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INTEGRATING AGROBIODIVERSITY CONCERNS INTO NATIONAL POLICIES, PLANS AND STRATEGIES IN EASTERN AFRICA

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Acronyms

AGR	Animal Genetic Resources
CAIS	Central Artificial Insemination Station
CBD	The Convention on Biological Diversity
CGIAR	Consultative Group on International Agricultural Research
COP	The Conference of the Parties
FAO	Food and Agriculture Organization
GBK	Gene Bank of Kenya
GDP	Gross Domestic Product
GNP	Gross National Product
GPA	Global Plan of Action
KARI	Kenya Agricultural Research Institute
KEFRI	Kenya Forestry Research Institute
NAGRP	National Animal Genetic Resources Program
NARS	National Agricultural Research Systems
NMK	National Museums of Kenya
NPGRP	National Plant Genetic Resources Program
OAU	Organisation of African Unity
PGR	Plant Genetic Resources
PGRC/E	Plant Genetic Resources Centre - Ethiopia
SBSTTA	The Subsidiary Body for Scientific, Technical and Technological Advice
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WCMC	World Conservation Monitoring Centre

EXECUTIVE SUMMARY

It is currently widely recognized that an emphasis on agrobiodiversity-agricultural biodiversity could meet the three objectives of the Convention on Biological Diversity (CBD)[1]: (i) conservation - with an emphasis on dynamic *in situ* conservation under traditional farming systems; (ii) sustainable use of agrobiodiversity as most appropriate for environmentally friendly, low-input agriculture and for marginal conditions; and (iii) given the high current and potential commercial value of agrobiodiversity, equitable sharing of benefits from use of biodiversity as a mechanism to generate funding for the national conservation of agrobiodiversity and for national agricultural development. Particularly, in agricultural economies, the conservation and sustainable use of agrobiodiversity components is fundamental to sustainable agricultural development because of its multiple benefits.

Agricultural biodiversity supports rural livelihoods through subsistence agriculture, contributes to national food and nutrition security and to scientific crop improvement. Conservation, sustainable use and enhancement of agrobiodiversity are therefore beneficial to achieve both food/livelihood security and sustainability aims. These concerns were the focus of the Agrobiodiversity Workshop organized by the African Centre for Technology Studies (ACTS) and the World Resources Institute (WRI) during the Second Eastern Africa Sub regional Forum on Biodiversity in November 17-19, 1997 at the International Centre for Research in Agroforestry (ICRAF) Nairobi, Kenya.

The forum was designed to promote the integration of specific agricultural and forest biodiversity concerns into biodiversity plans, policies and programmes. The forum mobilized the participation of various sectoral groups and interests (agriculture, forestry and economic planning) in national biodiversity planning process. Through the enhanced participation of the varied but related interest groups, the forum facilitated and promoted the sharing of experiences in integrating biodiversity concerns into sectoral programmes, policies and projects as required by Article 6 of the CBD. Eastern African countries- whose economies are dominated by agriculture and are Contracting Parties to the CBD, will through compliance to Article 6 requirements, contribute significantly to sustainable agricultural and subsequent economic development to meet both national and local food and livelihood security needs. These Parties- Ethiopia, Kenya, Uganda and Tanzania have obligations to integrate agrobiodiversity concerns- conservation and sustainable utilization of its components into national decision - making, in particular to the agricultural sector, and must be supported by effective legal and regulatory frameworks and; incentives.

Evidence from case studies in the region, which analysed the agricultural systems and their development, revealed that despite various socio-economic pressures on natural resources, Eastern Africa is still

home to a wealth of agricultural biological diversity with the potential to contribute to sustainable agriculture. This diversity is mainly found in traditional agricultural systems characterized by high intraspecific and interspecific diversity which enhances harvest security.

These traditional agricultural practices have played a great role in sustaining agrobiodiversity and the production systems and because of their ecological, biological and economic contribution to genetic diversity and livelihood, they form a basis for enhancing agrobiodiversity conservation. However, they are under threat of being diminished by agricultural practices propagated by policies designed to promote the Green Revolution. It is important to note that it is the Green Revolution technologies in agriculture that contributed to the significant increases in food production in the last few decades. For example, through the application of scientific advances on two exotic crop varieties - wheat and rice, they are responsible for the cereal yield take offs in a number of African countries during the 1980s[2]. Thus the technologies provided the stimulus that enabled the agriculture of many countries to expand and provide more food and jobs. However, they have led to the expansion of monocultural agro-ecosystems and gradual displacement of diverse traditional agro-ecosystems. Thus they have influenced the wealth of agrobiodiversity at the landscape, ecosystem, species and genetic levels. Decision makers must realize that there are many aspects of traditional farming which are still relevant and that modern methods could at best supplement indigenous and local technologies. Although there are some efforts - implied in policy documents and programs, to address the loss of agrobiodiversity these have only focused on conservation, and have been largely ineffective due to inadequate financial, legal and institutional capacities to design and implement policies that are focused on agrobiodiversity. For example, governments' initiatives in conservation of biodiversity through *ex situ* systems i.e. gene banks and botanical gardens, have proved to be weak and unsatisfactory. It is important to recognize that, for economic[3] and ecological reasons, there is no alternative to the conservation and continued use of crop and livestock diversity *in situ* i.e. on farmers fields and pastoralists range lands.

As long as these countries continue to lose their genetic base they will subsequently undermine the potential for food security leading to increased food aid dependency and loss of potential profits and dividends from wild genes. Since government policies have in part cpntributed to these processes, policy amendments may be a necessary step towards conservation. It is somewhat ironic that it is exotic crop varieties which are displacing traditional species which are typically traditional species indigenous in origin. Concrete measures need to be put in place, where lacking and or to enhance efforts on conservation and to consider programs for sustainable use of agrobiodiversity components. Specific efforts should be directed towards awareness raising on the understanding of agrobiodiversity issues which have not been given adequate attention by international, national and local stakeholders; increased investment in long

term biodiversity planning at all levels and conservation including research on traditional agrobiodiversity, and its integration into school curriculum; more comprehensive environmental accounting; providing economic and legal incentives for the development and promotion of traditional food crops to reduce the negative influence of the Green Revolution technologies and enhance community participation and their knowledge in national biodiversity planning and conservation.

1.0 Introduction

Integrating agrobiodiversity concerns into national development is fundamental to the effective transition towards sustainable agricultural production - a top priority in both developed and developing worlds. In particular, the stability and sustainability of agriculture is of paramount importance to Eastern Africa, because their economies are dominated by the agricultural sector (see Table 1). The dependence of these economies on agriculture therefore, makes conservation and sustainable utilization of genetic resources, and in particular, agrobiodiversity, a crucial item in the development agenda. Besides, these countries are Parties to the Convention on Biological Diversity (CBD) and are therefore obliged to those provisions requiring integrating agrobiodiversity concerns into mainstream development.

An analysis of efforts to incorporate agrobiodiversity concerns into national plans, programs and strategies reveal that Contracting Parties in Eastern Africa are far from fulfilling the Convention's objectives. This is evident in the following two observations. Firstly, the continuing loss of crop genetic resources due to the restricted focus of agricultural policies on a few introduced species. Secondly, despite the wealth and potential of agrobiodiversity in the region to contribute to food production it has not been explored to address the decline in food productivity and the increased dependence on food aid. This scenario calls for a critical review of the current national policies and programs that impinge on agrobiodiversity both directly and indirectly.

The following is a synthesis on efforts in Eastern Africa to incorporate agrobiodiversity concerns into mainstream development in line with requirements of Article 6 of the CBD which prescribes the critical steps each country must undertake to effectively conserve and sustainably use biodiversity[4]. The synthesis is based largely on key issues, ideas and case studies discussed during a regional forum on Biodiversity held in Nairobi in November 1997. The recommendations reflect the main priorities that were identified by thirty stakeholder participants from different institutions in Eastern Africa.

The paper begins by laying down the emergence of the Convention's focus on agrobiodiversity as a basis for it's integration in development. This is followed by an outline on the dynamics in agrobiodiversity linked to the major processes experienced in the agricultural sector with a view to identifying options for slowing, or reversing the negative impacts at the national level. The multiple roles of traditional farming systems in conservation and sustainable utilization of biodiversity of local and national importance are stressed. The factors affecting the status of agrobiodiversity are identified. These may be either political, social, cultural, economical or combinations of them. Subsequently, the paper analyses the position and role of various policy instruments in the development, management, enhancement of conservation, and sustainable use of components of agrobiodiversity. Finally, opportunities for enhancing and catalyzing the process of integrating agrobiodiversity concerns are discussed and priority areas for action proposed. The synthesis emphasizes the needs of development and argue that to achieve sustainable agricultural development, countries in the region should focus on those initiatives that will lead to the development, promotion, conservation and sustainable use of agrobiodiversity components.

2.0 The Convention on Biological Diversity and Agrobiodiversity

The Convention on Biological Diversity (CBD) provides a legally binding framework for the conservation and sustainable use of agrobiodiversity, in particular, and the transition towards sustainable agriculture in general[5]. The scope and the comprehensive nature of the objectives of the Convention lay the foundation for effecting such a transition. The objectives of the CBD are threefold : (1) conservation of biological diversity, (2) sustainable use of its components, and (3) fair and equitable sharing of benefits derived from its utilization. Integration of agrobiodiversity concerns into the CBD agenda was initiated at the first Conference of the Parties (COP) further to Resolution 3 of the CBD which was signed in May 1992. Resolution 3 of the CBD recognized *inter alia* the need for the provision of support to the implementation of activities on conservation and sustainable utilization of plant and animal genetic resources for food and sustainable agriculture[6]. *Decision I/9* of the first (COP) to the CBD in 1996 set out to consider the "conservation and sustainable use of agrobiodiversity within the context of the Convention's three objectives and it's provisions". *Decision II/1* of the second meeting of the COP took note of the report of the first meeting of the Subsidiary Body for Scientific, Technical and Technological Advice (SBSTTA), in which the SBSTTA, in it's recommendation I/2, proposed to provide to the COP "advice on scientific, technical and technological aspects of the

conservation of agrobiodiversity and sustainable use of it's components". The second meeting of the SBSTTA considered agrobiodiversity.

Through these concerted efforts towards agrobiodiversity it became widely recognised that an emphasis on agrobiodiversity could meet the three objectives of the Convention on Biological Diversity: conservation - with an emphasis on dynamic *in situ* conservation under traditional farming systems; sustainable use of agrobiodiversity as most appropriate for environmentally-friendly, low-input agriculture and for marginal conditions; and given the high commercial value of agrobiodiversity, the equitable sharing of benefits from the use of biodiversity as a mechanism to generate funding for the national conservation of agrobiodiversity and for national agricultural development. Moreover agrobiodiversity is a vital basis for food security of millions of people.

Subsequently, in the second meeting of the COP, a series of measures aimed at implementing Articles 6 and 8 (on *in situ* conservation) of the Convention on general measures for the conservation and sustainable use of biological diversity were adopted. The decisions of the COP, with regard to Articles 6 and 8, have so far focused on national strategies, plans and programmes. Article 6 (a) calls upon each Party to:

> "develop national biodiversity strategies, plans or programmes for the conservation and sustainable use of biological diversity, or adapt for this purpose existing strategies, plans, or programmes which shall reflect, *inter alia,* the measures set out in this Convention relevant to the Contracting Party concerned."

But Article 6 (b) envisages that future work will be implemented through

> "relevant sectoral or cross-sectoral plans, programmes and policies and invites each Party to "integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral - agriculture, forestry, marine, or cross-sectoral plans, programmes and policies".

It is from this perspective that the ecosystem approach to conservation has been adopted. Subsequently, the emphasis on sustainable agriculture in general and agricultural biological diversity in particular became an urgent matter for the Convention. The following COPs to the Convention reiterated the importance of agricultural biodiversity as containing the most vital elements of biological diversity essential for food and livelihood security and emphasized the pertinence to conserve and sustainably use agrobiodiversity[7].

