SUDAN:

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

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CHAPTER 1
Introduction

1.1 THE SUDAN: AGRICULTURE AND NATURAL RESOURCES

With an area of 2.5 million square kilometres, Sudan is the largest country in Africa and 9th largest in the world. It extends between latitudes 3° N and 22° N and longitudes 22° E and 39° E. It borders on nine countries: Libya, Egypt, Eritrea, Ethiopia, Kenya, Uganda, Zaire, Central African Republic and Chad.

The Sudan is generally a very flat country, most of its parts range between 400 and 450 m AMSL. Only on three of its boundaries are there extensive mountainous stretches: the Red Sea Hills and the foothills of the Ethiopian mountains on the east, the Imatong and Dongotana Mountains and the Nile-Congo watershed on the south and Jebel Marra on the west. In the centre, the Nuba Mountains and the Ingasana Hills are the only prominent mountainous areas.

The most important physical feature of the country is the River Nile which bisects it from south to north. Most of the main axis of the river is within the Sudan and all its tributaries run most of their lengths and converge within it too. That makes the Sudan more worthy of being called the land of the Nile though it is much less dependent on the river than Egypt, being endowed with adequate rainfall in many of its parts.

Rainfall varies from almost nil in the extreme north to 1500 mm per annum in its southwestern boundaries. This is the main factor defining the country's agro-ecological and vegetation zones. These zones extend from the desert in the north to the acacia desert scrub, acacia short grass scrub, acacia tall grass forest, forests and swamps and grassland in the south. Zoning based on vegetation is more appropriate for the theme of this report than frequently used divisions based on aridity and humidity, though the two do not differ much. To these divisions should be added the few montane areas, scattered from the extreme north to the extreme south, with their unique vegetation and climate.

During the last few decades, there was a noticeable southwardly retreat of isohyets coupled with more frequent droughts. This may be a constant trend or just a phase of a long cycle. This trend, combined with overgrazing and the removal of the tree cover for various purposes, is causing desert encroachment and perhaps a similar retreat of the boundaries of all the traditionally acknowledged ecological zones. There are also changes in the quality of their vegetational composition. Some species which were once dominant or very conspicuous have greatly dwindled, some almost to the brink of extinction.

The population of the Sudan is about 26 million people of whom some 80 percent are rural. They form a great mosaic of ethnic, tribal, linguistic, religious and cultural affiliations and traditions. Sudan has a domesticated animal wealth of over 60 million heads dominated by cattle, sheep, goats and camels. The country has also a great wealth of wild life extending from big game in the south and middle to the jerboa, snakes and antelopes of the desert in the north.

The Sudan is an agricultural country. Eighty percent of its population rely on agriculture for living. Agriculture employs 90% of the country's labour force and its industry - and those whom it employs- is mostly dependent on its agricultural products. Agriculture contributes about 35% of Sudan's GDP, the greatest of all sectors. The country's exports and foreign cash earnings are 90% agricultural.

Sudan's agriculture consists of three major subsectors:

1. The traditional rainfed subsector: This consists of millions of small subsistence farmers. These farmers grow sorghum, pearl millet, finger millet, cassava or maize for food and sesame, groundnut and some minor crops for cash. They usually keep some goats, sheep or cattle. They depend mostly on family labour, use locally made hand tools in farming, grow their favoured landraces and produce their own seeds. They use no fertilizers or pesticides and are thus greatly self-reliant for production inputs. These farmers -with their varied traditions, diverse ecological zones of production and conservatism- are the great maintainers of germplasm diversity.
2. The mechanized rainfed subsector: This comprises about 10,000 big farmers with farms of 1,000-2,000 feddans* and a few big companies with holdings of 20,000 - 200,000 feddans. Land preparation and seeding are mechanized but weed control and harvest are still largely manual. Of the subsector's annual area of 7-12 million feddans, sorghum occupies 80-85%, sesame 14-16% and cotton, sunflower and pearl millet and guar combined 1-2%. This subsector produces about 70% of the country's sorghum, 40% of its sesame and almost all of its sunflower and guar.

The subsector is fully market oriented. To meet the consumers demand it mostly grows landraces of sorghum and sesame, an improved variety of cotton, introduced varieties of guar and hybrids of sunflower.

3. The irrigated subsector: This accounts for about 4 million feddans of the country's crop area. It is dominated by the very large gravity irrigated Gezira, Rahad, New Halfa and Suki schemes. These schemes are managed by the government and cultivated by thousands of tenant farmers who grow almost all the country's cotton, most of its wheat, 35% of its groundnut and 10% of its sorghum. Pump irrigation accounts for about 25% of the irrigated area. Crops of the bigger pump schemes on the White and Blue Niles are almost similar to those of the gravity irrigation. The few big and hundreds of small pump schemes in Khartoum, Nile and Northern states produce most of Sudan's fruits, vegetables, winter legumes and spices. They also produce a good portion of wheat. There is a small area that is flood irrigated in two river deltas in eastern Sudan that grow cotton, sorghum, millet and castor.

The two last subsectors -the mechanized rainfed and the irrigated- are modern subsectors. They are almost confined to one ecological zone: the acacia short grass scrub. In this zone, some acacia species (*A.seyal, A. mellifera, A. nubica*) and some grasses, such as S*orghum purpureo-sericeum, S. aethiopicum, Cymbopogon nervatus* and *Hyperrhenia pseudocymbaria* used to dominate. Large scale land clearance for cultivation greatly diminished the population of these and tens of other species. Others are vigorously eradicated as weeds. Modernization also entailed the disappearance of once well-established landraces of crops. A few improved sorghum cultivars now occupy the place of the myriad of feterita and gassabi sorghum types which once dominated the Gezira Scheme.

The Sudan -with its wide ecological variation- produces a wide range of crops. These are produced on about 30 million feddans of cultivated land, 280 million feddans of natural range and pasture and 120 million feddans of woods and forests which produce more than 80% of the country's fuel and one of its most important exports: gum arabic. The greatest part of the range lands is overlapping with woodland. About 200 million feddans of these are potentially arable.

Though the cultivated species occupy the smallest area, they are by far the most essential for the people's livelihood and economy. However, the naturally growing forest, range and medicinal (and some food) species are much more numerous and richer in genetic variation. The country's great animal wealth is almost fully dependent on these wild species.

The following table shows the area and/or production of Sudan's important crops in 1991 according to FAO statistics. Annual area and production of the major rainfed crops (sorghum, millet, sesame and groundnuts) fluctuate greatly influenced by rainfall and prices, and 1991 was a low year for them. Recently, cotton area was greatly reduced in favour of food crops. Statistics for some crops are lacking.

Crop	Area x 1000 ha	Production x 1000 mt
Sorghum	4,691	2,941
Pearl millet	1,118	308
Sesame	538	97
Groundnut	232	193
Wheat	464	680
Seed cotton	179	273
Maize	25	63
Finger millet	?	?
Cassava	5	8
Total pulses	103	110
Rice	1	1
Sugarcane	80	4,500
Total vegetables and melons	-	903*
Total fruits	-	844**
Sunflower	32	11
Kenaf	-	3
Tobacco	?	?
Gum arabic	-	-
Kerkade (= roselle)	?	?

* **Tomato 150, eggplant 75, potato 15, melon 144, onion 40.**
** **Citrus 176, mango 130, banana 63, pineapple 5, dates 140.**

CHAPTER 2
Indigenous Plant Genetic Resources

Most of the agricultural development activities in the Sudan have been taking place in central parts of the country i.e. in rather fragile ecological zones. Adverse impacts were particularly evident in mechanized crop production schemes as a result of vast tree clearance and subsequent over-cultivation which resulted in serious erosion and degradation in marginal vulnerable land. Pasture lands have also been subjected to degradation and destruction due to overgrazing especially around water points dug in 1970's to solve water shortage problems. This has inevitably led to the loss of indigenous plant genetic resources to an extent which is unknown.

In addition, recent frequent drought spells probably caused loss of valuable pasture species and of wild and cultivated genetic resources.

The above - mentioned factors emphasize the need for urgent action to prevent further losses in plant genetic resources.

The formulation of viable and effective plans to achieve this goal will require an understanding of the status quo with respect to indigenous plant genetic resources.

This section provides information on plant genetic resources of forests and other crops in Sudan.

2.1 FORESTS

Of the total area of the Sudan (250.58 million ha), the productive forest trees and shrubs cover about 61 million ha i.e. 24% of the area.

The forestry sector contributes some 12% of the Sudanese GNP, besides the indirect benefit of environmental protection, soil amelioration, work opportunities for rural people, etc. The most tangible benefits are fuel wood and charcoal which provide 80% of the energy needs. A recent survey of

demand of forest products showed that the sixteen northern states consume 12.8 million cubic meters of fuel wood/annum. In addition, the annual exports of gum arabic range between 20 and 40 thousand tons and earn some US$ 50-120 million.

Forest genetic resources of the Sudan can best be described and listed according to the ecological zones. There are eight such zones described by J. Smith in 1949. He worked on species distribution based on rainfall and soil type. Appendix 1 presents the indigenous species. However, there are also introduced tree species which are now naturalized and contribute to the genetic resources of the Sudan. These appear in Appendix 2.

The forest resource provides fuel wood and sawn timber and gum arabic. Acacia seyal, A. senegal and A. nilotica come at the top of the species providing energy, gum and sawn timber, respectively. A. seyal is the main energy species and occurs on cracking clay soils that cover large areas. Although it is always removed for growing other crops, viz sorghum, cotton, sugarcane and sesame, its regeneration is easy and its domain is wide. Acacia senegal, the main gum-producing tree species, is also secure since its coppicing power is high and its valuable product (gum) kept it safe in a farming system similar to agro-forestry. Acacia nilotica is one of the main sawn timber and fuel wood tree species. It is riverine in its habitat, easy to regenerate and can stand flooding. It is the first forest species to be managed properly, and its rotation and management plan is well executed by Forests National Corporation (FNC) in a sustainable manner. These three species are well conserved by management and seed storage.

Threatened tree species and groups of trees are many. They occur in each of the eight ecological zones described earlier. This threat is caused by several factors including the biotic factors (man and his animals), fires and harsh climate conditions. Examples of threatened species include Cordia abyssinia which is heavily cut for its valuable timber combined with the difficulty of regenerating it. Balanites aegyptiaca faces the same fate. All the species in the desert zone and acacia desert scrub are threatened by over-cutting and over-grazing in addition to recurring drought. Species in the other zones whose frequency is naturally low and contain valuable timber, are also threatened.

