coverage was given to these events, so that the message could be conveyed country-wide.

In addition, multi-crop thresher, groundnut digger, sugarcane planter and Korean thresher were demonstrated to farmers at their fields.

The prototypes fabricated by the FMI collaborating manufacturers were tested in the field to evaluate their performance and to rectify any manufacturing defects.

3. *Introducing New Manufacturers:* The Industrial Extension Section carried out a study of the facilities of the potential collaborating manufacturers to assess their manufacturing capabilities. Three new firms have made agreements with the Institute for manufacturing the FMI-developed reaper-windrower. These are Bukhari Engineering Corporation, Karachi; Mohammad Tufail – Noor Ahmad Engineering Works, Hafizabad and Noor Wheat Thresher and Mechanical Works, Hafizabad.

THRUSTS FOR NEXT YEAR

1. Development of tractor mounted rice transplanter, direct drill, and sugarcane harvester.
2. Completion of design of groundnut thresher, and 2.2-meter reaper-windrower chain and sprocket type.
3. Commercialization of groundnut digger, sugarcane planter, 2.2-meter reaper-windrower (chain and sprocket type), and 1.2-meter power tiller mounted reaper-windrower.
4. Testing and evaluation of local and imported machines.
5. Continuation of mechanized tillage trials and extending their scope at farmers' fields.
6. Conducting surveys on agricultural machinery manufacturers, performance evaluation of harvesting machines and loan availability to the farmers for the purchase of agricultural machinery.
7. Organizing training programme on zero-tillage and design and development of farm machines.

SCIENTIFIC STAFF

1. Dr. S. Iqbal Ahmed	Project Director
2. Mr. A. Shakoor Khan	Senior Engineer
3. Mr. Mohammad Afzal	Senior Engineer
4. Mr. Sahabzada Anwar Ahmad	Assistant Engineer
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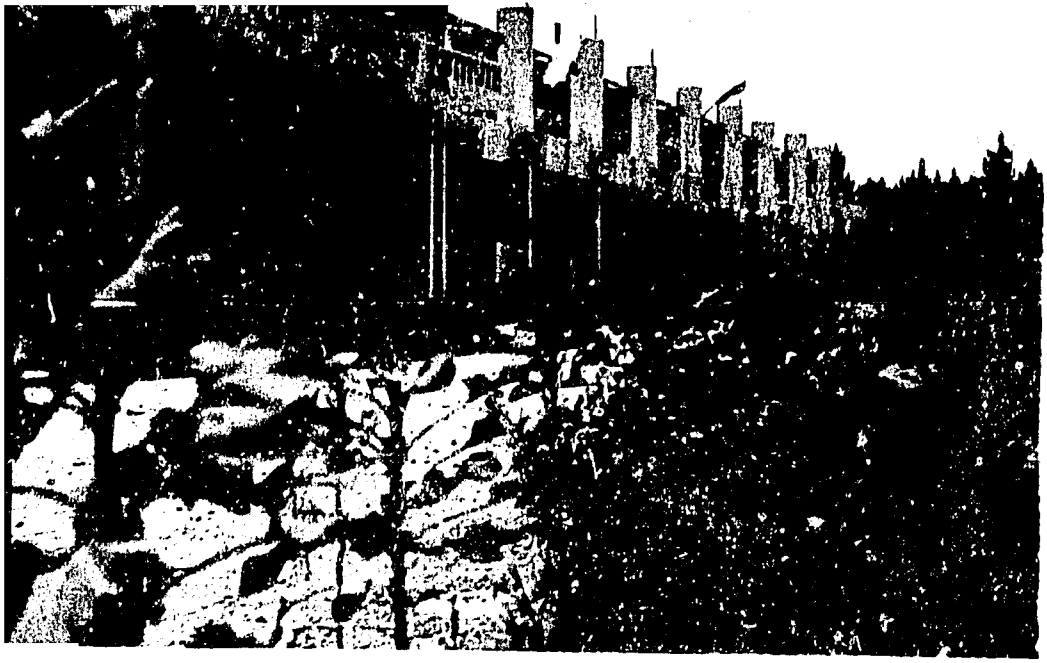

Arid Zone Research

OBJECTIVES OF RESEARCH PROGRAMME

1. To improve winter cereals.
2. To enhance water use efficiency for maximum production of crops.
3. To determine the crop response to application of fertilizer and moisture distribution.
4. To test and select the introduced and improved local species/cultivars of forage grasses, legumes/shrubs.
5. To improve range areas through soil and moisture conservation practices.
6. To assess traditional and prevailing practices in respect of feeding, breeding, management for sheep and goats production and possibilities for introduction of improved practices and technologies.
7. To investigate techniques for growing fodder crops with little inputs and minimum tillage.
8. To study wool production and marketing system in Baluchistan.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS/ACHIEVEMENTS

AZRI, Quetta

Plant Sciences Section

1. *Testing and Selection:* The experiment was carried out to select high yielding, disease and drought resistant plants with four winter cereals including bread wheat, durum wheat, barley and triticale. The segregating material (F_2–F_3) was received from ICARDA, Syria. All plants and entries showing signs of disease attack were discarded. At maturity, entries which did not ripen due to lack of moisture were also rejected. Thus only those plants and entries were harvested which matured in a shorter duration and proved resistant to disease attack.

Number of entries planted and harvested in segregating populations are given in Table 1 and those of Observation Nursery in Table 2.

2 *Production Agronomy Trials:* To determine optimum doses of inputs and farming practices for maximization of yield of wheat under dryland farming conditions, three experiments were conducted at high altitude in Baluchistan.

Two experiments were laid at Pishin using besides, 'Local White' as check, 'Zarghoon', 'Zamindar', 'Haramoun' and 'S311 x Nortina' varieties, sown in a Split Plot Design.

The results show that the spring sown crop failed completely due to lack of moisture. In the autumn sown crop Pakistani improved varieties, 'Zamindar' and 'Zarghoon' with grain yields of 706 and 646 kg/ha, respectively, out-yielded the 'Local White' (572 kg/ha). The ICARDA variety 'Haramoun' produced the minimum yield of 494 kg/ha. However, the ICARDA variety, 'Bezostaya' proved the best with grain yield of 856 kg/ha.

In the second experiment seed rates were tested and seeds @ 60 and 80 kg/ha produced higher yield. This shows that still higher seed rates could be tried. 'Local White' gave the best yields of 486, 625 and 843 kg/ha at seed rates of 40, 60 and 80 kg/ha, respectively, while, ICARDA

Table 1. Segregating population of winter cereals

Crop	No.of entries planted	No. of entries harvested
Winter bread wheat–F_2	816	11
Winter bread wheat–F_3	206	7
Winter durum–F_2	478	61
Winter barley–F_2	77	33

Table 2. Observation Nursery of winter cereals

Crop	No. of entries planted	No. of entries harvested	No. of entries selected	Gain (%) (selected/ harvested)
Winter bread wheat	143	65	15	41
Winter durum	396	284	22	66
Winter barley	140	77	18	42
Triticale	76	76	9	52

variety, 'Haramoun' gave yields of 358, 528 and 679, respectively.