In promoting the sustainable use of the components of agrobiodiversity, the Convention expects each Party to integrate the conservation and sustainable use of biological resources of relevance- i.e. agricultural, into national decision-making. This integration can take place at the policy, planning and management levels. Such integration will need to be supported by effective legal and regulatory frameworks, as well as, by the use of incentive measures (which include economic instruments, market

and other incentives). In addition, agrobiodiversity will need to be featured prominently in the systems of integrated environmental and economic accounting needed for the implementation of sustainable development[8]

The obligations under the Convention are intended to reinforce and guide the work that is already being undertaken by the relevant international, regional and national institutions, as well as market-based activities in the field of agricultural biological diversity. Recent international policy efforts to promote the conservation and sustainable use of agricultural biological diversity, find their most elaborate articulation in Chapter 14 of Agenda 21. Pursuant to the chapter, the international community, operating mainly through the Food and Agriculture Organisation (FAO) of the United Nations , has formulated a Global Plan of Action (GPA) on Plant Genetic Resources for food and agriculture, which was adopted by the Fourth International Technical Conference on Plant Genetic Resources held in June 1996 in Leipzig, Germany. Other important scientific and technological measures, such as international agricultural research activities under the auspices of the Consultative Group on International Agricultural Research (CGIAR), have contributed to the efforts aimed at the conservation and sustainable use of agricultural biological diversity. Other activities of relevance are carried out by the United Nations Educational, Scientific and Cultural Organisation (UNESCO), the United Nations Environment Programme (UNEP), the United Nations Development Programme (UNDP) and the World Bank, among others. These initiatives and other efforts world-wide provide valuable lessons, as well as form an important basis, for integrating agrobiodiversity concerns into agricultural development.

3.0 Agrobiodiversity in Eastern Africa

3.1 Agrobiodiversity defined

For purposes of this report (and the Convention) , agrobiodiversity (i.e. agricultural biological diversity) means the variability among living organisms associated with cultivating crops, rearing animals and the ecological complexes of which they are part: this includes diversity within species, between species, of ecosystems[9] and landscapes. As a fundamental feature of farming systems around the world, agrobiodiversity encompasses the following genetic resources: edible plants and crops, including traditional varieties, cultivars, hybrids, and other genetic material developed by breeders; and livestock (small and large, lineal

breeds, or thorough breeds) and freshwater fish; soil organisms vital to soil fertility, structure, quality, and soil health; naturally occurring insects, bacteria and fungi that control insect pests and diseases of domesticated plants and animals; agro-ecosystems components and types (polycultural/monocultural, small/large scale, rainfed/irrigated etc.) indispensable for nutrient cycling, stability, and productivity; and "wild" resources (species and elements) of natural habitats and landscapes that can provide services (for example, pest control and ecosystem stability) to agriculture[10]. An essential parameter to the definition of agrobiodiversity is the contribution by traditional practices, technologies and knowledge to sustain the diversity.

Agrobiodiversity offers multiple benefits to rural livelihoods (70% - 90% of the region's population)[11] through traditional farming systems for subsistence agriculture, scientific crop improvements and national food and nutrition security. Experience and research have shown that agrobiodiversity has many properties (see *Box 1)* of value to agricultural development. In effect, conservation, sustainable use and enhancement of agrobiodiversity can contribute towards food, livelihood security and sustainable agricultural development in Eastern Africa.

Box 1 : General Benefits of Agrobiodiversity[12]

Experience and research have shown that agrobiodiversity can:

- increase productivity, food security, and economic returns;
- reduce the pressure of agriculture on fragile areas, forests and endangered species;
- make farming systems more stable, robust and sustainable;
- contribute to sound insect pest and disease management;
- conserve soil and increase natural soil fertility and health;
- contribute to sustainable intensification;
- diversify products and income opportunities;
- reduce or spread risks to individuals and nations;
- help maximize effective use of resources and the environment;
- reduce dependency on external inputs;
- improve human nutrition and provide sources of medicines and vitamins; and
- conserve ecosystem structure and stability of species diversity.

(Adapted from UNDP, 1983[13]; Altieri, 1987[14]; Brookfield and Padoch, 1994[15] as summarized by L. A. Thrupp, 1997[16])

3.2 Status of Agrobiodiversity

The Eastern Africa biome is considered to be one of the richest ecologically diverse regions for both plant and animals species[17]. It is a major repository of biological and genetic resources for the advancement of agriculture, industry and medicine worldwide[18]. Table 1 briefly describes seven conservation sites in the region containing genetic resources of economic importance. A study carried out by the National Biodiversity Unit (1992)[19], revealed that Uganda has one of the highest number of biological resources in Africa; with 11% of the world's birds, 7.3% for the world's mammal species and yet it occupies less than 2% of the world's land surface. Some 5,000 plant species have been recorded in Uganda[20]. Kenya, a land of great ecological and natural diversity is home to 19[21] distinct biotic communities and more than 7,800[22] plants and animal species. Ethiopia has between 6000 and 7000 flowering plants while Tanzania has 10,000 flowering plants[23] .

In addition, the East African coastal rain forests contain a significant number of endemic species particularly of birds, amphibians and invertebrates. The lowland coastal vegetation of Kenya and Tanzania (including Zanzibar), has around 100 endemic plant species and five endemic genera: *Angylocalyx, Asteranthe, Lettowianthus, Mkilua* and *Ophryptealum*[24]. Kenya has 171 endemic plants and animal species which are cited to be endangered[25]. Ethiopia has between 600 and 1400 endemic flowering plants, Tanzania 1,122 and Uganda 30 endemic flowering plants[26]. Among the East African Upland forests are the Usambara mountains, which are of exceptional importance for endemic plants. Polhill (1968)[27] lists 112 trees and shrubs endemic to the mountains with another 30 or so nearly endemic. Polhill's totals for endemic plants include 50 tree species over 10m tall, of which three are in monotypic genera: *Cephalosphaera usambarensis, Englerodendron usambarense* and *Platypterocarpus tanganyikensis.* In addition, nine African violets *Sainpaulia spp* are endemic to the mountains.

This high level of endemism attests to the fact that Eastern Africa is one of the centers of diversity (see Figure 1 below). It represents one of the world's eight major centres of crop plant diversity. As one of the Vavilov[28] centers of diversity, it has increased the availability of crop progenitors for many of the food crops domesticated and grown worldwide. There are 12 widespread crops which are believed to have their centres of diversity within the region and three other Ethiopian crops have originated and evolved within the country [29] These are coffee (*Coffea arabica*), barley (*Hordeum vulgare*), sorghum (*Sorghum bicolor*), wheat (*Triticum* spp.), teff (*Eragrostis tef*), niger seed, noog (*Guizotia abyssinica*), linseed (*Linum usitatissimum*), sesame (*Sesamum indicum*), castor bean (*Ricinus communis*), pea (*Pisum sativum*), chickpea (*Cicer arietinum*), lentil (*Lens culinaris*), ensete (*Ensete ventricosum*) and chat (*Catha edulis*) (see also Table 2). Of particular importance is the species

richness of the montane grasslands of Ethiopia, which has contributed *Eragrostis pilosa* the progenitor of tef, *Sorghum arundinareceum* one of the progenitors of sorghum and wild legumes *Cicer cuneatum* and *Lens culinaris*[30].

Concurrently, over the past few decades, the region has also benefited from introduced agricultural genetic resources from other centres of diversity. For example, most accessions of crop genetic resources in the gene banks are of introduced varieties. Generally, these resources had properties which appealed to the prevailing socioeconomic environment and have played a major role in the development of agriculture in the region.

Table 1: Plants species diversity in selected conservation sites in Eastern Africa.

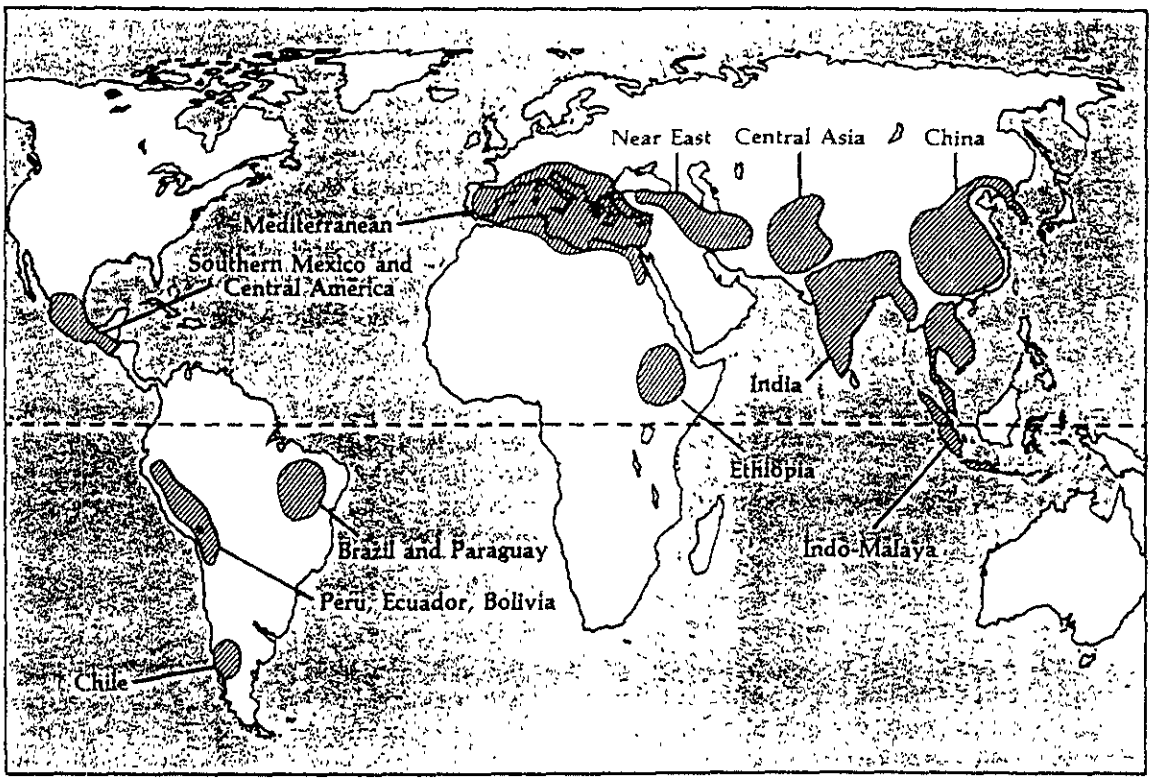
Site Name	Country	No. of Plants species	Examples of useful plants
Bwindi (Impenetrable) National Park	Uganda	1,000 taxa	Timber tree, bamboos, medicinal plants
Mbali-Mahali Hills	Tanzania	8,600	
Mt Kenya	Kenya	800	Timber trees,. fruit trees, medicinal plants
Bale Mts	Ethiopia	> 1,000	Wild and semi wild arabica coffee
Limestone Bush/woodland, Ogaden	Ethiopia, Kenya, Somalia		Frankincense, myrrh, yeheb nut
Rondo Plateau	Tanzania		
Eastern Arc Mts: Usambaras	Tanzania	1,921 taxa	African violet, timber and pole species

Source: WCMC, 1992

However as documented by FAO it is the introduced agricultural crop varieties that are dominating the agricultural landscape and economies (see Table 8). As in many developing countries they rely on exporting a single crop such as sugar, coffee, cotton[31]. Noteworthy however is the prevalence of poverty. It is estimated that 27 percent[32] of Uganda's rural population live below the poverty line, while in Kenya the percentage is 46 [33].