* One feddan = 4,200 m2, 0.42 hectare, = 1.04 acres

2.2 CEREALS

Sudan's flora includes all the three wild sorghums believed to be the progenitors of cultivated sorghum (viz. *S. aethiopicum, S. verticilliflorum* and *S. arundinaceum*). It is also the home of perhaps five or six other wild Eu-sorghums, including S. sudenense (Sudan grass) which attained international importance for forage. These wild sorghums, and the sorgos, are represented in the World Collection (especially in Dr. J. Harlan's collection). However, this representation is minimal and does not cover all the diversity in these taxa. This is even more true of germplasm kept within the Sudan.

Of the world millets only two are grown in the Sudan. Pearl millet (*Pennisetum glaucum = P. typhoides*) is the country's second crop in acreage following sorghum. Finger millet (*Eleusine corocana*) also occupies an appreciable area, mostly in western Equatoria.

Some authorities believe western Sudan is the centre of origin of pearl millet. A great diversity of characteristics exists in Sudanese millet, though, due to the cross pollination of the crop, only few distinct varieties are known. About 18 wild species of Pennisetum are found in the country, with some freely crossing with pearl millet.

There is also much variation in the cultivated finger millet. At least, two wild relatives, E. indica and E. flagellitera, exist in the Sudan. The former is believed to be the progenitor of the cultivated types.

Eighteen wild Setaria spp. were reported among Sudan's flora. Some are used as famine foods and some may have a potential in the breeding of the cultivated setarias.

The Sudan has no known progenitors or wild relatives of wheat. But as a result of early introductions, coming mainly from Egypt, landraces (i.e. farmers' cultivars) have evolved and were adopted in cultivation especially in the northern region.

One such cultivar "Beladi" was reported by Massey and Martin in 1921. It proved to be a mixture of lines. Besides, using mass selection from this cultivar, Massey and Martin tested and recommended for release cultivars Federation and Fairbanks from Australia, Rustom 141 from Iraq, but these had largely disappeared with time. In 1942, Hindi 62 was introduced from Egypt and recommended for cultivation in both Gezira and the Northern Region.

Since the early sixties, with the rapid expansion of wheat cultivation in the country especially in the Gezira, introduction activities were intensified -being aided by cooperation with international agencies like FAO, ClMMYT and ICARDA and as a result a number of cultivars had been released. These are listed below: Hudeiba 154, Hudeiba 164, Hudeiba 57, American 378 and Giza 144 in 1964; Falchetto in 1967; Giza 148 in 1968; Giza 155 in 1970; Mexicani in 1971; Condor and Chenab Mukhtar in 1978; Debeira in 1982; Wadi El Nil in 1987 and El Nilein in 1991. All but the first four are now available in the plant breeding section at Gezira Research station.

Wild rices are found in the water-logged swampy areas mostly in the sudd region of the southern Sudan. Five species of wild rice (*Oryza spp.*) were recorded in Andrews' (The Flowering Plants of the Sudan, vol III). The best known of these is *O. punctata*. Two wild rice species, namely *O. longistaminata* and *O. barthii* are of immediate interest to plant breeders because they cross freely with the Asian *O. sativa*. The presence of different wild rice species in the swampy regions of the Sudan makes the Sudan one of the important centres for rice germplasm collection and conservation.

Cultivated local rices in the Sudan are grown mostly on the White Nile river banks from Jebelein to Ed-Dueim by the local people on a limited scale.

2.3 OIL CROPS

The main sources of edible oil in the Sudan are sesame, cottonseed, groundnut and more recently sunflower.

Sesame (*Sesamum indicum* L., 2n = 26) is grown, in the Sudan, under rainfed conditions by subsistence, semi-commercial and commercial farmers. Selection by subsistence farmers resulted in many landraces adapted to different ecological areas, varying mainly in rainfall (300 - 1000 mm) and soil (sandy to heavy clay), and to the needs of the farmer (e.g. seed colour). All have one dehiscent pod per leaf axil, but they show variability in seed colour, days to maturity, degree of branching, number of locules per pod and pod size.

Three wild species of sesame are found in the Sudan, namely *S. alatum* (2n = 26), *S. radiatum* (2n = 64) and *S. anguistifolium* (2n = 64). *S. alatum* has long pods and winged seeds, and *S. radiatum* is characterized by dark black seeds with rough seed coat. Both have larger number of seeds per pod than the cultivated varieties.

Two other members of the family Pedaliaceae, namely Ceratotheca sesamoides and Rogeria adenophylla, were recorded as occurring wild in central and southern Sudan.

Collection and study of these five wild species is urgently needed because they (together with landraces) are in imminent danger of genetic erosion. They have never been utilized in the improvement of the cultivated varieties. Among the adaptive and desirable traits in these species are drought tolerance, disease resistance and long pods.

Groundnut (*Arachis hypogaea* L.,) is a native South American legume not known to the Old World in pre-Columbian times. Portuguese navigators are credited with introducing the crop to the western coast of Africa from Brazil, but it is not known when. West African immigrants are believed to have brought the crop to Sudan about 200 years ago, and they grew it in parts of western Sudan and along the Blue Nile. Documentation, however, is lacking.

The earliest forms of groundnut introduced belonged to the subspecies hypogaea. The small-seeded runner types were established on the sandy soils of western Sudan and the bunch types were grown along the Blue Nile on heavy clays. These two groups of groundnut form the land varieties in Sudan. Varieties of the subspecies fastigiata (varieties *vulgaris* and *fastigiata*) were introduced about sixty years ago as part of an improvement programme. Of these *fastigiata* introductions, the cultivar Barberton, primarily because of its early maturity, quickly replaced the late maturing land varieties of the runner type in the northern parts of Kordofan and Darfur.

Sunflower (*Helianthus annuus*) was introduced early in this century but commercial production on large scale started in the late 1980's by the private sector. Planting seed, usually hybrids, is imported annually.

In addition to sesame, groundnut and sunflower, there is a number of other potential sources of vegetable oil in the Sudan. These include herbaceous plants as well as trees. Among the former are castor (*Ricinus communis* L.), safflower (*Carthamus tinctorius* L.) and niger (*Guizotia abyssinica* Cass.).

Castor is widely distributed in central and southern parts of Sudan as semi-wild, and because of the vastness of the country and the variation in annual rainfall (0-1500 mm) many races have evolved differing mainly in height, number of days to maturity, branching and seed size and colour. No collection of this material has been made.

Safflower has been introduced from Egypt to the northern part of the Sudan at a very early date, and some variability is expected there. Only one wild species, namely *C. pericus* (*C. leucocaulos*), was recorded in the Red Sea State, eastern Sudan.

Niger is grown in small areas, around homesteads, near the boarders with Ethiopia. Three wild species (*G. villosa, G. scabra* and *G. schimperi*) were recorded in the Sudan.

Among the trees, the most important are oil palm (*Elaeis guineensis*), shea-butter tree (*Butyrospermum parkii*) and desert dates (*Balanites aegyptiaca*). The first two are found mainly in western Equatoria State, while desert dates are widely distributed in the Sudan.

2.4 FOOD GRAIN LEGUMES

A cool winter and availability of irrigation water in the former Northern Region of Sudan enables that region to grow several winter grain legumes. The four major ones are faba bean (*Vicia faba*), haricot bean (*Phaseolus vulgaris*), chickpea (*Cicer arietinum*) and lentil (*Lens culinaris*). Lupin (*Lupinus termis*) and pea (*Pisum sativum*) are also grown but have not received the research attention accorded the former four.

Of the summer grain legumes only cowpea (*Vigna unguiculata*) and pigeonpea (*Cajanus cajan*) are grown in appreciable area throughout the Sudan. The hyacinth bean (*Lablab niger* = *Dolichos lablab*) is grown on a still larger area, but mainly for fodder though some is harvested for bean. The Bambara groundnut (*Voandzeia subterranea*) is grown on a limited scale.

Faba bean is the most important pulse crop in the country occupying 60% of pulses area (followed by haricot beans, chickpea and lentil). It is a main constituent of daily meals in urban areas. Demand exceeds supply and prices keep rising.

Faba bean is not indigenous in the Sudan but local landraces have evolved from early introductions from Egypt and Ethiopia.

The haricot bean germplasm maintained by the breeders comprises 30 local landraces and about 350 accessions from CIAT (Colombia), USA, Egypt and Tanzania.

Chickpea is believed to have been introduced in the Sudan in some early time. Only one local landrace of the Kabuli type is known. This was out-yielded by the Faransawi variety.

A bulk of lentil seeds, collected from Dongola, Northern and Nile States in 1967/68, is the only known local landrace in the Sudan, and is believed to be of an Egyptian origin.

Though a limited effort was made to collect and maintain germplasm of the summer legumes, a wide range of variation exists among and within the many landraces of these legumes. This is especially true for cowpea with its great variations in plant size, seed size and colour and time to maturity. At least, 16 other *Vigna* species (including *V. vexillata*) is reported to grow wild.

2.5 SUGARCANE

In Sudan, the following two types of local sugarcane germplasm exist.

1. Wild local sugarcanes: These include two types, namely *Saachrum spontaneum* L. and *Erianthus maximus*. The latter grows on river banks and in water beds. Western Equatoria appear to be its home in the Sudan. The locals call it 'baluju'. It is strong and used as building material and flowers profusely.
2. Cultivated local sugarcane: Cultivated forms of local sugarcane are grown in many locations in the Sudan, but mostly in tropical and sub-tropical southern Sudan in stream beds and in the central Sudan on the Blue Nile banks, south of Sennar and Singa, and in Giraif near Khartoum. These sugarcanes have low sugars and are grown for chewing purpose.

2.6 VEGETABLE CROPS

For hundreds of years, wild types of vegetables such as okra, jews mallow and cucurbits were consumed by the Sudanese.

By the turn of the twentieth century, foreign rule introduced new kinds and varieties of vegetables. The following is an outline of wild relatives and indigenous cultivated vegetables.

Okra (*Abelmoschus spp.*): Okra (*Abelmoschus esculentus*) has been grown for many years by farmers in different localities leading to the development of variable landraces throughout the country. It also grows wild in the rainlands of central and western regions from which the dehydrated okra, locally known as 'waika', is obtained. Two other species, *A. ficulneus* and *A. manihot*, also grow wild in the rainlands and irrigated areas of the Sudan.

Watermelon (*Citrullus spp.*): The Sudan is a part of the African primary centre of diversity for this crop. Variable indigenous types of *C. lanatus* are produced in the rainfed areas of western Sudan. They lend themselves to a variety of uses including drinking water, food and feed.