The third experiment was laid at Kan Mehterzai with 'Local White' and 'Zarghoon' in a Complete Factorial Design giving fertilizer P treatments @ 0, 30, 60, 90 and 120 kg N/ha, and 0 and 40 kg P/ha, respectively. Highest yield was obtained at highest fertilizer doses for local (1740 kg/ha) and imported (2620 kg/ha) varieties.

Therefore, a five-fold increase in yield is possible by two inputs (seed and fertilizer). A still higher yield is possible if improved farming practices are followed, e.g., moisture conservation, weed control and sowing methods

Table 4. Total grain and TDM yield interactions of moisture x row spacing x fertilizer treatments

(kg/ha)

	Limited moisture				Residual moisture			
Row spacing	50.8 cm		101.6 cm		50.8 cm		101.6 cm	
Fertilizer	Applied	Nil	Applied	Nil	Applied	Nil	Applied	Nil
Grain yield	1100	851	1138	988	739	493	859	593
TDM	38366	21252	29094	19099	32035	19825	21286	17783

Land and Water Use Section

1. *Affects of Fertilizer and Properties of Soil Under Dry Farming:* The experiment was laid in Split Plot Design at limited and residual moisture levels on water melon cultivars, 'Sugarbaby' and 'Kabli' and four NPK treatments were given (Table 3).

Results indicated that the response of NPK fertilizer for the maximum production of water melon was significant upto NPK dose of 40:20:20 kg/ha under the existing conditions of the soil. Phosphorus and K improved plant resistance to moisture stress using NPK at this dose. However, their application reduced the transpiration rate of plant leading to a lowering of the water consumption of the crop.

2. *Soil-Plant-Water Relation, Yield and Total Dry Matter of Millet:* To evaluate the relative effect of the moisture stress, row spacing and fertilization on grain yield and total dry matter (TDM), an experiment was laid in a Split Plot Design. The soil type was sandy clay loam utilising limited and residual moisture levels at two row spacings and two fertilizer levels (Table 4).

The row spacing of 50.8 cm was found to be better for TDM production while 101.6 cm was grain yield under water deficit conditions. However the response of fertilizer application was better on TDM than on grain yield.

Range Management Section

Eight hectares area at Quetta is being developed for range improvement and soil and water conservation practices to study their effects upon soil formation and vegetation improvement. The practices will include check damming, contour-trenching, sowing and planting of different forage plants. Identification of the wild local vegetation of Quetta valley has been completed.

1. *Trees:* Only *Pistacia khanjuk* is sparsely found in and around the valley like Maslakh range etc.

2. *Shrubs: Haloxylon griffithii, Heliotropium strigosum, Astragulus* spp; *Lactua serriola, Sophora* spp; *Ephedra nebrodensis Funiculum geracium, Alhaji mauroroum, Stocksia brachica, Cousinia minuta, Veronica seniola* and *Artemisia maritinia* are commonly found in the region.

3. *Grasses:* Most abundant are *Stipa pennata, Chrysopogon aucheria, Cymbopogon schoenanthus, Poa sinaica, P. bulbosa, Bromus danthonae* and *Tetrapogon* spp.

Following 22 species of exotic and local grasses, medics and buffels were sown in 5m x 5m plots for adaptability studies.

Amorpha fruticosa, Chrysopogon aucheri, Lolium perrene, Clover, Nanbank buffel, Molasses grass, U.S.A. buffel-I, Haifa clover, *Atriplex, L. multiflorum, Bromus inermis, Medicago sativa, Chloris gayana,* Phylox, Buffalo gourd, Gayndah buffel, Biloela buffel, *Sirosh phalaris,* Berrel medic, Nungarin sub-clover, Wimmera rye, *Festuca arundinacea.*

Livestock Section

1. *Sheep and Goat Production Practices and Potential in Baluchistan:* The districts of Pishin and Sibi were surveyed during 1981-82, while the districts of Zhob, Loralai, Chaghai and Kharan were covered during the year under report. About 100–150 farmers were interviewed in each district. Livestock experts, wool traders, forest department officials, butchers and marketing experts were also contacted. Information and data collected were analysed and compiled for each district separately.

It was found that increased livestock (sheep and goats) productivity can result from controlled grazing, supplemental feeding, disease control and genetic improvement measures. Improved fertility at least on the Government farms like Yetabad and in

Table 3. Average yield of water melon cultivars

(kg/ha)

Year	Variety	'Sugarbaby'				'Kabli'			
	Fertilizer (N:P:K)	40:0:0	40:20:0	40:20:20	40:40:40	40:0:0	40:20:0	40:20:20	40:40:40
Limited Moisture									
1978		12475	13150	14668	14695	11475	12700	14300	14275
1979		12525	13250	14768	14725	11500	12800	14310	14280
1983		12500	13300	14708	14800	11525	12750	14305	14300
Residual Moisture									
1978		12470	13148	14660	14690	11473	12690	14285	14272
1979		12520	13245	14760	14720	11495	12798	14308	14275
1983		12498	13292	14700	14790	11520	12745	14300	14292

the flocks of settled population can be brought about by the estrus synchronization or control of reproductive cycle, semen preservation, improved pregnancy diagnosis, and super ovulation to enhance the number of animals. The improved mobility and increase in veterinary staff can prevent the pathological losses (10–15 percent).

2. *Production and Marketing of Wool in Baluchistan:* Wool traders, woolen mill workers, technical personnels and other people engaged in wool production or marketing directly or indirectly were interviewed. Besides, 100 samples of wool (50 percent from wool traders and stores, and 50 percent from body of animals of all four breeds) were collected from each district of the province. Their colour, staple length, fibre diameter (fineness), percentages of true fibre, medullation, colour fibre, white fibre, were noted on analysis.

The survey indicated following possibilities of improvement:

- Use of modern shearing machines to increase production by 10–12 percent.
- Wool sorting and scouring practices which are essential for clean wool production and can fetch more money per unit weight of wool.
- Culling or castration of coloured rams and introduction of prototype males will improve the quality of livestock and wool.
- Proper marketing and education of livestock owners in wool shearing, storage and grading can boost production of wool.

3. *Fodder Production Trial with Zero Tillage:* Eight rows of white corn, yellow corn, sorghum and millet *(bajra)* were sown about 1–2 cm deep with the help of a hand drill. Plots were not irrigated and the experiment was carried out under dry land conditions. The data were analysed and following conclusions were drawn:

- In an open soil, the micro-organisms like Nitrosomonas which are helpful in the process of nitrification are damaged by sunrays. The loss of gases can be minimised by zero tillage.
- The loss of soil in arid areas by wind erosion can be reduced.

Labour costs can be reduced and fodder can be grown with minimum inputs.

