COUNTRY REPORT ON THE STATE OF PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

UGANDA

Second Country Report on the State of PGRFA

Prepared by:

Plant Genetic Resources Centre

National Agricultural Research Organization (NARO)

Complied by:

Plant Genetic Resources Centre – NARO

Entebbe Botanic Gardens'

P.O Box 40,

Entebbe

Email: curator@infocom.co.ug

Tel: +256 414 320638

August 2008

Note by FAO

This Country Report has been prepared by the national authorities in the context of the preparatory process for the Second Report on the State of World's Plant Genetic Resources for Food and Agriculture.

The Report is being made available by the Food and Agriculture Organization of the United Nations (FAO) as requested by the Commission on Genetic Resources for Food and Agriculture. However, the report is solely the responsibility of the national authorities. The information in this report has not been verified by FAO, and the opinions expressed do not necessarily represent the views or policy of FAO.

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO in preference to others of a similar nature that are not mentioned. The views expressed in this information product are those of the author(s) and do not necessarily reflect the views of FAO.

CONTENTS

ABBREVIATIONS AND ACRONYMS

AVRDC	Asian Vegetable Research and Development Center
CBD	Convention on Biological Diversity
CBOs	Community Based Organisations
CFR	Central Forest Reserve (CFR)
CIAT	CIAT Regional Bean Program
CIDA	Canadian International Development Agency
EAPGREN	East African Plant Genetic Resource Network
GEF	Global Environment Facility
GIS	Geographical Information System
GMOs	Genetically Modified Organisms
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IITA	International Institute of Tropical Agriculture
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
NAADS	National Agricultural Advisory Services
NARO	National Agricultural Research Organization
NGOs	Non Governmental Organization
NISM	National Information Sharing Mechanism
PGR	Plant Genetic Resources.
PGRC	Plant Genetic Resources Centre
PGRFA	Plant Genetic Resources for Food and Agriculture.
PLEC	People Land Management and Ecosystem Conservation
PMA	Plan for Modernization of Agriculture
R & D	Research and Development
UNEP	United Nations Environment Programme

ACKNOWLEDGEMENTS

Production of this report was made possible by the contribution of many stakeholders from government departments and ministries, non-government organizations, public and private training and research institutions and individuals in their own capacities. The role played by the national steering committee in guiding the National Information Sharing Mechanism (NISM) secretariat and focal point remains key to this process for the present and future. The contact persons at institution level undertook their task of compiling data with diligence. The technical backstopping offered by Bioversity International was very instrumental. The CIDA financial support which facilitated the entire process is highly appreciated.

The following persons are gratefully acknowledged for their contributions in drafting the chapters: Beatrice Male Kayiwa, Ronald Naluwairo, Miriam Ojok Babigumila not forgetting John Wasswa Mulumba and Brenda Namulondo who were the NFP.

INTRODUCTION

1. Size and location

Uganda is a land locked country, located in East Africa, lying between latitude 4^0 12' N and 1^0 29' S and longitude 29^0 34' E and 35^0 E. It lies astride the equator, bordered by Sudan to the North, Kenya to the East, Tanzania to the South, Zaire to the West and Rwanda to the South West. The total land area is 236 000 km^2 of which 33 926 km^2 is permanent water and 7 674 km^2 is permanent swamp. Dry land accounts for 194 000 km^2.

2. Topography

Towards the South, the characteristic scenery consists of flat topped masa-like hills and broad valleys frequently containing swamps. Towards the North, the landscape consists of gently rolling open plains interrupted by occasional hills, mountains and inselbergs. Most of the country lies within altitude 900 – 1 500m above sea level. The lowest point in Uganda is at Nimule on the Sudan border in North Western part of the country, where the altitude is 600 m.a.s.l and the highest point is Mt Rwenzori whose highest pick is 5 100 masl.

3. Climate

Over most of the country, mean annual maximum temperatures range between 18-35^0C; and mean annual minimum temperature range between 8–23^0C. Relative humidity is often high, ranging from 70% to 100%. Mean monthly evaporation rates range between 125-200 mm. Most parts of the country have two rainy seasons, April-May and October-November with the exception of north eastern region which has one main season. The wettest part of the country is Lake Victoria shores, and the mountain uplands of the East and Western parts of the country where the mean annual rainfall varies between 1 200-1 500 mm. The driest part of the country is the North Eastern part, inhabited by the semi-nomadic Karamajong tribe. Here, the mean annual rainfall varies between 625-1 000 mm. The rainfall in almost all parts of the country adequately supports agriculture and soil types range from fertile volcanic ash, sandy gravel acidic or shallow poor soils.

4. Population

The population of Uganda stands at 30 million of which 50 % is below the age of 15. Despite the high incidence of disease, including HIV/AIDS, Uganda's population is growing fast and is over 80% rural. Human population growth rates for Uganda approach 3%. Human density estimates are also relatively high, with a national average of 102 people/km^2.

5. Vegetation

Uganda has a range of vegetation types from wetlands through savannas, forests and thickets to afro-alpine moors. This variety is associated with a wide range of physiographic and ecological conditions which include well-watered tropical zones through others with marked seasonality, semi-arid areas to mountains that are permanently covered by snow or ice.

Savanna communities cover about 45% of Uganda while many of the various forests and semi-evergreen thickets together cover no more than 4% of Uganda. Montane grassland, heath and moor land cover 1%.

The main factors causing this variety of vegetation are: climate; soil; organisms and fire which have considerable direct and indirect effects on the vegetation; altitude and topography through their effects on climate and the soil. The nature of the environment and the character of the vegetation are due as much to the interaction of these forces as to their individual effects.

Only a small proportion of the vegetation of Uganda can be regarded as wholly undistributed. The rest has been modified to various levels by human activities of the clearing of land for cultivation, the felling of trees for fuel wood, timber, poles and other materials, the grazing of livestock and repeated fires.

The mountains have been affected least and they still support relatively large areas of natural forest, grassland and afro-alpine communities.

In the high rainfall areas boarding Lake Victoria and in the western highlands, many forests have been reduced to a mosaic of forest and savanna areas, but they are no less obvious in the natural savanna areas.

6. Agriculture crop sector

Most of Uganda's farming systems comprise small-holder subsistence farms. These range from pastrol to very diverse crop systems comprising a wide range of genetic diversity both at intra and interspecific level. In addition a wide range of semi-domesticated and wild species of plants form part of the peoples daily livelihoods. The sourcing of food from wild involves gathering mainly indigenous fruit species and leafy vegetables. However, the wild sources continuously get depleted or destroyed due to activities such as charcoal burning, timber logging materials for crafts, selective harvesting of species with cultural significance, thus affecting different species in differing ways. The National Agricultural Advisory Services (NAADS) program focuses on 'improved varieties' in a bid to modernize agriculture in line with the Plan for Modernization of Agriculture (PMA). Native crop species are ignored by these efforts. However, the integration of natural resource management is becoming important in NAADS programs and offers opportunity for addressing this anomaly. Given the high population growth rate of approximately 3% and declining soil fertility, the food demand has risen and food production is streched to meet the food demand. Though most of the food crop produce is for domestic use, a good proportion of them (e.g bananas, sweet potatoes, cassava, etc.) are major components in the urban food markets. Traditional cash crops (e.g coffee, tea, cotton, etc.) show a decline and new cash crops (e.g Aloe vera, Vanilla, etc.) are gaining ground as commercial enterprises. Besides, the food crops (especially maize and beans) are exported to neighbouring countries which have food deficits. Over 80% of the population is in rural areas and mainly engaged in agriculture. However, many people, especially youth, continue to migrate to towns leaving behind old people and their young grandchildren, most of whom are orphans due to the AIDS scourge. The labour force engaged in agriculture is progressively becoming inadequate and due to having many child-headed households the range of crop species utilized consequently reduces.

The majority of farmers are small holders, living in scattered homesteads, and employing traditional agricultural techniques utilizing simple tools like hoe, panga and axe. Average acreage per small holding is between 1-10 ha. Mechanisation is very limited, irrigation of crops almost negligible and use of fertilizers and pesticides minimal.

The main food crops are maize, sorghum, finger millet, bananas, cassava, sweet potatoes, yams, beans, peas, groundnuts, Solanum potatoes, rice and sesame. The main traditional cash crops are coffee, cotton and tea. In addition to these are various arrays introduced and native semi-wild vegetables. Most fruits cultivated are introduced while indigenous ones are collected from the wild. In general these crops are grown under four main farming systems (Figure 1).

In the coffee-banana farming system, in the wetter areas of Southern, Western and Eastern parts of the country, perennial crops and exotic fruits and vegetables are grown. The main food crop is bananas and the main cash crops are tea and coffee.

The upland areas of the Western and Eastern parts of the country; high reliable rainfall and fertile volcanic ash are characteristic. Main crops grown are exotic fruits and vegetables, bananas and temperate crops such as wheat and barley.

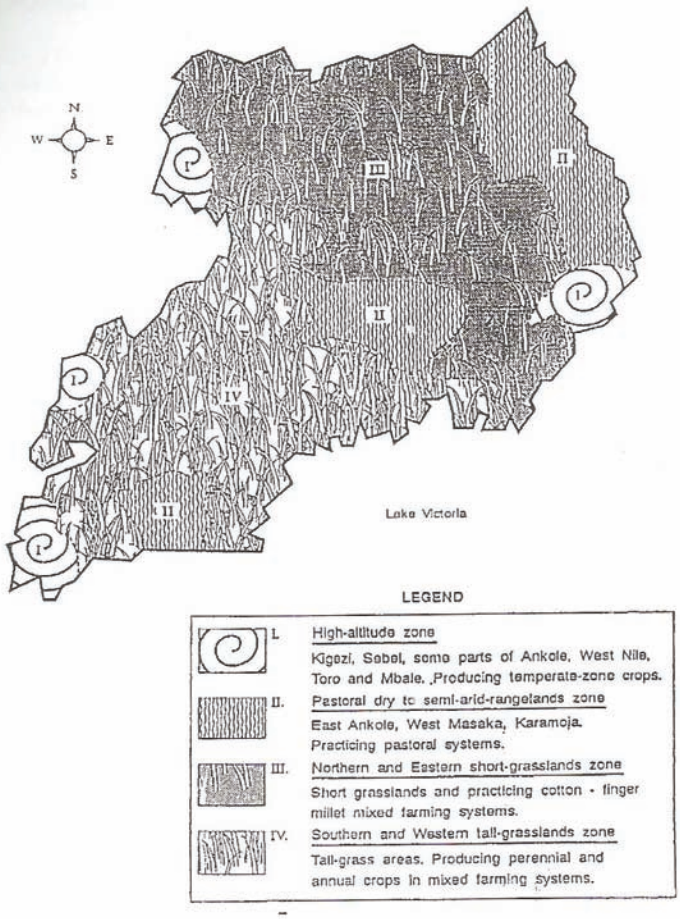
In the drier savannah areas of the North, East and Western parts of the country, the main crops are the annuals, few drought resistant perennials, and both local and introduced legumes. The main food crop is millet, and the main cash crop is cotton.

The semi-arid rangelands of the North- East and the South West parts of the country form the fourth type of agricultural zone. Here the main agricultural activity carried out is cattle keeping, in a semi-nomadic pastoral system.

Although agricultural crop production trends have shown increases over the years, yields/ha have continued to drop. Increase in production levels has therefore been due to increase in acreage rather than yields. Production constraints include pests, diseases and the lack of access to technologies and inputs necessary to increase yields.

The country is generally food secure, though the distribution of the food is unproportional as some parts experience shortages while others have surpluses. Improvement of the infrastructure, laying appropriate food storage strategies and policies are essential to address this anomaly. Food shortages have been experienced in areas of the north where due to insurgency agricultural production was halted. The changing weather patterns have also affected food crop production resulting in shortages.

FIGURE 1 Distribution of the four major agro-ecological zones of Uganda



Source: Strengthening of Agricultural Research in Uganda Agricultural Task Force, Agricultural Research Group 4, March 1987

Over the past 10 years effort has been made toward boosting crop production by encouraging people to take agriculture as a business as exemplified in the Plan for Modernisation of Agriculture (PMA). Through advisory services use of higher yielding crop varieties have become more widespread. There has been some rise in crop production in general, though in the case of food crops negative effects of high population obscure these changes. There have been changes in the demand of crop products with a rise in the crop diversity available in urban markets. The move to include non-traditional cash crops has resulted in many food crops gaining access to the export market, medicinal plants and flowers inclusive.

The conducive government policies on trade has led to entrepreneurs seeking markets abroad and offering prices that encourage farmers produce desired crops. Ugandan farmers have also embraced production of certified organic produce for export.

The limiting factors and major constraints affecting productivity and efficiency include:

- High costs of farm inputs
- Changing weather patterns leading to poor timing of farming operations
- Inadequate agro-processing capacity
- Poor road network and high transport costs to markets
- Limited capacity for quality control
- Diseases and pests
- Lack of credit facilities
- Educational limitations

In order to address these factors a network of well equipped information centers have been established at different locations in the districts where farmers can have their questions answered promptly. These information centers also serve as dissemination points for research information on any farming enterprise. The NAADS staff distributed countrywide also assist farmers make decisions on profitable crop production, advising on which farm enterprise is appropriate at individual locations. Government also has a policy on crop zoning with the aim of boosting crop production in regions where individual crops would face limited environmental stress. Producers are encouraged to add value to agricultural produce and many agro-processing plants have been established, with premier prices offered for superior products, with some exported. The improvement of road infrastructure is ongoing though at a slow pace since the funds required are enormous. Farm schools are run occasionally to help farmers improve on their crop production skills and business skills.

As the country diversifies its agricultural production, plant genetic resources are bound to play a crucial role in addressing breeding for disease resistance. The value of genetic resource in-country has already surfaced in case of coffee wilt. As the fruit processing industry picks up the various native fruits genetic resources are likely to play a big role in the juices/wines industry. Besides there are many neglected and underutilized crops that require genetic improvement and the genetic resources will be central in the crop improvement process.

7. Forest genetic resources

Forests and woodlands cover a total of 4.9 million hectares, about 24% of the total land area. Tropical High Forests (THF) cover 924 208 ha, forest plantations cover 35 066 ha and woodlands cover 3 974 102 ha. Of the 4.9 million hectares, 30% are in protected areas (Forest Reserves, National Parks and Wildlife Reserves) and 70% are found on private land. Protected Areas cover 1.9 million hectares. Of this, Central Forest Reserves cover 1 265 742 ha. The National Forest Authority (NFA) manages the central forest reserves. The forests on private land are in many cases being over-harvested, degraded and converted to other uses. In the higher rainfall areas of southwestern Uganda privately managed woodlots are intensively utilized to provide a steady stream of poles, firewood and other forest products, thus reducing the pressure on remaining natural forests that are in protected areas.

Natural forest types include those found at higher and lower altitudes and those with various plant compositions ranging from primarily evergreen to deciduous to bamboo forests. Tree planting activities of NFA are focused on introduced species (*Eucalyptus* spp., *Pinus* spp. and *Grevillea robusta*). Such activities are useful in meeting short terms needs for timber, though they could threaten the survival of native species if there are no guidelines for private tree planting. The introduction of exotic species into natural systems, however, is likely to affect the biodiversity and tropical forests in many ways. There is a possibility that exotic plant species can out-compete native species and replace them in the system, thus reducing the species diversity, lowering genetic diversity, and increasing the homogeneity of the landscapes.

The network of protected areas managed by Uganda Wildlife Authority (UWA) and the central forest reserves managed by National Forest Authority (NFA) are well established and serving to conserve a significant portion of the biodiversity and remaining tropical forests in Uganda. Uganda has 10 national parks, 13 wildlife reserves, 10 wildlife sanctuaries and five community wildlife areas which are managed by UWA.