The wild species *C. colocynthis* is growing in different parts of the country especially in the northern and eastern Sudan. Melons (*Cucumis spp.*): A variety of local landraces has been developed from *C. melo* in Sudan. Some of them belong to the group of cantaloupes and muskmelons and others belong to C. melo var. flexuosus or the snake cucumbers. *C. melo var agrestis* 'tibish' grows either wild or under cultivation. Several species of Cucumis are also known to be growing wild in Sudan such as *C. dipsaceus, C. ficifolius* and *C. prophetarum*.

Hot Pepper (*Capsicum spp.*): Landraces and old cultivars of hot pepper are numerous in the country. They are rain grown or irrigated. They show great variation in fruit shape, size, colour and pungency. Hot pepper production in various geographical localities has contributed a lot to the development of such variable landraces which are superior to introduced cultivars.

Onion (*Allium cepa*): A multitude of local types and landraces varying in skin colour, pungency and storability is known in Sudan. They were found to be superior to exotic material under experimental and farm conditions.

Tomato (*Lycopersicon lycopersicum*): Some local old types of tomatoes are present in the country and they are collectively known as "baladi" tomatoes. One of the important groups of them is cherry-like tomato produced in western Sudan for paste making.

Pumpkin (*Cucurbita spp.*): Local strains of various fruit shapes and colours are grown by vegetable farmers.

Leafy Vegetables: The species Corchorus olitorius is one of the most important leafy vegetables in Sudan; local cultivars are grown by farmers. Several other species of Corchorus are growing wild and some of them are used as leafy vegetable.

Local types of Portulaca oleracea (purselane) and Eruca sativa (green rocket) are also grown in Sudan as leafy vegetables, and some Portulaca species grow wild.

Some wild species of leafy vegetables are also used in Sudan like *Amaranthus spp*. and *Sonchus spp*.

Eggplant (*Solanum melongena*): Some old cultivars of this vegetable were grown in the country but they are almost replaced now by the exotic modern cultivars. Several species of *Solanum* including *S. incanum* and *S. dubium* grow wild.

Potato (*Solanum tuberosum*): Although potato cultivation in Sudan depends mainly on exotic advanced cultivars but an old introduced material is still produced in Jebel Marra in the far west and it is locally known as Zalingei potato.

2.7 ROOT CROPS

There are some local cultivars of the carbohydrate source root crops: sweet potato, cassava and yam.

Several landraces of sweet potato (*Ipomea batatas*) are found in Kordofan and Darfur regions in the west and in the southern states in addition to the irrigated sector of central Sudan. They are variable in branching habit, root colour and leaf shape.

Landraces of cassava (*Manihot sp.*) and yam (*Dioscorea sp.*) are known to be grown by inhabitants of the southern states for a long time.

2.8 FRUITS

The diversity of climate in the Sudan provided the country with the opportunity to grow various types of fruit crops, including date palm, banana, guava, citrus fruits and mango.

Date palm: Date palm has been under cultivation in the Sudan for a long time and the exact date of its introduction is not known. The cultivars are classified as dry, semi-dry and soft dates. Dry varieties are believed to have originated in southern Egypt and northern Sudan and not found elsewhere in the world. Different dry cultivars are grown in the Sudan -the most famous of which are barakawi, gundeila, bit tamouda and kulma. Semi-dry and soft varieties are grown in some parts of the country. These include several old introduced cultivars of soft dates, e.g. mishrig wad khateeb, mishrig wad lagai and medina.

Due to the out-breeding nature of date palms, a large number of seedling varieties (jau) have evolved. These are grown in northern Sudan and in some localized areas of the western Sudan and the Red Sea area.

Only one wild relative of date palm (*Phoenix reclinata*) is reported to be growing wild in Darfur region (Jabel Marra area) and in southern Sudan.

Banana: The Dwarf Cavendish is an old banana cultivar which has been the only variety grown in Sudan for about a hundred years. This cultivar is well adapted to Sudan conditions and is almost free of serious banana pests and diseases. In addition, local plantains are grown in southern Sudan.

Guava: A number of old guava cultivars has been adopted by fruit growers in the Sudan. These are usually named after places of their intensive production like Shendi, Shambat, Sinja, Ganib, Sudani and Musaid. However, these are no longer distinct cultivars since the only method used for guava propagation (in Sudan) is seed propagation which may not breed true to type.

Citrus: Citrus fruits including oranges, grapefruits and lime are major fruit crops introduced to Sudan over the years. They are distributed almost all over the country. Some old cultivars and new introductions of citrus are grown (Appendix 3).

The major old cultivars of oranges include varieties like Sinari, Beladi, Valencia, Navel and Nuri 16. In grapefruit, the major old cultivars are Foster pink, Beladi white seedless and Duncan. Old cultivars of lime include 'Beladi' Lime, Mexican Lime and Persian Lime. In sour orange, old cultivated material is used as the traditional root stocks for propagating citrus fruits. Some wild citrus trees are also reported to be growing in some parts of western and central Sudan.

Mango: It is one of the major fruit crops introduced to Sudan and grown almost all over the country. There are approximately 34 known old cultivars in Sudan (Appendix 4), and several unidentified ones.

In addition to the above mentioned fruit crops, some indigenous trees produce edible fruits, e.g. *Grewia tenax, Ziziphus. spinachristi, Balanites aegyptiaca, Borassus aethiopicum, Sclerocaria birrea, Hyphaene thebaica* and *Capparis decidua*.

2.9 FIBRE CROPS

More than 30 plant species indigenous to Sudan are used for fibre production (Appendix 5). Most grow wild and different parts of the plants are utilized in localities where they grow as a source of fibre, mainly for ropes. The most widely used is perhaps the dom palm (*Hyphaene thebaica*) whose leaves are used extensively for rope making. Other wild species used in different localities include *Grewia, Dombeya, Adansonia, Hibiscus, Bauhinia, Acacia, Lannea, Sanseveria, Borassus* and several others. The cultivated date palm produces two types of usable fibre.

Of the cultivated fibre crops, only cotton and, to a much lesser extent, kenaf and sisal are worthy of mention. Cotton growing and spinning in the Sudan dates back to a period before the Christian era as attested to by several historical records. This spinning and fabric making activity, before the start of commercial cotton growing by Ahmed Mumtaz Pasha in Tokar (1850-1860), apparently hinged on indigenous cultivars. The occurrence of such cultivars was very common in various parts of the Sudan. Truly wild types also occurred; *Gossypium* somalense (*Cienfugosia somalensis*) and *Gossypium anomalum*, both of which are lintless diploid and perennial cottons, were found in the Sudan. There were some local cultivars of G. arboreum which could be collected in various parts of Blue Nile, Equatoria, Darfur and Kordofan. The Sennar tree cotton, Nuba Red and Abu Hareira were typical local cultivars of *G. arboreum* of the Sudan. *G. herbaceum* var. africanum also existed in those same areas. These cultivars of *G. arboreum* and *G. herbaceum* may all be truly indigenous or very old (> 2 000 years) introductions from Arabia or India. Some local races of punctatum (*G. hirsutum*) were also present in various districts of the Sudan under different names like Belwa, Deblan, Mumtaz, Mayerno etc. Types of *G. barbadense* (kidney cotton = *G. barbadense var. brasiliense*) occurred for many years in Equatoria and were called "Roko" by the Zande.

Kenaf (*Hibiscus cannabinus*) was grown on a very limited scale until 1971 when comparatively large scale production was started to feed a large kenaf spinning and weaving factory.

Wild types of *H. cannabinus* are indigenous to many parts of the Sudan, but specially in Darfur. They are known by the local name "Karkanj" and used by the natives for cordage. These wild types have not been surveyed or collected.

Sisal (*Agave sisalana*) is a native of tropical south America of which no wild relatives are reported in the Sudan.

2.10 RANGE AND FORAGE PLANTS

About ten important forage crops are cultivated in Sudan including both local landraces and old exotic cultivars. In addition, natural range plants with very rich indigenous genetic resources exist in Sudan (Appendix 6).

2.11 MEDICINAL, AROMATIC AND POISONOUS PLANTS

There are more than 90 plant species indigenous to the Sudan that are considered as medicinal or aromatic plants (Appendix 7). Some are of local use in native medicine or cosmetics but many are exported, or exportable, for use in the international pharmaceutical or cosmetics industries. Except for about 13 species, none is cultivated but grow wild or as weeds in cultivated fields. The cultivated species are mainly grown for non-medicinal purposes such as spices and vegetables.

Besides, there are about 75 species that are listed as poisonous (Appendix 7). Some of these have different local uses including medicine.

2.12 ORNAMENTAL PLANTS

Most of the ornamental plants used in Sudan today originated from introductions made both by the British and some Sudanese during this century. However, there are some examples of indigenous plants actually being used as ornamentals.

The major divisions of ornamental plants and their genetic resources are discussed briefly below (Appendix 8).

1. Shrubs and trees: The potential of the indigenous species is great but not yet explored except for a few including *Dodonea viscosa* "Arkawit" and *Carissa*.
2. Bulbous Crops: They are not very well known in Sudan, although certain areas are very rich in indigenous material that hold a lot of promise. Again, this awaits exploration, collection and evaluation. *Crinum jagus* and *C. africana* are already in use, and gladiolus grows wild in certain parts of the Sudan.
3. Cacti and Succulents: Sudan is not known to be rich in cacti but is very rich in succulents. Erkawit area is the place to be surveyed and collected from, as a lot of Eurphorbias are indigenous.
4. Palms: Although most of the palms in culture now are introductions, Sudan is known to be home for dalaib (*Borassus aethiopicum*) and dom (*Hyphaene thebaica*). So there is a need to explore and collect especially in western and eastern Sudan.
5. Vines: Survey would surely reveal a lot of these types of plants. The existence of about five types of wild asparagus is already known.
6. Foliage Plants: Many species of Caladium and Coleus, just to name a few, are known to exist in the jungles of southern Sudan.
7. Turf Grasses and Ground Covers:Sudan's Savannahs are rich in members of the family Graminae. Collection and evaluation may result in establishing superior clones to suit the dry-hot conditions of the Sudan.

2.13 MISCELLANEOUS

Roselle

Roselle (*Hibiscus sabdariffa* L.) is a member of the family Malvaceae, and is believed to have originated in West Africa. It has two distinct varieties, namely altissima and sabdariffa. H. sabdariffa var. sabdariffa is the one grown in the Sudan under the colloquial name "karkade", mainly on the sand dunes of western Sudan. The calyx extract is a popular cold beverage particularly in urban centres and traditionally it has been used as a hot drink for treatment of cough.