AZRI Sub-station, D.I. Khan

1. *Wheat:* Varieties, 'Arz' (control), 'Inia', 'Naja', 'Sannine', 'LR-73', 'WL-711' and 'Khyber 79' were used in the experiment on $6m^2$ plot with four fertilizers under dry farming conditions. The overall crop conditions remained very poor due to moisture stress. However, variety, 'Sannine' (1193 kg/ha) proved the best with 46 percent increase in yield over the control (822 kg/ha). Therefore, 'Sannine' can easily replace the existing recommended variety under dryland farming conditions.

In another trial under rainfed conditions, varieties, 'Arz', 'Inia', Naja', 'Sannine', 'LY-73', 'Khyber-79', 'WL-711' 'Pawan', 'Sonalika' and 'Pak-81', were tested. 'Sannine' produced 82.6 percent higher yield than the minimum and 45.3 percent higher yield than the average of the remaining varieties.

2. *Oats:* Varieties, 'Atlantic', 'Avon', 'Oats-III', 'Victor' and local, were tested under rainfed conditions at Rata Kulachi, D.I. Khan. The grain yields were 623, 867, 412, 892 and 667 kg/ha, respectively

3. *Mung:* Twelve varieties were grown under four water stress levels. No variety could survive at 7.50 cm which was the heavist stress level. However, under 15.00 cm all varieties gave very poor grain yield ranging between 0.53 and 2.37 kg/ha. The local check gave the poorest performance whereas variety, 'M-605' with grain yield of 2.37 kg/ha proved the best.

At other water stress levels (viz., 22.50 and 30.00 cm) variety, 'Pak-16' out-yielded the check.

4 *Maash:* Varieties, 'No. 48', 'No. 59', 'No. 80, 'No. 216', 'No. 267', 'No. 654' and 'RC-18' were grown in a replicated trial at stress levels, 7.50, 15.00, 22.50 and 30.00 cm. The 7.50 cm level was very severe, the whole crop dried before maturity, while yield increased with stress levels for all the varieties. 'No.59' was giving highest yield of 534 kg/ha and 'RC-18' followed yielding 450 kg/ha. However, 'No. 267' gave the poorest yield at 30 cm stress level.

5. *Sarson:* Six varieties were tested under rainfed conditions. Variety, 'PR-7' produced maximum yield of 1271 kg/ha as compared to 1000 kg/ha in check:

6. *Raya:* Seven varieties were grown in a replicated trial under rainfed conditions. 'Dacca Raya' with grain yield of 1024 kg/ha proved the best and variety, 'MMF-2' produced the minimum yield of 650 kg/ha.

AZRI Sub-station, Umarkot

Agronomy experiments on *mung,* cowpea, *guar* and pigeonpea, were conducted. Branches/plant, height of plant, pods/plant, grains/pod and yield/plot were the parameters under test. Data were recorded and analysed statistically.

In *mung* results regarding branches/plant and height of plant showed high significance but due to insignificant results regarding other parameters none of the 12 varieties tested were recommended for the area.

Out of the ten cowpea varieties tried, 'TVx4272-0130' produced maximum grain yield of 0.2 kg/plot as against 0.1 kg/plot.

Among the six *guar* varieties, variety, 'GL-1' out-yielded check by 0.084 kg/plot in grain yield.

However, no significant results were obtained for any of the ten pigeonpea varieties put to trial.

AZRI Sub-station, Bahawalpur

1. *Oats:* Seven varieties, 'Fork Deer', 'Atlantic', 'Fatua', 'Victor', 'II', 'Local Faisalabad' and 'Avon' were tested without irrigation. Variety, 'Atlantic' performed better by giving yield of 757.5 kg/ha.

2. *Barley:* Varieties, '3309', '4342' and 'Hybrid' were planted under natural precipitation. Hybrid showed most significant result with production of 1892.5 kg/ha.

3. *Safflower:* Two varieties, with horns and without horns were planted with one irrigation. Hornless variety showed better performance by giving yield of 2868. 6 kg/ha.

4. *Wheat:* Fourteen varieties were planted in 272 plots and were irrigated twice. Among all varieties, '1287' performed better by yielding 1777.6 kg/ha.

5. *Triticale:* Three varieties were sown in 24 plots and were irrigated twice. Variety, '2' performed better giving yield of 1626.9 kg/ha.

6. *Guar:* Four varieties planted were 'Esser', 'Brooks', 'Mills' and '2/1'. No irrigation was given. Variety,

'No. 2/1' which gave yield of 2980.8 kg/ha performed better.

7. *Pigeonpea:* Seven varieties planted under rainfed conditions, were 'ICPL-81', 'ICPL-82', '74078-2', 'ICPL-87', 'ICPL-94,' 'ICPL-2' and 'ICPL-1'. The best variety was found to be 'ICPL-2' which gave yield of 1739.1 kg/ha.

8. *Mung:* Twelve varieties were planted with two irrigations Variety, 'E-III' was found best with production of 598.4 kg/ha.

Twenty seven varieties of different grasses and legumes were sown. Their seeds were collected and were planted at Bahawalpur farm and Cholistan farm at Chah Sulehwala.

THRUSTS FOR NEXT YEAR

1. Survey and identification of flora of arid and semi-arid areas.
2. Establishment of plant introduction garden for the improvement of crops of economic importance for arid/semi-arid areas.
3. Collection and testing of genetic material of valuable plants with particular reference to those which have value for multiple use in arid and semi-arid areas.
4. Development of new cultivars of legumes, fodder trees, shrubs and grasses by selection, breeding and testing for different zones of the country.
5. Detailed soil survey of potential arid lands.
6. Adjustment of crop density nutrient and water regime conducive to maximum production and re-evaluation of fertilizer needs of high yielding crops.
7. Classification of rangelands according to their conditions and trend.
8. Determining the grazing potential of the rangelands.
9. Evaluation of grazing systems including deferment of pasture and range areas.
10. Physiology of heat and salt tolerance.
11. Studies on traditional short and long-term responses of drought and disaster situations and of long-term adjustments to the threat of drought.

SCIENTIFIC STAFF

1.	S. Salahuddin Ahmad	Director
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4.	Dr. Muhammad Iqbal	Senior Scientific Officer
5.	Mr. K. N. Babar	Senior Scientific Officer
6.	Miss Bushra Malik	Scientific Officer
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8.	Mr. Abdul Rashid	Scientific Officer
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10.	Mr. Asghar Ali	Scientific Officer
11.	Mr. Abdul Wahid	Scientific Officer
12.	Mr. Shahid Rafique	Scientific Officer
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15.	Mr. Muhammad Munir	Scientific Officer
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18.	Miss Robina Mumtaz	Scientific Officer
19.	Mr. Khalid Mehmood Bhatti	Scientific Officer
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22.	Miss Surrayya Begum	Scientific Officer
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24.	Mr. Shaheen Iqbal	Scientific Officer
25.	Mr. Karim Nawaz	Scientific Officer

Southern Zone Agricultural Research

OBJECTIVES OF RESEARCH PROGRAMME

1. To establish a National Research Facility in the delta, coastal zone of Sind for conducting breeding research to evolve new varieties and increasing the productivity of sugarcane.
2. To develop improved package of technology for obtaining sustained higher production at real low cost.
3. To study the prevailing insect pests, diseases and weeds of sugarcane, assess crop losses, and devise effective control measures (cultural, chemical and biological) under this agro-ecological conditions.
4. To identify the use of by-products such as molasses, and bagasse.
5. To introduce new oilseed crops like coconut, oilpalm and tropical plants, best suited to the ecology of this region.