The deforestation rate in Uganda is estimated to be 55 000 ha per year, based on habitat change from 1990-1995.

8. Wetlands and water bodies

Wetlands originally occupied about 13% of the land surface area of Uganda but recent estimates indicate that wetlands now cover only 484 037 hectares or about 2% of Uganda's total area (National Biomass Report, 2003). Most wetlands in Uganda occur outside of protected areas, and their range and quality is rapidly being eroded for agricultural land. Papyrus and other wetland plants have commercial value, and of the plant species represented at least 22 species of plants are edible, and many other plants are used for medicinal purposes.

Open water is a category that includes major lakes such as Lake Victoria, Lake Kyoga, Lake Edward, Lake Albert, Lake George, and Lake Mburo and many smaller lakes, various stretches of the Nile River and rivers, streams and water bodies throughout the country. Collectively, these water bodies contain one of the largest assemblages of diverse freshwater fish species in the world.

The Government of Uganda sees the wise use of natural resources, PGRFA inclusive, as a means of eradicating poverty, and government's strategy hinges on conservation of soil, forests vegetation and biomass, water, wetlands and wildlife.

The government's Poverty Eradication Action Plan (PEAP) focuses on agriculture because:

- Agriculture, though represents a declining share of the GDP, it employs the largest number of Ugandans in rural areas compared to other economic sectors
- Most of the non-agricultural goods and services produced in rural areas are sold locally, so their production cannot expand unless the demand generated by agricultural incomes also expands
- Agriculture is particularly dependent on public goods, including research, extension and marketing support

The Government of Uganda, therefore, seeks to accelerate agricultural growth by providing improved public goods, including research, extension and marketing support, with the goal of increasing agricultural production and incomes; especially of poor rural households so as to assist them to escape poverty by producing and selling goods, especially plant based. Interventions in the modernization of agriculture include research and technology development, advisory services, rural financial services, rural infrastructure development, and sustainable natural resource use and management. Therefore, in the long run agricultural growth is expected to generate benefits to non-agricultural sectors in rural areas and beyond, through the consumption of non-farm products. Effort has been made to inventory, collect and redistribute appropriate trees/shrubs species, especially of fruits to target areas. While in the crop sector, the National Agricultural Research Organization (NARO) research programmes identify adapted crop varieties for use in the different ecological zones of the country and impact on appropriate crop choices for the zoning of crop production. The National Agricultural Advisory Services (NAADS) unit works closely with farmers in target areas to boost production & income generation. On the other hand, the National Environment Management Authority (NEMA) implements environment conservation activities planned, including plants, animals, soil & water conservation issues. Consequently NEMA spearheaded the development of environmental management strategic plans which included one on PGR management. Government appreciates participatory development efforts and many of the registered Communities based CBOs and NGOs programmes address PGRFA issues.

Uganda accesses to the International Treaty on PGRFA and has developed policies to address factors emphasized in the global plan of action, CBD and the international Treaty on PGRFA.

CHAPTER 1

THE STATE OF DIVERSITY

1.1 The state of diversity and relative importance of all major crops for food security

The main food crops are maize, bananas, finger millet, sweet potatoes, sorghum, cassava, beans, peas, groundnut, Solanum potatoes, rice and sesame. Other crops of relative importance in some regions are pigeon peas, cowpeas, etc. There are many vegetables cultivated, some introduced and others indigenous. Of the indigenous ones some are semi-wild and still collected from the wild. Wild ones of relative importance in North and north-east Uganda include *Cucumis figarei*, *Corchorus tridens*, *Crotararia ochroleuca*, *Hyptis spicigera*, among others.

Communities in North and North-Eastern Uganda traditionally keep seed of variable crops in granaries but production constraints and population increase resulting in food shortage eventually led to rampant thefts from granaries. This situation eventually led to a level of food insecurity and subsequent loss of some diversity within individual crops. Granaries are run by individual households and seed exchange amongst the community has been common.

Most of the fruits grown are introduced species (e.g Citrus species, pineapples, pawpaws, etc.) though some few indigenous ones such as *Garcinia buchananii, Carissa edulis, Saba comorensis*, etc. have been introduced in local markets. Though germplasm collections of these have been undertaken, their promotion to cultivation still requires extensive study. These, being wild plants, are not differentiated into varieties by the rural communities and have not been subjected to selection.

The banana still serves as a major staple food, a major cash crop on the local market and a fruit. Appraisal of the diversity in this crop revealed 84 distinct banana cultivars.

1.2 The state of diversity and relative importance of minor crops and underutilized species

Many underutilized crops (e.g yams (*Colocasia* spp, *Xanthosoma* spp, *Dioscorea* spp), are maintained by farmers to ensure food security. The majority of such species that are utilized at local level lack documentation that depict their variation, but the process of retrieving this information from farmers for documentation is under way. However, in these crops distinct cultivars are often not formally recognized but their diversity is based mainly on morphological factors. Therefore, in home gardens extensive amounts of genetic diversity are maintained even though the numbers of morphotypes and population sizes in any individual garden are often small. However, despite neglect by agricultural research and development, poor communities continue to grow minor crops such as bambara nut (*Vondzeia subterranean*), *Crotararia ochroleuca*, *Solanum nigrum*, etc. and market them at low scale.

Many of the plant species harvested from the wild or protected in backyard gardens in homesteads are multi-purpose plants, with those of medicinal value contributing a significant proportion. Once all these are characterized it will be possible to select or eventually improve on them thus enhancing the process of their domestication and contribute to agricultural diversification.

The rarer edible plants harvested in the wild or semi-protected by people in drier cattle corridor areas in North-East region (Karamoja and Katakwi) are of relatively low importance to areas with adequate rainfall. So there is little known about the wild fruits from such areas, though some information was captured on them by Katende *et al* in the two publications on indigenous trees and shrubs in Uganda and that on edible plants from the wild. These species include non-food *Acacia* spp and shear butter tree (*Vitellaria paradoxa* subsp *nilotica*) that could give a significant boost to the income of the people if exploited for gum Arabic and oil respectively. The diversity represented by such crops is still less studied and hardly collected for conservation. Ethno-botanic surveys so far undertaken reveal utilisation of plant diversity both wild and cultivated which has led to capturing different nutritional components in the people's diet at low cost. Unfortunately the rich diversity found in plants harvested from the wild in most areas of the country has not

been exploited through selective breeding (especially in indigenous fruits and vegetables to get more uniform varieties, which are a pre-requisite for consistent higher yields.

The diversity of wild plants harvested for food production has been subjected to control under the Uganda National Forest Authority. However, there is no policy/legislation in place to support Collaborative Forest Management processes especially where wild species are harvested for food purposes e.g bamboo shoots (*Arundinaria alpine*) and several species of mushrooms in the Elgon highlands in the Eastern region of the country. It is envisaged that potential livelihood benefits to local communities from Collaborative Forest Management are likely to be very low mainly because benefits/values of Collaborative Forest Management are not understood by the stakeholders.

Problems associated with sourcing food plants from the wild include supply dependence on seasons, which at times fluctuate depending on rains received and duration thus affecting marketable biomass. The popularity of wild sourced diversity in PGRFA is reflected in their demand at the markets. Market prices received for the supplies often double or triple in the dry season.

1.3 Factors influencing farmer's crop and variety choices

Food security is an important factor that influences the choice of crops and varieties that farmers grow and maintain. Yield and maturity period are the major factors that farmers consider in choosing varieties for most crops. In the case of bananas taste and dough quality are the other factors considered in the choice of varieties in addition to yield and maturity period. However, for specific varieties their cultural/traditional uses are key to their survival. Other factors generally considered for all crops include storability, drought resistance, taste, marketability, and ease of processing.

Generally the state of diversity of crop varieties, modern varieties and landraces/farmers' varieties inclusive, is dynamic. The traditional farming systems tend to have genetic diversity deliberately incorporated in them consistently and maintained for risk insurance against environmental stresses. However, agricultural policies for example Plan for Modernization of Agriculture, zoning of the country for specific enterprises aim at commercial production enterprises which involve use of modern agricultural practices that encourage large scale monocrops, with the subsequent increase in threats of genetic erosion.

Generally principle factors leading to PGRFA loss especially those maintained *in situ* or on-farm include:

- Habitat loss/land degradation or fragmentation
- Unsustainable harvesting and over-exploitation
- Preference of exotic crops or introduced commercial species

There are, however, very few long term studies to keep track trends in the loss and there is a recognized need to set up integrated monitoring programs for various taxa as part of long-term studies of universities and research organizations.

1.4 Factors driving change in crop diversity

Generally high levels of crop and variety genetic diversity are characteristic of areas where production is particularly difficult such as semi-arid or high altitudes places or isolated communities. This is because the production environment itself is extremely variable (such as the case study in Mwizi sub-county in the hilly rain shadow area of Mbarara district), and access to resources and markets is difficult. Besides high levels of diversity are also characteristic of home gardens where production is optimized in small areas to meet multiple use needs and maximize use of all available ecological niches.

The survival of certain cultivars can be linked to specific accompanying management practices, and use. For example some cultivars of bananas, millets, sorghums are retained in production due to cultural practices and ceremonies that make use of them. Meanwhile some landraces (e.g coffee, cassava, sweet potatoes, etc.) are being replaced in production due to their susceptibility to pests and diseases.

1.5 Surveying and inventorying PGRFA

Makerere University Institute of Environment and Natural Resources (MUIENR) maintains a database on vegetation in Uganda which could serve as a complementary to PGRFA surveys. The Botany department of Makerere University and the National Agricultural Research Laboratories maintain the country's central herbaria which have been very useful in planning of collection missions and surveys. In the past decade the Ministry of agriculture and agricultural research gave less emphasis to the minor food crops and as such production records on them are scarce and no inventory. The National Plant Genetic Resources Programme which was established in 1999 has undertaken surveys aimed at determining crops grown in the areas; assessing genetic diversity status of landraces; determining the diversity existing farming systems; and assessing the threats to crop genetic diversity. The on-farm surveying alongside crop germplasm collection have revealed more cultivated species diversity than recorded ever before. Generally data and information are collected through informal interviews and discussions with individual farmers at the household level, farmer groups, local agriculture extension workers at the district, county, sub-county and village level.

The collected information is managed using the Sesto Genebank Documentation System.

Several academic studies on genetic resources variation and utilization have been undertaken on indigenous species utilization in Busoga region, diversity in bananas, variation within wild coffees of Uganda, among others.

1.6 Promoting *in situ* conservation of wild crop relatives and wild plants for food production

By maintaining viable populations of threatened species like Shear butter trees (*Vitellaria paradoxa* subsp *nilotica*) rural communities have been sensitized by emphasizing the income generation aspects. In communities where land ownership is communal, participatory planning of the *in situ* conservation is crucial since decisions taken incorporate cultural values as well as people's livelihood. In areas designated as national parks or reserves, the communities' involvement in collaborative management of such areas enhances a sense of joint ownership thereby instilling a responsibility of sustainable harvesting. Such measures can only be achieved when the stakeholders are sensitized and act as members of a cohesive team. The wild crop relative and edible wild plants are components of the country's natural resources and policies related to their management are set by Ministry of Natural Resources and Environment. However, presently there is need to develop the relevant policies since those in place are vague on PGRFA.

1.7 Sustaining existing *ex situ* collections

Under Sida contribution, and the commencement of East African Plant Genetic Resources Network (EAPGREN), activities in Uganda boosted *ex situ* conservation efforts. Consequently Long term and Short term seed storage facilities have been established at National PGR Centre. Prior to that, *ex situ* samples and crop related diversity was being maintained by individual plant breeders at research institutes under ambient condition with consistent loss of some of the samples annually. Presently the collection of genetic resources for some of species has covered most of the agro-ecological zones, districts, major farming systems and major ethnic groups. However, the coverage of the different zones is not uniform.

Workshops have been held for participatory planning with stakeholders on PGR conservation strategies, with aim of having germplasm sample duplicates in-country in addition to those at the central genebank. Attempts are under way to initiate community based genebanks in different ecological zones, which hopefully will play a big role in sustaining local landraces and minor crops collections.

The germplasm conserved *ex situ* includes those of most traditional crops including sorghum, maize, finger millet, pearl millet, cowpea, beans, groundnuts, sweet potato and cassava.

Farmers generally use several seed storage methods. These methods, however, only meet short-term requirements of preserving seed from harvest to the next planting season. Studies aimed at adjusting the indigenous seed storage techniques are being done by the post harvest programme of NARO.

Some herb collections are held by private organizations such as the Homeopathy and Herbal Centre, Mudduawulira African Medicine, Uganda Commercial Aloe Vera Farmers Association, Tropical Aloe-Lands Foundation and Uganda traditional herbal medicine practitioners. Though these organizations set their priorities and activities independently, the Natural Chemotherapeutic Research Laboratories collaborates with these institutions and is in the process of collecting characterisation data on the chemical composition of individual herbs and indirectly establish a data base that could

serve as an inventory of the herbal collections held. However, there is still need for training the curators of these herbal collections in germplasm maintenance techniques *ex situ*.

1.8 Regenerating threatened *ex situ* accessions

The National PGR Centre has the responsibility to ensure timely viability monitoring and sourcing for suitable regeneration environment/locations for regeneration of accessions.

The same centre ensures that appropriate sampling strategies are applied and adequate population size used in regeneration to maintain genetic integrity. Procedures are in place to ensure proper handling of regenerated material at the National Genebank.

Some *ex situ* accessions are held in field genebanks and botanic gardens. Those in need of regeneration are often over grown or deteriorated due to environmental stress (e.g. pests, diseases, etc.). Such accessions are regenerated using established vegetative propagation techniques or by use of tissue culture utilizing disease free meristems. Plant nursery facilities to undertake the regeneration are in place at National Tree Seed Centre, National Forestry Research Institute, Entebbe Botanic Gardens; while tissue culture facilities at the National Biotechnology Centre can be utilized to regenerate accessions that have deteriorated due to disease.

1.9 Promoting sustainable agriculture through diversification of crop production and broader diversity in crops

Several farming systems have evolved in the different agro-ecological zones, influenced mainly by ethnic groupings with their associated socio-economic and cultural conditions.

The traditional cropping system in northern and north-east region is mainly based on cereals such as sorghum, pearl millets, millet and maize grown separately or intercropped with cowpeas, pumpkins, groundnuts, sesame and minor crops such as Malakwang (*Hybiscus* spp). The mid-western region is gradually transforming into a commercial production area for bananas and dairy cattle. This positive development is not, however, supporting diversification and its impact on nutrition at community level has already been felt in Bushenyi, where malnutrition has increased despite higher incomes. In the south-western highlands several initiations in crop diversification have been undertaken. However, these have been mainly on exotic species, particularly fruits. Nevertheless, this is likely to contribute significantly to peoples' welfare in a region which has been characterised by traditional growing of sorghum which takes 7-8 months to mature due to altitude.

Most of agriculture production is still in the hands of small-scale traditional farmers who largely use traditional practices including use of local crop varieties. Since such farmers operate at small scale it is possible to grow diversity of crops as farming operations are manual. However, level of production tends to be low unless improved varieties with higher yield per unit area are used. Therefore, in diversification of crop production through use of broader diversity in crops there is need to initiate breeding programmes for the individual component crops. This development is likely to move faster in major crops than in the minor crops where elite breeding lines may be non-existent. Farmers may be encouraged to maintain their selections within minor crops but also cooperate (by providing germplasm and participate in evaluations) with breeders in systematic improvement of these crops. This takes into account that the farmers and the local communities have over the years contributed to the development and maintenance of a rich crop genetic diversity on which they have depended for their livelihood in general and food security in particular.