There are many landraces of roselle in the Sudan with considerable variation in plant height, degree of branching, number of days to maturity, leaf shape, size of calyx, intensity of calyx colour, petioles and stem colour, adherence of calyx to the seed pod and acidity of calyx extract.

Guar

Guar (*Cyamobsis tetraglonoba*) as a commercial crop in the Sudan is of a very recent history. The real interest in evaluating its potential as a crop can be traced to 1982. In that year, the Gum Arabic Company in collaboration with Celanese (a USA company) introduced 14 improved varieties for evaluation. Some gave good yield which established guar as a new crop in the Sudan.

Prior to that -and perhaps since the forties- the ARC maintained a collection of only three improved varieties which were never evaluated exhaustively.

One wild species (*C. senegalensis*), but no landraces, of guar are known in Sudan. India and Pakistan have a kind of world monopoly on guar production and most probably they shall not provide other countries with germplasm.

There is a need to introduce more cultivated and wild types to support a breeding programme within Sudan.

The Gum Arabic Company does not have the facilities or the know-how of germplasm conservation and this responsibility should be shouldered by ARC's germplasm unit.

2.14 FAMINE FOODS AND OTHER USEFUL WILD PLANTS

Sudan's flora is rich in wild plants which have good potential food uses. Most are normally used on a very limited scale, except in times of need when they may be used extensively. Appendix 9 lists some species which were much used for food in western Sudan during the 1984/85 severe drought and crop failure. Chemical analyses revealed that some were richer in energy, protein, fat or minerals than the cultivated staples.

Some rare species are of great scientific interest from the morphological, evolutionary or phytogeographic point of view, e.g. the Dragoon tree (*Dracaena ombet*). Erkawit area in the Red Sea Hills was once dominated by this tree, but now it has almost completely vanished from there, though still common in Jebel Elba on Sudan's border with Egypt.

It was as recent as 1979 that a plant was collected from southern Sudan and identified at the Royal Botanical Garden, as a new genus, aptly named *Suddia sagitifolia*.

Aquatic plants and algae, usually overlooked, contribute significantly to the economic, aesthetic and cultural aspects of our lives besides their vital role as primary producers and fundamental components of the genetic resources of the fresh and marine aquatic ecosystems. To quote a few Sudanese examples: Cyperus papyrus can be used in paper industry; Herminiera elaphonoxylon for making rafts and packing material; Azolla aquatica for fertilizing rice fields; Spirulina spp. for their protein value and many marine algae for the production of glycerine, fats and drugs.

Tannin producing and gum producing plants in Sudan are listed in Appendix 11.

CHAPTER 3
National Collection and Conservation Activities

Sudan has not yet developed a national comprehensive system for the collection and conservation of its plant genetic resources. With the exception of very modest attempts in forest and range lands, there are no programmes for *in situ* conservation.

On the other hand, there are few *ex situ* collections, maintained by frequent regeneration and managed by plant breeders. However, a nucleus for a genebank has been established since the mid-eighties. Its activities centred around conserving the local genetic resources of some vegetables and medicinal and aromatic plants. It is conceived that this nucleus will be developed into a full fledged genebank to take care of genetic resources of forest and field and horticultural crops.

A brief description of the collection activities and conservation of genetic resources in the Sudan is outlined hereunder.

3.1 FORESTS

Forest genetic resources are conserved through the following methods:

a. Creation of forest reserves: These are large areas containing several tree species and are present in the eight ecological zones in the Sudan. Creating reserves in each of these zones leads to conservation of several species in their natural habitats, and the reserved area in 1994 has reached 5 million ha i.e. 2.2% of the country's area.

b. Forest plantations: In addition to natural forest reserves, forest plantations containing important tree species are established. This practice helps to conserve and improve the genetic resources by selection and breeding. The current area is 386,870 ha.

c. Forest Arboreta: These are established to conserve tree species. Trees are allowed to grow as long as they can last. They become sources of seeds and material for research. Few of these have been established, and more are needed in each ecological zone.

d. Seed collection, testing and storage: Seed centres have been established, and the staff were trained to collect seeds from natural stands according to specified criteria to avoid narrowing the genetic base. Seeds are cleaned, tested for germination, then stored and documented. Two tree seeds centres have already been established and two are planned for 1995. More of these centres are needed to cover the country's needs of germplasm conservation. Exploration of tree stands, their phenology and their extent are determined in forest reserves, plantation and natural unreserved forest. Then seed collection areas are demarcated and seeds are collected from trees of better form which are surrounded by several other trees. Provenances occur in stands of A. senegal on sand and those on clay. These differ in their gum yield.

3.2 CEREALS

Collections: Of Sudan's crops, sorghum's germplasm is the most widely collected, documented and preserved. Collection started in 1914 by Punter. In the late twenties and early thirties, the collection was augmented with local types and exotic introductions, specially from U.S.A. In the early forties, S.Evelyn added the most to the collection and painstakingly documented it. Plant breeders from 1952 to 1980 kept adding to the collection. During this period they freely supplied this material to whoever requested it; specially to workers in the USA and India.

Between 1975 and 1980, FAO sent two sorghum collection missions that covered western and southern Sudan and ICRISAT sent a mission that collected from Gedarif, Singa, Roseiris and Kurmuk areas. Researchers in Kadugli and El Obied made big collections in their respective areas. This collection well represents Sudan grain sorghums; only the southeastern corner of the country (bordering on Ethiopia and Kenya) and perhaps the Nile, Northern and Red Sea States might need further collections.

The millet breeder collected about 200 local pearl millet accessions. His collection was confined to Kordofan and Darfur States only. The collected germplasm is stored in paper and cloth bags under room temperatures and much loss occurs. With the lack of irrigation, regeneration of the germplasm

under marginal and erratic rains has also caused severe germplasm losses. No collection from other parts of the country were made. Furthermore, no effort was made to collect Eleusine or Setaria germplasm.

In 1921, 1956 and 1958 samples of a wheat landrace "Beladi" were collected from the northern region, and through mass selection improved cultivars were developed but the fate of most of these is not known. However, a strain believed to be one of those missing selections has been retained by the breeders in Gezira and Halfa Research Stations. It is also likely to find original "Beladi" mixtures in isolated islands in remote parts of the northern region. If no collections are made soon, these landraces may be irrecoverably lost as a result of the rapid spread of newly introduced cultivars.

Collections of wheat germplasm from Jebel Marra have been made by two missions dispatched with the help of IBPGR in 1981. A total of 47 samples were collected. Some were given to the breeder in Gezira Research Station which he later used in his breeding programme, however, some of these samples were damaged by store insects. Some samples were sent to IBPGR for long term storage.

In 1979-1980, IITA supported by IBPGR made two missions to Sudan for rice germplasm collection. Thirty five samples were collected; 26 were Oryza spp. and 9 were unidentified.

A plan for wild rice sample collection in the southern region-drainage basin of the White Nile river, by ORSTOM, IRAT and IITA was scheduled for 1983-1987 for traditional varieties and two wild species, namely O. longistaminata, O. barthii collection. There are 12 accessions from Sudan deposited at the IRGC, IRRI, Philippines.

As phase I of the Jonglei Canal excavation is half-way through the swampy region, and with the implementation of phase II of the project proposal, the swamps will dry up completely and this will ultimately affect the environment of the region and its ecology. It is, therefore, suggested that: IPGRI, the Sudan Government and the regional research organizations currently engaged in rice germplasm collection offer more help to save the Sudan's rich rice germplasm from disappearance.

IRAT and ORSTOM have already placed the sudd (swampy) region in the Sudan among the other African countries as first priority areas for rice germplasm collection.

Conservation: This has been one of the most serious weaknesses in breeding programmes of cereals in Sudan. Very valuable material of sorghum, wheat and other important crops was lost due to poor storage or even apathy by breeders who did not have the funds, facilities or capabilities to store large collections of genetic material.

There were inconsistent attempts to plant some of the local material on annual basis. But this method allows only very limited number of types to be carried and is subject to risks from drought, shortage of water, bird damage, insect and disease attacks and other hazards.

In cereals, for example, samples of almost all sorghum collected were and are sent to ICRISAT and to cooperating USA universities. This policy has proven very useful to the Sudan as material can easily be retrieved. During the last 20 years, there was much loss of sorghum types kept in Sudan due to poor storage and the disinterest of some sorghum breeders in maintaining a very big collection. They prefer keeping a smaller working collection and are assured of retrieving any other types they need from abroad.

In 1992, samples of the whole collection of Sudanese sorghums was sent by ICRISAT to Sudan where it was grown, described and catalogued. Samples from its harvest are kept by the Agricultural Research Corporation's (ARC) small germplasm unit which has better, though limited, storage facilities than the plant breeding sections which were historically responsible for the collection. These sections lack any kind of cooled stores.

All of the material reported above was acquired by the World Sorghum Collection in India from sources in Sudan and several other countries. This led to replications of many entries in that collection. The World Collection now includes some 3,000 entries of cultivated and wild Sudanese sorghums. Removing the replicates may reduce them to 2,000 - 2,500 entries.

Documentation: For documentation and detailed characterization of sorghum genetic material, the Sudan depends heavily on ICRISAT's work. The country does not have the facilities, funds or staff for detailed descriptions and documentation of its collection, specially if left to sorghum breeders who have priorities other than germplasm conservation. Such work should be the task of an entity whose only or main function is conservation of genetic resources.

Similar to the situation in sorghum, most of the recent genetic material of wheat, which was received as introductions either as advanced lines or released varieties has been adequately described, characterized and documented by geneticists in CIMMYT or ICARDA.

In rice, little was done with regard to description, characterization or documentation.

3.3 OIL CROPS

There are no programmes or projects for *in situ* conservation or *ex situ* cold storage of the genetic resources of oil crops in the Sudan.

Some attempts were made in 1950's and early 1960's to collect landraces of sesame and many introductions were made from most sesame growing regions of the world between 1950 and 1980. These were used by plant breeders.

In groundnut, local collection was very limited. The largest number of groundnut cultivars was introduced in the early fifties (Tozi collection) and was the basis for a system of classifying groundnut at the subspecies level. Over the years, breeders added new material to the "Tozi collection", primarily from the United States and from ICRISAT.

Because of the lack of proper storage facilities, sesame and groundnut collections were maintained by annual planting. This expensive method of maintenance was discontinued because of the scarcity of funds and lower priority given to this activity by the breeders. Most of these collections were lost due to destruction by store pests and loss of viability.