DETAILS OF EXPERIMENTS AND SALIENT FINDINGS / ACHIEVEMENTS

The initial development phase which included the clearing of the forest land, levelling of the area, and digging of 5000 RFT water channel, has been completed.

For the reclamation of land, paddy has been grown on six hectares. It is planned to grow berseem or some other leguminous crop during *rabi* on another 20 ha.

Contour survey on 30 m grid system of the area has been completed which has shown detailed elevations of 120 ha of land alongwith the areas, adjoining the water course. Bunds, roads, irrigation channels are being laid out. Site demarkation for buildings is being given a final shape.

PARC had a commitment with the provincial government to construct 30 cusec head regulator at Ex-daro branch and a culvert at Sujjawal to Mirpur Bathoro road, which will irrigate about 1200 ha of land for coconut plantation. Necessary drawings and estimates have been received from irrigation and highways departments, Government of Sind. It is expected that the work on this item will be completed during current financial year.

Necessary technical manpower, required at this stage has been recruited and posted at Sujjawal. Sanction for the purchase of the Farm Machinery was also received and an order for the procurement of tractor and 11 other implements is being placed with Millat Tractor Corporation of Pakistan.

A PC-I document for hte development project amounting 44.23 million rupees with FEC of 3.27 million rupees has been completed for submission to Planning Comission, Government of Pakistan.

A proposed site near Mirpur Sakro for establishing a Sub-station of Southern Zone Agricultural Research Centre (SZARC) has been approved by the Chairman, PARC after detailed scanning of the area. Soil survey of this 12 ha land is being conducted before this is finally acquired from Government of Sind. Pending launching of the proposed development project, necessary funds for this initial phase are being provided from Non-development budget of PARC. Development project is expected to commence from year 1984-85. Necessary provisions in the Annual Development Programme and sixth five year plan have also been made for this project.

THRUSTS FOR NEXT YEAR

1. About 5 ha of land will be brought under paddy cultivation.
2. Sugarcane varietal trials will be planted from September, 1984 that will embark the research activity on SZARC.
3. The farm at Sujjawal will also have a separate section on Plant Introduction for conducting research on tropical / sub-tropical plants which could be introduced in this region.

SCIENTIFIC STAFF

1.	Dr. Badaruddin Soomro	Project Director
2.	Mr. Ahmad Nawaz Niach	Scientific Officer
3.	Mr. Manzoor Ali Memon	Scientific Officer

Annexures

ANNEXURE-I

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Mr. Khalid Rashid Shahbaz	Public Relations Officer	828246
Mr. Mushtaq Ahmad Malik	Technical Staff Officer	828246
FINANCE DIVISION		
Mr. M. Majeed Akhtar	Member (Finance)	824826
Mr. Fazal Ahmad	Director (Accounts)	829833
FARM MACHINERY INSTITUTE		
Dr S. Iqbal Ahmed	Project Director (FMI)	820370
Dr. Mohammad Khalid	Principal Engineer(FMI)	820370
DIRECTORATE OF PLANNING AND TECHNICAL SERVICES		
Mr. Ikram-ul-Haq	Chief Scientific Officer	823577
DIRECTORATE OF SCIENTIFIC INFORMATION		
Mr. Anwar Ali Chaudhry	Director	829889
DIRECTORATE OF TRAINING		
Mr. M. H. Rizvi	Director	827036
DIRECTORATE OF INTERNATIONAL LIAISON AND TECHNICAL ASSISTANCE		
Mr. M. Amjad Virk	Director	822408
DIRECTORATE OF CIVIL WORKS		
Mr. M. Idrees Anjum	Project Director	829937
ADMINISTRATION		
Maj. (Retd.) M. N. Minhas	Director (Personnel Administration)	821000
Lt Col. (Retd.) Muhammad Aslam Raja	Director (Log. & Gen. Administration)	829792
Ch. Abdul Hafeez	Administrator (NARC)	821431
BARD PROJECT		
Dr. A. Rehman Khan	Project Director	826361

