BOTSWANA:

COUNTRY REPORT TO THE FAO INTERNATIONAL TECHNICAL CONFERENCE ON PLANT GENETIC RESOURCES

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Note by FAO

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CHAPTER 1
Introduction

1.1 LAND

Botswana is bounded by the Republic of South Africa on the southeast, by Zambia and Zimbabwe on the north and east and by Namibia on the west (Map 1). The altitude of Botswana is between 600 and 1,400 metres. Of the total land of 582,000 square kilometres, 85 percent consists of Kgalagadi sands covered with low thornbush vegetation. The soils of the eastern portion have some clay content. However, these soils are generally hard and clod forming, with a high bulk density and a strong tendency towards surface crusting. Natural fertility is low, particularly in phosphorus (Sims, 1981). The eastern parts of the country, also has approximately 10,000 hectares of irrigable soils mainly along rivers.

The country is divided into freehold land (being used for crop and livestock production), communal land which is controlled by Land Boards and State land which is made up of forests and game reserves. The land use pattern can be summarized as follows:

Table 1 Land Use Pattern

Type of use		Area (km)
Arable		13,600
Grazing	fenced	29,300
	unfenced	410,530
Swamp and open water		24,000
Forests		3,200
National Parks, game reserves		100,500
Urban and industrial		600

1.2 CLIMATE

Temperatures are highest, and are most uniform, during the peak of the summer (December - January). Frost occurs occasionally throughout eastern Botswana during the winter (April - July). Mean monthly maximum temperatures range between 32°C to 35°C in the summer period and mean monthly minimum temperatures vary from 4.4°C to 7°C in winter. Solar radiation is not a limiting factor in agricultural production. The humidity is generally low (Pike, 1971).

Rainfall is limited and variable. Average annual rainfall varies between 650 mm in the north to 250 mm in the southwest. Ninety percent of the rain falls between November and April.

Potential evapotranspiration from the crop exceeds available rainfall throughout the year and within any rainy periods, there can be gaps in rainfall of several weeks. Rainfall is even highly variable in Kgalagadi.

1.3 PEOPLE

At the time of the 1991 Census, Botswana had a population of about 1,326,796. The majority of the people live in the eastern part of the country. Most people live in rural areas but the population living in urban areas is increasing.

1.4 FARMING SYSTEMS

Farming families traditionally have a permanent home in their respective village, with a temporary house on their arable holdings (which may be 50 km away), and another house at a cattle post (communal grazing area) and they migrate seasonally between the village and the lands.

Traditionally, food production has been the responsibility of the women, while men spend most of their time at the cattle post herding the livestock. There is a clear distinction between women's and men's activities but this is not totally rigid and there is a degree of overlap on some operations as well as instances of each sex doing tasks usually carried out by the other. Men generally take major responsibility for land clearing, ploughing and planting.

Once ploughing is finished, the men go to the cattle post and the women remain at the lands and are responsible for weeding, harvesting and threshing of the crop.
The system of cultivation in Botswana is characterized by animal traction in the form of cattle, although a few farmers use donkeys and tractors. Farming is mainly mixed, with the majority of small scale farmers engaged in both cattle and arable farming.

Floodplain farming is carried out in areas of the Okavango swamps which are seasonally flooded. Planting takes place when floods recedes which may be early in the rainy season. The depressed areas have soil with high clay content compared to surrounding areas, and are in general, considerably more fertile.

Major crops and pulses of significance in terms of economic importance or for domestic consumption include sorghum, maize, millet, cowpeas, sunflower and groundnuts. Crop production is very erratic as it is influenced by rainfall and other factors including the timely availability of drought power, and timeliness of critical operations such as ploughing, planting and weeding. The average annual size of the national harvested grain crop ranges between 20,000 tonnes in drought years and 116,000 tonnes (1988) in good years, out of an annual requirement of 200,000 tonnes. This represent 10 and 25 percent of national domestic requirements, the balance being imported.

1.5 SEED PRODUCTION

The Seed Multiplication Unit of the Department of Agricultural Research is the sole producer of improved seed for Botswana. A seed inspection, testing and quality control programme and legislation is in place. Certified seed of improved varieties is produced under contract by commercial farmers. Some seed growers such as the Botswana Development Corporation, a parastatal institution, have irrigation facilities on their farm to provide supplementary irrigation when needed.

A premium price is paid by the Seed Multiplication Unit to its contract seed growers. Seed processing is done by the unit at Sebele Research, where a processing plant is in place.