1.10 Promoting development and commercialisation of underutilised crops and species

The list of underutilized food plants encountered in the surveys in Eastern, Northern and West Nile region of Uganda is long, but a selected few which had already penetrated the urban and roadside markets and for which there is limited information on the variation and productivity included the following: Maleha (*Arundinaria alpine*), Vidolodolo (*Colocasia* sp/ *Xanthosoma* sp), Sungu (*Vondzeia subterranea*), Olujo/ Okwer (*Cucumis figarei*), Otigo (*Corchorus tridens*), Alajo/Alayo (*Crotararia ochroleuca*), Amola (*Hyptis spicigera*), Wotawa/ Olawa (*Phaseolus lunatus*) The expanded production of these species faces threat of low seed availability and lack of agronomic recommendations. For those harvested from the wild

the genetic resources need to be salvaged prior to loss of their habitat due to vegetation clearance. In a bid to promote such crop species, there is need to obtain funding so that basic agronomic trials and variety studies can be undertaken so as to come up with agronomic recommendations. These recommendations will assist farmers manage higher acreages of such crops than they are used to and produce quality harvests for marketing.

The emerging private sector has taken advantage of the knowledge of plants traditionally utilized for medicine or cosmetics and they are exploiting these resources through destructive harvesting. The PGR Centre is initiating activities to link up with the private sector to work out appropriate utilization ways.

Through holding stakeholders workshops the government ministries, NARO, Bioversity International and other independent organizations (NGOs) have made efforts towards creating fora which allows the various stakeholders' contributions to be taken into consideration in decision making for agricultural production. NGOs operating in rural areas can play a big role in promoting a minor crop to commercial status. For example CONVOL, an American NGO promoted Shear butter (*Vitellaria paradoxa* subsp *nilotica*) to commercial level in Northern, north-east and north-west districts (Lira, Gulu, Katakwi, Arua, etc.) especially empowering women processors and fruit gatherers. However, the boost was short lived as activities dwindled when financial assistance from donor subsided. The lesson learnt here is that whatever commercialization is initiated there is need to ensure that there is inbuilt capacity to financially sustain the enterprise.

1.11 Developing markets for local varieties and "diversity rich" products

Some of these crops (e.g *Arundinaria alpine*, *Colocasia* sp/ *Xanthosoma* sp, *Cucumis figarei*, *Corchorus tridens*, *Crotararia ochroleuca*, *Hyptis spicigera*) have niche markets which can be encouraged and in doing so provide a source of income especially for the vulnerable groups like women and youth. However, their market chain is poorly developed. The undervaluing of local crop varieties, especially those of indigenous crops, used by rural communities has partly contributed to the loss in diversity in such crops as well as genetic erosion yet urban consumers are still willing to pay for these products of biodiversity.

Better commercialization of products derived from local crop varieties products such as oil from Shear butter (*Vitellaria paradoxa* subsp) has promoted income generation for the rural poor and increased value and appreciation of this tree which was otherwise threatened in areas of its distribution. However, consistence in this promotion effort is essential as farmer communities have limitation in marketing large quantities destined to far off markets.

The increased degree of entrepreneurship has had an impact on utilization of some crops. For example some rare varieties and excess produce of banana crop are converted into bottled juice and wine, products that have a longer shelf life and ensuring spread of use countrywide; while at the same generating income to both processors and farmers.

Vegetable producers have embraced marketing of the products in dry form (e.g. *Solanum anguivii* fruits, *Colocasia* leaves, spp leaves, etc.) and this extends the shelf life of such vegetables and possibly stablising the pricing.

1.12 Supporting seed production and distribution

Seed production and distribution of PGRFA are generally handled in the informal sector whereby individual farm households carry out most of the seed processing functions on their own with little or no specialization. i.e they handle all species common on the farm. Normally, the high costs of seed production and distribution have to be met by effective demand but demand for rare species has been relatively low. About 60-70% of seed used by smallholders is saved on-farm, and the remaining 20-30% is borrowed or purchased locally. In 2006 the National PGRC started organizing farming communities in formation of community based genebanks, though this process is still at its formative stage in one district. In 2005 two exploratory seed fairs were run in western region and small seed amounts of varieties of farmers' choice were distributed. However, for this system to contribute effectively there is need to produce such desired varieties under a larger scale and this is dependant on funds secured. Victoria Seed Company is presently undertaking this type of work though at limited species level. The question still remains whether the seed produced under this commercial enterprise would be cost friendly to the intended users.

As regards indigenous fruit trees the National Tree Seed Centre under its Commercial Tree Nursery currently undertakes seed production and its distribution on request or to supply to schools to popularise tree planting as a means of environment improvement and conservation of rare species through use. Species priorities setting has taken into account species' ecogeographic distribution and threat to genetic erosion.

1.13 Developing monitoring and early warning systems for loss of PGRFA

Poverty has led to use of scarce resources for income generation e.g. charcoal burning in case of precious trees such as Shear butter and *Acacia* spp. Presently there are too many independent rural based organizations undertaking activities related to PGRFA with limited formal monitoring. There is still need to lay down strategies with participation of stakeholders. Several projects involving stakeholders leading to developing policy advice and options for PGR have been undertaken. These include UNEP/GEF project on Use of diversity to control Pests and Disease, Community based Management of PGR in semi-arid areas, East African Biodiversity Project among others. The most significant has been the project undertaken specifically to come up with a national policy on PGRFA. The details on practical implementation of the monitoring system are still being developed but are outlined in this draft policy on which is yet to be passed by cabinet.

In addition Uganda has set up a Ministry of Disaster Preparedness, which in collaboration with Ministry of Agriculture, Animal Industry and Fisheries, as well as local district administration can monitor and address issues of loss of PGRFA. The modalities of operation of such a system are yet to be worked out.

The Ministry of Agriculture, Animal Industry and Fisheries established the Early Warning Unit which is in charge of policy and legislative development, prevention of agricultural related hazards and hazard mapping. In addition the Agricultural Sector Program Support (ASPS) has the goal of setting up famine early warning system network. The PGRFA are central in this type of work.

CHAPTER 2

THE STATE OF *IN SITU* CONSERVATION

2.1 *In situ* management

The concept of *in situ* conservation has been embraced by many countries including Uganda. The terms *in situ* conservation may refer to safeguarding biodiversity in areas that include the most representative or unique ecosystems. *In situ* areas normally include endemic, rare, endangered and wild relatives of domesticated species. The benefit to *in situ* conservation is that it maintains recovering populations in the surrounding where they have developed their unique and distinctive properties. The need to develop work on *in situ* conservation of PGR is emphasized in the Convention on Biological Diversity (CBD) and in Agenda 21.8.

During the preparatory processes of the second report on the state of the world's plant genetic resources for food and agriculture, key priority activities were indicated *in situ* conservation, these included:

- Plant genetic resources inventories and surveys
- Conservation of wild Plant Genetic Resources for Food and Agriculture (PGRFA) in protected areas
- Ecosystem management for conservation of Plant Genetic Resources for Food and Agriculture (PGRFA) and crop-associated biodiversity outside protected areas
- On-farm management and improvement of Plant Genetic Resources for Food and Agriculture (PGRFA)

2.2 Plant genetic resources inventories and surveys

Uganda as a developing country has realized the need for inventories and surveys and some of the key actions taken to improve inventories and surveys were to establish priority activity areas, support on-farm management and improve PGRFA, assist farmers in disaster situations and restore agricultural systems and community based research. The surveys and inventories do not only stop on crops and food but they also cut across plants used by indigenous communities for their different cultural purposes, medicinal values, fruit species, nut species, timber and non timber products to mention but a few. However, inventories and surveys in Uganda have faced certain constraints. Despite these constraints, there have been diagnostic and baseline surveys on crops like; cotton, beans, groundnuts, cassava, millet, sorghum and sunflower in different locations like Karamoja, West Nile, Acholi, Kisoro, Ngetta, Apac, Kuju, Kumi, Bukhalu, Nakabango and Mukono.

2.2.1 Inventories and surveys

A siginificant amount of inventories and surveys have been undertaken in different parts of the country targeting different PGR. This has included both farmlands and forest reserves. Some of the forest reserves surveyed included; Bukaleba, Kasyoha-Kitomi, South Busoga forest reserves, Magezigomu communal forest reserve, Bwindi, Mbulamizi and Kanongalo forest reserves.

Bukaleba Central Forest Reserve (CFR) is a forest reserve which is being depleted at a very high rate and yet it has exhibited high populations for indigenous fruit species like *Garcinia buchananii*. *Garcinia buchananii* has been identified as one of the most important local fruit tree and is also said to be medicinal. The species is being destroyed because of the harvesting process which is through debarking and collecting roots.

An inventory and survey of useful trees and shrubs of Uganda revealed a total of 326 plant species. Some of these plants are recorded in Appendix 1. In this survey, they mainly tackled issues of conservation and management of PGR with a biodiversity point of view. The survey also encouraged the promotion of importance and knowledge on all trees and shrubs in Uganda.

Another inventory of wild food plants and mushrooms in Uganda was carried out and a total of 297 species were documented. Some of the species are documented in Appendix 1. This inventory greatly encouraged the general public,

organizations and institutions to conserve indigenous species because of the knowledge they had acquired from the survey. Over 200 of these species and some edible mushrooms were documented with botanical descriptions.

A survey of locally used plants in Bulamogi County in Eastern Uganda revealed a total of 205 plants species. The diversity included those used as human herbal medicine, human edible plants, fuel wood, cattle fodder and cattle herbal medicine. It was noted that 77.3% of the plants were found in the wild and only 16.4% were cultivated in fields, fallow land and home gardens.

A survey of East African highland banana landrace proportions on-farm which also emphasized *in situ* conservation and focused on the farmer's perception and indigenous knowledge (IK) in conservation of the banana was undertaken in Uganda and Kagera region off Tanzania. Other surveys on banana conservation and utilization in Lwengo sub-county, Masaka district and PLEC experiences in Mwizi sub-county, Mbarara district were used for purposes of identifying best practice for conservation of crop landraces under semi-arid conditions. Data from individual household surveys revealed 66 banana cultivars with 21 associated practices contributing by variable proportions to either conservation or improved production but with some combination practices specific for individual cultivars.

A survey was carried out on *Artemisia afra* , an indigenous species in the Mt. Elgon ranges and germplasm collected to for studies on artemisnin content and other attributes.

Ecogeographic and Market surveys were carried out on, *Carissa edulis, Mondia whytei, Physalis* spp , *Syzigium cordatum* and *Dovyalis macrocalyx* in Rukungiri, Mbarara, Bushenyi, Masaka, Iganga, Mubende, Busia, Bugiri, Kamuli, Mpigi, Wakiso, Nakaseke, Luwero, Nakasongola, Kasese, Rakai, Moyo, Arua, Ntungamo, Bugiri, Busia and Mayuge districts. Distribution and size-class structure of *Garcinia buchananii* in Bukaleba Central Forest Reserve was extensively studied. Baseline survey on neglected and underutilized crop species (NUCS) was undertaken in the aspects of Marketing; Conservation, institutional frameworks, research and development activities, constraints and priorities in West Nile, Sironko and Mbale.

2.3 Conservation of wild PGRFA in protected areas

Uganda's system of protected areas extends to nearly 15% of the country's land which is about 200 000km^2 and covers most of the ecosystems. Uganda's protected areas may be natural ecosystems or semi natural ecosystems and these protected areas have extremely high levels of biodiversity . They are in form of forest reserves, national parks, wildlife reserves, biosphere reserve like Queen Elizabeth National Park, and Sites of Special Scientific Interests like Ramsar site in Uganda. The loss of biodiversity in protected areas has tremendously decreased, however, it was noted that outside protected areas, biodiversity loss was still continuing as of 2005. This is not exclusive of PGRFA. This implies that the protected areas play a large role in the effectiveness of managing and conserving PGRFA.

2.3.1 State of *in situ* conservation in forest and reserves

National Forestry Authority (NFA) is a government body in charge of forest reserves. They have since reported on the state of conservation in forest reserves around the country. The presidential and parliamentary elections (2006) escalated illegal activities in protected areas. A case in point was the forest reserves where unruly mobs attacked NFA staff who tried to stop lawlessness in CFR like Kibale District and South Busoga FR. After elections, the new Government was formed; the Ministry of Water, Lands and Environment was split into two with the Ministry of Water and Environment and Ministry of Lands, Housing and Urban Development. The Ministry of Lands, Housing and Urban Development was put under another Ministry. After these new changes, an oil palm growing company in Kalangala District renewed their bid for central forest reserves on Bugala Island and the bid was granted. In 2007, a sugar producing company neighboring Mabira Forest Reserve also put in their bid for part of Mabira. The general public caused an up roar but later they resumed their bid for 7 100 ha of Mabira CFR. This calls for attention because the protected areas have many PGR that should not only be conserved but also are important for the livelihood of the people. Other stakeholders (private sector) should be involved in the conservation of PGR. This can be done through meetings, the media and other public relations events.

2.4 Ecosystem management for conservation of PGRFA and crop-associated biodiversity outside protected areas

In Uganda, there are at least 90 types of natural and semi-natural vegetation. However, natural ecosystems are continuing to become smaller due to many reasons. Conservation and management of ecosystems involves species, the community around and crop-associated biodiversity. These ecosystems serve as a reservoir to many of plant species. These include wild relatives of crops critical for crop improvement as well as wild species not yet domesticated but utilized by people for diverse purposes. A mechanism should be put in place so that PGRFA is not lost. Plant genetic resources in Uganda range from crops, food, indigenous wild fruits, nuts, vegetables, pastures, medicines, indigenous staples and introduced crops. These are distributed across diverse ecological zones in Uganda. Crop associated biodiversity benefits the ecosystems by providing nutrient cycling, pest and disease regulation, pollination, and other wider ecological services. This is because of the complex relationships that exist among systems and species in an ecosystem which is usually the natural setting. Crop associated biodiversity plays an important role in the *in situ* conservation of plant genetic resources, while proper management can contribute to the sustainable utilization of plant genetic resources.

2.4.1 PGRC and ecosystem management

The list of medicinal plants and their various uses seem to be endless. However some plants are being over exploited i.e. the bark of the "red flame tree" (*Spathodea campanulata*) which is being exploited because of its medicinal purposes to increase fertility in women, *Prunus africana* for the production of a drug that cures prostrate cancer, *Syzigium cordatum* that is being exploited by cosmetic industries because of its ability to cure skin problems, *Mondia whytei* (commonly know as 'Omulondo'), *Garcinia buchananai* e.t.c. Proper management and conservation of PGRFA in the ecosystems may also lead to production, development and protection of both the PGRFA and community. In such cases it is also important to liaise with the private sector so that PGR are used sustainably and conserved.

Natural catastrophes such as the November 2007 floods in Teso region destroyed a lot of diversity in the ecosystem. The war in northern Uganda that has persisted for more than 20 years has caused severe loss of PGR and distorted many ecosystems in the northern region. There has however been an influx of introduced species in the area because of the loss of their indigenous PGR.

It is therefore important to promote alternative conservation methods and also enrich collections of wild species by working hand in hand and getting into the management plans of the protected areas to preserve the wild species. Plant Genetic resource centre is working towards creating community gene banks to enhance the conservation programmes (i.e. PGRC is establishing a community gene bank in Mityana).

2.5 On-farm management and improvement of PGRFA

PGRFA are grown on-farm lands and can be found scattered around the farm. This type of practice involves management and protection of various categories of PGRFA and selected or endangered species on-farm land. On-farm conservation, especially of food crops, is a major contributor to conservation of plant genetic resources. Farmers are stakeholders in this aspect and are custodians of associated indigenous knowledge that need be documented and best practices up-scaled. To a fairly large extent, on-farm management has been addressed.

2.5.1 Documented on-farm activities

A study on banana cultivar diversity and associated conservation practices was undertaken in Lwengo sub-county, Masaka District. A total of 66 cultivars were recorded as grown in the sub-county and the analysis revealed that a total of 19 of these were rare cultivars.