3.4 FOOD GRAIN LEGUMES

None of the winter grain legumes is indigenous to the Sudan. However, most of them are early introductions that evolved into landraces which have been collected and maintained by the plant breeders. Most of the breeding efforts in these legumes depend on introduced germplasm.

About one thousand accessions of faba beans were acquired from Europe, Egypt, Ethiopia and ICARDA. To this was added some six hundred single plant and mass selections.

Nearly 400 accessions of local landraces and introductions of haricot bean are maintained. For chickpea, about 1,000 accessions were provided by ICARDA

and ICRISAT of which only 50 proved adapted to Sudan and are maintained. Of these, 90% are Kabuli and 10% Desi type.

Out of about 1,700 lentil accessions from ICARDA and Ethiopia, that were evaluated in Sudan, only about 200 accessions adapted to the Northern Region are maintained.

In spite of a rich native germplasm of summer legumes, e.g. cowpea and pigeonpea, limited collection of this germplasm has been made. Breeders maintain a collection of varieties introduced from IITA, ICRISAT and the USA.

Other grain legumes whose germplasm need to be collected and maintained include: lupins, hyacinth bean, wild and cultivated species of Phaseolus, Bambarra groundnut and sword bean (Canavalia ensiformis).

The horticulturists in the 1980's collected 123 local samples of eight leguminous crops, most of which are mainly field crops. Some accessions were lost due to store insects and the others are maintained by ARC's PGR unit.

3.5 SUGARCANE

In 1956-1957, Spontaneum Expedition Scheme (SES) collected from Sudan a sample of S. spontaneum L. and code named it SES 601. SES 601 is today conserved with the 3,300 world's largest collection of sugarcane species at the Sugarcane Breeding Institute, Cannanore, Kerala, India.

3.6 VEGETABLES

Individual collection efforts for the indigenous vegetable landraces were started by scientists of the Horticultural Research Section in the ARC after its establishment in the mid- sixties. The targeted crops were mainly onion, hot pepper and okra. Such collections were mainly for the breeding programmes which lacked proper storage facilities.

During the first half of the eighties, IBPGR supported three collection missions for the horticultural crops. Such collecting tours were executed by scientists from the Horticultural Research Section, ARC. They covered parts of

central and eastern Sudan in 1982, western Sudan in 1983 and northern Sudan in 1984. A total of more than one thousand accessions of vegetable crops were collected -represented mainly by okra, hot pepper, watermelon, onion and tomato. Such collected material is well conserved and partially characterized by the PGR unit of the ARC.

3.7 FRUITS

Efforts were made during the seventies to collect and conserve some of the local and old cultivars of date palm in some of the agricultural research stations, but such efforts lacked sustainability and the materials collected face loss through negligence and bad management.

No proper conservation efforts are practised for the preservation of local banana and guava germplasm.

Some collection blocks were established at Shendi and Hudeiba Agricultural Research Stations for living storage of the known cultivars of citrus and mango fruits. Such blocks also lack funding and proper management.

3.8 FIBRE CROPS

Of the fibre crops, only cotton and kenaf's germplasm received some attention with regard to collection and preservation.

Cotton: *in situ* conservation activities for cotton are non-existent. With respect to *ex situ*, there is a very important old cotton genebank in Shambat which existed for almost three quarters of a century. Its assembly started in the early 1920s, possibly with the appointment of the first full time cotton breeder in 1925 concurrent with the start of large scale cotton production in the Gezira following the construction of Sennar Dam. Collection and maintenance of both local and exotic cotton types was started and was apparently in response to the continuously unfolding problems of diseases that pressed hard during the three decades that followed. Collection was continued, and early in 1950, the total number of accessions in the cotton "Type Collection" was over 1 300 belonging to five of the linted cultivated and fourteen of the wild lintless species of the genus Gossypium. Some of these are listed below:

Species	no. of Accensions
A: Semi-wild species of cultivated types	
G. barbadense	92
G. hirsutum	351
G. herbaceum	52
G. arboreum	87
B: Wild diploids	
G. anomalum	10
G. sturtii	1
G. australe	2
G. bickii	1
G. sturtianum	1
G. thurberi	7
G. armourianum	1
G. raimondii	1

The number of accessions is now about half the original number. This is a serious loss as some of these types are very difficult to find now. These collections are stored at room temperature and maintained through periodical renewal. One quarter of the material is grown annually for this purpose. Field preservation was tried as a less expensive means but was not secure.

This collection, unfortunately, was not duplicated inside the Sudan, and its twin collection in Trinidad (West Indies) disappeared since late 1940s.

Some records are kept for seed amount and some morphological traits. When seed samples are sent out in exchange with breeders abroad, only morphological descriptions are included.

Characterization for disease and pest resistance, photochemical properties or other physiological traits is not satisfactory. Kenaf: Most of the kenaf varieties developed by breeders for cultivation were from exotic materials introduced from Cuba, Guatemala, Ghana, Tanzania and India. Most of these came through USAID. A gene pool of some 160 varieties was maintained, about 360 pure lines were selected from these varieties. Of these varieties and selections, only one variety now exists in cultivation, the rest were lost due to lack of good storage facilities and the discontinuation of the breeding programme.

There is a strong need to collect local germplasm and introduce exotic types, but this requires staff and facilities.

Other Species:No efforts have been made to collect or preserve germplasm of the wild species used for fibre production. At present, they do not seem to be threatened by genetic erosion.

3.9 RANGE AND FORAGE PLANTS

Very little efforts have been made to conserve the genetic resources of range and forage plants mainly in the form of seed. The Range and Pasture Administration (RPA) of the Sudan have adopted an economical and socially viable approach for management and rehabilitation of depleted rangelands through establishment of range reserves.

The main activities carried out in these reserves are:

1. Seed production and collection.
2. Adaptability experiments.
3. Measurement of degree of competition.

Two types of reserves are practised:

a. Closed reserves: In these, selected degraded range sites are fenced. There are 29 closed reserves occupying more than 100 000 feddans (1 fed. = 0.42 ha). They are not properly managed and often under pressure from the local inhabitants.

b. Open reserves: Pilot grazing sites are established in this type with involvement of the local population under the technical advice and supervision of the RPA staff. There are two open range reserves in El Manzofa and El Taka villages (Kordofan), each occupies an area of 3 x 3 km.

RPA carries out other activities of genetic resources conservation in two forage production sites located in Sennar (500 feddans) and Ungarko (2,000 feddans). In these two sites, there are seed stores that lack temperature and humidity control facilities. This is in addition to 11 seed bulking nurseries of limited areas scattered throughout the country.

3.10 MEDICINAL, AROMATIC AND POISONOUS PLANTS

There is no *in situ* conservation of the medicinal and aromatic plants, but at present most of them do not seem endangered in their natural habitats. However, with regard to *ex situ* conservation, some species are conserved either in the National Botanic Garden in Khartoum or in the PGR unit at the ARC. Only limited efforts were made to collect, characterize and document the species of this group of plants.

3.11 ROSELLE

Some scientists in the universities and ARC have made some limited collections for their own breeding and research programmes. Few accessions are preserved in the PGR unit of the ARC and they have been morphologically characterised.

3.12 PGR UNIT, ARC

A nucleus for a genebank has been established in the Agricultural Research Corporation (ARC) since the mid eighties. Till recently, this nucleus genebank has been used for conserving the local genetic resources of vegetables and medicinal and aromatic plants. At present, the ARC has taken steps to promote this genebank unit into a national one to cater for all local crop genetic resources.

1. Type of Collections: More than 1,500 accessions of locally collected horticultural germplasm are conserved in the PGR unit. In 1994, representative small samples of 2,096 accessions of Sudanese sorghum have been acquired and deposited for storage in the unit. The collection comprises diversified wild and cultivated material from indigenous locally adapted crop germplasm of which the most important crops are sorghum, okra, watermelon, hot pepper, onion and roselle. This is in addition to some breeder's lines of tomato. This collection narrowly represents the diversity of Sudanese genetic resources of vegetables and medicinal and aromatic plants especially in some crops and species. Each accession from

the Sudan sorghum collection is only represented by a small sample not exceeding 500 seeds. Such limited representation of diversity is mainly due to the limited geographical coverage of previous collecting missions, and to the limitated storage capacity of the unit.

2. Storage Facilities: The PGR unit has got in total seven deep-freeze chests with a capacity of 600 litres each. Only three of them have proper aluminum filing systems. Temperature in the deep-freezers is adjusted at -20°c and seed moisture content is adjusted at or below 7%. Seeds are packaged in laminated aluminum foil packets. All the equipment, including storage facilities and other seed processing equipment, are accommodated in 8x4 m laboratory. The equipment in this unit were provided by some international organizations like IBPGR and UNDP, but running and maintenance expenses are covered by the ARC. All the material is treated as an active collection. A duplicate collection for some accessions is preserved in a separate deep freezer accommodated in a different room for safety purposes. The processing of seeds for permanent storage is sometimes hampered by the lack or shortage in technical and labour staff and equipment.

3. Documentation: Documentation for the different categories of data including collection, conservation and characterization is done manually. However, recently the unit received one personal computer which will assist in the documentation. The information is usually available to users through their direct contact with the PGR unit.

4. Evaluation and Characterization: about 50% of the horticultural germplasm in the unit has been partially characterized following the IPGRI published descriptor lists for most of the crops. Those crops for which IPGRI has not yet published descriptor lists, e.g. watermelon and roselle, were characterized following descriptor lists developed internally by the unit. Some limited preliminary evaluation work has been carried out in some important horticultural crops germplasm on yield potential and tolerance to some prevailing pests and diseases.Part of the characterization and evaluation results has been published in the ARC annual reports and in some foreign periodicals. To accomplish full characterization and evaluation of the conserved material, the PGR unit needs strong financial and technical support.

5. Regeneration: Neither periodical monitoring for seed viability nor regeneration is carried out due to shortage in technical staff and funding for this item. Most of the sorghum collection is believed to be at low levels of viability due to its storage in unfavourable conditions for some time before acquisition by the unit. The regeneration of this very much valuable material is an urgent task necessitating special support.

CHAPTER 4
In - Country Uses of Plant Genetic Resources

Sudan's agricultural policy is based on two major objectives:

1. Increased production to insure self sufficiency of all crops, and to realize a surplus for export. Within this, food security has the highest priority.
2. Optimal use and conservation of natural resources for sustainable production.