Seed distribution in the country is done mainly by Botswana Agricultural Marketing Board. A major feature of the seed programme is the free issue of

seed to farmers during droughts. However, in a good year, seed is sold but at a considerably subsidized price.

CHAPTER 2
Indigenous Plant Genetic Resources

2.1 FOREST GENETIC RESOURCES

The vegetation of Botswana consists typically of nine types of tree and bush savanna with woodland as listed below:

1. Shrub Savanna
2. Tree Savanna
3. Close Tree Savanna on rocky Hills
4. Semi-arid Shrub Savanna
5. Grass Savanna
6. Aquatic Grassland
7. Dry Deciduous Forest
8. Riparian Forest
9. Woodland

Although these resources cover over 60% of the country, they are relatively unproductive. The high value forests of potential commercial value are found mainly in Chobe District. Six forestry reserves have been gazetted and the two main species harvested in these areas are *Baikiaea plurijuga* and *Pterocarpus* angolensis. Most of the timber products are exported, either to Zimbabwe or South Africa. Forestry operations are currently regulated by extraction licences.

The Forestry Act of 1968 specifies the following species as protected trees on State Lands.

Afzelia quanzensis
Baikiae plurijuga
Guibourtia coleosperma
Plerocarpus angolensis
Entandophragma caudatum
Adansonia digitata
Berchemia discolor
Diospyros mespiliformis

Most deforestation occurs not through logging activities only, but also through collection of wood for fuel and the subsequent environmental degradation around villages and towns is very significant. Wood is used for a variety of purposes such as energy, construction, fencing and crafts. In rural areas in particular, wood is the major source of energy and fencing material.

The main Chobe Forestry Block comprises some 5,179 square kilometres, 60% of which lies within the Chobe Game reserve. Forests and woodlands occur mainly in the Chobe and Ngamiland (Figure 1). Because of damage to the trees from frequent fires, these natural resources could be wasted if exploitable timber is not sustainably extracted.

2.2 VELDPRODUCTS

Veldproducts are widely used for food and income generation through trade. The Mokola palm *(Hyphaen ventricosa*) which is found around the Okavango and Makgadikgadi pans is used to make baskets. Basketry is a major source of employment and income in northwest of Botswana. Another important veld product is the grapple *(Harpogophytum procumbens)* which is predominantly found in Kgalagadi is harvested by the poor and sold for cash.

These and other resources such as the *Grewia flava* provide a major source of income for poor sections of the population and therefore they are particularly valuable.

Whilst traditionally veldproducts have been used mainly for subsistence purposes, more recently commercial uses have developed involving processing in some cases. Although the usage and the extent to which products are threatened are not known, it is certain that depletion of the grapple plant and thatching grass occurs due to lack of care taken when harvesting, resulting in destruction of plants.

2.3 UTILIZATION

Recently, there has been some attempt to halt the depletion of the grapple plant mainly in Kgalagadi. The Agricultural Resources Board has introduced a license system for the harvesting of this plant.

The trend towards increasing use of Veldproducts is likely to continue in future due to rural industrialization and the Government recognizes that other initiatives will be required to prevent depletion of these genetic resources.

2.4 WILD RELATIVES OF CROP PLANTS

It is widely believed that Botswana is part of the primary centre of diversity of wild Vigna, wild Sesame and other relatives of cultivated crops. In a recent collection mission covering a distance of approximately 4,000km, more than fifty accessions were collected representing 10 species. The number of accessions and their species are shown in table 1:

Table 1 Seed Accessions of Wild Relatives of Crop Plants and Vegetables

Species	No. of accessions
Cittrullus lanatus var. colocynathoides	11
Gynandra gynaddropis	10
Vigna unguiculata sp. dekinatiana	9
Corchorus sp.	7
Cleome monophylla	4
Sesamum sp.	3
Amaranthus sp.	2
Cucumis metiliferus (Wild)	2
Vigna luteola	1
Vigna unguiculata sp. unguiculata	1
Lagenaria siceraria	1
Total	**53**

2.5 DISTRIBUTION OF WILD SPECIES

Vigna sp.

The wild cowpea is found throughout Central, Chobe and Ngamiland districts (Figure 1). The highest populations of this species are found in the Chobe, growing on roadsides and climbing on fences.

Citrillus lanatus

Citrillus lanatus tends to grow in association with cultivated water melons in the Central district where many collections were made. Plants which had wild melon characteristics were observed and it was concluded that these were derivatives of hybrids between the wild melon and the cultivated water melon races.