ANNEXURE-II

INLAND TRAINING SPONSORED BY PARC

S. No.	Name	Field of training	Institution
		LONG-TERM	
	M.Sc.		
1.	Khalil-Ur-Rehman	Rural Sociology	University of Agric., Faisalabad
2.	Abdul Qayyum	Agric. Economics	University of Agric., Faisalabad
3.	Ahrar Khan	Vet. Pathology	University of Agric., Faisalabad
4.	Abdul Ghaffar	Animal Breeding and Genetics	University of Agric., Faisalabad
5.	Mohammad Tariq Ch.	Animal Nutrition	University of Agric., Faisalabad
6.	Munir Ahmad Alvi	Biochemistry	University of Agric., Faisalabad
7.	Sajjad Rabbani	Microbiology	University of Agric., Faisalabad
8.	Anwar-ul-Haq	Microbiology	University of Agric., Faisalabad
9.	Mohammad Nasir	Forestry and Wildlife	University of Agric., Faisalabad
10.	M. Ayub Khan	Plant Breeding and Genetics	University of Agric., Faisalabad
11.	M. Shafqat Shahzad	Statistics	University of Agric., Faisalabad
12.	Muzaffar Iqbal	Agric. Economics	University of Agric., Faisalabad
13.	Ahmad Khan	Plant Breeding and Genetics	University of Agric., Faisalabad
14.	Qurban Hussain	Parasitology	University of Agric., Faisalabad
15.	Mohammad Younas	Pathology (Veg)	University of Agric., Faisalabad
16.	Rashid Mahmood Nagra	Pathology (Veg)	University of Agric., Faisalabad
17.	Murid Hussain Javed	Animal Reproduction	University of Agric., Faisalabad
18.	Shahid Hussain Bukhari	Animal Reproduction	University of Agric., Faisalabad
19.	Muhammad Sarwar	Animal Nutrition	University of Agric., Faisalabad
20.	Mukhtar Ahmad Nadeem	Animal Nutrition	University of Agric., Faisalabad
21.	Mohammad Ashraf Anjum	Animal Nutrition	University of Agric., Faisalabad
22.	Iftikhar Ahmad Khan	Animal Nutrition	University of Agric., Faisalabad
23.	Mohammad Lateef	Livestock Management	University of Agric., Faisalabad
24.	Mohammad Ramzan	Livestock Management	University of Agric., Faisalabad
25.	Javed Iqbal	Animal Breeding and Genetics	University of Agric., Faisalabad
26.	Tajamal Mahmood	Rural Sociology	University of Agric., Faisalabad
27.	Abdul Wahid	Livestock Management	University of Agric., Faisalabad
28.	Mohammad Anwar	Animal Reproduction	University of Agric., Faisalabad
29.	Riaz Ahmad	Vet. Pathology	University of Agric., Faisalabad
30.	M. Shafqat Shahzad	Statistics	University of Agric., Faisalabad
31.	Zartaj	Agronomy	NWFP Agric. University, Peshawar
32.	Aziz-ur-Rehman	Agronomy	NWFP Agric. Univesity, Peshawar
33.	Noor Zaman	Agriculture	NWFP Agric. University, Peshawar
34.	P.M. Moshabber	Irrigation and Water Management	University of Engg. and Tech., Lahore
35.	Miss Anjum Ara Siddiq	Microbiology	Quaid-e-Azam University, Islamabad
36.	Amar Nazir Minhas	Agric. Economics	Quaid-e-Azam University, Islamabad
37.	Imtiaz Ahmad Qamar	Ecology	Punjab University, Lahore
38.	Saif-ud-Din Jehangir	Vet. Pathology	College of Vet. Sci., Lahore
39.	Mohammad Arshad	Microbiology	College of Vet. Sci., Lahore
40.	Rashid Ahmad	Microbiology	College of Vet. Sci., Lahore
41.	Zahid Saeed	Microbiology	College of Vet. Sci., Lahore
42.	Abdul Raoof	Microbiology	College of Vet Sci., Lahore
43.	Mohammad Nawaz Saeed	Nutrition	College of Vet. Sci., Lahore
44.	Ghulam Murtaza	Forestry	Pakistan Forest Instt. Peshawar
45.	Muhammad Shafique	Forestry	Pakistan Forest Instt. Peshawar
46.	Maqsood Ahmad	Forestry	Pakistan Forest Instt. Peshawar
47.	Imtiaz Ahmad	Forestry	Pakistan Forest Instt. Peshawar
	B.Sc.		
48.	Maqbool Hussain Khan	B.Sc. (Hons), Agric.	Barani Agric. College, Rawalpindi
49.	Noor Alam Khan	B.Sc. (Hons), Agric.	Barani Agric. College, Rawalpindi
50.	Fazal Rehman	B.Sc. (Agronomy)	NWFP Agric. Univ., Peshawar
		SHORT-TERM	
1.	Dr. S. Karam Shah (Director, ASI)	Course on Operations, Research and Quantitative Techniques	O&M Division, Cabinet Secretariat, Islamabad
2.	Mr. Habibullah Khan (SO, ASI)	Course on Operations, Research and Quantitative Techniques	O&M Division, Cabinet Secretariat, Islamabad

ANNEXURE-III

FOREIGN TRAINING SPONSORED BY PARC

S. No.	Name and Designation	Field of Training	Institution/Country	Period
		LONG-TERM		
1.	Mr. Sikandar Ali SSO, NIAB (Faisalabad)	M Sc. in Soil Microbiology	IRRI–Philippines	4th November, 1982– 3rd November, 1984
2.	Mr. Abdul Qayyum Asstt. Entomologist, CIDA Barani Project, Islamabad	M.Sc. in Entomology	Australia under Colombo Plan	14th February, 1983– 31st May, 1985
3.	Dr. Mohammad Akbar CSO, NARC	Senior Post Doctoral Fellowship	IRRI–Philippines	March, 1983 – March, 1984
		SHORT-TERM		
1.	Dr. Zahoor Ahmad, SSO, (PGR/PIC), PARC	FAO Training Course on Documentation Management of Genetic Resources	Agric. Experimental Station, USDA, Beltsville, USA	2–20 August, 1982
2.	Mr. Rafiq Masih, Asstt. Entomologist, PMP, PARC	Training Course in Plant Protection	Italy	5th October, – 30th June, 1982
3.	Mr. Mohammad Hashim Laghari, DD(Crops), PARC	FAO Training Course in Marketing and Processing of Dates	Baghdad, Iraq	20th November, – 7th December, 1982
4.	Mr. Mohammad Akmal Siddiqui Plant Physiologist, PARC	Rhizobium Technology	Bangkok, Thailand	1st November, – 10th December, 1982
5.	Mr. Nasir Ali Jaffery, Asstt. Botanist (Pulses) RRI, Dokri (Sind)	Food Legumes	ICARDA, Syria	January–July, 1983
6.	Mr. Yaqub Mujahid, SO, NARC	Training in Cereal Improvement	ICARDA, Syria	4th January, – 15th July, 1983
7.	Mr. Hamidullah Jan, Agric. Research Officer, ARI, Tarnab	Training on Pulses	ICRISAT, India	February – July, 1983
8.	Mr. Nazir M. Merchant, (Pulses Botanist), RRI, Dokri (Sind)	Training on Pulses	ICRISAT, India	February–July, 1983
9.	Mr. Manzoor Ahmed Asstt. Botanist (Pulses), AARI, Faisalabad	Modern Training in Breeding Pulses	ICARDA, Syria	February–July, 1983
10.	Mr. Ahmed Ali Hakro, Asstt. Plant Pathologist, CDRI, PARC, Murree	Wheat Pathology	CIMMYT, Mexico	February – August, 1983
11.	Mr. Nafis Sadiq Kisana, SO, NARC	Wheat Breeding	CIMMYT, Mexico	1st February – 1st August, 1983
12.	Mr. Salim Shaikh, ARO, ARI, Sariab, Quetta	Wheat Agronomy	CIMMYT, Mexico	February–July, 1983 (6 months)
13.	Mr. Syed Abid Hussain, Asstt. Botanist, (Wheat), ARI, Tandojam	Wheat Breeding	CIMMYT, Mexico	15th February – 15th August, 1983
14.	Mr. Attauddin, ARO, ARI, Tarnab	Wheat Pathology	CIMMYT, Mexico	February–September, 1983
15.	Mr. Syed Zafar Masood SSO, PARC, Malir Halt, Karachi	Regional Network for the Production Marketing and Control of Pesticides in Asia	Pacific Training New Delhi (India)	1st April, 1983
16.	Miss Riaz Kausar SO (Fisheries), PARC	Third Aquaculture Training Programme	SEAFDEC, Philippines	4th April, 1983 – 1st April, 1984
17.	Mr. Urs Mohammad Samo, Lecturer, SAU, Tandojam	SIDA Post-graduate Training Course on Animal Reproduction	Upsalla University, Sweden	April, 1983 – January, 1984
18.	Mr. Syed Iqbal H. Shah, AD (Fisheries) Mianchannu (Multan)	Third Training Course in Integrated Fish Farming	Regional Aquaculture Lead Centre, WUXI, China	18th April– 17th August, 1983
19.	Mr. M. Anwar Ali, ARO, (Wheat) RRI, Faisalabad	Wheat Agronomy	CIMMYT, Mexico	May–October, 1983
20.	Mr. M. Iqbal, ARO, ARI, Sariab, Quetta	Wheat Breeding/ Pathology	CIMMYT, Mecico	2nd May – 2nd November, 1983
21.	Mr. M. Yousaf, SO, NARC	Sunflower Training Course	Italy	10th May – 12th August, 1983
22.	Miss Shaheena Yasmin, SO, (Wheat), NARC	Training in Cereal Technology	CIMMYT, Mexico	1st June, 1983