At the local level evidence is abound on the abundance of indigenous nutritious food plants found and consumed in Eastern Africa which have been noted to play a significant role in food security. Such traditional food plants include sorghum, bulrush millet, finger millet, teff, cassava, sweet potato, yam and cocoyam. There are also edible, fleshy often succulent parts of plants such as the fruits, leaves, flowers, stems or roots which may be eaten green, fresh or boiled. These include African spinach, okra, rosella, *Solanum* spp., ensette, *Celosia* spp. and fluted pumpkin[34].The

Figure 1: Vavilov centres of crop genetic diversity. Source Reid W. V. and Miller K. R 1989 (WRI)[35], adapted from Hawkes



Examples of crops with high diversity in each area include:

China: Naked oat, soybean, adzuki bean, common bean, leaf mustard, apricot, peach, orange, sesame, China tea.
India: Rice, African millet, chickpea, mothbean, rice bean, horse gram, asparagus bean, eggplant, rat's tail radish, taro yam, cucumber, tree cotton, pepper, jute, indigo.
Indo-Malaya: Yam, pomelo, banana, coconut.
Central Asia: Wheat (bread, club, shot), rye, pea, lentil, chickpea, sesame, flax, safflower, carrot, radish, pear, apple, walnut.
Near East: Wheat (einkorn, durum, Poulard, bread), barley, rye, red oat, chick pea, pea, lentil, blue alfalfa, sesame, flax, melon, almond, fig, pomegranate, grape, apricot, pistachio.
Mediterranean: Durum wheat, hulled oats, broad bean, cabbage, olive, lettuce.
Ethiopia: Wheat (durum, Poulard, Emmer), barley, chickpea, lentil, pea, teff, African millet, flax, sesame, castor bean, coffee.
Southern Mexico and Central America: Corn, common bean, pepper, upland cotton, sisal hemp, squash, pumpkin, gourd.
Peru, Ecuador, Bolivia: Sweet potato, potato, lima bean, tomato, sea island cotton, papaya, tobacco
Chile: Potato
Brazil and Paraguay: Cassava (manioc), peanut, cacao, rubber tree, pineapple, purple granadilla.

Source: Adapted from *Hawkes* 1983

FAO lists at least 40 food and fruit bearing forest species from Eastern Africa[36] These food plants are established consumption items in addition to the main staple food crops which are mainly introduced improved varieties of a few cereals (see Table 3).

Table 2: Food crops of the world originating from Eastern Africa

Family	Species	Food	Origin
Cucurbitaceae	*Cucumis melo*	Melon/ water melon	Wild forms found in eastern tropical Africa
Leguminosae	*Pisum sativum*	Pea	Probable centres of origin is Ethiopia,
	Vigna unguiculata	Cowpea	The common cultivated subspecies is thought to be derived from wild plants in Ethiopia several thousand years ago
Pedaliaceae	*Sesamum orientale*	Sesame seed	Possibly Ethiopia
Rubiaceae	*Coffea arabica**	Coffee	Ethiopia

*Coffee grows wild in the threatened forests of the Ethiopian massif. Much of the forest habitat in Ethiopia has been destroyed. Habitats of wild coffee are also threatened in Kenya. Protection of *C. arabica* in the wild must be a conservation priority.
Source: WCMC, 1992

Table 3: Main staple food crops of eastern Africa

Country	Crops (and average daily per capita consumption in kilo calories)
Ethiopia	maize (359), sorghum (336), teff (309), pulses (219) wheat (219), barley (186), ensette (49) millet (43).
Kenya	maize (934), wheat (142), pulses (102), sweet potato (49), potato (47), cassava (46), sorghum (19), millet (11)
Tanzania	maize (569), cassava (569), rice (149), sorghum (120), pulses (110), millet (64), sweet potato (64), wheat (48)

Uganda	Cassava (493), plantain (356), sweet potato (229), millet (213), maize (186), pulses (164), sorghum (132)

Source: FAO food balance sheet data, 1981- 1983 averages, computed as of mid-1986

3.3 Trends in agriculture and agrobiodiversity

The agricultural landscape in the region, for the most part of the arable land, presents a mosaic of monocrop systems of introduced food and cash crops, which have extensively encroached into the marginalised patches of traditional farming systems. The latter are defined by high levels of agrobiodiversity among elaborate farming systems and practices that have survived changes in governance and socio-economic development in the region. They are a reflection of strategies adopted by farmers to save their land, crop land races and diversity through various farming practices to meet their subsistence and economic needs. Until the advent of the Green Revolution[37], farmers relied on these traditional subsistence cropping systems and their ecologically adapted food crops, to meet their food and nutritional needs. Although diminishing, these traditional farming systems have and continue to contribute to the rich biodiversity base and food sources in Eastern Africa, through the application of indigenous people's innovations and technologies over many generations.

However, these systems have not been brought significantly into the mainstream partly due to poor knowledge of the systems. This knowledge gap is attributed partly to the percieved need by the national and international research institutions to focus solely on high production and new technologies with little attention to indigenous technologies. Yet in recent years some analysts or programs in these institutions have recognised the advantages of diverse indigenous agroecosystems. In a joint study, the Organization of African Unity (OAU) and FAO urge specific new policies to develop and popularize these systems, noting that a greater variety of food sources makes Africa far less vulnerable to seasonal shortages and climatic shifts[38]. In order to optimize the benefits from traditional farming systems, it is imperative at this point, to identify and highlight their important attributes.

3.3.1 Traditional agricultural systems as repositories of crop genetic diversity.

A traditional agricultural system is a production system that integrates indigenous and naturalised animal and plant crop species, including a diversity of crops for both subsistence and cash objectives, on arable and non-arable land mixed into one complex - agroecosystem. Variability in

agrobiodiversity is at the heart of the range of adaptations in the agroecosystem. For instance, a salient feature of these systems, is their high degree of plant diversity (*Tables 4 &5* in *Box 2)* in time and space in the form of polycultures and/or agroforestry patterns [39]. These form an is an important production strategy for the people to meet the challenges posed by the variability in seasons.

Box 2: Home gardens in Kakamega District in Western Kenya[40]

In Kakamega District, the Luhya like most rural indigenous people in Kenya have maintained mixed home gardens as an essential component of a Boma unit, as a strategy to provide easily accessible food.. Home gardens fulfill a subsistence function as well as an income function and efforts to integrate the neglected uncultivated plant resources could bring them, into a more central focus for recognition and pertinent action for a positive change..

A recent survey [41] in the District, revealed that an aggregate Boma unit can be partitioned into three domain types. The first is undifferentiated units (of less than 0.8 ha in size). In this case, this fixed plot of land could be regarded as a home garden cum 'shamba' with a crop on it growing at any time of the year. Production of food is thus throughout the year. The second is the domain type whereby a piece of land close to the home compound is used for growing vegetables, fruits, spices, etc., throughout the year. The remaining land is used for growing either cash crops (tea and or coffee) or cereals (mainly maize and millets). The third domain type is the traditional back-yard (kitchen) gardens. These were observed to occur in large scale farms and in urban and peri-urban areas where the garden is part of the home compound.

Species diversity in home gardens

In the home gardens several plant crops with different life cycles, growth patterns and cultural requirements. are noted growing in multi-cropping and multi-storied systems, are noted. These include vegetables, fruit trees, root and tuber crops, herbs and spices, medicinal plants, condiments, etc. These various types of crops are found growing at different phenological stages. They are mainly temporal of woody and/ or herbaceous types and/or seasonal, perennial or pluri-seasonal (planted in one season to be harvested in another). Some plants especially indigenous ones are self seeding[42] but are encouraged to grow. Therefore, the gardens were found to have a mixture of plants However special indigenous vegetables like *Gynandropsis gynandra, Crotolaria brevidens, Corchorus olitarius* and *Brassica oleracea* var *acephala* were seen to be grown on small patches in pure stands. In urban areas at the backyard, crops like carrots and tomatoes were also being grown in pure stand clusters. Overall, the multistoried nature of spatial arrangement in a boma unit tended to be irregular and appeared very haphazardly but intimately mixed.

Results from a survey on cropping system in Kakamega by Akundabweni and Chweya reveal a wide range of indigenous plant species. . (see *Table 4* below). An ethnobotanical survey conducted by the Plants For Life program at the Kenya Forestry Research Institute (KEFRI) revealed a further 30 species of indigenous food crops out of which ten are actively sold in the local markets (Table 5).

Table 4: Food crops grown in western Kenya

Source Akundabweni L. S. M and Chweya J. A. , 1993
Cereals: Maize (*Zea mays*), bulrush millet (*Pennisetum typhoides*), finger millet (*Eulisine coracana*), sorghum (*Sorghum vulgare*), barley (*Hordeum*), oats (*Avena sativa*).
Roots and Tubers: Sweet potato (*Ipomoea batatas*), Cassava (*Manihot esculentum*), Irish potatoes (*Solanum tuberosum*), yams (*Dioscorea* spp), arrowroots (*Xanthosoma* sp.)

Grain legumes: Beans (*Phaseolus vulgaris*), cowpeas (*Vigna unguiculata*), green grams (*Vigna* spp), *Pisum sativum*, "tsbande" (Luhya), *Vigna subterrranea*, formerly *Voandzeia subteranea*, soyabeans (*Glycine max*), green peas (*Pisum sativum*), groundnuts (*Arachis hypogea*) , black grams (*Vigna mungo*).
Vegetables: Kales (*Brassica oleracea* var *acephala*), onions (*Allium cepra*), *Crotolaria brevidens*, brinjals (*Solanum melongena*), tomato (*Lycopersocon lycopersicum*), *Amaranthus* spp, *Gynadropsis gynandra*, "tsisuza" (Luhya) which is *Solanum nigrum*, *Corchorus olitorius*, cowpea leaves, pumpkin leaves (*Curcubita moscata*), sugarloaf (*Brassica oleracea* var *capitata*), rape (*Brassica napus*), cabbage (*Brassica oleracea* var *capitata*), *Commelina spp. enderema* (*Basella alba*) kitiezo (Luhya) or *Erythococca bogensis*..
Fruits : Mangoes (*Mangifera indica*), guavas, banana (*Musa* spp), passion fruits, avocado, oranges, pawpaw, *"jamna"*, *"osuga"* (*Solanum nigrum*), strawberries, loquats, tree tomato, pineapple, lemons (*Citrus* sp) grapes, *"zambarau"*, *"chinkorogoinwa"* *"omonyangateti"* (Kisii).
Sugars and sweeteners: Mayengo (Luhya), sweet banana, pineapple, sugarcane, lemons.
Fats and oils: Groundnuts, simsim, avocado, sunflower.
Beverages: Coffee, tea, fermented finger millet, sorghum or maize, shinokho, vusera, soybeans.
Spices/ herbs/ condiments: Pepper (Capsicum spp.), onions, tomatoes, lusosi (mint), ginger, dhania (Coriander)..

Table 5. Indigenous food plants of Kakamega

Edible wild Fruits: *Manilkara butugi* Ludulio, *Bequaertiodendron* Musania, *Chrysophyllum albidum* Mululu , *Hoslundia opposita* Shikuma , *Vitex doniana* Omuhutu, *Lantana trifolia* Lumenenambuli, *Annona senegalensis* Kumufuora, *Rhus natalensis* Obusangula, *Rhus vulgaris* Obusangula, *Carissa edulis* Eshikata, *Cordia africana* Mukumari, *Rubus pinnatus* Obuabari, *Garcinia buchananii* Kumukhomeli, *Trema orientalis* Musagala, *Ziziphus abyssinica* Mukomboti, *Toddalia asiatica* Luabare, *Teclea nobilis* Mutare, *Mimusops bagsharrei* Ludolia, *Vangueria apiculata* Mukomosi.
Edible tubers : *Mondia whitei* Mukombero

Species in the local markets
Vegetables: Lisutsa, Shikubahubi, Tsitsaka, Shikuma, Shikangania, Munyama
Fruits: Shikata, Lipera, Obusangula, Omushirinya.