Sesamum sp. (wild relative of *Sesamum indicum*)

This species do not seem threatened because of its abundance particularly in areas where human activity is very high. It grows on roadsides, in abandoned fields and in overgrazed areas. Existing populations do not show much variation.

Amaranthus sp.

Although abundant, this plant is only found around kraals where soil fertility is high due to kraal manure.

Corchorus sp.

The distribution of this species is country-wide.

Gynandropis gynadra

This species grows in backyards and in some cases in cultivated fields as a weed. Large populations are found in Maun (Ngamiland) around old dwelling sites.

Cleome monophylla

This species seems to have no habitat preference.

Cucumis metuliferus

Large populations are found along the Nata/Maun highway.

Oryza sp.

Oryza longistaminata is report to be the most important wild rice found in the Okavango Delta (Vaughan, 1993). Approximately 7 accessions were collected in the delta by the International Rice Research Institute.

Other wild species found in Botswana include a variety of forage grasses. Many of these were collected in the Kgalagadi by the International Board for Plant Genetic Resources (Moss, 1989).

2.6 LANDRACES AND OLD CULTIVARS

In recognition of the importance of crop genetic resources and the need for their formal conservation, the Government of Botswana has established the Plant Genetic Resources Centre whose mandate is to explore, collect and conserve plant genetic resources.

Recognizing that traditional agriculture serves as a natural repository for the diverse genes of landraces, great efforts have been made to collect these resources.

In 1980, the Department of Agricultural Research (DAR) in collaboration with the International Crops Research Institute for the Semi-Arid Tropics undertook a collecting mission which resulted in the collection of sorghum and pearl millet germplasm in different districts in Botswana. The collected samples belong to the following taxonomic races:

Kaffir The majority of the samples collected belong to the race Kaffir in its basic form or an intermediate race durra-Kaffir. This race is widely distributed throughout the country. Two varieties (Kanye Standard and Marupantse) are the most popular among the Kaffirs.

Durra - Kaffir The two most popular local varieties (Segaolane and Town) of Botswana belong to this intermediate race. Apart from the agnomic eliteness of these landraces, some of them have been reported to be resistant to sorghum downy mildew. Approximately 49 samples were collected during the expedition.

Guinea Twelve accessions of this race were collected. The landraces in this race are characterized by drooping panicles and this characteristic provide some resistance to bird attack.

Guinea - Kaffir This intermediate race includes some of the sweet stalk sorghum landraces. The head shape and plant type resemble a typical Kaffir.

Durra This is another important race which is sparsely distributed in the country. Eight landraces were collected and are being evaluated.

In addition to the sorghum collections, forty seven samples of pearl millet were also collected during this joint mission. There is quite a good range of variability in the pearly millet germplasm. Head shapes vary from long cylindrical to short globose with conical and oval shapes in between. There is also considerable variation in bristling and grain compactness.

Another collection mission whose aim was to collect bambaranut, groundnut and finger millet was accomplished in 1985 with the financial assistance from the International board for Plant Genetic Resources and technical support from the International Crops Research Institute for semi-Arid Tropics.

A number of collecting expeditions were also undertaken in 1982 and these resulted in a substantial number of cowpea germplasm being collected. These missions were sponsored by the United States Cowpea Collaborative Research Support Programme.

The landraces of Botswana are of immense value to the various crop improvement programmes because of their adaptability to low moisture and poor soil conditions and their agronomic superiority and most importantly their food grain quality. Some of the sorghum varieties such as Segaolane and Town have been converted into A-lines for use in the hybrid programme.

CHAPTER 3
National Conservation Activities

Although formal conservation of plant genetic resources is relatively new in Botswana, the use of local germplasm in research dates back to the early 1950s in an attempt to improve landraces through selection. However, most of the indigenous germplasm from which local varieties were developed were not preserved as the objectives were short term. Records show that improved crop varieties of sorghum, millet, maize, caster bean, cotton, soyabean and sunflower were introduced in the early 1950s but some of these were abandoned because of their ill-adaptability to the semi-arid climatic conditions of this country.

The situation has changed since the establishment of the Germplasm unit in the early 1980s and the conservation of plant genetic resources is now receiving considerable attention.

3.1 *IN SITU* CONSERVATION

Government attach great importance to ensuring that each community has good access to *in situ* woodland resources, which are capable of meeting its fuel and timber needs on a sustainable basis.