SEMINARS, CONFERENCES AND TRAINING COURSES ORGANISED BY PARC

1. Second Meeting of Board of Governors, Islamabad; 4th July, 1982.
2. Workshop on Farming System Research, Islamabad; 1–12 August, 1982.
3. Training Course on Pulses Pathology, Islamabad; 2–9 August, 1982.
4. National Seminar on Wheat Research and Production, Islamabad; 17–19 August, 1982.
5. Regional Workshop for Farm Machinery Manufacturers, Lahore; 23rd August, 1982.
6. Training Course on Identification and Control of Weeds, Islamabad; 23–26 August, 1982.
7. Meeting of Interdisciplinary Research Committee, Islamabad; 2nd September, 1982.
8. Symposium on Dairy Development in Pakistan, Islamabad; 4th October, 1982.
9. Travelling Seminar on Maize, NWFP and Azad Kashmir; 4–9 October, 1982.
10. Training Course on Rabi Crops for Extension Workers of Islamabad District, Islamabad; 14th October, 1982.
11. First National Training Course on Biological Nitrogen Fixation, Islamabad; 19–21 October, 1982.
12. National Workshop on Potato Research, Islamabad; 20–21 October, 1982.
13. Workshop and Symposium on Environmental Mutagens and Carcinogenesis, Islamabad; 20th October – 4th November, 1982.
14. Meeting of Fisheries Experts, Islamabad; 26th October, 1982.
15. Symposium on Agricultural Genotoxicity in Developing Countries, Islamabad; 1–5 November, 1982.
16. Training Course on Mushroom Cultivation, Islamabad; 15–21 November, 1982.
17. Meeting on Strengthening of National AGRIS Liaison Office in Pakistan, Islamabad; 18th November, 1982.
18. Training Course on Poultry Production Technology, Islamabad; 21–30 November, 1982.
19. Training Sessions for Rodent Control, Islamabad; 4–11 December, 1982.
20. Meeting of Barani Agricultural Research and Development Project, Islamabad; 6th January, 1983.
21. Meeting of National Coordinated Farm Management Project, Islamabad; 8–9 Janaury, 1983.
22. Annual Meeting of Cooperative Research Programmes on Maize, Sorghum and Millet Crops, Islamabad; 16–17 January, 1983.
23. Course on Management Skills Development, Islamabad; 27th January, 1983.
24. Training Course on Poultry Production and Management, Tarlai, Rawalpindi; 7–12 February, 1983.
25. National Training Course on Beekeeping, Islamabad; 15–21 February, 1983.
26. Training Workshop on Organic Recycling, Islamabad; 22–24 February, 1983.
27. Training Course on Wheat Pathology, Islamabad; 27th February – 1st March, 1983.
28. National Meeting on Animal Power in Pakistan, Islamabad; 28th February, 1983.
29. Workshop on Least Cost Ration Formulation, Islamabad; 12–26 March, 1983.
31. Travelling Seminar on Pulses, Islamabad; 19–24 March, 1983.
32. National Training Course on Range Management and Forage Production, Islamabad; 26th March – 1st April, 1983.
33. Fourth National Seminar on Rice Research and Production, Islamabad; 2–4 April, 1983.
34. National Training Course in On-Farm Maize Research Management, Islamabad; 6–21 April, 1983.
35. Meeting of Wheat Variety Evaluation Committee, Islamabad; 25th April, 1983.
36. Meeting of Technical Committee on Agricultural Economics, Islamabad; 4–5 May, 1983.
37. Training Course on Rice Production Technology, Islamabad; 13–24 May, 1983.
38. National Meeting on Tissue Culture, Islamabad; 18–19 May, 1983.
39. Training Course on Kharif Crops Production Technology, Islamabad; 11–13 June, 1983.