All research programmes aim at meeting these two objectives simultaneously. Their vehicle for achieving this is increased productivity which directly increases production and indirectly protects the natural resources by requiring less land, less water, etc., to produce the country's needs. In all species with adequate indigenous germplasm, main reliance is on the local germplasm because of its better adaptation and its produce quality which meets the local consumer's needs. Yet, exotic germplasm resources are also widely used in search of attributes lacking in the local germplasm. This is especially true of crops totally new to the country (e.g. sunflower and guar) or older crops whose centres of diversity are outside Sudan (e.g. cotton, groundnut, tomato, etc.).

The potential gains from utilizing available germplasm in plant breeding are tremendous. The great ecological, social and economic diversity of the country and its crops calls for greater efforts by plant breeders to meet the country's goals. However, the staff needed to meet this challenge is insufficient. The plant breeders available are well trained and experienced but they are comparatively few. Material incentives for retaining them on the job are poor. Many good breeders have left in search of better paying jobs, mostly outside Sudan. For those who stayed on, shortage of funds, materials, equipment and supporting staff present real constraints. Only programmes with international support enjoy better status. Almost all agricultural research in Sudan is carried out by government funded institutions, and relying on foreign donors support, which is not always certain or forthcoming, adversely affects breeding and other research programmes.

Most of the plant breeding efforts in the past favoured the commercial and semi - commercial farmers. During the colonial period, there were no breeders for crops other than cotton, which was produced for export. Only in 1951, a

single breeder was recruited to work on crops other than cotton (sorghum, sesame, groundnut, etc.). His efforts mainly served the big mechanized farms, which were market-oriented, with little spill-over benefits to the small, traditional subsistence farmers. Only during the last twenty years were research stations established and breeders directed to serve the needs of these small farmers. Yet, breeding programmes, for various reasons, still favour commercial farmers in the irrigated schemes and rainfed mechanized farming.

Products of breeding are released to all farmers without discrimination, but weakness of the seed industry and difficulties of distribution limit the benefits of breeding. Again-and against government's intensions and wishes-conditions favour the bigger farmers. Only recently did private seed companies start to emerge. Their successful establishment is hoped to extend the benefits of crop improvement to larger numbers and a broader cross section of farmers.

Sudan's germplasm is maintained mainly for the country's use and benefits. However, most of this germplasm has been sent without restrictions to all countries and institutions except those embargoed by the United Nations, Arab League or Organization of African Unity. The country expects and usually gets similar and equal treatment from other foreign governments and organizations. This works to the mutual benefit of both sending and receiving parties. In fact, Sudan has benefited greatly from materials received from other countries, even in crops, like sorghum, which are indigenous to the country. Sorghum hybrids released, or being developed, were only possible with introduced germplasm. All or most groundnut and wheat varieties released are from introductions.

Benefits derived from utilization of Sudan's germplasm-indigenous and exotic-vary in their nature and purpose according to the crop. For sorghum, for example, the benefits were for the whole country in food security and for all types of farmers growing the crop. The same is true for pearl millet though it, almost exclusively, benefitted the subsistence rainfed farmer. Cotton is mainly for export purposes and mainly benefits the irrigated farmers and tenants of the former Central State. Winter pulses (faba bean, haricot bean, chickpea, lentil) are mainly utilized by the small pump-irrigated farmers in the former Northern State.

The country has thus used its germplasm to benefit all types and categories of farmers. Its present policy in this respect emphasizes benefits to the long-neglected small subsistence farmers.

These differences in benefits to different farmers groups notwithstanding, Sudan has used its germplasm resources to enhance quantity and / or quality of

production of many crops. Notable gains were realized in cotton, sorghum, wheat, groundnut, sesame, pearl millet, winter pulses, onion, tomato, okra, cowpea, roselle and grapefruit. Smaller gains were made in several other crops.

The full benefits from these improvements could have been much greater were it not for some constraints. These are:

1. inability to provide adequate breeder seed supplies,
2. weakness of foundation seed production,
3. weakness of the seed industry-private and public,
4. difficulties of transportation that hamper seed distribution,
5. a very weak extension service and poor coordination and interaction among concerned institutions.

Recent government policies and actions (e.g. enactment of a seed law, establishment of the Seed Council and the National Germplasm Committee and genebank, incentives for private seed companies) shall remove many institutional constraints. Financial constraints still continue to limit the contribution of currently available plant breeders, seed specialists and extensionists. Personnel available in these disciplines are not adequate and their numbers and skills need to be augmented by training and motivating them to stay on the job. These are two aspects where international cooperation can offer badly needed assistance.

The benefits gained from Sudan germplasm resources represent but a small part of a great potential. To maintain and augment this potential for greater exploitation in the future, preservation of this germplasm should be given priority. Detailed characterization and documentation should have the second priority.

The germplasm collections are either poorly or not at all characterized or documented which limits their present utilization. International assistance in training nationals in germplasm management for this purpose is badly needed. It should best come from or through the UN and other international organizations or from governments willing to help.

A brief description of the germplasm utilization activities in forests and different crops in the Sudan is outlined hereunder.

4.1 FORESTS

The Forests National Corporation (FNC) determines plantation programmes of priority species. Then seed requirement by species is determined and the tree seed centre has to supply these either from its stocks or by organizing a collection programme for this purpose.

The main direct benefit is security of the plantations and afforestation programme by seeds of known origin and at reasonable price. Any excess of seeds can be sold for use outside the country. With regard to exotic tree species, Sudan is now self sufficient in Eucalyptus seeds and Tectona grandis (teak) seeds.

The main constraints which retard adequate utilization of PGR are shortage of finance, lack of tree breeders and research plantations and other facilities. Assistance is needed in expertise, equipment and training to improve utilization of PGR. It is preferable that FAO or any UN-system organization provides this assistance.

4.2 CEREALS

Sorghum breeders in the Sudan are perhaps the sole users of the sorghum collection. Beside the indigenous types, they use a big number of introduced types especially cytoplasmic male steriles, but only for grain sorghum. There is no use for the country's rich resources of wild sorghums for forage nor of its superior sorgos for syrup production. Future use of these two latter types requires more thorough collection of their germplasm.

Internationally, Sudan's sorghum germplasm has been utilized extensively and beneficially specially in USA. Other than the kafirs of southern Africa, no sorghum contributed to the crop's current high international status as did Sudan's feterita, milo, hegari, mugud, ziraizeera and Sudan grass types. Milo is one of the two parents whose combination gives the cytoplasmic male-sterility which made sorghum hybrids possible. Thus, international utilization -past and present- of Sudan's sorghum germplasm by far exceeds Sudan's own utilization.

The pearl millet collection is maintained by the crop's breeder and is not duplicated elsewhere. However, this material is sent upon request to other local

and foreign researchers without restrictions. The millet material is used to develop new varieties or hybrids of higher and stable yield with specific quality traits, especially grain colour and resistance to pests and diseases.

Up to now only one imported composite millet variety performed better than the local landraces and was officially released to farmers. Its acceptance was less than expected due to its grain colour and susceptibility to a head-tunneling caterpillar.

In wheat, there was very limited utilization of local landraces in varietal improvement programmes. These local landraces generally evolved from traditional cultivars that used to be grown in neighbouring countries and found their way across the border to the Northern Region of Sudan. However, these local landraces were tall, susceptible to lodging and disease and generally low yielding. Thus, in the sixties, when there was rapid expansion of wheat area in the warmer parts of the country to satisfy local needs, the Mexican varieties proved attractive. Hence, the expedient policy of research to adopt Mexican varieties after testing proved a viable alternative and resulted in a rapid spread of Mexican varieties at the expense of local ones to the point of virtual elimination of the local landraces.

4.3 OIL CROPS

Improvement of sesame started in the early 1950's with the objective of producing non-shattering high yielding varieties for mechanized production. A population segregating for the indehiscent gene (a recessive mutant discovered in Venezuela, in 1943) was imported from the U.S.A. The selected lines from this population and the lines produced by transferring the gene to the local types proved to be poor yielders.

Landraces are still widely used in the Sudan, particularly in western and southern states. A large number of these land- races were collected in the 1950's and early 1960's. Selection within these landraces resulted in the release of six white-seeded and two brown-seeded varieties. These were made available to the commercial and semi-commercial farmers, but were generally not known to the subsistence farmers. Some of these have already disappeared or became mixed beyond recognition.

Intervarietal crosses, involving local and introduced varieties of sesame , were made to combine in one variety some of the characters that were thought to

contribute to high yield. However, the resulting lines were not superior to the local landraces.

In the mid-1970's, a joint breeding programme between the Agricultural Research Corporation and the University of California, Riverside, was started with financial support from UNDP. This led to the release of one sesame variety (Kenana 1) in the mid-1980's. It is a high yielder, white-seeded and practically single-stemmed.

In groundnut, the exotic germplasm was used for direct evaluation and selection and for hybridization followed by pedigree selection. The main objectives were increased pod yield, shelling out-turn and oil content. Over the last 25 years, four varieties were released; three were introductions and one from the hybridization programme.

In sunflower, the main activities, at present, of the national breeding programme involve introduction and evaluation of F1 hybrid varieties.

4.4 FOOD GRAIN LEGUMES

Almost all the legume germplasm used by Sudanese breeders is exotic. The breeders acquire, maintain and supply this germplasm to other scientists requiring it.

Breeding of these crops aims primarily at increasing production, vertically and/or horizontally, for self-sufficiency. No specific farmers group is a targeted beneficiary. However, the irrigated small farmers of the Northern Region benefit most from improvement of the winter legumes. The summer legumes are mostly rainfed and benefit the small traditional farmers of that sector.

To serve these groups of farmers, breeders have developed and released many improved varieties of faba bean, haricot bean, chickpea, lentil and cowpea. Greater achievements in these and other species could have been attained. However, all research is conducted by government institutions only whose scientists are highly capable but their numbers are inadequate and their efforts are hampered by great and chronic shortages in operating funds, equipment, materials, transportation and supporting staff, besides their low salaries and incentives.

4.5 VEGETABLES

Formal vegetable breeding programmes in the Sudan were started relatively recently after the establishment of a horticultural section in the ARC in the mid sixties. Before that, farmers have contributed a lot in the selection and adoption of local cultivars of some popular vegetables like okra and onion. The breeding in several vegetables has depended on exotic cultivars, e.g. tomato, watermelon and eggplant.

The local genetic resources of okra, onion and hot pepper proved to be superior to introduced varieties. Through purification and successive selection three vegetable cultivars of each of onion and okra were developed and officially released. A hybridization and backcrossing programme, using the wild tomato species, Lycopersicon pimpinellifolium, has succeeded in producing tomato cultivars with tolerance to the tomato yellow leaf curl virus.