3.2 *EX SITU* COLLECTIONS

Although the National Plant Genetic Resources Centre currently maintains 1,400 accessions of sorghum, pearl millet, cowpea, groundnuts, and bambara, more germplasm will be collected from those areas which were not visited by previous collection missions. The following priority areas have been identified for future collection:

Okavango Delta:	*particularly for wild rice*
Kgalagadi District:	*Cucumis, citrullus, forages Veldproducts*
Central District:	*Sorghum, cowpea, cucurbits*
Chobe District:	*Sorghum, cowpea*
Ngamiland District:	*Maize, sorghum, pearl millet, phaseolus sp.*
Southern District:	*Mungbean, sorghum, cowpea*
Northeast District:	*Sweetpotato, pearl millet, groundnuts, sorghum, bambara*
Kgatleng District:	*Bambara, pearl millet, sorghum, cowpea*

3.3 UTILIZATION OF COLLECTIONS

The genetic materials from the local collections are utilized in the breeding programmes. The crop improvement programmes are screening the collections for desirable traits and the results of the screening trials are very encouraging. The elite materials, particularly sorghum and cowpeas are being tested in agronomic trials and selected for further improvement.

3.4 STORAGE FACILITIES

The germplasm is currently stored in coldrooms operating between 5-10°C and in deep freezers and is kept as simple collections, neither designated as base nor active. Duplicate samples of most of the collections are maintained at the International Institute of Tropical Agriculture (IITA), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), National Seed Storage Laboratory in the United States and the Kew Gene Bank in England.

A new national gene bank is being constructed at the Department of Agricultural Research headquarters for exclusive use by the national plant genetic resources programme. The new building consists of a seed threshing and cleaning room, seed drying and packaging room, coldroom (10m x 12m), seed testing Laboratory (5m x 8m), computer room and staff offices. In addition to the coldroom, there are five deep freezers to be used for seed storage. The new facilities will be ready for occupation by the end of 1995.

3.5 DOCUMENTATION

An inventory of the crops conserved have been computerized. Characterization data is in both hardware and software forms as well as stored manually in germplasm catalogues.

3.6 REGENERATION

The Plant Genetic Resources Programme has periodically grown out the germplasm to maintain viability. This has been mostly so with cowpeas, which are susceptible to damage by cowpea storage weevil. While it is necessary to minimize the frequency of growing out of the germplasm, regeneration cannot be avoided as storage facilities are currently not ideal for some of the crops.

3.7 EVALUATION AND CHARACTERIZATION

A number of germplasm collections of sorghum, pearl millet, cowpeas, bambara and groundnuts have been characterized using the International Board for Plant genetic Resources (IBPGR) descriptor list. Evaluation for resistance to disease, insect and other stresses is carried out by crop improvement programmes and emphasis is on traits that are of high priority to the commodity.

CHAPTER 4
Crop Improvement Programmes

Agricultural Research in Botswana was established formally in 1948, with a small agronomy and crop screening programme. In 1968, a fully fledged Agricultural Research station was created in Gaborone with sections in agronomy, plant pathology and entomology. The Department was further restructured in 1990 and it now has two divisions: Crops Research and Animal Production and Range Research.

Within the Crops Research Division, Crop improvement programmes cover cereals (sorghum, maize and pearl millet), cowpeas and groundnuts. There is also germplasm maintenance facility which provides the improvement programmes with indigenous germplasm as required.

The primary objective of the crop improvement programmes is to develop improved varieties and hybrids with drought tolerance, acceptable agronomic and food qualities, resistance to disease and insect pests.

Before 1983, work had concentrated on the evaluation and selection of varieties under local production systems. Since then, improvement programmes for sorghum, millet, cowpea and groundnuts have been initiated.

4.1 SORGHUM IMPROVEMENT PROGRAMME

Over 6,000 lines of sorghum have been obtained from various countries through the International Crops Research Institute for the Semi-Arid Tropics. From evaluation of these, 73 have been selected and are being used for crossing with promising local germplasm to develop elite lines and varieties. An introduced A-line was successfully used as a donor parent in crosses to convert local B-lines into male - sterile female parents to be used in a hybrid programme.

4.2 GROUNDNUTS IMPROVEMENT PROGRAMME

The area of groundnut in Botswana is still small but nevertheless, an improvement programme is now underway. Some 150 landraces have also been collected.

4.3 GRAIN LEGUME IMPROVEMENT PROGRAMME

Approximately, 1,000 landraces of cowpeas have so far been collected, described and evaluated. Crosses have been made between local germplasm to generate lines with good tolerance to drought and mosaic virus.