Seed companies have played a pivotal role in marketing the new varieties and ensuring availability of seed, while NGO's have helped in establishing on-farm trials in collaboration with NARO. On-farm trials involve farmers/consumers in technology/variety selection and hence incorporate their selection criteria in breeding work and help identify varieties that are acceptable for farmers and consumers for release.

On-farm evaluation of cassava mosaic disease-resistant varieties has been undertaken. A number of banana on-station and on-farm evaluation experiments have also been conducted and five new banana genotypes have been released. Six high yielding matooke cooking cultivars and four exotic cultivars (FHIA17, FHIA25, FHIA23, and Km5) had been selected

by farmers by 2004. This has been spearheaded by NARO and its partners.

On-farm and multi-location activities have integrated the use of the parasitoid *Heterospilus coffeicola* in the ecologically based pest management programmes for the coffee berry borer in the districts of Rukungiri, Wakiso, Masaka, Mbale, Tororo, Busia, Luwero, Kumi, Soroti, Mpigi and Bushenyi. Agronomic packages to accompany the release of the lowland arabica varieties are also being developed.

Also, some IPM strategies have been adopted by farmers in Pallisa (Kibale Opwateta) Kumi (Kachede) Kaberamaido (Acanpii) like the use of neem and Tephrosia extracts for the control of pests on cowpea. These management practices are unique in that they resulted in reduced application of insecticides to control pests on cowpeas (from 8 to 3 sprays) and introduction of alternative pesticides (Neem and *Tephrosia* extracts) as well as the practice of pest scouting and monitoring.

A number of national and regional forums for stakeholders have been involved in on-farm conservation. These include; Kasana Twegatte farmer group, Twekembe farmer group, Kyosimba Onaanya farmer group, Agaliawamu farmers group, Nyanja Tukolabukozi famers group, Nakaseke district, Fight farmers association, Mbirizi farmer's group, Mwizi farmer's group, Soroti District Farmers Association, Tuyiye Agricultural Farmers Initiative, Katakwi Farmers Association and Nuvita Farmers' Pride . This has enhanced proper planning and community based management of PGR, as well as studies on soil nutrient depletion and weed invasion in upland and paddy rice production systems in Semuto sub-county.

In situ conservation activities at the PGRC concentrated on identifying farmer groups and communities that are organized with the aim of fostering genetic diversity on-farm. Fifteen farmers associations were identified in Kakindu sub-county in Mityana District. Arrangements are underway to work with these communities to further on-farm conservation through establishment of community gene bank, seed fairs and exchange visits. Other farmers' groups were identified in Kabale district for possible training in PGR management.

CHAPTER 3

THE STATE OF *EX SITU* MANAGEMENT

3.1 Institutional organization

The Plant Genetic Resources Programme established in 1999 and located at Entebbe Botanic Gardens was in 2007 transformed into the Plant Genetic Resources Centre (PGRC) in 2007. The PGRC is one of the centres and units under the National Agriculture Research Laboratories (NARL). The PGR Centre comprises the National Genebank and Entebbe Botanic Gardens. The NARL is one of the institutes under the National Agricultural Research Organisation (NARO). NARO's mandate is to undertake, promote and streamline research in agriculture, livestock, fisheries and forestry, and to ensure the dissemination and application of research results. The location of the PGRC in the NARO setup provides opportunity for it to be easily accessible by the National Agricultural Research Systems (NARS). NARO is the R & D arm of the Ministry of Agriculture, Animal Industry and Fisheries. The PGRC responsibilities include:

- Securing genetic diversity
- Undertaking Botanic Gardens activities
- Agricultural research on PGR related issues
- Dissemination of agricultural technologies
- Sensitisation of the population on plant diversity conservation
- Promote utilisation
- Providing advice on PGR policy development

Some of these have to some extent been achieved over the last few years through exposing conservation initiatives, and a number of news reports, videos and other public awareness materials have been successfully produced and disseminated. Many different kinds of public awareness activities have been undertaken including personal contacts, group exchanges and demonstrations, diversity fairs, school poetry, song and drama events, competitions, distribution of printed materials, and production of audio-visual aids. Many local groups have prepared extremely interesting public awareness materials especially at the annual agricultural shows. In liaison with TV media viewers have been exposed to issues on value of the neglected and underutilized crops and their relationship to good management of the natural vegetation and factors leading to environmental degradation. Some local councils have taken on the initiative to revise or develop bylaws that directly or indirectly conserve the plants habitats or assist in preserving PGRFA on-farm.

On-farm surveys undertaken revealed a number of Indigenous management practices but modifications for some of them was considered necessary to ensure seed viability sustenance at farm level.

To achieve a collaborative PGR management framework, national workshops have been held with the partner institutes so as to formalize partnerships with other national and international institutions, with assistance from Bioversity-SSA. Such workshops have helped in providing a forum to establish the purpose of the PGR conservation and utilization agenda as well as each partner's responsibilities and commitments.

3.2 The state of collections

Plant breeders at the Research institutes and the University maintain working collections of various crops in variable numbers. Assessment of the physical state of these collections was undertaken in 2002 – 2003 at five research institutes under the NARO, the Tree Seed Centre and the Makerere University Genebank. The germplasm was mainly kept in paper bags at ambient temperature and was therefore vulnerable. Though over 60% of the overall collections were in good physical state, the rest of the germplasm was in deteriorated state, especially those that had been neglected due to loss or transfer of a breeder or technician in charge. Those in good state (e.g groundnuts, cowpeas, maize, beans, etc) were regenerated after every two seasons and this was labour intensive, often subjecting the collection to variable human errors, not to mention genetic erosion and loss of integrity.

The cold storage facilities that were previously operational at Makerere University Genebank Kabanyolo and Serere Agricultural and Animal Research Institute (SAARI) had broken down by 2001. However, with assistance to EAPGREN from Sida cold storage facilities were installed at the National genebank at Entebbe. Phased transfer of germplasm from research institutes and other stakeholders is under way.

Many of the collections have limited passport data attached and this information was not computerized. The PGR Centre has compiled this information and made sure that all recent and ongoing collections have the standardized passport data forms filled at time of collection.

Less than 15% of the collections are characterized, though not fully. The characterization is mainly from evaluation of the germplasm for specific biotic constraints of special interest in individual breeding programmes. The limited characterisation limits use of these accessions.

Basically germplasm collection, characterisation, conservation as well as basic botanic studies undertaken are documented. The documentation of the collections at institutions is mostly manual and not standardized and the availability of these collections for distribution is not streamlined. The PGR Centre has developed data capture forms as a step toward organized documentation and in addition utilizes the SESTO Genebank data management tool.

There are collections of vegetatively propagated crops (e.g. bananas, sweet potatoes, cassava, yams, etc.) maintained as live plants in selected locations at research institutes. The problems experienced in holding such collections include infections with virus, and other diseases, pest problems and effects of weather change, especially droughts. The capacity for keeping collections *in vitro* is very limited and only a few accessions of cassava and sweet potatoes are maintained.

3.3 Collecting

There have been mainly externally organized collections especially by international centres like CIAT, IITA, ICRISAT, AVRDC in collaboration with national programmes on targeted crops and germplasm of pigeon peas, bananas, yams, beans, local vegetables, etc. collected. There is no outlined criteria followed for all crops and as such decision to collect is individually arrived at by the specific crop programmes involved. Collection teams are multi-disciplinary though taxonomists are scarce and introduce a constraint.

In composition of collecting mission teams the PGR centre and research staff work in collaboration with scientists from universities and local community knowledgeable individuals are co-opted to collection in regions covered.

The PGR Centre has focused on the collection of indigenous fruits, vegetables, cereals and legumes. A GIS section was set up at Kawanda Research Laboratories Institute to assist in provision of guidance in germplasm collection. There are detailed maps available which can be used in planning collection routes and GPS are in use to provide location specific information needed in passport data. Problems are experienced in getting sufficient logistics (e.g vehicles and funds).

3.4 Types of collections (major and minor crops)

Vegetative field genebanks include those of coffee at Kituza, cassava, yams and sweet potatoes at Namulonge and Serere, bananas at Mbarara.

All crop research institutes where there are breeding programmes hold seed collection of their mandate crops, mainly food crops. Some of the minor fruit trees harvested from the wild have representative seed samples held at the Tree Seed Centre, while the national genebank hold relocated bean germplasm in addition to new collections of variable vegetables.

The *in vitro* collections of cassava and sweet potatoes are held at Namulonge. Recently the *in vitro* capacity has been improved with the establishment of the Biotechnology Centre.

Collection of rare and threatened species include *Syzgium guineese, Rhus vulgaris, Saba comorensis, Landolphia dawei, Parinari curatellifollia, Carissa edulis, Garcinia buchananii* among others have been planted in fruit block of Entebbe Botanic Gardens.

3.5 Storage facilities

The storage facilities at the PGR Centre caters for both long term and medium term conservation at -20^{0}C and -5^{0}C C respectively. The seeds at , 4-7% mc are packaged in aluminium foil bags, sealed air tight before putting them into storage freezers. Freezers used ran by power from mains (problem with intermittent supply). Most of the germplasm that was being kept at institutes has been secured at the PGR Centre.

Ex situ collections are held in variable containers and under variable temperature and relative humidity levels at institutes. Required storage facilities include: Freezers, dehumidifires, packaging materials (Aluminium foil bags, water tight glass bottles or jars), drying agents e.g Silica gel. The unstable power supply adversely affects the effectiveness of use of cold storage. Trying to avoid the erratic power problem, the national bean programme made use of drying seed to low moisture content (6-7% mc) and packaging it in air tight sealed glass bottles. The stored seed retained viability at above 85% five years later. However, this has not been emulated on other crop seeds.

3.6 Security of stored material

Apart from the accessions that have been collected in collaborative missions with collectors from abroad who go back with samples, the rest of the germplasm collections are held by the collaborating institute that collected it and usually not duplicated in country. The security offered by duplication has not been entrenched in the system. However, with increased activity of the national genebank intends to keep duplicates of all collections held at research institutes. The PGR Centre will also be sending duplicate germplasm to Svalbad in Norway.

3.7 Documentation and characterization

Documentation across crop based programmes is inconsistent but this information has been retrieved from research institutes and is in process of being incorporated in the Sesto Genebank Documentation System.

Characterisation data that is documented is biased toward specific traits of interest to the breeding programme of each specific crop. This implies that the characterization available is of limited use as informed choices can only be made only for such traits and not in regard to other traits that stakeholders may be interested in. Location where the characterization work is done are in many cases done at convenience as some ideal eco-locations may be inaccessible at desired times due to limited logistics. Where data on specific traits is undertaken at inappropriate locations the efficiency and compliance of data collected may sometimes be relatively low.

3.8 Germplasm movement

There has been no well organized system for germplasm movement into and outside the country, particularly for PGRFA. For non-PGRFA, however, access regulations under the National Environment Act are followed. With the entry into force of the International Treaty, the PGR Centre has a task to inform stakeholders on what is expected and tend in organizing germplasm movement. Stakeholders still require sensitization on use of SMTA and its operationalisation.

All germplasm samples imported or exported from Uganda strictly have to be accompanied by Phytosanitary Certificates so as to safeguard the country's agriculture and PGRFA. The Quarantine facilities are located at entry points for policing incoming germplasm and referring it to quarantine station at Kawanda for investigation where need be. Germplasm sent as *in vitro* material is usually disease free and need not be quarantined but the capacity to handle such germplasm is limited. However, there is still need to step up sensitization of the public on values of quarantine. The requests for germplasm have no centralized reception point and the requests are handled on individual basis. Policy guidelines have been devised and their enforcement would make it possible to keep track of the germplasm movement.

3.9 Roles of botanical gardens

Entebbe Botanic Gardens holds Plant collection of indigenous fruits, wild relatives of crops, tropical forest spp., medicinal plants, ornamentals and improved crop varieties; representing over 100 genera and over 500 species. It serves as a recreation and educational centre for families, clubs, institutions and school children whereby the people are introduced to values of plant diversity through direct interaction and guided tours. The Nursery section provides planting material of any selected plant spp, and visitors can place orders of planting material seen in the gardens and in addition seedlings of threatened indigenous species (e.g. *Garcinia buchananii, Prunus africana, Carrisa edulis*, etc.) are also provided at subsidized prices with aim of promoting restocking of areas where they were originally distributed. Therefore Entebbe Botanic Gardens mission is to "promote the knowledge and appreciation of plants and their products as well as providing services through scientific research, education and recreation".

Other botanic gardens, especially in city suburbs (e.g. at Bugolobi, Kitintale, etc) and rural based ones (e.g. at Busukuma) are for recreation purposes only. Yet other, especially at Makerere University, are for teaching purposes. Toro Botanic Gardens has a collection of spices, Prunus africana, exotic vegetables, etc. More collaboration is required in order to provide linkage of these gardens and promotion of conservation related activities.

3.10 An assessment of major *ex situ* needs

On examining the present state of *ex situ* collection in both seed and field genebanks, the following needs are noted:

There is need to update inventories on PGRFA so that these resources can be prioritized in order to set up systematic exploration and collection. Presently species of interest are picked at random whenever interest in them is aroused and collection missions are not centrally coordinated. A good database inclusive of species diversity, spatial distribution and taxonomic information will help in targeting collection sites more efficiently in addition to maximizing scarce resources available. Comprehensive ecogeographic surveys are absolutely essential whereby personnel of different but relevant disciplines are represented.

Presently different stakeholders plan and conduct collection missions independently which sometimes lead to duplication of effort and resources. Besides the seed collections made may in some cases be exposed to improper storage which results in loss of some samples that have deteriorated seed. It would be advisable for the stakeholders to include persons conversant with genetic resources guidelines on handling collections in the field. Such persons should also contribute to the planning of missions, even those conducted at closed community level.

Development of orthodox seed conservation facilities is of paramount importance. The centralized cold storage for long term base collection and short term collection still require a better equipped laboratory. Appropriate facilities and processes that ensure seed longevity should also be adhered to by stakeholders that maintain working collections.

Many tropical fruit bearing species have recalcitrant seeds for which it is necessary to develop *in vitro* conservation and cryopreservation capacity. Besides vegetative propagation tends to preserve the genotypes intact and is therefore advantageous especially where the sexual phase (seed) is subject to recombinations. With much variation in vegetative material having arisen from beneficial mutations (e.g in banana, sweet potato, etc), developing *in vitro* and cryopreservation is essential.

Despite environmental risks associated with crops in the field, setting up field genebanks and botanical gardens in specific locations is essential. These can be used as educational, awareness and sensitization tools as well as conservation of the species in environments they are adapted to.

All neglected and under-utilised species for which baseline data has been compiled have to be represented in the *ex situ* collections. Effort has to be made to include as many descriptor states as possible; especially those obtained from farmers in case no formal descriptors are in place and this would facilitate their characterisation.

A well equipped laboratory should be in place to facilitate a functional monitoring system for ensuring the viability of germplasm and seed processing for storage.

The staffing of the genebank is presently very scanty so effort has to be put on developing adequate human resources with appropriate training.

Collecting all PGRFA for conservation in genebanks is an expensive and uphill task. Alternative approaches such as creation of community conservation areas that are rich in PGFRA could be incorporated. In such areas more species variation would be conserved in their natural habitat with assurance that the sensitized communities will be collaborators in ensuring safety of the germplasm. Such areas could be accorded special conservation status as Protected Areas rich in PGRFA.

Encourage and support on-farm management and improvement as it is evident that most of the variation in landraces collected was developed from farmers' selections on-farm. However, the various management practices and equipment used in germplasm management on-farm require additional scientific input to make them more efficient.

Farming communities should be made to participate in modifying their seed production and conservation practices so that they are able to raise good quality seed that can be maintained in community genebanks that are closer to them and contain samples unique for that community.