Traditional farming systems are an extremely rich source of agrobiodiversity[43]. Around 60 percent of the world's agricultural land is still farmed by traditional, or subsistence methods[44]. Shifting and subsistence agriculture, which involves 500 million people on 8.3 per cent of the world tropical land area[45], is characterized by a very abundant agrobiodiversity. These properties are attributed to the diverse indigenous technologies that have been developed by traditional farming communities, to suit different ecological and socio-economic needs. Based on centuries of experimentation, traditional farmers have evolved cropping patterns which suit their particular situations and demonstrate their excellent ability to manage intraspecific diversity of land races, which include native or "wild" species and naturalised species. The traditional varieties found in these systems tend to have a greater inherent, intravarietal

diversity than modern ones and in many African countries, small farmers play a central role in the conservation of germplasm. These systems or practices include rotation, the use of transitional crops, agroforestry, homestead gardens and mixed crop farming.

Rotation: As a rule, a given crop is not grown in successive years on the same field. This rotation helps keep weeds down and reduces the demand on hand weeding. It also varies the demand on nutrients from the soil, helping in keeping it fertile and healthy. When the crops grown are pulses, the magnitude of restoration of fertility owing to the biological fixation of nitrogen, is substantial and can lengthen the time interval between fallows, or even altogether eliminate the need for fallowing.

Transitional crops : Transitional crops can grow well in a broad range of ecological conditions. In Ethiopia, the cowpea is a traditional and transitional food crop, found at low altitudes, ranging from 1900 - 2300 m a s l in drier areas. It becomes more important at altitudes below 1900 m a s l. Others include: 'Wanza', and *'enkoy'* figs, which are some of the several wild fruit trees occurring extensively in the lower altitude zone ranging from 1900 - 2300 m a s l. Many wild herbs e.g. nettles, eaten as vegetables, mostly in times of food shortage, or for special nutritional purposes, are transitional crops.[46]

Agroforestry: A land use system that involves socially and ecologically acceptable integration of trees with agricultural crops and/or animals, simultaneously or sequentially, so as to get increased total productivity of plant and animal in a sustainable manner from a unit of farmland, especially under conditions of low level technology inputs and marginal lands[47].

Homestead gardens: The homestead farm or homegarden is the traditional agricultural system that is found widely throughout East Africa, and is usually a very small plot of land. It consists of a combination of crop species grown within the compound. The largest number of crops in mixtures are found in this system and are grown for food as well as other uses[48] (See Box 2). It forms the centre from which paths lead to other field systems or other production units.

Mixed crop farming: The mixed crop field is similar to the homestead garden in terms of the types of crops grown, but is farther away from the homestead. Crop mixtures are grown, which reduces the risk of crop failure. Varieties with different maturing dates are also grown so that planting is spread over as long a period as possible. Between five and ten crops are planted together with the main staple (see Box 3)

BOX 3: The Haya Traditional cropping technique [49]

The Haya who live in Tanzania, are sedentary with very stable villages occupied under conditions of high population density. They practice a type of mixed husbandry involving tree crops and the keeping of cattle.. The Haya use a distinctive set of crops and cropping techniques for each main type of land. The different combinations of land and cropping techniques make unique farming systems suitable to the weather and soil conditions. Three different field types can be identified each having it's own location-specific combination of cropping system components (e.g. soils, crops, fallow periods, weed, pests and diseases). *Kibanja* located around the homestead on deep soils; bananas are grown in mixture with beans, coffee and several other crops; e.g. *Kikamba*, located at the edge of the *Kibanja;* it may be fallowed for short periods, or cropped with banana, or annual crops (e.g. root crops, groundnuts); *Rweya* located at some distance from the homestead on common land; it may be fallowed and cattle grazed for long periods (5 - 10 years), or cultivated for short periods (1 - 2 years) with bambara nuts, or cassava[50]. This arrangement is deliberate to complement each cropping system. For example, the high diversity and variety of species in the *Kibanja* plot is due to the fertilizing function of the *Rweya* by way of domestic refuse, ashes, mulch and manure mined through cattle[51]

Source: Kamara B, 1997

Through these agricultural and land management practices and technologies *inter alia* , traditional farming communities, have made a significant contribution to the conservation and enhancement of biodiversity and they can make an important contribution to the development of socio-economically and environmentally sound agricultural production systems.These systems represent strategies to meet both predictable and unforeseen ecological and economic circumstances. They promote diversity of diet and income source, stability of production and minimization of risk and maximization of returns under low levels of technology. For example, the resulting genetic diversity confers at least partial resistance to diseases specific to particular strains of crops and allows farmers to exploit different micro-climates and derive multiple nutritional and other uses, from within species and genetic variation[52].

The survival of traditional farming systems is attributed to the fact that they perform important functions where the modern agricultural production systems fall short. For instance, when the rains fail, or when the crops are attacked by diseases and pests, indigenous food crops found in these systems have helped reduce the negative impacts caused by shortfalls in food production. This is because having survived many centuries of climatic changes, these indigenous species have adapted to demanding ecological conditions and require little input for their growth[53]. In terms of household food and economic security, indigenous food plants provide supplementary farm production; seasonal food and income; and characteristically, energy rich buffer food, during drought—and increase quantities of food consumed.

Being rich in nutrients, they provide essential nutrients and contribute to a high quality diet. The seeds of leguminous plants are rich sources of protein. For example in East Africa these include the cowpea, pigeon pea, bambara groundnut and the locust bean[54] which supply valuable nutrients

which complement the energy content of the staple food in the local diet. Data in Table 6 displays evidence of the high nutrition values of traditional food crops while Table 7 gives a comparison of some nutrients found in exotic vegetable and indigenous leafy vegetables consumed in eastern Africa. Such data explains in part how reduction in consumption of indigenous foods -due to changing economic conditions and diet preferences has led to the poor nutrition status of children in for example Kakamega in Kenya. The table provides nutrition values of protein and amino acid lysine, for indigenous species, whose consumption would reduce the prevalence of marasmus and related disease conditions among the population in the area. Cultivation and planned use of such indigenous plants should be promoted [55].

Table 6: Variation in protein content of some indigenous plants

Botanical Name	**% protein**	**Lysine content (mg/g N)**
Collected from Western Province (Kenya)		
Commelina nudiflora	15.6	-
Basella alba	20.5	-
Erythrococea bongensis	18.1	-
Curcubita pepo	31.1	204.4
Vigna schimperi	18.6	-
Triumfetta annual	24.7	-
Corchorus trilocularis	25.4	-
Bought in local markets (Nairobi)		
Amaranthus lividus	26.7	330.0
A. hybridus	17.8	-
Gynandropsis gynandra	35.8	245.0
Vigna unguiculata	28.5	271.5
Crotolaria brevidens	32.5	261.9
Corchorus olitorius	22.5	168.0
Brassica integrifolia	28.9	-
Solanum nigrum	29.3	257.0

Source Akundabweni L. S. M and Chweya J. A. , 1993.

Table 7: Comparison of some nutrients found in an exotic vegetable (cabbage) and indigenous leafy vegetables consumed in eastern Africa.

(per 100 grams fresh weight)

Vegetable	Calcium (mg)	Iron (mg)	Vitamin (mg)	Vitamin A (ug)
Cabbage	47	0.7	54	100
Corchorus olitorius	360	7.2	80	6410
Manihot esculenta	303	7.6	311	11775
Moringa oleifera	571	11.4	182	11920
Vigna unguilata	256	5.7	56	7970

Source: Wu Leung, W-T, Busson, Felix and Jardin, Claude. Food composition Table for use in Africa. US Department of Health, Education and Welfare, and FAO. Rome, 1968

When compared with exotic foods, indigenous foods are cheap- an important attribute to the rural communities in Eastern Africa, a significant proportion of whom are poor. They are therefore especially important for people with low incomes in both rural and urban communities. Evidently, these farming systems have great potential in contributing to food self sufficiency and security. The need to increase focus on important indigenous food species cannot be overemphasized. In particular, governments need to reduce their dependence on food aid from international relief agencies. This is important because food aid undermines the potential of indigenous species as it doesn't offer incentives to encourage their production.

Traditional farming systems also support conventional agricultural systems through the supply of valuable genetic material for crop improvement. The continuing need for pest and disease resistance to overcome the breakdown of disease resistance in uniform widespread varieties of major crops, has forced breeders to widen the search from crops to crops relatives, in search for genetic agrobiodiversity. It is traditional farming systems that have provided the valuable genetic resources. In addition, recent advances in crop plant genetics and biotechnology indicate that wild crop species can play a vital role in future economic development through agribusiness.

Although these traditional systems still persist, they are essentially being replaced by influences of modern agricultural systems. These modern systems characterised by —introduction of monocultural high yielding crop systems, application of fertilizers, pesticides—are gradually displacing traditional cropping systems, contributing to loss of agricultural biodiversity.

3.3.3 Conventional agriculture dominating traditional agricultural ecosystems

Many current agroecosystems in the region are characterised by the production of cash crops in modernized monocultural systems. These systems are based on the "Green Revolution" model of agricultural development which emphasizes high yielding varieties and high technology inputs. For instance, Kenya, Uganda and Tanzania produce significant quantities of maize and wheat and are major exporters of coffee, tea and pyrethrum, which play a significant role in their economies (see Table 8) Most of the varieties grown were introduced from other centres of biodiversity or from research institutes in other countries. These cash crops and varieties are spreading out into most of the arable land and taking over land previously inhabited by indigenous food crops and natural forests. These are developed using genes from wild relatives and are produced by both subsistence and large scale farmers. These distinctive monocrop systems rely on heavy chemical inputs and machinery applications.

Table 8: The performance of the agriculture sector in the economies in Eastern Africa.

Country	Contribution of agriculture to GD (%)P	Contribution of agriculture to employment	Export crops	Contribution of export crops to total export earnings (%)
Ethiopia	50	86	Coffee	90
Kenya	>30		Coffee, tea, pyrethrum, horticultural	60
Uganda	50	80	Tea, tobacco, coffee, cotton	>90
Tanzania	50	>80	coffee, cotton, sisal, cashewnuts, tea, tobacco, pyrethum	70

Source: Data generated from various publications[56]

This commercial agriculture developed slowly in the first years of the 20th century and steadily assumed cash crop export importance in the middle of the century. These varieties and the monoctulture model were strongly supported by policies and economic incentives; and were also promoted through research and development programs of Northern

agencies and by national institutions or by the CGIAR[57]. The potentials of cash crop economy were believed to have very important ramifications for alleviating poverty. As a result, efforts to increase land productivity became a priority and therefore, policies were designed to provide conditions which were aimed to enhance the opportunities of households and in particular, rural households, to raise the incomes through increased productivity. These included infrastructure development, credit facilities, subsidies on agricultural inputs and the establishment of processing plants. These acted as economic incentives for expanding land under cash crop production and agricultural production grew rapidly, increasing its share to the GDP in the region. Inevitably, these led to encroachment into forest land and increased the monocultural, to traditional farming agricultural system proportions (see *Box 4*).

Increasingly, human selection pressures favoured introduced crop varieties replacing indigenous varieties. For example, in the hot lower highlands (1500 - 1900 m. a. s. l.) of Ethiopia, sorghum, tef, maize, finger millet, sesame, coffee and chat are the main crops. Traditionally, cowpeas have been cultivated with maize and sorghum, but it is being replaced by haricot beans. Bambara groundnut, a relatively new introduction, sometimes found in the wetter western parts of the country,

BOX 4: AGRICULTURE IN UGANDA[58]

Of the total area under cultivation, around 30 % is devoted to bananas, cereals are grown on 25% of the cultivated area almost 20% of the cultivated area is devoted to root crops, while pulses, oil seeds and industrial crops occupy the remaining 25% of the cultivated area. The main food crops include : bananas, cereals (maize, millet and sorghum) legumes (beans, field peas, pigeon peas) oil seeds (simsim, soya beans, groundnuts and root crops (Irish and sweet potatoes, cassava, yams). Traditional cash crops are :coffee (*C. robusta, C. arabica*); cotton; tea and tobacco. Due to the good grazing environment, cattle, sheep and goats are kept. Approximately 90% of the cattle is owned by small holders and pastoralists.