4.6 FRUITS

For the date palm, local and old cultivars still form the basis for dates production in the Sudan. Introduction of foreign cultivars was started rather early, and recently a programme of introducing Iraqi cultivars has been initiated to widen the genetic base of date culture and expand production to non-traditional areas.

As for banana, Dwarf Cavendish is the only cultivar which is now widely grown in the Sudan. However, recently other banana cultivars (Grand Naine, Williams and Honduras as well as their mutants) have been introduced for evaluation.

With regard to guava, all the cultivars mentioned before are widely spread throughout the country, with material being always transferred from one place to another. However, some guava cultivars (Pakistani, Beamonl, A-H-180, A-H -132 and A-H-157) had been introduced to the Sudan by the ARC sometime ago, but these are probably lost.

In the early seventies, several new citrus cultivars (mainly oranges and grapefruits) were introduced from the U.S.A. They have been tested and evaluated in different sites of the agricultural research stations. Some of them performed very well and were officially released for the growers.

Introduction of new mango cultivars is limited. At least four cultivars were reported to have been recently introduced.

4.7 FIBRE CROPS

The cotton collection type is actively used in the development of new cotton varieties. Resistance to both blackarm disease and jassids was developed at Shambat through direct recourse to the collection. Some accessions are now being evaluated for use as parents in a fusarium wilt resistance programme. The country at present does not maintain any germplasm of any other fibre crop.

4.8 RANGE AND FORAGE PLANTS

Seeds of disappearing or endangered indigenous natural range species are collected, from the managed range reserves, forage production sites, bulking nurseries or from some pockets of naturally protected sites, and broadcast in degraded areas.

As part of the RPA activities in the improvement and rehabilitation programmes in the post-drought period, eight adaptable range species were introduced from Australia and broadcast in the drought affected areas of the semi-desert and low rainfall savannah ecological zones during 1993/94 rainy season. They included new varieties of five already existing range species which are: *Bracharia decumbent, Cenchrus ciliaris, C. setigerus, Chloris gayana and Panicum coloratum*. In addition to these species, three other species were introduced for the first time in the Sudan, namely Stylosanthes amiga, S. hamat and S. scabra.

In the last few years, some private sector companies have been involved in the introduction, evaluation and distribution of some forage crops. For instance Pioneer Company is marketing a hybrid of grain sorghum and Sudan grass as a fodder.

4.9 MEDICINAL, AROMATIC AND POISONOUS PLANTS

Except for some species that are considered as spices or vegetables, no use is made of the germplasm of the medicinal and aromatic plants in plant breeding or other research activities. In the mid-seventies, a plant breeder collected and started selection of senna, *Cassia acutifolia* (= C.nigricans ?), but his efforts were not continued.

4.10 ROSELLE

Recently individual plant selections for desirable calyx characteristics have been started within small collections.

CHAPTER 5
National Goals, Policies and Programmes

The Sudan has not yet developed a nationally and centrally coordinated and funded PGR programme. However, activities in collection, conservation, evaluation and utilization of indigenous PGR have been going on, to various extents, but in a fragmented and non-coordinated manner. The absence of a central genebank and a national PGR authority has been the main weakness in this respect.

The formulation of a national PGR committee by the Minister of Agriculture, Natural Resources and Animal Wealth in 1990 was considered a main step towards having a national PGR policy body. This committee is composed of scientists and officials representing the ARC, universities, national agricultural administrations and NGOs. The main task of the committee, as stated in the ministerial decree of its formation, is to draft and execute a national policy for collection, conservation, evaluation and documentation of PGR and to establish a national centre for that purpose.

A national PGR workshop was organised by the committee in 1992 in which reports and papers were presented on the situation of different PGR in the Sudan. The suggestion of having a national PGR programme and a well staffed and equipped PGR centre under the umbrella of the ARC was greatly supported by the workshop.

Following that event, a proposed programme for the collection, conservation, evaluation and documentation of PGR was presented and approved by the central planning authority in 1993. The execution of such programme has not started yet due to lack of funding from either internal or external sources.

Training of staff has formed an integral but limited part in some of PGR activities. During the first half of the eighties, a programme for the collection and conservation of horticultural crops was jointly executed by the Horticulture Research Section of the ARC and the IBPGR. Training of scientists and assistant scientists was given a high priority in that programme. Some scientists attended short training courses on PGR. A fellowship for M.Sc. in PGR was awarded in 1984/85 by FAO/IBPGR to an ARC research assistant scientist. Training of a few assistant scientists and technicians in the

field of PGR was continued since that time, funded by IBPGR. But at present, out of four staff members who had received proper training only two have remained on the job.

At present, syllabi of the Sudanese universities do not include PGR courses; introduction of such courses may prove helpful. In this regard, training trainers in international or regional centres must receive due attention.

Sudan with its uniqueness in some of the indigenous PGR, like sorghum, pearl millet, okra, etc., and its diversified ecological conditions can play a significant role in the training programmes dealing with exploration and collection of PGR in various ecosystems. This could be done through a well designed and coordinated programme involving international and national training and PGR institutes.

CHAPTER 6
International Collaboration

Sudan is in the process of defining its environmental action plan guided by the UNCED Agenda 21 and the Africa Region Agenda which were approved by the Ministers of Environment in 1993. The Convention on Biological Diversity was ratified by the Council of Ministers in early February 1995. Sudan is a member of FAO Commission on Plant Genetic Resources and is a signatory of the International Undertaking.

In forests, FNC has benefited from projects supported by various organizations, e.g., UNSO, Sahel International U.K., and countries, e.g. the Netherlands, Germany, Denmark, Ireland and Norway. Moreover, the Forestry Research Centre (FRC) got support from DANIDA, through UNSO, for the establishment of three tree seed centres and training in seed technology as well as technical support. Furthermore, support was also provided by FINNIDA in silviculture, agroforestry and tree breeding, by FAO in neem germplasm network and by Winrock International for a Bamboo network.

In field crops over the years, Sudan has collaborated with International Agricultural Research Centres (IARCs), such as ICRISAT, ICARDA, CIMMYT and IITA, and with IBPGR and its successor the newly formed International Plant Genetic Resources Institute (IPGRI). It has also collaborated with UN organizations, such as FAO, UNDP, and IAEA; governmental international research centres, organizations and programmes, such as IDRC, GTZ, and INTSORMIL; some governments and seed companies.

The strongest collaborative involvement was with ICRISAT and ICARDA because they have research mandate over the most important cereals and legumes grown in the country : sorghum, pearl millet, wheat, faba bean and groundnut.

The forms of assistance received from the IARCs included:

1. training which covered in-service training, short term fellowships and M.Sc. degree scholarships;
2. supplying enhanced germplasm for selection by national breeders, international yield trials and nurseries containing germplasm with specific attributes such as resistance to economically important pests and diseases;
3. providing some laboratory and field equipment;
4. fielding technical staff such as the two breeders by ICRISAT whose cooperative programme with the Agricultural Research Corporation resulted in the release of the first sorghum hybrid and the first open-pollinated pearl millet variety;
5. organizing collection missions;
6. facilitating retrieval of national germplasm.

Some shortcomings, however, exist:

1. Foreign support to PGR activities in Sudan has neither been substantial nor sustainable. An international fund for PGR would guarantee sustainability which in turn would strengthen local support.
2. Some commodities of great importance to subsistence farmers in the Sudan such as sesame and cotton and some prospective crops e.g. sunflower and castor are not in the mandate of any of the commodity IARCs.
3. Farmers' needs and quality preferences, such as oil content and composition in groundnut and seed coat colour and plant height in sorghum and millet, are not always taken in consideration in the improvement efforts followed by the commodity IARCs.

CHAPTER 7
National Needs and Opportunities

The rich indigenous PGR of the Sudan forms a very valuable plant heritage for mankind. The country encompasses within its borders a great diversity of potentially important species .

Sudan is internationally famous for producing some important products from the naturally occurring or locally cultivated plant species. Gum arabic, roselle and senna provide good examples of such products. Uniqueness of the Sudan in possessing rich genetic resources of some staple food grains, like sorghum and pearl millet, gives the country a great opportunity to contribute to sustaining and securing food for a great sector of inhabitants in the world. Underutilized or neglected plant species can be used in the future for food, industrial, medicinal or ornamental purposes.

This plant heritage with all its diversity, uniqueness and potentiality is exposed at present to different erosive factors. This calls for serious and urgent action to prevent the degradation and loss of this national resource.

A national policy, enlisting the support, in the context of an international plan seems to be the right approach.

Such policy should address the following aspects:

1. Assessment of the present actual status of PGR.
2. Recruitment and training of personnel including PGR specialists and utilizers (breeders) in addition to technicians.
3. Construction of buildings and provision of equipment for the conservation, evaluation and documentation of PGR.
4. Launching exploration and collection missions on a priority basis for both crops and geographical regions covering all known crops in the country.
5. Characterization, evaluation and documentation of the collected PGR and assessment of their potential benefits.

A national PGR system in the Sudan has to be developed in a gradual manner taking into consideration the present activities and institutional divisions. An ultimate goal must be the establishment of a national PGR centre with legal and technical power for collection, conservation and exchange of the whole PGR in the country.

In the short run, the current activities must be promoted and expanded in a coordinated effort through the National PGR Committee. These activities are:

1. Promotion of the present PGR unit in the ARC to be a central genebank holding the base and active seed collections of all crops and providing living storage for some vegetatively propagated crops, e.g. fruits. Available resources and requirements for this centre are given in Appendix (11).
2. Provision of support to the Forestry Research Centre, the Forestry National Corporation and the Horticulture Administration to rehabilitate their arboreta, botanic gardens and natural reserves.
3. Provision of support to the national Range and Pasture Administration in the rehabilitation of the natural range reserves.
4. Establishment of new ex situ field genebanks and natural *in situ* reserves.