One critical challenge in handling little known indigenous species is the limited knowledge in seed behaviour and physiology. This curtails the rate at which the species can be collected and conserved or regenerated outside their natural environment.

CHAPTER 4

THE STATE OF USE

4.1 Expanding the characterization, evaluation and number of core collections to facilitate use

Presently there are no core collections as the PGR accessions held have not been evaluated extensively so as to decide on the composition of core collections. Much of the material needed in breeding crop plants is drawn from germplasm received from international research centres where the core collections for individual species are held. More funding is required to facilitate characterization and evaluations of accessions held, especially those of minor crops and indigenous PGRFA which so far don't have core collections elsewhere.

4.2 Increasing genetic enhancement and base-broadening efforts

The Plant Genetic Resource Centre spearheads germplasm collection in liaison with breeding programmes and needs expressed by plant based industries. Using the database developed on distribution of *ex situ* germplasm held by different institutions, the PGR centre can assist in locating germplasm that would be useful in the enhancement process.

The work at the National biotechnology laboratories at Kawanda includes the following:

- Genetic engineering of banana varieties with resistance to pests and diseases, improved architecture and increased nutritive value.
- Development of transgenic crop varieties resistant to biotic and abiotic stresses, improved nutritive value, food safety and market quality traits.
- Development of disease free *in vitro* planting material and other novel biotechnology products of industrial and pharmaceutical value.
- Functional genomic studies for gene and molecular marker discovery of economically important traits, disease diagnostics and indexing

The above work is mainly long term intentions with little physical entities in place yet. The pressure for release of new varieties to meet erratic stress factors in the production environment (e.g. coffee wilt, banana wilt) have led to search for resistance genes in local PGR. However, the introgression of such identified genes is a long term process and hence the resort to biotechnology methods. The policies and laws governing use of products of genetic engineered crop varieties are still under legislation and generally GMOs face some resistance. There is still need to step up public awareness on these issues.

There are upcoming private tissue culture enterprises which can take on multiplication of novel enhanced genotypes, though capacity for the genetic enhancement at such enterprises is not developed yet. The universities in the country are doing very limited pre-breeding work due to fund limitations. This has therefore led to the on-going breeding work failing to utilize wild crop relatives. Besides the human resources for genetic enhancement are extremely limited and where available, for example at the Biotechnology Centre, effort is directed mainly on banana.

Promotion and selections among medicinal and vegetable plants still utilizes intra-specific diversity and would benefit from selection and genetic enhancement. Such work however is hindered by lack of funds and the conflicting interest of stakeholders in the field of bio-prospecting.

4.3 Promoting agriculture through diversification and crop production and broader diversity in crops

Participatory planning and collaborative work on several PGR projects have indirectly helped in capacity building, including strengthening the capacities of farmers, indigenous and local communities, and their organizations and other stakeholders, to manage agricultural biodiversity sustainably. Awareness of value of diversified crop production is being promoted by rural based NGOs, while in the past decade Makerere University Faculty of Agriculture, NARO, among others have over the last decade organized several workshops aimed at elucidation of the benefits of broader diversity in crops.

The policy on crop zoning has not been well embraced by the farming fraternity and as such crop production has remained diverse. Though the formal seed production system caters for only major food crops the farmers' are able to reproduce the genetic resources they value. As is clear in case of local bean variety Kanyebwa the farmers who grow this highly marketable landrace can obtain better income per kilogramme and their product hits the market much earlier than modern varieties produce. Production of several landraces offers opportunity of choice to consumers and indirectly sustains crop diverse in the production system.

The local vegetables that are part of the recipes for traditional meals have increased demand in urban centres and Botany Department and Faculty of Agriculture Makerere University as well as Horticulture Research Programme of NARO have undertaken many studies and projects with farmers aimed at increased production of diverse vegetables.

For minor crops the farmers farthest from market centers tend to grow rare landraces mainly for domestic use. The evidence that farmers (for example in Mwizi) that grow more rare landraces also sell the grain locally which implies that such transactions provide an incentive for maintaining such materials in the mainstream production and markets.

Households with more active adults engaged in agriculture are also more likely to maintain diverse landraces of social value, compared to those with younger household heads/or child headed households as is the case in areas that have been affected by the AIDS scourge.

The PGR Centre, through its research component, has undertaken baseline surveys of diversity of crops on-farm in the districts of Mbale, Sironko, Arua, Nebbi, and the central region; whereby unavailability of seed of some crops emerged as a major contributing factor to abandonment of some crops. However, research work undertaken by the socio-economic section of the National Bean Programme introduced a training of small scale farmers in seed production thereby trying to build horizontal linkages between the informal and formal seed sectors. Such empowerment of the farmers is can facilitate transformation of seed production by small scale farmers dealing in PGRFA that are not covered by the formal seed sector and thereby boosting diversification in crops grown.

The National Agricultural Advisory Services (NAADS) program has a focus on 'improved varieties' in a bid to modernize agriculture in line with the Plan for Modernization of Agriculture (PMA). Native species are ignored by these efforts. However, the integration of natural resource management is becoming important in NAADS programs and this offers opportunity for addressing this anomaly.

4.4 Promoting development and commercialisation of underutilised crops and species

The promotion of *in situ* conservation, on-farm conservation inclusive, for wild crop relatives, wild plants and underutilized food crops has been taken as the basic step in promotion of underutilized species. The upcoming establishment of supermarkets, especially those in urban centres, with more stringent demands on quality of products is a positive drive for improvement of underutilized crops. Some farmers have recognized the trend and make appropriate selection for the specialized markets for a better price. As the market expands research components on breeding and agronomic aspects needs to be boosted so as to come up with recommendations to the farmers of these crops.

Some of the underutilized crops need to undergo value addition through processing so as to prolong their shelf life and expand on their distribution. Some local leafy vegetables are now available in dry powder form. While species *Aloe* spp juice is made one of the components in popular bottled fruit juices such as passion fruit.

In order to promote the underutilized crops and species, their value has to be well appreciated by the consumers. Agronomical research and biochemical analysis of the underutilized plant species positively contribute to their promotion to commercial scale. The universities and NARO established food science departments where part of their responsibility is providing chemical and nutrient value profiles for such plant species. However, there is little or hardly any funding allocated to underutilized crops research and such the required information is in most cases very scanty.

4.5 Supporting seed production and distribution

Seed companies in operation put emphasis on modern cultivars of staple food crops, while under Ministry of Agriculture development or establishment of markets for local varieties is not a national priority. Formal seed companies are demand and profit driven. In order to attract seed companies in diversified crop seed production the demand for such seed has to be high enough. The seed companies undertake seed drying, cleaning, dressing, packaging, labeling and marketing of certified seed. However, many of the minor crops don't have formally released cultivars and may not quite meet the certification demands.

Farmers have always produced their home saved seed for the minor crops, though in low quantities and with rise in production of such crops seed quantities and their distribution need to be stepped up. The following approaches have been tried:

Initiatives in schools whereby in the agriculture lessons school children have been sensitized about value of disease free seed and ways of ensuring seed cleaning for subsequent planting. The assumption is that in their involvement at farms at home such knowledge would be passed on to the adults in the farming households or the knowledge could be passed on at open days.

Since many farmers plant local varieties basically for home consumption and sale of surplus and due limited market demand for local varieties in the seed industry, farmers have to be trained in the basics of seed production. The seed they produce can then be sold to other farmers. This approach was used by CIAT as a promotion drive for popular local bean varieties and also for empowering the farmers association with income generation.

Small farmer groups, CBOs and NGOs have in the past tried to produce and package local vegetables seeds for example Buga (*Amaranthus* spp) Ntula and Nakati (*Solanum* spp), but these such seed has been characterized by low germination percentages. This implies that such groups might bridge the seed production gap if given appropriate training and guidance especially on maintenance of high seed viability during storage.

Some private companies such as Victoria Seeds Limited, Mt. Elgon Seed Company, Nalweyo Seed Company (NASECO LTD), Harvest Farm seeds Limited, FICA Seeds Limited, Suruka Agro-supplies Limited, East African Seeds Company General and Allied , Otis Gardens Seeds and Regina Seeds (Seminis E.A) have initiated production of some minor crop varieties but this is very recent and the implications are not clear yet.

Generally the private initiatives lack financial support and trained personnel but also the industrial processing capacity is low. In order to boost the production and distribution of less known indigenous crops a 'niche-variety-registration' system could be introduced to run parallel to official variety release system provided the consumer demand is in place.

4.6 Developing new markets for local varieties and "diversity rich" products

There has been increased sell of food supplements derived from plant products. Some locally based enterprises have started packaging processed plant products. For example, with assistance of Natural Chemotherapeutics Research Laboratory medicinal plants like *Zanthoxylum chalybeum, Phyranthus amarus, Zingiber officinale, Rosemarins officinale, Guajava psidium, Hibiscus acetocela*, etc. have gained market both locally and internationally.

In collaboration with Mukono Zonal Agricultural Research and Development Institute and the potato programme at Namulonge Crop Research Institute farmer groups have started processing, packaging and selling Vitamin A enriched juice of *Ipomoea batatas* as well as herbal based antifungal soap utilizing the sweet potato leaves. Again making use of indigenous knowledge on available PGR some local based enterprises have been set up producing herbal based antifungal and skin cleansing soaps. These soaps have been found effective, gaining market though there is still need to improve on the product visual appeal characteristics.

Through the government body, the Uganda Export Promotion Board (UEPB) a Bio- Trade Unit carries out the liaison between producers, collectors and traders of the country's bio-based products. A national bio-trade pre-assessment study and proposed country programme is in place which serves as a guide in the process of developing new markets for local varieties and "Diversity Rich" products. However, on-going R & D efforts by public agencies are often scientifically driven as opposed to private sector needs. Implications have been the increased importation of commercial species such as *Aloe vera*, with demonstrated research findings, while native species such as *Aloe ferox* with similar attributes are not exploited. One of the problems associated with trade in the natural products is that processing into extracts and essential oils is often at cottage industry level, operating small quantities and using rudimentary technologies. Therefore, investment in processing technologies and skills development for processing is still required, particularly on-job skills development in processing natural ingredients for cosmetic and pharmaceutical products as well as essential oils.

The increased emphasis on the value of nutrition in treatment of HIV/AIDS patients has drawn attention to local herbs amongst the country's PGR and these have been incorporated in food products or individually promoted as "Diversity Rich" products.

4.7 Distribution of PGR

There has not been a national land use policy, implying that production or distribution of PGRFA is random or dependent on survival of specific natural ecosystems or cultural norms and traditions. The land fragmentation leading to numerous small farms, sometimes occupied by variable ethnic groups has considerable implications for the crop diversity and differential impacts on cultivar diversity across crops as well.

Social class and education level of members of the community affects both inter- and intra-specific diversity. Higher utilization of a diversity of PGR is associated with rural communities that are closer to production source, and also often with lower education level. The PGR utilized by urban communities, often embracing a diverse food culture, tend to be of limited inter- and intra-specific diversity.

On the other hand very limited distribution of PGR accessions has been recorded at the National Genebank and the Makerere University Genebank at Kabanyolo. However, all foreign missions take samples of what they collect but records of its secondary distribution abroad are scanty.

4.8 Utilisation and enhancing the use of PGR

The scientists of the National Agricultural Research Organisation (NARO) are continuously working to identify local crop cultivars that have high adaptation to biotic and abiotic stress environments so that this germplasm can be used in similar stress-environments, whereby some are used in breeding or are directly distributed in areas of where their identified positive attributes are in high demand. Training of scientists in the disciplines of plant breeding, plant pathology, entomology, etc. is given high priority as their input is crucial in enhancing evaluation and use of PGR. However, utilization of available PGR is hindered by the limited systematic evaluation and documentation. The PGR centre has since 2004 undertaken work on developing a centralized user friendly information and documentation system, so that there is faster identification of accessions with desired traits for breeding purposes. The on-farm evaluations (e.g cassava, bananas, beans, etc.) have provided insight about farmers' perception of new varieties and their landraces and such information will be utilized in enhancing use of available PGR.

There is still need to keep track of the PGR utilization through a follow up on publications made and strengthening a feedback mechanism between suppliers of PGR materials and users.

In agro-forestry a number of species (e.g *Sesbania* spp, *Panicum* spp, Tropical fruits, etc.) have been directly adapted from germplasm collections. In such cases selections have been done within samples and thereafter multiplied and distributed, thus extending their use from the wild.

Participatory plant breeding (PPB) approach has been used by crop based programmes (e.g. beans) so as to let farmers select and adopt new lines that bear characteristics of their preference. Improving on-farm seed storage was also found to be important in the maintenance of traditional cultivars.

There has been development of mechanisms for cooperating with NGOs, private organisation, international aid agencies and organisations in effort to distribute suitably adapted germplasm into areas recovering from disasters. However, capacity development to deliver seed of adapted local varieties as needed to help re-establish indigenous agricultural systems in areas affected by natural disasters, war, and civil strife is still wanting. NARO and the agriculture ministry have been involved in strengthening farmers' and local communities' ability to cope with disasters by supporting the re-emergency of local seed supply networks. One of the ways in which the national gene bank intends to strengthen supplies of important local cultivars of interest to farmers would be through collaborative work with community genebanks based in different ecological zones. The operators selected from the community would be given training in appropriate seed processing techniques so as to ensure good quality seed is distributed.

Though the farmers in most agricultural zones are abandoning landraces as market infrastructure develops, a sizable proportion of farmers continue grow either landraces only (depending on the crop in question) or both landraces and modern varieties. This is probably because landraces that meet their cultural needs are not readily available at the market place and besides modern varieties tend to get higher financial returns.

At Makerere University small proportions of conserved accessions have been utilized for training purposes of agriculture students. Other undergraduate courses on plant conservation initiated by the Forestry Faculty and the Botany department have helped boost PGR awareness and research.

4.9 Challenges and constraints in use of PGR

Core collections have not been established since most crops in the collections are not indigenous and hence variation represented is limited. As for native plant species capacity to assemble large germplasm collections is lacking as well as the financial resources. Priority lies in establishing the species inventory and the variation represented.

There will be need to:

- To publicize policies, legislation related to Plant Genetic Resources.
- To develop and implement informal public education and awareness Programs
- To promote formal education on Plant Genetic Resources in educational institutions
- Train professionals in relevant fields to undertake this work

Constraints faced in use of PGR include:

- Inadequate funds for collection, conservation, benefit sharing, etc
- Low crop productivity leading to comparatively low income
- Poverty leading to use of scarce resources for income generation e.g charcoal burning of some tree or shrub species without replanting
- Environment degradation – deforestation, soil depletion & erosion when it rains, poor health conditions of the plants and hence inadequate and poor yields
- Government bodies set up need more collaboration, too many independent related activities
- Land ownership issues versus *in situ* conservation (Gov't, private)
- Unpredictable weather patterns resulting in droughts, excessive rains effects, and consequently unpredictable harvests
- Inadequate infrastructure – Laboratories & others

Future research should address the following issues and devise ways of overcoming them:

- Population & poverty influences – pressure on land & natural resources
- Increasing opportunities for off-farm employment may have a negative impact on prospects for conservation of PGRFA
- Databases fragmented – access limited, datasets incomplete
- Most *ex situ* seed stock are exotic, indigenous species poorly represented & less appreciated by youth (future generation)
- Non-sustainable harvesting affecting specific spp (medicinals)
- Incomplete plant inventories, biopiracy
- Collections represent few distribution sites & limited species range
- Characterisation lagging behind
- Species distribution maps lacking & utilisation records fragmental
- No planned activity calendar (education & awareness)
- More equipment required lacking
- Local collection not extensive or lacking
- Difficulty in acquiring germplasm from different international sources
- Library & herbarium facilities limited and in some cases lacking
- Most tropical fruits have recalcitrant seed with unclear seed behaviour requiring basic studies
- Targeting rare spp is expensive & decision on species to be addressed need more stakeholder participation
- Economical to concurrently do germplasm multiplication & characterisation
- Difficulty to collect recommended quantities in field for genebank purposes
- Limited geo-references/herbarium data
- Improved link up with on-going work by private firms, NGOs, Universities, etc
- Germplasm conserved on-farm limited in quantity, private & open to environmental hazards
- Basic research often given low priority in funding (especially where focus is on PMA)

CHAPTER 5

THE STATE OF NATIONAL PROGRAMMES, TRAINING AND LEGISLATION

5.1 National programmes

Prior to 1999, Uganda did not have any active programme on plant genetic resources for food and agriculture. The national programme on plant genetic resources called the Plant Genetic Resources Programme was established in 1999 under the Forestry Research Institute (FORI) of the National Agriculture Research Organization (NARO). Hitherto, the National Plant Genetic Resources Coordinating Committee whose establishment in 1992 marked the beginning of organized plant genetic resources activities in Uganda was the Government establishment in charge of plant genetic resources issues in the country.