According to a report by the World Bank (1993) it was estimated that the national cattle population decreased by about 25% from 5 million in 1979 to about 3.9 million in 1987. The sheep and goats population decreased by 36% in the same period. Rampant cattle thefts and rustling, wanton killing and occasional outbreaks of epidemics are thought to have contributed to the drastic decline in livestock numbers during this period of civil strife. Before 1986, the short-horn Zebu was estimated to constitute 70% of the national herd while the Ankole and Nganda contributed 15% and 13% respectively. Imported temperate breeds and tropical breeds (Boran, Tposa and Turkana) constituted the remaining 2%. Following massive thefts and rustling of cattle in the northern and northeastern Uganda where the Zebu was the predominant breed, the proportion of short-horn Zebu was reduced to 30% of the national herd. The proportion the Ankole thus increased to 50%.

The proportion of exotic and crossbred cattle has also been increasing at the expense of native breeds. Until recently, indigenous breeds have been known to contribute more that 95% of the domestic animal biomass and 80% of all animal products in Uganda. However it is evident from *Table 4* that exotic and crossbred cattle are increasing at a rate two times that of native breeds. This apparent breed substitutions is mainly in order to sustain the growing demand for higher yielding and fast growing animals in order to sustain the growing demand for food. This has resulted in a change in the production systems from the traditional pastoral system, characterized by communal grazing to sedentary, and intensive and semi-intensive production systems.

is now expanding in drier areas. Bananas and oranges are the traditionally grown fruit trees, but it is introduced varieties that are now grown in commercial farms with the traditional varieties being restricted to home gardens. Several fruit trees have been introduced recently. e.g. avocado, custard apple, bullock's heart, guava, grapefruit and mandarin. The constant need to increase productivity and reduce losses to pests has steered biotechnology research and plant breeding programs towards hybrid varieties which have inherent narrower genetic base thus eroding the genetic diversity. The expansion of the modern agroecosystem thus affects the agrobiodiversity at different levels: at the landscape through conversion of traditional farming systems; at the species composition level by use of introduced species; and at the genetic diversity level by use of high yielding varieties with narrow genetic base.

Additionally, however, the success of this green revolution is also regrettably associated with declining food production. In many parts, as the production of cash crops increased, the food crop production declined, leading to food shortages and increased incidence of malnutrition. Food availability in many parts (see Boxes 4 & 5) has been irregular in terms of production and distribution. These countries have therefore become net importers of food all year round, due to over-reliance on cash crop farming. Nutritional evaluation from the Home Economics Offices and Ministry of Health staff in Kenya, in the field, have shown that the cash crop zones also have the higher malnutrition cases, despite the fact that farmers in these areas earn better incomes than their counterparts elsewhere[59]. Malnutrition prevalence in the Kakamega district include cases of under weight, kwashiorkor, marasmus, anaemia, vitamin A deficiency, pellagra, constant weight for 3 months, or more and faltering growth. This poor nutrition situation can be attributed to the changing diets where the growth and consumption of nutrient rich traditional food crops is declining. Other socio-economic problems such as large families, low income and increasing population pressure on land also contribute to malnutrition.

Current trends on cash crop production also indicate that although the land is extensively cropped over time and the production potential high, the productivity for most of the cash crops is declining (see *Boxes 4 & 5*). Of particular concern, is food cash crop production that the rural poor

now solely depend on for subsistence and cash. This is evidenced by erratic food shortfalls across seasons and a considerable worsening of distribution in consumption. In addition, if farmers are forced to eat their seed in times of drought the consumption of traditional varieties (c.f. green revolution varieties) will be more prevalent. This has resulted out of recurrent droughts, pests and diseases, land degradation and increasing costs of agricultural inputs. Only the resource rich farmers can afford to apply modern methods of farming such as, using machinery, application of fertilizers and pesticides. Subsequently, rapid growth of population with limited resources has generated low production, low savings trap and hence increasing marginality and poverty. As a result, household food insecurity is now a common problem.

BOX 5 : AGRICULTURE IN KAKAMEGA DISTRICT

The impact of the Green Revolution on the agricultural biological diversity is evident in the agricultural landscape of Kakamega district where monocultural agricultural systems are dominant. There are two main land uses: agriculture and livestock keeping. About 70%[60] of the area in Kenya's Kakamega district is under cultivation of maize both for commercial and home consumption purposes. The main crops grown in the district are maize, beans, sweet potatoes, cassava, sorghum, finger millet, sugarcane, tea coffee and sunflower. Of the main food crops, maize and beans are the most important staples. Usually the food crops are grown by small scale farmers in polycultural (mixed) systems. On the other hand, the cash crops are coffee, tea and sugarcane which are always grown in monocultural systems.. Among the cash crops, sugarcane is the most important. Another major cash crop that is picking up very fast in the district is sunflower because of its favorable prices. Sugarcane and maize are the main sources of income. This economic attribute has provided incentives for the expansion of land under their production. leading to displacement of diverse local products, thus eroding biodiversity of the landscape. For instance, this expansion is now overtaking land for livestock keeping- pastures in which wild plants and animals are found.

The success of the expansion has been catalyzed by the development of infrastructure including roads, market facilities and housing. As a result it has raised the standards of living of those in the production areas. However due to overemphasis on cash crops at the expense of food crop production, they have to spend more cash on the average per unit of commodity on food. The district experiences food deficit. For instance in the maize production areas there are 176,000 farm families, each requiring an average of 15 bags per year. This implies that to sustain the population the district requires 2.64 million bags of maize, whereas, on average, it produces 1.7 million bags, presenting a deficit of 0.99 million bags to be imported from other districts

Notably also is the declining trends in production of most of the other crops grown except for sugarcane The root causes of this situation are the high population density and inequitable tenure structure which have resulted into land fragmentation... Due to the rapid population growth (2.98% per year) in the district there is an increasing mismatch between the supply and demand of basic facilities. In addition due to lack of adequate resources,, peasants farmers often tend to adopt intensive and inappropriate land use methods leading to environmental degradation. and loss of biodiversity.
Source: Mutta et al, 1997

Deforestation processes for agricultural expansion also contributes to loss of agrobiodiversity by extending the impact of monoculture systems

and destruction of the wild relatives of indigenous plants. There is evidence that the eastern Africa nations which form a cohesive unit of moist forests and share problems of small, fragmented areas of forest, are under extreme pressure of encroachments and exploitation. Within the period 1981 - 1985 Ethiopia's annual deforestation rate was 60 km^2, Uganda's and Tanzania's was 100 km^2, and Kenya's 110 km^2[61] . By 1989 the annual deforestation rate in Ethiopia was 2,000 km^2[62] In Tanzania, the forests are being reduced at unsustainable rates - by 55% per year in Kilimanjaro region and by 30% in the Mwanza and Mara[63]. At the turn of the century, Uganda's forests extended over an estimated 12.7 per cent, today they cover less than 3 per cent[64]. Due to political instability in Uganda in the 1970s illegal encroachment and deforestation caused a 50% reduction in forested area between 1971 and 1987[65]. According to the WCMC report, current annual rates of both population growth (3.3 per cent per annum (p.a.)) and deforestation (2 per cent p.a) suggest that Uganda may lose all of its forests before the turn of the century. This loss of indigenous forests has important ramifications for availability of agrobiogenetic resources for both subsistence and conventional agriculture and scientific crop improvement.

4.0 FACTORS AFFECTING AGROBIODIVERSITY: CAUSES AND PROCESSES

No single, or simple cause can be blamed for the loss of agrobiodiversity. It is the unfortunate consequence of a combination of a number of processes. The direct causes are habitat conversion and deforestation mainly for modern agricultural expansion. But these are driven by a combination of different processes or factors which can be categorized into socio-economic, political and cultural. These include external influences through colonization by the West, adoption of incompatible natural resources management technologies, acculturation and influences of the market forces on introduced food species. More specifically they are demographic pressure; inequality and poverty; perverse food policies; changing food preferences; breakdown of traditional institutions; and civil wars and insecurity. All these factors have had significant influences on the agricultural landscape in general and on the agrobiodiversity complex, in particular. The impact of the interactions of these factors on agrobiodiversity can be traced through the historical development of agriculture in the region, particularly, the colonization and the evolution of the agricultural technologies in the past few decades.

The expansion of monocultural agricultural systems is cited as the most significant reason for the diminishing traditional agricultural systems and consequent decline in agricultural biodiversity in many parts of the

world[66]. In addition, it is also cited as a major cause of deforestation leading to decline in wild genetic resources[67]. Globally, nearly one third of the world's land area is used for food production making agriculture the largest single cause of habitat conversion[68]. The technologies associated with monocultural expansion are reductionist in nature with respect to species diversity and have adverse effects on the biotic and structural complexity at the landscape level[69]. At the landscape level, habitats are modified to give way to these systems leading to direct losses of wild genetic resources both known and unknown.

This expansion has mainly been promoted by policies and programs that were designed to increase food production, in response to socio-economic conditions related to the growing population's food demand and economic poverty among the rural poor.

4.1 Demographic pressure

Population growth rates in the region, represent some of the highest in the world and without a matching economic growth and food production trends there is little hope for food self sufficiency and security. Kenya's population is one of the fastest growing in the world. The total number of people was estimated at 23.2 million people in 1989, with the current official growth rate being 3.4 per cent, per annum. If the fertility (7.8 %) and mortality rates remain constant, Kenya's population is predicted to be 31.9 million by the year 2000. The average population density is 37 persons per km^2, but is unevenly spread and over 80 per cent, live on less than 20 percent of the land area[70]. The area of cultivated land in Kenya is around 2,257 km^2 or only 4%[71] of the total land area and as such, there is considerable pressure on land, resulting not only in over-use, but also excessive fragmentation. In Uganda the population is estimated at 19.2 million (1996) growing at an annual rate of about 2.5%[72]. Based on the 1990 population estimates, Tanzania will have to feed an additional 18.7 million people by the year 2010[73]. This ever increasing human population exerts increasing pressure on the available agricultural and other biological resources.

Influences of population increase are also being felt in the traditional cropping system for example, in the Tanzania *kibanja, kikamba* and *rweya* arrangement[74] (see Box 3 for description of the system). Until recently, the whole system stayed in balance and could sustain a high population density, because there were sufficient numbers of hectares of *rweya* to keep one hectare of *kibanja* productive without causing irreversible degradation of the *rweya*. However, during the last century, population density has increased and cattle numbers have decreased to such levels that the system is getting threatened. In addition, where land is inadequate, farmers are forced to plough on ecologically fragile arid and semi arid lands, where modern agricultural practices are unsustainable and often lead to land degradation.

4.2 Inequality and poverty

Prevalent poverty and marked inequities in the distribution of income/ resources are also the underlying causes of environmental degradation. Inequities shapes patterns of resource use at all levels, from the local to the global. For example inequities in access to land tenure in eastern Africa has been linked to over exploitation and intensive and extensive agricultural crop production leading to land degradation and low food production. In the search for increased food production the poor have been pushed towards more ecologically fragile lands threatening agricultural biodiversity.

4.3 Perverse food policies

Furthermore, government food policies lean towards continued national self sufficiency, aimed at increasing food production through increased land under agriculture. The approach has been intensified production of high yielding varieties of food crops. Government priorities in food crop production have therefore resulted in promotion of the major cereals: wheat, rice and maize and ensuring their adequate supply is the basis of most food and security policies. Intensifying the crop production methods essentially involves substitution of indigenous crop and animal genetic resources with marketable "improved" foreign genotypes and their accompanying technologies. Fiscal and physical infrastructure for the promotion of these high yielding varieties have been put in place. These include credit facilities, marketing infrastructure, extension literature and construction of processing plants. Such policies have in effect had a strong influence on cropping choice and on land use patterns.