PARTICIPATION IN SEMINARS, CONFERENCES AND STUDY VISITS ABROAD

S. No.	Participant	Subject of Meeting with Venue and Dates
1.	Mr. Dur Mohammad Jandon SSO, PIC, PARC, Karachi	Study Visit to See the Coconut Research Institute and Cultivation of Date-palm at Sri Lanka and Make Final Selection of Coconut Seeds for Plantation in Pakistan; 11–21, July 1982.
2.	Mr. Zulfiqar Ali Khan, Director of Agriculture Extension, Baluchistan, Quetta	– do –
3.	Mr. Tauqir Ahmed Ansari, Project Director WL&FD, Government of Sind, Karachi	– do –
4.	Dr. G.R. Sandhu, Director-General, NARC, Islamabad	Workshop on Priorities in Bio-technology Research for International Development, Washington, USA; 26–30 July, 1982.
5.	Ch. Zafaruddin, Director (RM&F), PARC, Islamabad	Two-week Visit to China to Study Sericulture from 12th August, 1982.
6.	Mian Muhammad Shameem, Conservator of Forests, Development and Working Plant Circle, Lahore	– do –
7.	Mr. Mir Baz Khan, AD (Sericulture), Forest Department, NWFP, Peshawar	– do –
8.	Mr. Munawar Hussain, Plant Pathologist, CDRI, PARC, Islamabad	Four-week Visit to Kenya to Study Wheat Nurseries from 24th August, 1982.
9.	Dr. Manzoor Ahmad Bajwa, Director (Wheat), AARI,Faisalabad	– do –
10.	Mr. Abdul Aziz Khan, SSO, VPCL, PARC Karachi	Conference on the Organisation and Practice of Vertebrate Pest Control, Hampshire, U.K.; 31st August -- 3rd September, 1982.
11.	Dr. S. Iqbal Shah, Co-ordinator (Anim. Nutr.), PARC, Islamabad	Workshop on the Feasibility of By-Products and Non-conventional Feed Utilization for Animal Production at Nairobi, Kenya; 26–30 September, 1982.
12.	Dr. Hayat Mohammad Bhatti, AC (Soils), AARI, Faisalabad	International Conference on Organic Matter and Rice at IRRI, Los Banos, Philippines; 27th September – 1st October, 1982.
13.	Dr. Taj Mohammad Chaudhry, AC (Soils) ARI, Tandojam	– do –
14.	Dr. A. K. Khandaza, SSO, CDRI, PARC, Islamabad	International Symposium on Seed Pathology, Copenhagen, Denmark; 8–29 October, 1982.
15.	Dr. Riaz Ahmad Khan Member (Social Sciences), PARC, Islamabad	Meeting of Asian Cropping Systems' Working Group, Bangkok, Thailand; 11–15 October, 1982.
16.	Dr. Muhammad Akbar, Coordinator (Rice), NARC, Islamabad	15th Session of International Rice Commission in Free Town, Seirra Leone, Africa; 11–16 October, 1982
17.	Dr. Zia-ur-Rehman, Director (FMI), NARC, Islamabad	7th Session of Technical Advisory Committee of the Regional Network of Agricultural Machinery (RNAM), Tokyo, Japan; 13–19 October, 1982.
18.	Dr. C. M. Anwar Khan, Member (Natural Resources), PARC, Islamabad	Conference of Directors of National System in Asia, Jakarta, Indonesia; 24–29 October, 1982.
19.	Mr. Umar Khan Baluch, Director of Research (PP), PARC, Islamabad	First Meeting of Technical Advisory Committee, Manila, Philippines; 8–15 November, 1982.
20.	Dr. Syed Iqbal Ahmed, Coordinator (ADI), NARC, Islamabad	Experts Consultation on Appropriate Use of Animal Energy in Agriculture, Rome, Italy; 15–19 November, 1982.
21.	Dr. M. Qasim Chatha Coordinator (Maize), NARC, Islamabad	Symposium on International Agro-climatology of Sorghum/Millet, Hyderabad, India; 15–19 November, 1982.
22.	Dr. Sh. M. Shabbir, SSO (Animal Nutrition), NARC, Islamabad	Study Visit in the Field of Computer Programming to California Polytechnic and State University, USA; 17–30 November, 1982.
23.	Mr. Mohammad Pervez Masud, Secretary, Agriculture Department, Government of Punjab, Lahore	Seven-day Visit to Attend the Collaborative Rice Research Programme with IRRI, Los Banos, Philippines; from 25th November, 1982.
24.	Dr. G. R. Sandhu, Director-General, NARC, Islamabad	International Conference on Chemistry and World Food Supplies – The Frontiers, Manila, Philippines; 6–10 December, 1982.
25.	Dr. Ahmad Saeed Khan, Professor and Chairman, Department of Agricultural Economics, UA, Faisalabad	– do –
26.	Dr. M. Akmal Khan, Associate Professor, Department of Nutrition, UA, Faisalabad	– do –
27.	Dr. Amanat Ali, SSO (Animal Nutrition), NARC, Islamabad	Seminar on Appropriate Technology and Rural Development in Research and Practice, Bangkok, Thailand; 5–19, December, 1982.
28.	Dr. Syed Mujtaba Naqvi,	Workshop to Discuss Chemistry Research and Set Priorities for USAID in the Areas

(Continued)

	Director, NIAB, Faisalabad	of Soils and Plant Nutrition, Plant Pest Relationships, Aquaculture and Food Sciences Technology, Los Banos, Philippines; 11–14 December, 1982.
29.	Dr. Riaz Ahmad Khan, Member (Social Sciences), PARC, Islamabad	Meeting of the Coordinating Group of Experts on Food and Agriculture from Developing Countries, New Delhi, India; 14–16 February, 1983.
30.	Mr. Umar Khan Baluch, Director of Research (PP) PARC, Islamabad	Consultation in Post-harvest Technology and Quality Control for Food Grains, Bangkok, Thailand; 15–19 February, 1983.
31.	Dr. Hafiz Ahmad, Director (GSRL), PARC, Karachi	– do –
32.	Dr. S. A. Qureshi, Director-General, AARI, Faisalabad	Meeting of IBPGR, Rome, Italy; 25–26 February, 1983.
33.	Dr. M. Yousaf Chaudhri Member (Crop Sciences), PARC, Islamabad	30th Meeting of Technical Advisory Committee, Rome, Italy; 8–15 March, 1983.
34.	Dr. Muhammad Aslam, Coordinator (PP), CDRI, PARC, Islamabad	Study Visit to Mexico, USA and Philippines; 16th March – 26th April, 1983
35.	Dr. N. I. Hashmi Coordinator (Wheat), NARC, Islamabad	– do –
36.	Mr. Muhammad Pervez Masud, Secretary, Agriculture Department Government of Punjab, Lahore	Study Visit to IRRI, Los Banos, Philippines; 16–22 March, 1983.
37.	Mr. Shaheen Majid, Documentation Officer, PARC, Islamabad	Workshop on the Training of Users of Agricultural Information Systems, Laguna, Philippines; 20–26 March, 1983.
38.	Mr. M. M. H. Baig, Senior Chemist (PMRI), PARC, Karachi	Regional Pesticides Network Experts Group Meeting on Pesticide Data Collection System, Bangkok, Thailand; 20–26 March, 1983.
39.	Dr. Abdul Rehman, Project Director (BARD), PARC, Islamabad	Visit to ICRISAT and Dryland Project and Attended Symposium on Maximum Data Sets for Agro-technology Transfer, Hyderabad, India; 21st March – 1st April, 1983.
40.	Mr. Umar Khan Baluch, Director of Research (PP), PARC, Islamabad	FAO Workshop on Survey of Farm Level Storage Losses in Major Food Grains, Rome, Italy; 16–26 April, 1983.
41.	Dr. Riaz Ahmad Khan, Member (Social Sciences), PARC, Islamabad	International Rice Research Conference, Manila, Philippines; 18–22 April, 1983.
42.	Dr. Abdul Majid, Director, RRI, Kalashah Kaku	– do –
43.	Dr. I. M. Bhatti, Director, RRI, Dokri	– do –
44.	Mr. Anwar Ali Chaudhry, Director (Scientific Information), PARC, Islamabad	Workshop on Management of Agricultural Information Services and Centres, Bogor, Indonesia; 18–23 April, 1983.
45.	Mr. Aurangzeb Khan, SSO (SCAN Project), PARC, Islamabad	Symposium on Maximum Data Sets for Agro-technology Transfer, Hyderabad, India; 21–26 April, 1983.
46.	Mr. M. Sadiq Bhatti, SO (PGR), NARC, Islamabad	Workshop on Conservation of Rice Germplasm at IRRI, Los Banos, Philippines; 25-26 April, 1983.
47.	Mr. Arbab Ali Soomro, Rice Botanist, RRI, Dokri, Sind	– do –
48.	Dr. Abdur Rauf Khan, Deputy Director (Tea), PARC, Islamabad	Visit to China for Study of Tea Production; 8th May – 10th June, 1983.
49.	Dr. Amir Muhammed, Chairman, PARC, Islamabad	Visit to Nepal for Pakistan–Nepal Cooperation in the Field of Agriculture and Animal Husbandry; 12–17 May, 1983.
50.	Dr. Haleem-ul-Hasnain, Member (Animal Sciences), PARC, Islamabad	– do –
51.	Dr. Abdur Rehman, Professor in Plant Breeding and Genetics, UA, Faisalabad	– do –
52.	Dr. Manzoor Ahmed A. Baluch Director (Res.), PCCC, Karachi	– do –
53.	Mr. Bashir Ahmad Malik, Coordinator (Pulses), NARC, Islamabad	International Workshop on Faba Bean, Kabuli Chickpea and Lentils in 1980's at ICARDA, Aleppo, Syria; 16–20 May, 1983.
54.	Dr. Muhammad Tufail,	– do –