Soon after its establishment, the Programme developed a five-year strategic plan (2000-2005) to guide its activities in achieving its objectives and goals. The major areas of concentration in this strategic plan were the conservation of plant genetic resources (especially plant genetic resources for food and agriculture), research, education, awareness, and increasing income from the Entebbe botanical gardens for the development and strengthening of the programme including the gardens. Over the years, despite the challenges it faces, the programme has made a number of recognizable achievements and has expanded in many respects. The Entebbe Botanical gardens have been improved on in many respects including introduction of a number of plant species from the different regions of Uganda and outside the country. Perhaps the greatest achievement of the Programme in the last 10 years is the establishment of the National Gene Bank at Entebbe. The bank is expected to play a great role in securing Uganda's diverse plant genetic resources for food and agriculture. It will also play a big role in facilitating access to the stored germplasm as the information on their availability becomes available to the different stakeholders. Already the bank is involved in several collection missions.

With the new NARO structure provided for under the National Agricultural Research Act 2005, the Plant Genetic Resources Programme was moved from FORI and placed under the National Agricultural Research Laboratories Institute. It is comprised of two major components i.e. the Entebbe Botanical Gardens and the National Gene Bank. Because of its expansion and widening role in the area of plant genetic resources (in particular plant genetic resources for food and agriculture), the Programme's status has now been changed to a Centre. It is now known as the Uganda Plant Genetic Resources Centre managed by the Head of the Centre, assisted by the Curator of Entebbe Botanical Gardens and the Manager of the National Gene Bank. The Mission of the Centre is to strengthen the national capacity to conserve plant genetic resources and sustainably utilize them for food security, sustainable agriculture, environmental resilience and economic development. The purpose of the centre is to among other things secure the genetic diversity from natural and man-made calamities, to maintain genetic integrity of collections, to support on-going crop improvement, to support farmers' effort in nurturing diversity and to encourage public-private investment into underutilized species.

The strategic objectives of the Centre include:

- To collect and maintain stocks of diverse plant germplasm;
- Enhance utilization of germplasm through characterization (morphological and molecular), evaluation and genetic enhancement;
- To develop information and documentation systems and strengthen linkages among stakeholders;
- To promote community based and on-farm conservation of plant genetic resources as a basis for sustainable natural resource management;
- To contribute to he development and promotion of acceptable germplasm exchange mechanisms; and
- Enhance the role of Entebbe Botanical Gardens.

Among the major challenges faced by the Centre (bearing in mind its expanded role as highlighted above) include: insufficient human and infrastructural resources, involving as many stakeholders as possible in its programme of work,

the lack of a specific policy and legal framework on plant genetic resources for food and agriculture, strengthening community management of plant genetic resources for food and agriculture and insufficient Government funding. This is inspite of the fact that Government support and funding to the Centre has been improving over the years.

5.2 Education, training, research and public awareness

Education, training, research and public awareness are very important in understanding the dynamics involved in the conservation, improvement and sustainable use of plant genetic resources for food and agriculture.

5.2.1 Education, training and research

Although a lot of research on plant genetic resources goes on in the country especially under the framework of NARO and in the Universities, it is difficult to tell in exact terms how much research is conducted on issues of plant genetic resources for food and agriculture. As such it also becomes difficult to state in exact terms the research needs of the country in the area of plant genetic resources for food and agriculture. However, it is hoped that under the new framework of the National Agricultural Research System (NARS), it would be easy to coordinate and establish the researches that go on in the country not only in the area of plant genetic resources for food and agriculture but plant genetic resources generally.

In the area of education and training, there are currently a few programmes run in different universities and other tertiary institutions that deal with issues related to plant genetic resources for food and agriculture. These programmes are run mainly in the faculties of agriculture, forestry, and environmental management. They mainly deal with issues biodiversity generally. The Plant Genetic Resources Centre is yet to conduct a full survey on the programmes in Uganda's institutions of higher learning that address issues of plant genetic resources for food and agriculture with the aim of informing future interventions. But among the strategies and priorities that are stated in the draft National Policy on Plant Genetic Resources for Food and Agriculture for strengthening national capacity in education, training and research include:

- Developing, supporting and promoting programmes for scientific and technical education, training and research on plant genetic resources for food and agriculture;
- Promoting public-private partnership in education, training and research in the area of plant genetic resources for food and agriculture;
- Developing training information on plant genetic resources for food and agriculture targeted for different audiences
- Incorporating issues of plant genetic resources for food and agriculture in education and training curriculum of relevant institutions at all levels;
- Networking and collaboration in education, training and research in the area of plant genetic resources for food and agriculture.

5.2.2 Public awareness and information exchange

Although public awareness and information on issues of plant genetic resources for food and agriculture has tremendously increased over the years (especially in the last five years), the national information management and exchange system on plant genetic resources is still very weak. Thus access to data and information on plant genetic resources for food and agriculture in the country is still very limited. This curtails the full utilization of plant genetic resources for food and agriculture by the different stakeholders and also leads to inadequate public awareness and appreciation of issues pertaining to the resource.

Notwithstanding the status quo, it is important to highlight the fact that the Plant Genetic Resources Centre has been doing and continues to do a lot in the area of public awareness, documentation and information exchange. For instance under the National Information and Documentation Centre which is under development, it has managed to document a lot of information on plant genetic resources using SESTO which is an online data portal developed for public access of information on stored and conserved material. It is also currently spearheading the development of a National Information Sharing Mechanism on Plant Genetic Resources for Food and Agriculture. As an integral part of the National Task Force for Implementation of the International Treaty on Plant Genetic Resources for Food and Agriculture in Uganda, the Centre has also been pivotal in organizing and conducting regional and national consultative meetings on

development of a national policy on plant genetic resources for food and agriculture. All these meetings were also aimed at raising public awareness on issues of plant genetic resources for food and agriculture. A key finding of the National Task Force during the various regional workshops was that while the citizenry was generally not conversant with many contemporary issues to do with plant genetic resources for food and agriculture, they clearly understand and appreciate the value of the resource to their livelihood, general welfare and the national economy.

Among the strategies and priorities that the Draft National Policy on Plant Genetic Resources for Food and Agriculture identifies include:

- Creating and supporting an information resource unit on plant genetic resources for food and agriculture and putting in place mechanism for ease of access to the information;
- Developing mechanisms for information flow and exchange at community level;
- Developing a country database on plant genetic resource for food and agriculture
- Developing and maintaining a catalogue of gene bank germplasm holdings and making it available to potential users
- Developing a comprehensive information network that links the National Information Resource Unit on Plant Genetic Resources For Food and Agriculture to regional and international data bases and information systems; and
- Developing and pursuing a vigorous public awareness programme

5.3 Legislation with relevance to plant genetic resources for food and agriculture

Over the past decade, there are a number of laws and regulations that have been passed and or amended which have a bearing on plant genetic resources for food and agriculture. It is however important to point out that up to now, Uganda does not a specific policy or legislation on plant genetic resources for food and agriculture. This sub section is a highlight of the major laws that have been passed or amended in the last decade with a strong bearing on plant genetic resources for food and agriculture. These include the 1995 Constitution of the Republic of Uganda, the Land Act of 1998, the National Agricultural Advisory Services Act, 2001, the National Forestry and Tree Planting Act 2003, the National Agriculture Research Act of 2005, and the Seeds and Plant Act, 2006. The major regulations passed in the above regard are the National Environment (Access to Genetic Resources and Benefit Sharing) Regulations of 2005. These are discussed in Chapter 7.

5.3.1 The Constitution

The first and most important legislation governing issues to do with plant genetic resources for food and agriculture in the country is the 1995 Constitution of the Republic of Uganda. While the Constitution does not explicitly provide for plant genetic resources for food and agriculture, it contains statements in the National Objectives and Directive Principles of State policy that are generally accepted as providing the general framework for the management, conservation and sustainable use of plant genetic resources for food and agriculture. Objective XIII directs the State to protect important natural resources, including land, water, wetlands, minerals, oil, fauna and flora on behalf of the people of Uganda. Objective XXVII compels the State to promote sustainable development in the management of the environment and natural resources. This implicitly includes plant genetic resources for food and agriculture. In particular, Objective XXVII (ii) provides that the utilization of the natural resources of Uganda shall be managed in such a way as to meet the development and environmental needs of present and future generations of Uganda. Specifically, Objective XXVII (iv) requires the State including local governments to create and develop parks, reserves and recreation centers and ensure the conservation of natural resources; and promote the rational use of natural resources so as to safeguard and protect biodiversity of Uganda. Of direct consequence to plant genetic resources for food and agriculture is Objective XXII, which deals with the issue of food security and nutrition. This Objective compels the State to take appropriate steps to encourage people to grow and store adequate food; and establish national food reserves.

Overall, although the Constitution does not specifically contain provisions dealing with plant genetic resources for food and agriculture, it provides the general framework for their management and sustainable use. Under this Constitutional framework, specific laws, rules and regulations on plant genetic resources for food and agriculture can be developed.

5.3.2 The Land Act, 1998

It is undisputable that land ownership and security of tenure plays an important role in the way plant genetic resources are managed, conserved and utilized. Although issues of plant genetic resources for food and agriculture did not inform the enactment per se, the 1998 Land Act was enacted to provide for the tenure, ownership and management of land; and to amend and consolidate the law relating to land tenure in the country.

In line with Article 237 of the Constitution which provides that all land in Uganda belongs to the citizens and shall be vested in them in accordance with the Constitution, Section 2 of the Land Act provides for four land tenure systems, namely: customary tenure, freehold, mailo and leasehold. Mailo tenure involves holding of registered land in perpetuity and permits the separation of ownership of developments on land (especially those made by lawful or bonafide occupants) and land itself. The Act provides for the procedure of conversion of customary tenure to freehold tenure and leasehold into freehold. It provides for Communal Land Associations and grants security of tenure to a category of persons known as lawful and bonafide occupants. At the moment, Government is in advanced stages of amending the Land Act to deal with the question of the rampant land evictions and land grabbing which is a common phenomenon.

5.3.3 The National Agricultural Advisory Services Act, 2001

The major objective of this Act was to establish the National Agricultural Advisory Services Organization (popularly known as NAADS) for the promotion of market oriented agriculture and in particular to support and regulate provision of advice and information services to farmers. Among the stated objectives of the Organization include: the promotion of food security, nutrition and household incomes through increased productivity and market oriented farming, empowerment of farmers to access and utilize contracted agricultural advisory services, and the creation of funding options for delivery of agricultural advice to farmers especially subsistence farmers, particularly women, youth and the people with disabilities.

5.3.4 The National Forestry and Tree Planting Act, 2003

According to the long title of the National Forestry and Tree Planting Act, 2003, it is stated that the Act was enacted to make provision for the conservation, sustainable management, use and development of forests for the benefit of the people of Uganda; declaration of forest reserves; promotion of tree planting and establishment of the National Forestry Authority. Section 5 creates trust obligations in regard to the management of forest reserves in Uganda. It states that the Government or the Local Governments shall hold in trust for the people and protect forest reserves for ecological, forestry and tourism purposes for the common good of the citizens of Uganda. As regards forest biological resources, Section 29 (1) provides that all forest biological resources and their derivates, whether naturally occurring or naturalized within the a forest, shall be conserved and managed for the benefit of the people of Uganda in accordance with the Act and in accordance with any other law relating to biological resources. The Minister responsible for forests is designated as the lead agency for purposes of regulating access to forest genetic resources.

Critical for plant genetic resources for food and agriculture, Section 13 of the Act provides among other things that forest reserves shall be developed and managed so as to conserve biological diversity, ecosystems and habitats; natural resources (especially soil, air and water quality) and natural heritage. Section 52 establishes the National Forestry Authority (NFA) whose major functions include the development and management of all central forest reserves, provision of innovative approaches for local community participation in the management of central forest reserves, and establishment of procedures for sustainable utilization of Uganda's forest resources.

It is clear from the above snapshot that while a number of laws and regulations have been passed that have a bearing on plant genetic resources for food and agriculture, non specifically deals with plant genetic resources for food and agriculture. While there are a number of reasons that can explain for this state of affairs, two major ones can be pointed out. First, the need to specifically legislate on issues of plant genetic resources for food and agriculture only came to be realized recently especially after the entering into force and Uganda's accession to the international treaty on plant genetic resources for food and agriculture. Secondly, while plant genetic resources for food and agriculture constitute one of the most important resource for achieving many of Uganda's development goals including poverty eradication, food security and rural transformation, issues to do with the resource rarely attract the attention of the politicians who are in charge of Government decision making. Therefore in terms of priority, plant genetic resources policy and legislative issues are often relegated.

5.3.5 The National Agricultural Research Act, 2005

The National Agricultural Research ACT, 2005 provides for the development of an integrated agricultural research system for Uganda for the purpose of improving agricultural research services delivery, financing and management. According to Section 3 of the Act, the purpose of the enactment is to among other things facilitate the achievement of sustainable increases in economic, social and environmental benefits from agricultural research services and products, to provide for a market-responsive and client oriented national agricultural system that generates knowledge and information, and disseminate demand driven problem solving, profitable and environmentally sound technologies on a sustainable basis, and provide linkages, partnerships and collaboration among various categories of agricultural research service providers whether public, private, local, regional, or international in the conduct, financing and development of agricultural research in Uganda.

The overall goal of the National Agricultural Research System (NARS) is to address challenges presented in the Plan for Modernization of Agriculture (PMA) strategy and the National Agricultural Research Policy (NARP) principles to provide research services that address in a sustainable manner, the needs and priorities of the majority poor. In this respect, the major objective of agricultural research in Uganda as provided for in Section 4 of the Act is to transform agricultural production into a modern science-based market oriented agriculture capable of greater efficiency, profitability and of sustaining growth in the agricultural sector while contributing to poverty eradication.

The National Agricultural Research System provided for in the Act includes all stakeholders whether in public or private sector. The Act establishes the National Agriculture Research Organization (NARO) as the principal institution for the coordination and oversight of all aspects of agricultural research in Uganda, including providing strategic direction for publicly funded agricultural; research and coordination and oversight of implementation of the agricultural research policy. In addition to NARO, the system comprises of public agricultural research institutes, universities and other tertiary institutions, farmer groups, civil society organizations, private sector and any other entity engaged in the provision of agricultural research services. The National Agricultural Research ACT has greatly streamlined agricultural research related issues in the country and it is expected to enhance and promote research in agriculture especially research on plant genetic resources for food and agriculture.