Basically, by focusing on cash and export crops, the governments opened the rural economy to the influences of the global system of markets that transmits international prices to local communities. The result has been that most farmers are unwilling to continue producing basic food crops for domestic consumption because of the new opportunity to profit from commercial crop production. The value of traditional food plants has thus been eclipsed by the economic attraction of other food and non-food crops leading to reduced focus on production of these food crops. In effect, national agricultural policies are stimulating genetic erosion through the process of modernization of agriculture that promotes hybrid crops .

Despite the expansion of monocultural agricultural systems, the food produced does not meet the population's demands. Today Eastern Africa finds itself using substantial amounts of foreign exchange to import food and other agricultural produce that otherwise could be produced with underutilized human and natural resources. This calls for a critical review of agricultural and related policies such as food security. It is important to

note that unless policies towards indigenous food crops become more supportive the biological and genetic base for agricultural development will continue to diminish. The poor economic situation of the rural people and the distorted economic policy incentives will continue to lead them to more and more of cash crop farming. While the indigenous crops are very important to them, there are no incentives for the farmers to conserve these resources and continue to innovate. Policies that will encourage the integration of the two agricultural production systems[75] are an imperative to enhance the conservation of agricultural biodiversity.

4.4 Changing food preferences

The Western colonization led to changed values, norms and traditions, resulting in Eastern Africa acculturation of the indigenous people. For instance, extinction of tribal cultures is responsible for the changing food preferences. Food preference which is closely tied in with socio-cultural background of the people will influence the selection of crops cultivated for subsistence. It is one of the reasons for the loss of domesticated, or cultivated crops important in agricultural production and/or, as food and cash crops from their traditional areas of cultivation. For example, the Haya in Tanzania highly prefer bananas as staple food[76]. Therefore, even in relatively dry areas, the Haya attempt to grow bananas even though other crops are better adapted. High consumer preference for maize in Tanzania and Kenya has led to it's cultivation in less suitable areas of marginal rainfall. This has often resulted in food security stress in those parts and calling for emergency food relief as a result.

It is also suggested that western influences/acculturation on management of natural resources supported by centralized governance systems have contributed to marginalisation of traditional agricultural management systems, which have sustained agricultural biodiversity, both domesticated and in the wild relatives. This marginalisation is closely associated with the lack of awareness of the value of these systems and has subsequently led to their under valuation. Their contribution in national accounting systems is not included and as such, there are no policy incentives for agrobiodiversity conservation.

4.5 Breakdown of traditional institutions

External influences through colonization by the West are believed to have started processes leading to emergence of centralized governance systems and consequent destabilization of traditional governance systems. During this period, the state adopted European technologies to force their will on the various parts of the country. The increasing strengthening of the centralized government means an equally increasing weakness of the local traditional management. Before the emergence of the centralized state,

hereditary community leaders such as village elders, were responsible for regulating the management of and uses of wild plants and animals, as well as the overseeing of land tenure and management, including agricultural production and the conservation of agrobiodiversity. However, the new agents of the centralized state were keen to destroy traditional organizations. As a result, virtually all collective responsibility for the land and it's natural resources collapsed wherever central authority was strongly established. These trends have led to land degradation, characterized by the elimination of many species to extinction. New systems of management are failing because they are incompatible with the old land and resources tenure systems. National governments have frequently taken responsibility for resource management away from local people, those likely to be most concerned and knowledgeable about maintaining the productivity of resources, often encouraging poaching and encroachment.

With the emergence of the state which centralized power by destroying local organization, the collective components of land tenure and management were destroyed[77]. The poverty of the rural population makes them very vulnerable to coercion by the centralizing state making it easy for the officials to destroy traditional organizations and with it, traditional land and natural resources management. The new administrators and courts have been given power of decision over access to land and have reduced the traditional land management systems and land tenure enforcement system to a passive role. In Ethiopia[78], the destruction of the traditional management systems, is proportional to the extent to which the central government had established it's authority. For example, in the enset growing areas, the population density was so high that Emperor Menelik's distribution of the land to his warlords had little practical impact and the warlords did not find the land attractive. Therefore, these areas retained their land tenure and land management systems and it does now look paradoxical that these, the most densely populated parts of the country, have the best managed land, and a better endowment of biomass, and a reasonably good conservation of biodiversity. In the arid lowlands, the land never became attractive either for the earlier aristocrats, or for the late warlords. Therefore, it remained in it's traditional communal ownership and management system, being used largely by transhuman pastoralists and hunter gatherers.

Repeated allocations of land during this period, produced a growing insecurity of tenure. As a result of a century of insecurity of tenure, the peasants lost the motivation to sustain the resources. Trees, shrubs and herbs on uncultivated land started to be seen as openly accessible. Subsequently, the whole population became vandalous towards biomass and biodiversity.

4.6 Civil wars and insecurity

Civil wars and insecurity in the region have also had significant impact on the environment. These countries have had great burdens placed upon their environments and economies by refugees who have fled from civil strife in Sudan, Ethiopia, Somali, Rwanda and Burundi. They have also impacted on the infrastructure leading to environmental degradation and loss of biodiversity.

5.0 National Governments' Initiatives

This section presents an analysis of the states' responses to problems of loss of agrobiodiversity as reflected in constitutions, national development plans, macro and micro level policies and programs. It is based on the premise that the level of integration of agrobiodiversity concerns, reflect the level of commitment to addressing the problem of the loss of agrobiodiversity. In recognizing the severity of the problem of loss of agrobiodiversity, a valid question is whether the initial steps towards an effective policy and legislation have been taken, and whether the developments, as promised produce the required capacity to conserve and sustainably use agrobiodiversity. Although it may be premature to judge, there isn't adequate evidence on the ground to show that these initiatives have been successful in Eastern Africa. The effectiveness of these instruments in reducing genetic erosion is evaluated with a view to identifying the shortfalls and areas that need strengthening. New areas of focus that could enhance the positive impacts of conservation initiatives are also identified.

Responses to loss of agrobiodiversity can be traced through the evolution of the integration of environmental concerns into national policies, plans and strategies. It is apparent that all the Eastern African governments recognize the problem of environmental degradation, in general, evident in policy documents. However, the extent of focus to specific components of biodiversity varies with each country. Moreover, most of the countries still have relatively weak capacities to implement the policies; they face major challenges to put the policies into practice. Notable from the studies, well placed policies fail because of lack of technical, fiscal, institutional and moral capacity to implement them.

Pertinent to agrobiodiversity concerns is the extent to which these countries have firstly responded to the requirements of the CBD in general, and secondly to Article 6 in particular.

5.1 Responding to the CBD

The domestication of the CBD in Eastern Africa has been progressing albeit very slowly. At the forefront is Ethiopia which has been a leader in regional initiatives to develop African wide policies on biodiversity. In particular, national processes have been initiated to address various policy concerns through the formulation of national biodiversity plans and programs. In addition, specific efforts have been geared towards identified provisions and or themes in the CBD. These are:

i) Article 8 (j) which stipulates that knowledge, innovation and practices of communities shall be respected, preserved and maintained, as well as used with the approval and involvement of the communities, which own them is being addressed in Ethiopia.
ii) Article 15 on regulation of access to genetic resources. Regimes are being developed in Ethiopia, Kenya and Uganda,
iii) Article 16 on biosafety for genetically modified organisms and from alien species. Legislation is being drafted in Ethiopia and Kenya.

Although the implementation of these regimes have implications for agrobiodiversity, the domestication process has not kept pace with emerging concerns on agrobiodiversity. For example, the concerns for conservation and sustainable use of agrobiodiversity as detailed in the following case studies have yet to receive adequate focus at the sectoral level. The current focus is concerned broadly on loss of genetic resources and effective policy implementation is constrained by lack of legal, technical, institutional and economic capacities within the decision making process. Ethiopia, which appears to be ahead of the rest, has integrated agrobiodiversity concerns into the main policy documents- the constitution, development plan and various policies. However, the development of legislation to put macro-level policies into effective micro-level policies has been slow. In addition, the institutions in-charge of biodiversity conservation are also hampered by lack of technical manpower. In Kenya there are many institutions with programs on biodivrsity management. However, lack of institutional and technical capacity coordination is a major drawback to effective implementation of biodiversity programs. Concrete measures need to be put in place to respond to the factors and processes that have adverse impact on agrobiodiversity. Contracting Parties should initiate, where lacking, and or enhance focused efforts on conservation and to consider focused programs for sustainable use of agrobiodiversity components.

5.2 Ethiopia

Ethiopia has the most specific and extensive policy documents in Eastern Africa, as far as agrobiodiversity is concerned. Detailed in the constitution, the five year development plan, the environmental policy and seed industry policy, are remedial measures responding to genetic erosion, impact of the green revolution, marginalisation of local governance systems as well as addressing issues of community participation and environmental rights.

Article 44 of the Constitution of the Federal Democratic Republic of Ethiopia, which provides for rights to a clean and healthy environment formed the foundation for developing policies and laws for restoring, protecting and sustainably using biodiversity[79] Article 88 responds to two aspects: land degradation and erosion of biodiversity and; destruction of local organizations by the centralizing state. The Article aims at countering the adverse trends genetic erosion and strengthening local initiatives respectively.

The *Five-year Development Plan* of the government, published only in Amharic, is more specific on environmental rehabilitation, reforestation and conservation. It states:

> '...The development strategy chosen should restore the deteriorating environment to it's original good quality.'

Though the five-year development plan provides for large increases in the use of chemical fertilizer, the government realizes that this could damage the environment. To reduce this risk,

> '... the chemical inputs used, will be appropriately chosen, their use will be minimized to the extent possible and care will be taken about their utilization'.

This development plan also proposes to develop capacity for self administration among the local organizations. It proposes to support more development in the less developed regions, so as to work towards equality of opportunities and strengthening democratic organizations, especially at the lowest level of administration and at grassroots levels. This plan should if implemented, place the initiative for land conservation back in the hands of the peasants and the pastoralists to make a quick reversal in favor of conserving biodiversity.

The macro-level policies of the government of the Federal Democratic Republic of Ethiopia give biodiversity conservation sufficient attention. The environmental policy of Ethiopia, has a section specifically dedicated to biodiversity, and other sections which deal with sectors which impinge on biodiversity.

One of the ten sectors treated by the *Environmental Policy* is genetic, species and ecosystems biodiversity, which includes the following policies:

a) To promote an *in situ* system of conservation in a nature reserve, a farmer's' field, as the primary target for conserving both wild and domesticated biological diversity; and also promote an *ex situ* system in gene banks, farms, botanical gardens, ranches and zoos to supplementary *in situ* conservation;

b) To promote *in situ* conservation of crop and domestic animals, biological diversity, as well as other man made and managed ecosystems, through the conscious conservation of samples of such ecosystems, even when change as a whole is taking place;

c) To ensure that factors such as the level of vulnerability, uniqueness, importance and economic and environmental potential of the genome, be taken into account in determining priorities in conservation; and

d) To ensure that the conservation of genetic resources *in situ* maintains a dynamic system of genetic variability in an environment of constant selection pressure that is normally present in the natural, or human-made ecosystem.

Another sector in the policy, which has direct bearing on the conservation and sustainable use of agrobiodiversity, is Soil Husbandry and Sustainable Agriculture". The relevant sectoral policies emphasize:

> improving and intensifying existing farming systems particularly traditional land management systems by developing and disseminating technologies which are biologically stable, a economically viable and environmentally beneficial for farmers.
>
> crop breeding from multiple lines to increase the plasticity in adapting to environmental variations and resistance to pests and diseases;
>
> increased famers' access to land and natural resources with a view to enhancing investment in sustainable land managment technologies.