4.4 SEED DISTRIBUTION

Seed Multiplication and certification is conducted by the Seed Multiplication Unit (SMU), a service unit of the Department of Agricultural Research. Certified seed is grown under contract by commercial farms.

Seed processing is done by the Seed Multiplication Unit at Sebele, where a processing plant is in place. Seed distribution in the country is done mainly by the Botswana Agricultural Marketing Board.

CHAPTER 5
National Policy

The government recognizes that improving the agricultural sector will benefit the welfare of the majority of its people besides diversifying the economic base and reducing food imports. In 1987, government established a National Plant Genetic Resources Centre to serve as a counterpart to the Southern African Development Community (SADC) Regional Plant genetic Resources Centre. The national centre is responsible for the coordination of all national collection, conservation and it also serves as a national storage Laboratory where diverse genetic resources are preserved. This national storage laboratory is coordinated by the National Plant genetic Resources Committee whose primary functions including the following:

- development of the infrastructure for the preservation of the national plant genetic resources;
- provide coordination of all organizations in the collection, conservation and exchange of germplasm;
- development of national policies and legislation for the conservation and exchange of germplasm.

Although funding of the centre is the responsibility of the government, some significant contributions in the form of scientific equipment have been received from the Swedish International Development Agency (SIDA) and the International Board for Plant Genetic Resources (IBPGR).

It is clear from the above commitments that government attach great importance to the conservation and sustainable utilization of plant genetic resources.

5.1 TRAINING

The current staff establishment include a Curator with M.Sc. degree in Plant Genetic Resources Management, one Technical Officer with a University Diploma in Agriculture plus a Certificate in Plant Genetic Resources Management and a Technical Assistant with a Certificate in Agriculture and has attended a course on plant genetic resources management at ILCA, Ethiopia.

Although the current staff of the national gene bank are adequately trained, there is a need for taxonomic training to support the gene bank. Emphasis should be at M.Sc. level.

5.2 NATIONAL LEGISLATION

The current legislation concerning plant genetic resources is contained in the Seed Certification Act of 1976 which makes provision for the control of the sale, export and use of seeds.

There is also, a Plant Diseases and Pest act of 1959 which provide for the prevention of the introduction into and the spread within Botswana of plant diseases and plant pests. Presently, there are no plant quarantine facilities in Botswana. However, the Department of Crop Production and Forestry has plans to establish a quarantine unit within the Division of Plant Protection. The situation at the moment is such that reliance is placed on phytosanitory certificates issued by exporting countries to determine entry eligibility.

CHAPTER 6
Regional and International Cooperation

Botswana has carried out joint collection expeditions with scientists from IITA, ICRISAT, the Royal Botanic Gardens with financial support from IPGRI. Table 2 shows seed collections at foreign genebanks and these are duplicates of materials maintained locally.

Table 2 Seed Collections Maintained at other Gene Banks

Location	No. & type of accessions
1 IITA, Nigeria	Cultivated cowpea 457, wildcowpea 38, Bambaranut 9
2 ICRISAT, India	Sorghum 190, pearl millet 65
3 NSSL, USA	Cowpeas 400, sorghum 190, pearl millet 64
4 Kew Gene Bank	>1000 collections of various plant species

Plant Genetic Resources Programme serves as a counterpart to the SADC Regional Plant Genetic Resources Centre (SPGRC) and it continues to receive significant contributions in the form of scientific equipment from SPGRC and the Nordic Gene Bank (NGB).

6.1 UNITED NATION INITIATIVES

Botswana was represented at the Convention on Biological Diversity held at Rio in June 1992 and it supports the initiatives geared towards the conservation and sustainable use of biodiversity and natural habitats.

6.2 NATIONAL NEEDS

In order to safeguard the plant genetic resources inventories and conservation of wild plant material, it is necessary to have an adequately staffed and equipped National herbarium. The current herbarium is insufficiently equipped and Taxonomic botanists are lacking. Coupled with this problem is the apparent lack of plant quarantine facilities such as laboratories, screenhouses and qualified personnel to carry out these functions. There is an urgent need to establish the plant quarantine service in order to avoid the introduction of quarantine pests and diseases.

6.3 CONCLUSION

In conclusion, we wish to propose the following elements for inclusion in the Global Plan of Action:

- Establishment of national herbarium and training of systematic botanists.
- Training of both scientists and Technicians in genetic resource management.
- Establishment of communication links at national, regional and international levels for exchange of information.

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FIG: 1 BOTSWANA: POSITION AND DISTRICT BOUNDARIES