5.3.6 The Seeds and Plant Act, 2006

The importance of seeds in any agricultural system let alone to plant genetic resources for food and agriculture cannot be over-emphasized. They are the first and most important in-put in any agricultural system. They are the foundation of plant genetic resources. Thus provision of quality seed and guarantees for safety and easy access should be at the center of policy and law making in the agricultural field. It is in this vain that the Seeds and Plant Act, 2006 was enacted. The Act repeals and replaces the Agricultural Seeds and Plant Act (Cap 28 Laws of Uganda, 2000). It provides for the promotion, regulation and control of plant breeding and variety release, multiplication, conditioning, marketing, importing and quality assurance of seeds and other planting materials. It establishes the National Seed Board under the ministry responsible for agriculture to advise the minister on the national seed policy, the informal seed sector and variety introductions among other things. The Board is also responsible for establishing a system of implementing seed policies and formulating and advising the minister on the regulations and standards regarding the development of seeds in the country. The Act also establishes a technical committee known as the Variety Release Committee whose function is to serve as a National Variety Release Committee; to review and maintain the National List and approve new varieties; and to approve the release of new varieties and entry into the seed multiplication programme. Section 8 of the Act designates the National Seed Certification Service to be in charge of all matters related to seeds including the design, establishment and enforcement of certification standards, methods and procedures. In terms of releases, the Act requires that all imported and domestic varieties shall under go testing in variety performance trials for at least two main growing seasons before their release. All plant breeders must apply to the Certification Service before release of their varieties. The naming of the variety is the responsibility of the breeder subject to approval by the Variety Release Committee. Section 16 provides for establishment of a Seeds and Plant Tribunal to handle any grievances resulting from decisions undertaken under the Act. The Act also gives the Minister powers to designate suitably qualified public officers to act as inspectors, seed analysts and registrars of plant varieties. It also provides for issues regarding multiplication; licensing; seed conditioner and conditioning; seed marketing and seed testing.

From the above highlight, it is clear that though Government has not specifically enacted legislation on plant genetic resources for food and agriculture, it has passed a number of laws especially in the agricultural sector whose over all effect is to streamline and improve on a number of biodiversity related issues including those relevant to plant genetic resources for food and agriculture.

CHAPTER 6

THE STATE OF REGIONAL AND INTERNATIONAL COLLABORATION

6.1 Regional and sub-regional networks, international crop-specific networks and sub-regional collaboration for maintaining *ex situ* collections

Uganda is part of the Eastern Africa Plant Genetic Resources Network (EAPGREN), a regional network with the overall goal of enhancing the regional capacity to conserve and sustainably utilize PGR. One of the main focus areas is building sufficient capacity in the region for *ex situ* collections. Uganda is also participating in the ASARECA Agro-biodiversity and Biotech Program which, among other areas, has prioritized establishment of regional capacity to conserve and make readily available germplasm of vegetatively propagated crops.

Uganda is also already a beneficially of the Global Crop Diversity Trust which is providing resources for the regeneration of threatened germplasm in *ex situ* collections.

6.2 International programmes

NARO and its institutes work closely with the Consultative Group on International Agricultural Research (CGIAR) and its various international agricultural research centers (IARCs). Different commodity programmes participate in evaluation of breeding nurseries and thereafter incorporate some of the acquired germplasm in their *ex situ* working collections.

6.3 International agreements

Uganda is a signatory to the CBD and also to the International Treaty on Plant Genetic Resources for Food and Agriculture. The national processes to ensure full domestication of these instruments and their implementation are on-going and some accomplished. Access and Benefit sharing regulations are in place together with the institutional framework for their implementation. The government also in process of developing policies and legal instruments for PGRFA, protection of relevant traditional knowledge, equitable participation in sharing benefits derived from the use of genetic resources especially in National Parks.

In the policy frameworks, the following issues have been addressed:

- Access and Benefit Sharing (ABS)
- Farmers' rights
- Intellectual Property rights (IPR) Policy (sui generis) aimed at protection of indigenous and local community rights (Traditional Knowledge inclusive)
- Biosafety regulations
- Benefits accrued from use of PGR (biodiversity prospecting inclusive) are in form of infrastructure and capacity building, and embedded within on-going community based programmes.

6.4 The global system for the conservation and use of PGR

Uganda is a member of the FAO of the United Nations and participates fully in the Commission on Genetic Resources. Uganda also participates in the global activities spearheaded by Bioversity International and its sister CG Centres. Uganda has hosted and participated in germplasm collection missions organized by the different International research centres

for specific crops for which high diversity has been recognized as present in Uganda. Presently the regional INBAB office for dealing with banana conservation and utilization is hosted by Uganda with variable activities on conservation and use of banana diversity.

The commodity based breeding programmes have continued to participate in evaluation of international nurseries (e.g cow pea, beans, pigeon peas, etc.) aimed at identifying specific PGR adapted to the environment and utilizing them in crosses with well adapted varieties.

6.5 Assessment of major needs to improve international collaboration

Fully operationalising the provisions of the International Treaty on PGRFA both at national and international level is key to the improvement of international collaboration. The provisions and commitments to supporting developing countries there-in need to be taken up seriously. Awareness creation among stakeholders at national level, putting in place policy and legal instruments and operationalizing them, setting up the necessary infrastructure for realization of the objectives of the Treaty and the Global plan of action are paramount for improved international collaboration.

CHAPTER 7

ACCESS TO PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE, SHARING OF BENEFITS ARISING OUT OF THEIR USE, AND FARMERS' RIGHTS

Uganda is party to key international instruments governing access to plant genetic resources including sharing of benefits arising from their use. In particular, Uganda is party to the Convention on Biological Diversity, which it ratified way back in September 1993. But the most important international legal and policy instrument that Uganda became party to in the last decade that governs issues of access to plant genetic resources for food and agriculture and benefit sharing arising from their use, is the International Treaty on Plant Genetic Resources for Food and Agriculture. Uganda deposited its instrument of Accession on the 25/3/2003. As party to this instrument, Uganda is obliged to put in place legal, policy and administrative measures to meet its obligations including measures on access, benefit sharing and farmers' rights.

7.1 Access to plant genetic resources for food and agriculture and benefit sharing

Over the last ten years, the Government of Uganda has taken proactive steps to improve on issues of access to plant genetic resources for food and agriculture. The major policy and legislative steps undertaken include the promulgation of the National Environment (Access to Genetic Resources and Benefit Sharing) Regulations, 2005 and the development of the Draft National Policy on Plant Genetic Resources for Food and Agriculture. The other major step taken was the establishment of the National Gene Bank.

7.1.1 The National Environment (Access to Genetic Resources and Benefit Sharing) Regulations, 2005

The National ABS Regulations as they are commonly referred to, represent the most important step by the Government of Uganda in as far as putting in place a regulatory framework for access to genetic resources and related issues is concerned. The major objective of the Regulations is to prescribe the procedure for access to genetic resources for scientific research, commercial purposes, bio prospecting, conservation or industrial application. They apply to access to genetic resources generally (which includes plant genetic resources for food and agriculture) or parts thereof, whether naturally occurring or naturalized, including genetic resources bred for or intended for commercial purposes within Uganda or for export, whether in *in situ* conditions or *ex situ* conditions.

They provide that the right to determine, control and regulate access to genetic resources found in Uganda is vested in Government for the benefit of the people of Uganda. Of critical importance, Regulation 10 provides that no person shall access genetic resources from any part of Uganda, unless that person has:

- obtained Prior Informed Consent and entered into an accessory agreement with the lead agency, local community or owner
- carried out an environmental impact assessment
- entered into a Materials Transfer Agreement
- obtained an access permit from the Competent Authority

Regulation 5 designates the Uganda National Council for Science and Technology as the Competent Authority for matters relating to access to genetic resources. The functions of the Competent Authority include: receiving and facilitating the expeditious processing of all applications for access to genetic resources submitted to it; coordinating all activities of lead agencies relating to access to genetic resources; and establishing and maintaining a depository for all

Material Transfer Agreements and Accessory Agreements.

As regards access to plant genetic resources located outside the country, it is instructive to note that the Regulations are quiet about the issue. At the moment, it is difficult to tell how much germplasm is accessed from outside and under what conditions. This is especially so because Uganda lacks a centralized information system where such statistics could be got. The little data that is available is in the hands of individual scientists and selected individual breeding programmes and institutions.

Part IV of the Regulations deals with issues of the Material Transfer Agreement and Benefit Sharing. Regulation 14 provides that a collector shall not access or export genetic resources without entering into a materials transfer agreement with the lead agency. Under Regulation 15, it is provided among other things that the materials transfer agreement will require the collector to pay any required fees to Government and the concerned private owners or local communities for their contribution in the generation and conservation of the genetic resources to which access is sought. The materials transfer agreement also requires the collector to provide for the manner of sharing benefits arising from intellectual property rights accruing from genetic resources. The materials transfer agreement is also supposed to provide for participation of the citizens of Uganda or institutions located in Uganda, in research, development, management and utilization of the genetic resources accessed at stages access. Regulation 20 provides for the basic principles in sharing the benefit. It provides that the benefits accruing from the collection, modification and use of genetic resources shall be shared in accordance with the principle of fairness and equity, and on mutually agreed terms. The Regulation further provides that the benefits accruing from access shall vary on a case-by-case basis but shall include:

- Participation by Ugandan citizens and institutions in scientific research and other activities involving access to genetic resources
- Sharing of access fees and royalties, research funds, licence fees and other special fees that support conservation of biodiversity
- Payment of salaries where mutually agreed
- Collaboration in education and training related to genetic resources
- Technology transfer under favourable terms
- Access to scientific information such as biological inventories and taxonomic studies
- Contribution to development of local communities
- Joint ownership of patents and other relevant forms of intellectual property rights

Although these regulations provide a streamlined procedure of access to plant genetic resources and the mechanism of sharing benefits arising therefrom, they have not yet been tested. It is therefore difficult at the moment to tell how far they have gone in improving and facilitating access to genetic resources and in particular plant genetic resources for food and agriculture and how far they have ensured the equitable sharing of benefits arising from their access/use.

7.1.2 The Draft National Policy on Plant Genetic Resources for Food and Agriculture

In fulfilling its obligation under the International treaty, and more important as a way of harnessing the full potential of plant genetic resources for food and agriculture in national development, including ensuring that these resources are sustainably utilized, in 2004, Uganda began the process of developing a national policy on plant genetic resources for food and agriculture. The National Agriculture Research Organization (NARO) through a multi-sectoral and multi-professional National Task Force spearheaded the process that resulted into the development of the Draft National Policy on Plant Genetic Resources for Food and Agriculture. The draft instrument now awaits cabinet approval. The process leading to this important draft instrument was a highly consultative one, including regional and district consultative workshops, many Task Force meetings and discussions and a national consultative workshop. Many of these regional and district workshops were also used to sensitize the people about issues of plant genetic resources for food and agriculture including the need to conserve, sustainably manage and utilize the resource.

The Draft National Policy on Plant Genetic Resources for Food and Agriculture contains a set of coherent and streamlined policy interventions, actions and measures that Government in partnership and collaboration with stakeholders will undertake in the short and long term to ensure the conservation and sustainable use of plant genetic resources for food and agriculture, and to maximize their potential in national development while ensuring equitable sharing of benefits that arise from their utilization. Specifically with regard to the question of access to plant genetic resources for food and agriculture, the draft policy acknowledges that despite the diverse resources that naturally occur in Uganda, the major crops grown in Uganda originated elsewhere. It is therefore recognized that the historical and continuous interdependence on plant genetic resources for food and agriculture between and among states is critical and should be

guaranteed. As a policy direction, the draft policy therefore provides that the country should put in place mechanisms that will facilitate both international and national access to the country's plant genetic resources for food and agriculture and that will ensure the fair and equitable sharing of benefits arising from such access. In this regard, the draft policy instrument provides that Government will build and improve on infrastructure and other facilitates that are important for exchange and access to plant genetic resources for food and agriculture. The benefits envisioned from access to plant genetic resources for food and agriculture include all those stipulated in the National Environment (Access to Genetic Resources and Benefit Sharing) Regulations as highlighted above.

7.2 Farmers' Rights

The adoption and coming into force of the International Treaty on Plant Genetic Resources for Food and Agriculture added momentum to the need to recognize farmers' rights as a way of rewarding efforts of farmers in the conservation and improvement of plant genetic resources for food and agriculture and as a mechanism of continuous enticement in this regard. The Treaty represents an international consensus on the need to protect and promote farmers' rights as one way of ensuring equitable sharing of benefits arising from the use of plant genetic resources for food and agriculture. Article 9.2 of the International Treaty encourages Governments to take appropriate measures to protect and promote farmers' rights in accordance with national needs and priorities.

While the treaty does not create any obligations on Governments to recognize and protect farmers' rights, recognizing the importance of farmers' rights in the conservation, improvement and sustainable use of plant genetic resources for food and agriculture, and in national development generally, the Government of Uganda has been taking proactive steps in the last decade to protect and promote these rights. Perhaps the firs step by Government to protect and promote farmers rights are the provisions contained in the Plant Variety Protection Bill, 2004, first published in 2002. The 2004 Plant Variety Protection Bill provides for farmers' rights and community rights almost in similar respects as the African Model Law on the Protection of the Rights of Local Communities, Farmers and Breeders, and for the Regulation of Access to Biological Resources. The Bill provides that farmers' rights to their varieties shall be recognized and protected under the rules of practice as found in and recognized by law. It provides for farmers' rights to include the protection of farmers' traditional knowledge relevant to their plant varieties, participating in decision making processes at national level relating to the conservation and sustainable use of plant varieties, the right to save, use and exchange and sell farm saved seed or propagating material, the right to participate equitably in sharing of benefits arising from the use of their plant varieties and the right to use a new breeders' variety to develop farmers' varieties. The Bill does not however provide any guarantees or clear mechanisms for realization of farmers' rights as it does for plant breeders' rights. It is instructive to point out however that Cabinet directed that issues of farmers' rights be removed from the Bill and catered for elsewhere. Consquently, even if the Bill was to pass into law, it now won't provide for farmers' rights.

At the moment therefore, it is only the Draft National Policy on Plant Genetic Resources for Food and Agriculture that provides for Framers' rights in substantial details. Through this instrument, the Government acknowledges and appreciates the role played by farmers and their traditional knowledge systems in nurturing, conserving and making available plant genetic resources for food and agriculture which are the foundation of Uganda's agricultural system and the national economy. Among the national needs and priorities that the draft instrument sets out in terms of realization of farmers' rights include:

- Development of a *sui generis* system for the protection and promotion of farmers' rights
- Establishment or designation of a national focal point on farmers' rights to continuously play an advisory role to Government, farmers and other stakeholders on matters regarding implementation and realization of farmers' rights
- Promoting the formation and strengthening of farmer groups and organizations at various levels of local government through which information can be shared and common strategies developed
- Initiation and support of capacity building programmes to raise farmers' awareness and understanding of key and contemporary issues regarding plant genetic resources to enable them make informed decisions
- Political profiling of issues to do with plant genetic resources for food and agriculture including farmers' rights.

Although the Draft National Policy on Plant Genetic Resources for Food and Agriculture is yet to be approved by Cabinet, as a proactive step, the Ministry responsible for Agriculture through NARO and in particular the Uganda Plant Genetic Resources Centre has started initial steps of developing a draft for a National Plant Genetic Resources law to implement the policy directions in the draft policy instrument. Following on the policy direction in the draft policy

instrument to develop a sui generis legislation to protect and promote farmers' rights and Cabinet decision that issues pertaining farmers' rights be removed from the Plant Variety Protection Bill, a major part of this draft deals with issues of farmers' rights and equitable sharing of benefits arising from the use of plant genetic resources for food and agriculture. Since the draft is just in its initial stages and has not yet been published or discussed with stakeholders, it suffices for this report to indicate that that process has started.

CHAPTER 8

THE CONTRIBUTION OF PGRFA MANAGEMENT TO FOOD SECURITY AND SUSTAINABLE DEVELOPMENT

8.1 Contribution to agricultural sustainability

The breeders have continued to source for disease resistance genes in the available germplasm and incorporating it into well adapted varieties.