The *Seed Industry Policy* is also aimed at helping the farmer increase agricultural production through the use of improved seeds when necessary, and keeps this to the minimum possible and ensures that high yielding farmers' varieties continue to be used and encourages the use of native agrobiodiversity, in the development of varieties. In this context, it states

'...The accelerated genetic erosion of local land races and farmers' varieties, as a result of aggressive promotions of improved exotic varieties will be minimized and checked through implementing

balances, developments in the areas of plant genetic resources conservation, and seed production and supply'. 'The national crop breeding programs will as much as possible, be based on the principle of using the indigenous crop genetic resources and the agricultural systems as the foundation of the crop improvement work'. One important implication is the decoupling of seed and other inputs, so as to prevent the giving up of existing genetic resources, in order to have access to agricultural inputs. This is done by preventing 'private (domestic and foreign) seed enterprises; from having 'monopoly of the production and supply of seed of any one crop' and by promoting 'the active participation of farmers in the seed industry and the sustainable use of local cultivars...'

This is done by establishing a rigorous system of seed testing, approval and registration of improved varieties, which takes several years and by requiring that all varieties, locally developed, or imported, be subjected to it.

The current seed policy also responds to incidences where chemically based seed packages have been introduced, in which the traditional mix of cereals, pulses and oil crops have been severely disrupted, not only diminishing the agrobiodiversity of these areas, but also the nutritional balance of the crop mix making it impossible for the farmers to plant pulses. As a policy seed and chemical inputs-chemical fertilizers, herbicides and fungicides can not be packaged as a single unit. This policy is also aimed at checking the impact on the environmental pollution.

Consistent with the development of policies which are supportive of the conservation and sustainable use of agrobiodiversity, activities aimed at the conservation and sustainable use of agrobiodiversity are being implemented.

Ex situ Preservation

The gene bank in the Biodiversity Institute has been collecting, cataloguing and characterizing crop germplasm for nearly three decades. It has now approximately 56,000 accessions of 101 crops and related species[80]. Breeders in the country have been using it's collections and a number of modern varieties have been developed from Ethiopian farmers' varieties e.g. tef, wheat and sorghum

In situ conservation

The Biodiversity Institute realized the inadequacy of *ex situ* conservation and has been pioneering in methods of enabling peasant farmers to continue in their traditional *in situ* conservation irrespective of the pressures that would push them into changing their farming systems.

Concern about the loss of plant genetic resources led to the establishment of the Plant Genetic Resources Centre (PGRC/E) in 1976. The centre is

involved in exploration, collection and preservation of crop germplasm, together with the provision and exchange of germplasm for crop breeding programmes. Collection of plant genetic resources includes the collection of land races from drought prone areas for storage at seed reserve centres and redistribution to farmers when required. This is an insurance measure to prevent major losses of crop genetic diversity by consumption of seed in times of famine or the replacement of traditional varieties by imported seeds distributed through relief agencies.

Reintroduction of lost farmers' varieties

An even more exciting development has come from a partnership between breeders and the gene bank in the in returning of farmers' varieties to areas from where they had disappeared[81]. A notable example is the reinstitution of farmers' varieties of durum wheat just south of Addis Ababa. The best yields were selected from seed originally collected from the area and mixed to form a multiline mixture. On land which had been planted to pulses as in traditional fertility management, these composites yielded better than their counterparts, improved varieties planted in the same area with the application of the recommended amounts of fertilizer.

The Ethiopian policies offer important lessons as a model for other African policies to adopt as a crucial step to addressing loss of agrobiodiversity. However, for these policies to have a positive impact they must be backed by a strong technical capacity to translate them into concrete focussed actions and implement them - a challenge that the Ethiopian decision making process must now overcome.

5.3 Kenya

In Kenya, concerns on agrobiodiversity can be inferred from the focus on environmental conservation, where agricultural systems are concerned. Traditional policy formulation in Kenya is sectoral, whereby there is an array of policy and legal measures to promote environmental management in general and biodiversity conservation in particular, for land use, water, forest resources, minerals, wildlife, fisheries, agriculture etc. This demonstrates that the government recognizes that loss of biodiversity will negatively impact national development objectives and initiatives must be geared towards conservation of the natural resources, to safeguard the loss. For example, the *Sessional Paper No. 10* of 1965 on African Socialism and it's application to planning in Kenya, emphasized the need for policies to promote environmental management, in general and biodiversity conservation in particular. With reference to agriculture, is the *Population and Food Policy* which aims at increasing food self sufficiency through the promotion of monocultural cropping systems. The

focus has tended to be on introduced crops and their varieties, but with indigenous food crops not highly rated. Various crop policies have thus been developed to essentially promote their mass production for cash and export. These include the coffee, tea, pyrethrum, policies in which are fiscal and economic incentives for the extensive cultivation of high yielding varieties. With reference to agrobiodiversity, it is in those programs that address plant genetic resources that this analysis is based upon..

An analysis of efforts to conserve plant genetic resources in Kenya reveal that *ex situ* conservation is more practical than *in situ* conservation, because of the demographic pressures on natural resources. However, *ex situ* conservation is often costly and under limited economic resources not a very sustainable intervention.

The implementation of sectoral policies meant that sectoral institutions be created. Kenya has created a wide range of institutions to deal with the various aspects of biodiversity management[82]. Most are engaged either in research, or in practical conservation. Those that deal with plant genetic resources are the Ministry of Agriculture, Kenya Agricultural Research Institute (KARI), which houses the following departments: the National Agricultural Research Systems (NARS), the Plant Quarantine Station and the Gene Bank of Kenya (GBK); KEFRI which houses the Kenya Forestry Seed Centre and the Plants for Life Research programme, the National Museums of Kenya (NMK) which houses the East African Herbarium and the Centre for Biodiversity.

The National Agriculture Research System, is the main institutional system addressing conservation in agriculture. It is the main framework for breeding and *ex situ* conservation of genetic resources, focusing mainly on plant genetic resources. The Central Artificial Insemination Station (CAIS) and the Naivasha based Livestock Breeding Station, deals with livestock germplasm conservation and breeding. However, a large portion of the germplasm stored is exotic[83].

The Plant Quarantine Station was established to ensure that crop germplasm used in agriculture is free of diseases and pests and to detect these in imported plant materials and certain standards set up by the Kenya Standing Technical Committee, on plant imports and exports. In addition, it is involved in plant germplasm conservation and is the focal point for acquiring exotic germplasm. The focus again, on stored germplasm, has been mainly on exotic food crops.

The GBK was established to collect, characterize and preserve genetic resources to address the problem of loss of crop genetic resources. It focuses on maintaining germplasm accessions of cultivated crops and forages, 80% of which are forage crops. The other 20% of germplasm maintained includes food crops, mainly cereals and legumes. Although there have been some efforts on indigenous crops, the focus is still wanting.

The NMK was established to regulate all of Kenya's archeological and paleontological sites and monuments. It's general mission is 'to collect,

document, preserve study and present our past and present cultural heritage and enhance knowledge, appreciation, respect, management and use of these resources, for the benefit of Kenya and the world. It holds classic reference collections of plants, animals and prehistoric specimens from Eastern Africa, as well as from other collection centres from different parts of Africa. The Botanical Sciences Division has been involved in taxonomic descriptions of plant specimens collected in the field and propagation of endangered plant species. It has developed a herbarium with more that 600,000 different plant species used in various ways in Africa, including food, medicine, socio-cultural practices, commercial and domestic uses. In 1992 the NMK established the Centre for Biodiversity, whose functions include: research and conservation of plant and animal genetic resources. The Centre co-ordinates all national activities in biodiversity research and conservation.

KEFRI was established to undertake research on forestry and forestry related issues. The institute not only undertakes research on biotechnology for the establishment of plantations, but also focuses mainly on introduced species. The Seed Technology program has established the Kenya Forestry Seed Centre, which has been collecting and storing seeds from various ecological zones for both exotic and indigenous species, including food species. However, propagation and establishment technologies for most indigenous species have not yet been studied. The Plants For Life Programme has for the past 6 years been involved in documenting indigenous knowledge on indigenous plants used for food and medicine by various local communities in Kenya. This effort is aimed at preserving indigenous knowledge that is currently threatened by influences of acculturation. The knowledge documented is contributing to the establishment of a database on useful indigenous plants and forms an important basis for further studies on their utilization and conservation.

5.4 Tanzania

In Tanzania, several policies have varying roles and relevancy to agrobiodiversity. These include the Arusha Declaration (political) and the sectoral Agricultural policy of Tanzania and respond in general, to the need to improve farming systems, efficiency in agricultural production and marketing, favorable producer prices, but not explicit to traditional farming systems. In view of the importance and potential of agrobiodiversity in achieving these aims, the strategies and programs should be geared towards arresting genetic erosion. Currently little or no attention is paid to indigenous food crops and races, or less commercial crops[84].

5.4.1 The Arusha Declaration:

The underlying objectives of the Arusha Declaration of 1967 were social and economic equality, self reliance, attainment of co-operative production and social-economic transformation of the people and their production methods. The document recognized that long term agricultural development in Tanzania will require the improvement of farming systems, efficiency in agricultural production and marketing, favorable producer prices, provision of improved storage facilities, improved management skills and prompt purchase of farmers' produce. The document did not however, show priorities and means through which those objectives could be achieved.

5.4.2 The agricultural policy

This policy was enacted in 1983. One of it's targets was to ensure that different types of agricultural production are co-ordinated and developed on dual basis of maximum efficiency and the interest of the producers, as seen by them[85]. Through this policy, agriculture was and is, being asked to provide both food for domestic consumption and foreign exchange earnings for acquiring goods and services necessary to develop an industrial base. Tanzania's food policy has not been directed at trade-off of food versus cash crops. Policy was rather directed at generating more output from agriculture, because both cash/export and food crops, were necessary to support the industrial transformation [86]. There are many factors which have affected the performance of the agricultural sector, in relation to the twin goals. Among the factors which have depressed the performance, was the impact of villagization. Bad weather and in some areas poor agricultural practices, have also contributed to poor agricultural performance.

5.5 Uganda

In Uganda the government has recently come out to initiate national programs addressing plant and animal genetic resources of agricultural importance. A National Plant Genetic Resources Program, was established in 1992 and the National Animal Genetic Resources Program in 1994[87]. These programs respond to plant and animal genetic erosion, lack of awareness and inadequate research efforts on indigenous varieties.

5.5.1 The National Plant Genetic Resources Programs (NPGRP)

In 1992, a National Plant Genetic Resources Co-ordination Committee was established. It was mandated to set up priorities, or plant genetic resources

collection, characterization, conservation, evaluation and documentation. A National Plant Genetic Resources Program (NPGRP) was developed and launched.

The objectives of the NGRP are to:

a) institutionalize the NPGRP, support and integrate it into the national economic development plans
b) appreciate the value and full potential of the contribution of Plant Genetic Resources (PGR) to national agricultural economic development and environmental conservation
c) arrest the erosion of PGR in Uganda
d) promote conservation and judicious utilization of PGR in Uganda
e) establish an acceptable mechanism for germplasm accession and exchange
f) establish mechanisms that will enhance regional and international collaboration.

The activities in this program have therefore aimed at:

1. Raising awareness on the need for conservation and utilization of PGR
2. Reviewing and streamlining the organizational framework of the PGR program in Uganda
3. Identifying mechanisms to re-activate and revitalize the PGR program
4. Identifying priority start up activities
5. Recommend policy guidelines and role of institutions involved in handling plant genetic resources.

5.5.2 The National Animal Genetic Resources Program (NAGRP)

In 1994 the government of Uganda set up a multi-disciplinary, multisectoral National Animal Genetic Resources Program.

It has two main objectives;

1. To ensure the conservation of diversity of animal genetic resources in Uganda
2. To ensure sustainable and the best use of the AGR

Specific objectives include:

i) Developing a national AGR Conservation Policy including *in situ* and *ex situ* conservation
ii) Developing and establishing an appropriate institution framework for co-ordination, regulation and monitoring of AGR conservation activities
iii) Creating awareness among the population on AGR
iv) To characterize and document the AGR
v) To promote research on AGR.

From the AGRP, the national animal breeding policy and action plan were formulated. The objective of the policy, is to promote optimum management, conservation and sustainable use of PGR to meet stakeholder needs and aspirations, while ensuring protection of the environment.