(Continued)

	Gram Botanist, AARI, Faisalabad	
55.	Dr. Akhtar Beg, Coordinator (Oilseeds), NARC, Islamabad	International Rapeseed Workshop/Conference, Paris, France; 16–22 May, 1983.
56.	Dr. Riaz Ahmad Khan. Member (Social Sciences), PARC, Islamabad	Farming System Research Workshop at ICARDA, Aleppo, Syria; 24–26 May, 1983.
57.	Mr. Muhammad Hashim Leghari, Deputy Director (Research), PARC, Islamabad	International Workshop on Promoting Research in Tropical Fruits, Jakarta, Indonesia; 29th May – 7th June, 1983.
58.	Mr. Amir Hussain, Horticulturist (Coconut) Sind Horticulture Institute, Mirpur Khas	– do –
59.	Mr Umar Khan Baluch, Director of Research (PP), PARC. Islamabad	Conference on Worldwide Approach to Agro-chemicals, Tokyo, Japan; 7–9 June, 1983.
60.	Dr. M. Qasim Chatha, Coordinator (Maize), NARC, Islamabad	Seven-day Study Visit in the Field of Maize, Potato, Sunflower and Sugar beet to Yugoslavia from 13th June, 1983.
61.	Dr. Akhtar Beg, Coordinator (Oilseed), NARC, Islamabad	– do –
62.	Syed Mehfooz Ali Shah, Coordinator (Potato), PARC, Islamabad	– do –
63.	Mr. Sardar M. Mughal. PSO (Plant Virology), PARC, Islamabad	– do –
64.	Mr. Umar Khan Baluch, Director of Research (PP), PARC, Islamabad	Meeting of Second Technical Advisory Committee on Regional Network for the Production, Marketing and Control of Pesticides in Asia and Far East Suweon, Korea; 26th June – 2nd July, 1983.
65.	Dr. Muhammad Yousaf Chaudhri Member (Crop Sciences), PARC, Islamabad	Visit to Tunisia; 26th June – 5th July, 1983.
66.	Mr. M. A. Maqbool, Nematologist, PARC, Karachi	Annual Meeting of American Phytopathological Society at Iowa University, Ames, USA; 26–30 June,1983.
6	Dr. Bakht Roidar Khan, SSO, PARC, Islamabad	Cereal Conference on British Wheat Yield Boost, U.K.; 29th June, 1983.

PARC PUBLICATIONS

Periodicals

1. Pakistan Journal of Agricultural Research (quarterly)
2. Progressive Farming (bimonthly)
3. PARC News (monthly newsletter)

General Publications

1. Mash Cultivation (Urdu)
2. Injurious Insects of Sugarcane and their Control (Urdu)
3. Fattening Lambs with Poultry Litter and Poultry Manure
4. Calendar of Events
5. Wheat Cultivation Recommendation for 1982-83 (Urdu)
6. Adoption of Improved Agricultural Technology from Amongst the Developing World, Egyptian Experience and its Application in Pakistan
7. Issues of Food Distribution in Pakistan; Staff Paper
8. A Suggested Approach for Developing Pakistan's Agricultural Statistics; Staff Paper.
9. Weeds of Wheat and their Control (Urdu)
10. Raya and Mustard Cultivation in Pakistan (Urdu)
11. Scope of Agro-forestry Research and Development in Pakistan
12. Rearing of Cross-bred Dairy Calves
13. Safflower Cultivation (Urdu)
14. Manual for Feed Analytical Laboratory
15. Hand Book of Vertebrate Pest Control in Pakistan
16. PARC Competitive Examination Papers for S.R.O's and R.O' s under Talent Pool Scheme
17. Arid Zone Research Institute (Brochure)
18. Agricultural Research System in Pakistan – a review
19. Livestock Resources of Islamic World
20. Farm Water Management
21. Recycling of Animal Wastes as a Source of Nutrient for Fish-culture within an Integrated Livestock System – a review
22. Proceedings of International Seminar on Sheep and Wool
23. Guide to Formulation of Cattle and Buffalo Rations Based on Sugar Mill By-products
24. Plant Pathology Research Activities in Pakistan
25. Agricultural Education in Pakistan
26. Farming Systems Research: An Exploratory Survey of Rainfed Agriculture in Northern Punjab
27. Pakistan Bibliography of Agriculture
28. Statistical Bulletin on Rice in Pakistan
29. Maize Cultivation Recommendations for 1983 (Urdu)
30. Proceedings of Symposium on Dairy Development in Pakistan

PUBLICATIONS OF PARC SCIENTISTS

Wheat, Barley and Triticale

1. Khan R.A.; Hashmi, N.I.; Nasir, M.; Munir, M. and Hobbs, P.R. 1982. Farming systems research– an exploratory survey on rainfed agriculture in northern Punjab. Staff Paper Series. Pakistan Agricultural Research Council, Islamabad. 12 p.
2. Saleemi, A.R.; Ajmal, S.U.; Mustafa, S.Z. and Anwar, R. 1982. Development of high yielding durum wheat in Pakistan. Pakistan J. Agric. Res. 3(2): 125–128.

Rice

1. Avesi, G. M. 1983. Raising rice nurseries. Progressive Farming, 3(3): 15–17.
2. Avesi, G. M. 1983. Mode of inheritance to green leaf hopper resistance in some rice varieties. Presented at 4th National Seminar on Rice Research and Production 2–4 April, 1983, Islamabad.

Maize, Sorghum and Millet

1. Chatha, M.Q. and Javed, H.B. 1982. Status of sorghum and millet production and research in Pakistan. Presented at Int. Agro-Climatol. Sorghum and Millet Symp. ICRISAT, Hyderabad, India.
2. Chatha, M.Q.; Anwar, R. and Shakoor, A. 1983. Spring maize cultivation. Progressive Farming, 3(2): 5–7.
3. Chatha, M.Q.; Shakoor, A.; Keiro, H.K.; Anwar, R.; Naeem, M.; Malik, H.N.; Javed, H.I. and Ahmed, S. 1983. Maize Production Manual, Islamabad, Pakistan Agricultural Research Council, Islamabad. 143 p.

Oilseed Crops

1. Beg, A. 1982. Soybean as pulse. Progressive Farming, 2(4): 16–19.
2. Beg, A. and Ali, N. 1982. Rape and mustard – invaluable edible oil crops of Pakistan. Progressive Farming, 2(5): 20–26.
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