Diversification of marketable PGRFA has contributed to their being retained in the cropping system, especially in regard to local vegetables.

8.2 Contribution to food security

It is possible that in North-Eastern and Western regions some crop varieties may have got lost through effects of hailstorms and flooding of large areas due the weather changes in the year 2007. The prevailing effects of climate change have resulted in poor performance of crops countrywide. However, the local varieties, with their variability in adaptive genes have sustained the rural communities affected by unpredictable rains, floods and drought. The crop genetic resources that exist within these communities are valued by traditional farmers for their special attributes, which contribute to the overall objective of ensuring food security both at household and community levels. Through the project on community based management of PGR on-farm conservation practices for specific crop (banana) were identified in relation to varieties. These conservation practices contributed to basic livelihood strategies of communities especially in regard to supply to niche markets and ensuring food security.

8.3 Contribution to economic development

The improvement in road infrastructure partly strengthened roadside local markets thereby indirectly contributing to raising rural incomes, especially income of the local poor who market the rarer but desirable PGRFA (e.g cocoyam). However, farmers' access to larger markets would give better benefits. The market chain for different PGRFA is extremely varied with the balance favouring urban traders as opposed to producers. However, the prevailing boom of supermarkets acting as higher value market niches is slowly upgrading the monetary value of rarer under-utilised crops.

There has been increased demand for herbal products for medicinal and nutrition purposes. This has impacted on supply increase and since many of the herbs are sourced from the wild there has been increased incidence of unsustainable harvests. The acting coordinating body, Export Promotion Board, is tasked with ensuring there are rules laid up to facilitate this bio-trade for economic development. The improved prices of biodiversity products on the market has served as an incentive for the rural communities in ecosystems that support such crops to maintain them *in situ*, sometimes by setting up bylaws on them. Some rural based NGOs have assisted rural communities (e.g honey producers in West Nile) by offering financial assistance in processing of products and ecolabelling them so as to enhance their competitiveness on market.

Uganda farmers have also joined in to produce highly priced organic produce in conformity with the certification specified by the European Union, in collaboration with International Federation of Organic Agriculture Movement (IFOAM).

The Uganda BioTrade Programme aims at promoting trade in biological resources as part of the country's effort to diversify its export base and ensure the sustainable commercialization of bio-products and services and improve livelihoods of the rural communities.

8.4 Contribution to poverty alleviation

With the increased emphasis on use of traditional herbal medicine, many rural based people have benefited from sale of herbal products. Besides, advocacy carried out on value and uniqueness of indigenous fruits have boosted their appreciation and more of these PGRFA are increasingly appearing on local markets, sale of which is income for the vulnerable people who collect/harvest them. Given the nutritional status of the PGRFA, rural communities that consume them are nourished and with the good health attained they can effectively work to increase on crop acreage and production. Markets for products and services derived from biodiversity are growing, offering opportunities for generating alternative sources of income and for production processes based on sustainable use biodiversity.

REFERENCES

Adams R.J and Jenkins M.D, (1990). Biodiversity in Sub-Saharan Africa and its Islands, convention, management and sustainable use. Occasional papers of IUCN species survival commission : No.6, IUCN, The World Conservation Union.

BCG, Plants for the planet, Enabling Botanic Gardens

Bennun, L. A, Aman, A.R and Crafter, S.A. (1992). Conservation of Biodiversity in Africa, local initiatives and institutional Roles. Proceedings of the conference held at the National Museums of Kenya: A publication of Center for Biodiversity National Museums of Kenya

Biocontrol Unit Summary of Achievements July- Dec 2007

Crop and Crop associated Biodiversity pollinators Case studies, (2008). www.fao.org/Ag/agp/AGPS/C-CAB/case.html, 16:17 hrs, 11th April 2008.

Draft National Policy on Plant Genetic Resources for Food and Agriculture

Guidelines for country reports. (2005). Preparation of the 2nd report on state of the worlds Plant Genetic Resources for Food and Agriculture: Item 5 of the draft provisional Agenda 3rd session, Rome, 26th-28th October.

Iwanaga, M. (1998). International Plant Genetic Resources Institute. Via della sette chiese 142, 00145 Rome Italy, ISBN 92-9043-370-1

Katende. A. B, Birnie. A and Tengnas. B. (1995). Useful trees and shrubs for Uganda: Identification, Propagation and Management for Agricultural and Pastoral communities. Published by Regional Soil Conservation Unit, RSCU, Technical Handbook No.10.

Katende. A. B, Ssegawa. P, Birnie. A, Holding. C and Tengnas. B. (1999). Wild food plants and mushrooms of Uganda: Technical hand book No.19, Published by Sida's Regional land Management Unit.

Karamura A.D., 1998. Numerical Taxonomic studies of the East African Highland Bananas (Musa AAA-East Africa) in Uganda. Thesis submitted for the degree of Doctor of Philosophy. Department of Botany, The University of Reading, pp.1-192.

Male-Kayiwa B.S, Wasswa, M. J, Nkwine, C. Kalanzi, A and Karamura, D. (2003). Project Community-Based Management of On-Farm Plant Genetic Resources in Arid and Semi-Arid Areas of Sub-Saharan Africa. Final Report: Case Study of Bananas in Uganda. IPGRI-GEF-UNEP. 10th March

Male-Kayiwa B.S and Wasswa, M. J. (Anonymous). Community – Based Management of On-Farm Plant Genetic Resources with reference to Semi-Arid Region in Uganda. NARO, Plant Genetic Resources Programme, Entebbe Botanic Gardens.

NASARRI (2007). Quarterly report-plans for third quarter 2007-08: From M&E.doc

National Forest Authority, (2006). Forestry Resources Management and Conservation Programme Global Commitment: Annual Report for July 2005 - June 2006, 8 ACP UG 030

NEMA. (1998). State of the Environment Report of Uganda. Republic of Uganda, National Environment Management Authority.

NEMA. (2001). National Biodiversity Strategy and Action Plan. 1st Edition, NEMA

NEMA. (2002). State of the Environment Report of Uganda 2002, Republic of Uganda, National Environment Management Authority. UNDP, UNEP, World Bank

NEMA. (2005). State of the Environment Report of Uganda 2004/2005, Republic of Uganda, National Environment Management Authority.

Prof. Kasenene John, Personal communication. Makerere University, Department of Botany, 15th April, 2008. 15:34 hrs

Tabuti J. S. R. (2003). Locally used plants in Bulamogi County, Uganda: Diversity and modes of utilization. Medicinal, edible, fodder, and Fire wood species. Doctor Scientiarum thesis 15, Agricultural University of Norway.

Wasswa, M. J. (2004). Collection, Conservation, and Characterization of Plant Genetic Resources: Progress Report Plant Genetic Resources, Project 14, MTP11 **30th April – 3rd May,**

Wasswa, M. J. Kiwuso, P and Basoga, M. (2006) Development and integration of artemisia in the control of malaria in Uganda: Artemisia progress report Plant Genetic Resources Programme, September – October 2006

APPENDIX

SOME OF THE FAMILIES CONTAINING WILD AND SEMI DOMESTICATED SPECIES USED FOR FOOD AND AGRICULTURE IN UGANDA

Family	No.of species	Uses	Remarks
Acanthaceae	11	Medicinal, Food, Fodder crop	77.3% of the herbal medicines grow wild while 16.4% are cultivated
Alliaceae	1	Medicinal, Food	Plant is cultivated in gardens
Aloaceae	1	Medicinal	-do-
Amaranthaceae	7	Medicinal, Nutritional, Food	Plants are semi wild and others cultivated in gardens
Anacardiaceae	8	Medicinal, Nutritional, Fruit, Food, Wood products,	Plant is cultivated in gardens
Annonaceae	1	Spiritual,	-do-
Anthericaceae	3	Medicinal, ethno veterinary	-do-
Apiaceae	1	Spiritual, Medicinal, ethno veterinary, Wood products,	-do-
Apocynaceace	7	Medicinal, Fruit, ethno veterinary, Food, Wood products, ornamental	Plants are wild
Aquifoliaceae	1	Wood products	
Araucariaceae	1	Wood products, ornamental	Plants are usually grown on the farm
Araceae	3	ethno veterinary, Food	76.3% of the plants used for ethno veterinary medicine grow wild and are threatened due to unsustainable harvest
Arecaceae	1	Food	Plant is cultivated in gardens
Aristolochiaceae	1	Medicinal, ethno veterinary	-do-
Asclepiadaceae	3	Medicinal	-do-
Asparagaceae	1	Medicinal, ethno veterinary	-do-
Asteraceae	14	Medicinal, Nutritional, Spiritual, ethno veterinary, Food, Oil, Fodder crop	Plant is cultivated in gardens and others are wild
Balanitaceae	2	Medicinal, cattle treatment, Wood products	-do-
Basellaceae	1	Medicinal, Food	Plants wild
Bignoniaceae	3	Medicinal, wood products,	-do-
Bombacaceae	2	Ornamental, Medicinal, Fodder crop	It could be promoted more for its useful kapok
Boraginaceae	5	Fruits, Food, wood products,	Wild and not protected
Brassicaceae	2	Food	Plants are cultivated in gardens
Bromeliaceae	1	ethno veterinary, Food	Plant is cultivated in gardens
Burseraceae	1	Food, wood products	Plant is cultivated in gardens
Caesalpiniaceae	2	Food, wood products	Wild, not cultivated but protected on-farm by the local people

Family	No.of species	Uses	Remarks
Cannaceae	1	Food	Some plants are wild and introduced
Cannabaceae	1	Medicinal, ethno veterinary, Food	Semi wild indigenous plants
Capparidaceae	4	Medicinal, Food	Semi wild, wild, indigenous
Caricaceae	1	Spiritual, Medicinal, Fruit	Semi wild
Casuarinaceae	2	Firewood	
Cecropiaceae	1	Firewood	
Celastraceae	1	Medicinal , ethno veterinary, Wood products,	-do-
Chenopodiaceae	2	Medicinal, ethno veterinary	-do-
Chrysobalanaceae	1	Firewood	
Clusiaceae	1	Medicinal	-do-
Combretaceae	3	Medicinal, wood products, Spiritual, Fodder crop	-do-
Commelinaceae	1	Spiritual, Food, Fodder crop	-do-
Convolvulaceae	3	Medicinal, food	Cultivated plants
Crassulaceae	2	Medicinal	-do-
Cucurbitaceae	9	Spiritual, Medicinal, Food	Some plants are semi wild, , cultivated or introduced
Cupressaceae	2	Spiritual	-do-
Dioscoreaceae	10	Medicinal, Food	Cultivated and introduced
Dracaenaceae	2	Spiritual, Medicinal	Some are cultivated, others wild, introduced and some species are indigenous
Ebenaceae	2	Spiritual, Medicinal	-do-
Euphorbiaceae	17	Medicinal, Spiritual, food, Wood products, Oil, ethno veterinary, Fodder crop	Some species were recently introduced, Wild , cultivated or indigenous
Fabaceae	43	Medicinal, Spiritual, food, Wood products, Oil, ethno veterinary, Fodder crop	Some species are wild, indigenous, cultivated, and recently introduced
Flacourtiaceae	3	Medicinal, ethno veterinary, Food	Wild and indigenous
Gramineae	3	Non-woody products, Food,	
Guttiferae	1	Wood products	It is usually intercropped with coffee
Hyacinthaceae	1	Medicinal	-do-
Hydnaceae	2	Medicinal, Mushrooms	Collected from the wild, not cultivated, easily assessable
Hymenocardiaceae	1	Spiritual, Wood products,	-do-
Lamiaceae	9	Spiritual, Medicinal, ethno veterinary, Food	Semi wild, introduced
Lauraceae	2	Food, Wood products	Semi wild, recently introduced
Loranthaceae	1	Spiritual, Medicinal	-do-
Malvaceae	5	Medicinal, Food	Wild and introduced
Meliaceae	4	Medicinal, Wood products, ethno veterinary	-do-
Melianthaceae	1	Woody products, medicine, Food	Can be planted in farms with other crops

Family	No.of species	Uses	Remarks
Menispermaceae	2	Spiritual, Medicinal	-do-
Mimosaceae	11	Wood products, Fodder crop, Medicinal, Food,	Can be intercropped
Moraceae	12	Spiritual, Medicinal, Wood products, ethno veterinary, Food, Fodder crop	Wild, Semi wild, Indigenous or cultivated
Musaceae	7	Spiritual, Medicinal, food, ethno veterinary	Cultivated, old introduction
Mrysinaceae	1	Wood products	
Myrtaceae	7	Medicinal, Wood products, Fruit, Food	Cultivated and introduced, while others are semi wild
Nyctaginaceae	1	ethno veterinary, Fodder crop	-do-
Nymphaceae	2	Food	Wild and introduced
Ochnaceae	1	Woody products	
Oleaceae	3	Woody products, Medicinal	
Oliniaceae	1	Woody products, Medicinal	
Orchidaceae	1	Medicinal,	-do-
Oxalidaceae	1	Medicinal,	-do-
Palmae	2	Food, Oil, Medicine	
Papilionaceae	5	Food, fodder, medicinal, woody products	Cultivated and semi wild
Passifloraceae	2	Medicinal, Fruit, Spiritual, Food	Cultivated, wild and introduced
Pedaliaceae	2	Medicinal, Oil, Fodder crop	Cultivated and introduced
Pinaceae	1	wood products	Is normally grown near crops
Pittosporaceae	1	wood products, Medicinal	
Phytolaccaceae	1	Medicinal,	-do-
Plumbaginaceae	1	Spiritual, Medicinal,	-do-
Poaceae	14	Spiritual, Medicinal, Oil, Food, Fodder crop	Cultivated, wild, introduced
Podocarpaceae	2	wood products	Cultivated, wild,
Polygalaceae	2	Medicinal, ethno veterinary, Wood products,	-do-
Polygonaceae	3	Medicinal, ethno veterinary, Food	Wild and introduced
Proteaceae	2	Woody products, fodder, ornamental	
Ranunculaceae	1	Spiritual, Medicinal	-do-
Rhamnaceae	2	Medicinal, Wood products,	-do-
Rosaceae	2	Wood products,	
Rubiaceae	3	Medicinal, Berries, ethno veterinary, Food	Cultivated and introduced
Rutaceae	8	Medicinal, Fruits, Spiritual, Woody products, ethno veterinary, Food	Most species are semi wild and cultivated
Sapindaceae	2	Medicinal, Woody products	-do-
Sapotaceae	2	Medicinal, Oil, Woody products, Food	-do-
Simaroubaceae	1	Medicinal, Fodder crop	-do-
Solanaceae	15	Medicinal, food, Spiritual, ethno veterinary	Semi wild and cultivated species

Family	No.of species	Uses	Remarks
Sterculiaceae	3	Fodder, medicine	
Strychnaceae	1	Spiritual, ethno veterinary	-do-
Tiliaceae	3	Medicinal, Food, Wood products,	Wild foods
Theaceae	2	Food, wood products	Usually grown in plantations
Thymelaeaceae	1	wood products	
Tricholomataceae	5	Medicinal, mushrooms	Collected from the wild, not cultivated, not protected, destructive pathogen on forest trees
Typhaceae	1	Medicinal, Fodder crop	-do-
Ulmaceae	3	Wood products, Medicinal,	
Urticaceae	1	Medicinal,	-do-
Verbenaceae	7	Medicinal, ethno veterinary, Food, Wood products,	-do-
Vitaceae	4	Medicinal,	-do-
Zamiaceae	1	Ornamental	
Zingiberaceae	3	Medicinal, Food	Some introduced edible plants have become naturalized and grow wild
Zygophyllaceae	1	Medicinal,	-do-

Source: Katende et al, 1995, Katende et al, 1999 and Tabuti J. S. R. 2003