The policy focuses on providing guidelines to farmers, investors, researchers, extension workers and civic leaders on suitable breeds for the various production systems; alternative breeding programs; import/ export and dealing in animal genetic materials; breeding and management systems for conservation and sustainable use of indigenous animal genetic resources and the use of modern breeding technologies. It further identifies priority areas for research, development and the legal and institutional frameworks required for effective implementation. It places great emphasis on rational exploitation of available resources, while recognizing the changing role of Government, fundamental rights of the people and the privatization, liberalization and decentralized democratic governance policies adopted by the Government.

The Uganda National Animal Breeding Bill (1997) seeks to establish the National Animal Genetic Resources Council; the National Animal Genetic Resources Center, Data bank and to provide for the promotion of sustainable animal genetic improvement, regulation and control.

6.0 Recommendations

Although agrobiodiversity concerns have been variably mentioned in policy and program documents their impact on reducing genetic erosion has been minimal if not absent. For integration to be effective, it must go beyond rhetoric to the translation of the objectives into concrete deliberate actions. It should be directed towards those actions that will reduce the impact of the factors and processes affecting loss of agrobiodiversity identified above. It must be supported by effective legal and regulatory frameworks as well as by the use of incentive measures which include economic instruments, markets and other incentives.

Successful conservation and sustainable utilization of biodiversity requires a successful interaction of many variables across fields of study, sectors of responsibility for governance and all stakeholders. In particular, Eastern Africa should focus on policies and programs, supported by the appropriate legal and economic incentives, to enhance conservation of agrobiodiversity and its sustainable utilization. In particular, the initiatives should be geared towards mitigating the negative impacts of the Green Revolution technologies by promoting traditional agroecosystems through balancing and promoting types of varieties as well as avoiding conversion to single monocultures.

During the multistakeholder workshop on Agrobiodiversity held in Nairobi in November 1997, the participants identified the following priority concerns and recommendations as areas for action and policy change. Areas of intervention include: integrating agrobiodiversity concerns into the policy process as exemplified by the Ethiopian models noted above; enhancing awareness of agrobiodiversity concerns among all stakeholders including decision makers- to enhance their understanding of the potential of indigenous cropping systems to contribute to food, nutrition and economic security and the imperative to design policies for these systems; increasing investment in biodiversity management, research and conservation of indigenous food crops with a view to contribute to modern agricultural systems and sustainable agriculture; expanding environmental accounting to include socio-economic contributions by traditional crops so as to avoid those policies that could have a direct impact on them; providing economic and legal incentives for the promotion of traditional farming systems to contribute towards equity in access to resources and infrastructure for the development and promotion of indigenous food plants, and; enhance the participation of local communities and their technologies in development to increase their stake in natural resources management and obligation to safeguard them .

First and foremost, countries of Eastern Africa should learn and adopt appropriate policy models such as of Ethiopia which has made some progress as noted above. However as demonstrated it is of paramount importance to ensure that the policies advance to effective implementation by according strong legal, technical and fiscal capacities.

6.1 Awareness raising and training

Lack of awareness of agrobiodiversity conservation issues was identified amongst decision makers, technical field staff and farmers. This has a lot of implications for mainstreaming agrobiodiversity into national programs. It is important to increase awareness among decisions-makers on the full or potential value of agricultural biodiversity and the impact of agricultural policies that neglect traditional agricultural technologies. Information sharing among development agencies is an important process in enhancing public awareness. These agencies include government agencies (Research and extension), non-governmental organizations,

private bodies and farmers. Agrobiodiversity issues should be part and parcel of the extension messages from field staff in agriculture and related sectors to farmers. The field staff should be trained and sensitized on key agrobiodiversity issues and how they relate to their day-to-day activities and farmer's problems. Farmer field school approaches could also be employed building upon the successful examples seen in Integrated Pest Management. As researcher-extension-farmer linkages evolve, it is clear that researchers must learn from farmers also.

This process must therefore be integrated into a mechanism for generating, processing and storing in a retrievable form all information pertinent to agrobiodiversity at all levels. Such information would enable monitoring of the trends of key agrobiodiversity components which should be disseminated widely including integration into school curricula. To address lack of agrobiodiversity information research should increasingly focus on traditional agricultural technologies in order to generate relevant knowledge for appropriate policy intervention.

6.2 Increased investment in biodiversity management and research

Current research efforts and investments in conventional crops, is one of the factors that has led to the diminishing interest on traditional farming systems and crop varieties. Many governments' investment in research, is very minimal and in the face of economic forces, traditional varieties have been neglected. For example, the lack of improved varieties of some legumes (e.g. greengram, chick pea, bambara nuts, hyacinth bean and lima bean), is attributed to lack of research efforts and investment towards the diversity of these crops.

It is therefore recommended that for the traditional farming systems and crop varieties to survive, research is needed to enhance their positive attributes and broaden their utilization. There is need for reorientation of agricultural research and development (R&D), from it's current pre-occupation with a narrow definition of productivity, towards looking at rural systems in totality. More research is needed into the total biomass production of a village ecosystem; into multiple cropping systems; into the revival and enhancement of indigenous crop varieties and into the various incentives systems which would encourage farmers towards biodiverse agriculture.

There is need for a thorough study of the traditional farming systems, to enable an understanding of the ecological and social basis for their success. The principles derived, can then be applied to the new emerging systems of modern agriculture. Such studies are important to educate decision-makers in the true value of agricultural diversity, and in an

expanded definition of productivity. Researchers should exploit the research opportunities offered by these systems. The high level of diversity offers an invaluable opportunity to study the enormous capacity of traditional farmers, to generate, utilize and manipulate agrobiodiversity. The complementarity and resilience of the highly diverse fields, with the potentially more productive areas for maintaining agrobiodiversity, along with improved productivity for food security, is a key feature of the traditional agricultural system which requires further systematic study and support, as well as development.

It is important that target goals are set for the area (percentage aand total, species (inter- and intraspecies divrsity) and viability of traditional farming systems.It is not enough to say they are a good thing. Tangible indicators will be needed to show progress in the area of promoting and conserving agrobiodiversity. Questions arise as to methods for meaningfully monitoring agrobiodiversity and this should become a research focus.

Research and development must also include a true assessment of the value of traditional agro-diversity, wild relatives and non-cultivated species, using local farmers' own values, as a base. It needs to build much more on the many important characteristics contained within the crops including grain productivity, taste, smell, colour, drought and disease resistance, ability to grow in adverse conditions, efficiency in input use, fodder output and others. Although some work has been done to this end, many traditional varieties are yet to be fully screened for their usefulness in specific conditions. There is need to promote the value of indigenous crop plants, than is presently the case, by way of utilization and quality research which should be undertaken to increase the number of ways in which indigenous germplasm can be used[88]. In recognizing the role of the local innovators, R& D should be much more participatory, so that priorities and strategies for research emanate from the needs, opinions and knowledge of farmers, and so that results are tested and implemented by farmers. In a complementary effort and in recognition of the positive attributes of modern farming systems research efforts should be put on farming systems approaches, to identify the optimal production mixes between intensive and extensive systems. Mixed and multiple cropping management will go along way in optimizing biological diversity.

6.3 Environmental accounting

Environmental accounting should be much more comprehensive, particularly, with reference to the inclusion of agrobiodiversity in economic analysis. Agricultural productivity statistics that have focused on a few introduced cash crops, should consider the contribution of

traditional food crops to food production. This plays the important role of informing the policy process of issues that could have a most direct impact on the economy and areas that need strengthening for example, the importance of mandatory imposition of environmental impact assessment for agricultural projects geared towards looking at impacts on agricultural biodiversity.

6.4 Economic and legal incentives

An analysis of traditional agricultural systems reveal attributes that offer economic and conservation incentives to sustainable agriculture. The promotion of traditional farming systems may prove productive and profitable from an economic point of view, since input costs are marginal and losses through pests, diseases and erratic climate are minimal. In addition, integrating plant and animal resources should be further encouraged to exploit complementarity and synergistic relationships, thereby enhancing economic viability of most of the production systems. There is a great potential to increase and sustain food production through a mixture of strategies -mixed and multiple cropping, to revive and sustain diversity.

These attributes should justify the re-orientation of the agricultural credit and subsidy system towards encouraging biodiverse farming in particular significantly include the non-cultivated but nurtured species[89]. Today's credit systems, biased towards Green Revolution inputs, are a major disincentive for biodiverse agriculture. Instead, it could be reversed to support forms of farming which can combine diversity and productivity and which help farmers to become as self-reliant as possible. Considerable work needs to be done on building up a responsive and cheap transportation arrangement, ensuring the availability of widespread distribution centres for indigenous and as well as naturalised food crops.

From the stand point of the national economy there is need to create conditions which stimulate peasant agricultural production from the traditional farming systems. Peasants rely on the national economy for advancement, beyond the subsistence stage and for improvement in their living standards through the availability of health services, transport services, the possibility of marketing their surplus easily and the possibility to acquire goods which can make their lives more comfortable.

Increased investment in the less dealt with crops, is proposed as a long term strategy for food security and improved nutrition. Diversity markets can considerably help promote agrobiodiversity by providing economic incentives to invest in the production of indigenous food crops. This initiative should be supported by market assessments for diverse indigenous crops and products, access to capacities to add value, efficient information system and adequate infrastructure.

Tenurial and intellectual rights of farming communities need to be secured. It is unlikely that current models of intellectual property rights, being heavily weighted in favor of private monopolies are suitable. Indeed, it has been argued persuasively by several experts that such models could disrupt community systems and that there are other viable alternative models which provide for much greater space to community-held resources and knowledge rights[90]. For instance, the Working Group on Traditional Resources Rights has suggested Traditional Resource Rights as a bundle of rights which protect, conserve and compensate for the knowledge and resources of local communities[91]. Countries should promote the domestication, of the Convention provision on farmers' intellectual property rights. Current initiatives to develop innovative systems to protect/acknowledge communities/groups' knowledge and achievements in genetic resources and agrobiodiversity should be enhanced to best practice[92].

6.5 Local community participation

To ensure that these new strategies are adopted and used, local inhabitants must be involved[93]. In due recognition of the high diversity within the traditional farming systems, there is now welcome attention to the role of traditional farmers in the management of agrobiodiversity. The stabilized equilibria in traditional agroecosystems are complex and very difficult to modify, without upsetting the balance and risking the loss of genetic resources, not to mention the negative effects on social organization[94]. In fact, it is argued that many land races, wild and weedy relatives can be preserved only in agroecosystems under traditional management and, furthermore, only if this management is guided by local intimate knowledge of the plants and their requirements[95]. Communities should therefore be active players in research and development[96].

Local communities should also be involved in participatory estimation and valuation of agrobiodiversity so that: local people would look at the resources as a source of their livelihood and survival; to demonstrate in practical and realistic terms, the importance of biodiversity to policy makers and political leaders; to influence governments, local authorities and individuals in resource allocation and ensure integrated planning and decision making is based on information on biodiversity values and benefits.

On this basis, are recommended rural development approaches derived from decisions of policy makers and researchers external to the community of local farmers, to reflect indigenous social, ecological and ethnobotanical considerations [97].

Since local farmers are the custodians of the traditional farming technologies that would enhance agrobiodiversity, it will be more profitable to integrate their knowledge into policy formulation and implementation. This can be achieved by:

a) Ensuring representation and active participation of farmers and farmers' groups in national, local, regional and international forums and policy planning on agrobiodiversity
c) Creating forums and workshops that link local groups with higher level policy institutions (concerning agrobiodiversity)
c) Gathering and systematizing information on farmers' local knowledge and practices on agrobiodiversity, to inform policy and to relate positively to farmers with the view to empower the farmers
d) Implementing programs and policies that promote farmer-based knowledge and practices of agrobiodiversity through farmer participation in project planning, education on agrobiodiversity, innovative farmer to farmer extension methods and participatory farmer to farmer extension methods.

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