CHAPTER 8
Proposals for a Global Plan of Action

1. The developing countries are rich in useful germplasm which they are not able to collect without outside help. They need international assistance in:
   - training of national professional and technical personnel in germplasm collection, conservation and management.
   - Establishment and maintenance of national and regional genebanks.
   - Equipping and funding missions for germplasm collection of national, regional or international importance.
   - Setting up regional and international germplasm networks to facilitate flow of materials and information.
2. Some important crops of the developing countries should be included in the mandates of IARCs or similar organizations. These crops include sesame, sunflower, safflower, cotton, etc.
3. There is need for establishing conventions that ensure the free exchange of germplasm between nations and acknowledge breeders and farmers rights.
4. The top priority at the international level should be for collection of endangered germplasm, specially crops outside the mandates of IARCs, training, establishment of genebanks, assignment of neglected "orphan" crops germplasm to international centres, networking and international conventions, in a descending order of priority.
5. Within the coming ten years, a critical mass of well trained and equipped germplasm staff can be built in all important countries. During the same period, these cadres can collect the germplasm most important and/or most endangered in their respective countries. This requires international assistance for the poorer countries.

The Sudan will actively work and cooperate towards achieving its proposals for the Global Plan of Action. In this regard, the country is prepared to work towards achieving and contributing in certain national and regional issues. In particular, Sudan can make available relevant expertise for regional and /or international cooperation, as well as availing its diverse ecosystems for training in exploration and collection of PGR.

APPENDIX 1
A list of the Indigenous Tree Species by Ecological Zones

1. Tree species in the Desert zone

Acacia flava (Syn. A. ehrenbergiana).
Capparis decidua.
Leptadenia spartium, L. pyrotechnica.
Maeriana crassifolia.

2. Tree species in Acacia Desert Scrub

Acacia albida.
A. flava.
A. mellifera.
A. radiana.
A. senegal.
A. seyal.
A. tortilis.
Balanites aegyptiaca.
Boscia senegalensis.
Capparis decidua.
Commiphora sp.
Grewia tenax.
Gossypium anomalum.
G. somalense.
Hyphaene thebaica.
Leptadenia spartium.
Maerua crassifolia.
Salvadora persica.
Ziziphus spinachristi.

3. Acacia Short Grass Country

Acacia mellifera.
A. senegal.
Adansonia digitata.
Albizzia sericocephala.

3. Acacia Short Grass Country

A. aylmeri.
Codaba rotundifolia.
Combretum hartmanniarum.
Commiphora sp.
Hyphaene thebaica.
Sclerocaria bierra.
Terminalia brownii.

4. Acacia Tall Grass Country

Acacia campylacantha.
A. fistula.
A. mellifera.
A. nilotica.
A. senegal.
A. seyal.
A. sieberiana.
Anogeissus schimperi (syn. An. leocarpus).
Balanites aegyptiaca.
Boswellia papyrifera.
Crateva adansonii.
Dichrostachis glumerata (syn D. cinaria).
Ficus sp.
Lannea humilis.
Lonchocarpus loxiflorus.
Oxytenantheca abyssinica.
Sterculia setigera.
Stereospermum kunthianum.
Z. spinachristi.

5. Mixed Deciduous Fire-swept Forest

Acacia camphylacantha.
A. hebecladoides.
Adenium honghel.
Afzelia africana.
Albizzia anthelamintica.
A. cericocephala.
A. zygia.
Amlygono carpus sp.
Anogeissus schimpiri.
Anona senegalensis.
Antiaris toxicaria.
Borassus aethiopicum.
Bridelia micrantha.

5. Mixed Deciduous Fire-swept Forest

Burkea africana.
Butryrospermum niloticum.
Chlorophora excelsa.
Cola cordifolia.
Cordyla sp.
Dalbergia melanoxylon.
Daniella oliveri.
Detarium senegalensis.
Diospyros mespiliformis.
Entada sudanica.
Erythrophleum guineense.
Gardinia lutea.
Grewia mollis.
Hymenocarpa acida.
Irringia smithii.
Isoberlinia doka.
I. tomentosa.
Khaya senegalensis.
Kigelia aethiopica.
Lannea keristingii.
Landolphia florida.
Mimusops djurensis.
Mitragyna inermis.
M. schimperi.
M. stipulosa.
Parinari curatellifolia.
Parkia oliveri.
Pilostigma reticulatum.
Prosopis africana.
Pseudocedrala kotschyi.
Pterocarpus lucens.
Pycnanthus kombo.
Sarcocephalus esculentus.
Sclerocaria birria.
Strychnos spinosa.
Syzigium guineense.
Upaca sp.
Tamarindus indica.
Vitex cuneata.

6. Mixed Deciduous Grassless Transitional Forest

Anogeissus schimpiri.
Mimosops sp.
Ruth sp.
Tamarindus indica.

7. Closed Lowland Forest, Including Fringing or Gallery Forest

Alsonia congensis.
Canarium schweinfurthii.
Ceba pentandra.
Chlorophora excelsa.
Chrysophyllum sp.
Cofea robusta.
Entandrophragma sp.
Erythrina sp.
Ficus sp.
Funtumia elastica.
Khaya grandifoliola.
Maesopsis eminii.
Mildbraediodendron excelsum.
Mitragyna enermis.
M. stipulosa.
Schrebera macrantha.

8. Mountain or Cloud Forest

Acacia abyssinica.
Acacia mollisima (introduced).
Dombeya mukole.
Erythrina tomentosa.
Fagara sp.
Faurea speciosa.
Hagenia abyssinica.
Juniperus procera (introduced).
Olea chrysophylla.
O. welwischii.
Peteris aquilina.
Podocarpus milanjianus.
P. gracilios.
Protea gaguedi.
Rubus sp.

APPENDIX 2
Introduced and Naturalized Tree Species in the Sudan

1. Desert Zone Under Irrigation

Acacia farnesiana.
Azadirachta indica.
Conocarpus lancifolius.
Cassia auriculata.
Casuarena equisetifolia.
Eucalyptus camaldulensis.
E. microtheca.
Parkinsonia aculeata.
Prosopis chilensis.
Prosopis juliflora.

2. Acacia Desert Scrub Under Rainfall

Azadirachta indica.
Cassia auriculata.
Parkinsonia aculata.
Prosopis chilensis.
Prosopis juliflora.

3. Acacia Short Grass Country Under Rainfall

Azadirachta indica.
Cassia siamea.
Conocarpus lancifolius.
Eucalyptus camaldulensis.
E. microtheca.

4. Acacia Tall Grass Country

Azadirachta indica.
Cassia siamea.
Conocarpus lancifolius.
Eucalyptus camaldulensis.
E. microtheca.

5. Mixed Deciduous Forest

Cassia siamea.
Cedrella tona.
Gravelia robusta.
Eucalyptus territicornis.
Leucaena glauca.
Tectona grandis.

6. Mixed Deciduous Grassless Transitional Forest

Same species as above plus some trials of lowland Pines, e.g *Pinus oocapa, P. pinea*

7. Closed Lowland Forest

Same species as in 6.

8. Mountain or Cloud Forest

In addition to the species in 7, the following were successfully introduced:
Cedrella toona.
Cuppressus lusitanica.
Cupressus sempervirens.
Eucalyptus globulus.
E. grandis.
Pinus raddiata.

APPENDIX 3
Old and Newly Introduced Citrus Cultivars in Collection Blocks

Old Cultivars (introductions)

a. Sweet orange (*Citrus sinensis* Osbeck)

- Beladi.
- Navel.
- Nuri 16.
- Sinari.
- Valencia (unidentified).
- Buttler.

b. Grapefruit (*Citrus paradisi* Macdf)

- Beladi white seedless.
- Duncan.
- Foster pink.

c. Mandarin and mandarin-like (*C. reticulata Blanco*)

- Yousif Effendi.

d. Lime (*C. aurantium*)

- Beladi lime (Key west, Mexican lime, Persian lime).

e. Lemon (*C. .....*)

- Adalia.

f. Root stocks

- sour orange.

New Cultivars (introductions)

a. Sweet orange:

1. Naval group:

- Gillete.
- Frost.
- Parent.
- Thackery.

2. Valencia group:

- Campbell.
- Olinda.

3. Hamlin

b. Grapefruit

- Carpenter.
- Davis.
- Duncan.
- Howell.
- Little river.
- L.V.M. Brown.
- Miami.
- Marsh seedless.
- Red blush.
- Ruby

c. Mandarin and Mandarin-like

- Honey.
- Minneole tangelo.
- Kara.
- King.
- Kinnow.
- Orlando tangelo.
- Temple orange.

d. Lime

- Bearss (Tahiti, Persian).

e. Lemon

1. Eureka group:
   - Allen.
   - Cascade.
   - Cavers.
   - Cook.
   - Forst.
   - Lisbon.
   - Rosenberger.

f. Root stocks

- Citrus macrophylla.
- Poncirus trifoliate.

g. Cleopatra mandarin

- Carrizo citrange.
- Rangbur lime.
- Sour orange (Brazil).
- Sour orange (U.S.A.).
- Swingle citrumelo.
- Troyer citrange.
- Volkamariana.

APPENDIX 4
Old and Newly Introduced Mango Cultivars in Sudan

Old Introductions:

1. Abu samaka
2. Alfonso
3. Aromanis
4. Aziza
5. Bashaier
6. Bull heart
7. Disbsha
8. Dr. knight
9. Ewase
10. Galbour
11. Golouk
12. Kawaja
13. Khartoum
14. Kitchiner
15. Langabranis
16. Mabrouka
17. Mahmoudy
18. Malgouba
19. Miska
20. Nylum
21. Perri
22. Shendi 1
23. Shendi 2
24. Sigrest
25. Sinnari
26. Taymour
27. Toto kambo
28. Toto Perri
29. Wali Basha
30. Zibda Egyptian
31. Zibda Indian
32. Zibda local

New Introductions:

1. Heden
2. Kent
3. Sensation
4. Sabrin

APPENDIX 5
Some Indigenous Fibre-Bearing Species of the Sudan

Species Arabic	English or other local name
Abutilon graveolens	Hambouk
Acacia mellifera	Kittir
A. orfota (= A. nubica)	La'ot
A. raddiana	Seyal
Adansonia digitata	Tabaldi, Boabab tree
Bauhinia reticulata	Kharoub
Borassus aethiopium	Dalaib
Calotropis procera	Usher, Dead Sea apple
Chorcorus olitorius	Mulokhia, Jews Mallow, jute
Crotalaria spp.	Sofira
Chrozophora crocchiana	Dergo, ergisi
Daemia cordata	Umm-el-leben
Desmostachya cynosuroides	Halfa
Dombeya multiflora	Gergedan
Dracaena ombet	Batt, dragon tree
Grewia mollis	Basham (Ar.), Poingo (Zande)
Hibiscus cannabinus	Karkanj, teel, Deccan hemp
Hibiscus sabdariffa	Kerkade, roselle
Hyphaene thebaica	Dom, dom palm
Lannea spp.	Um leyona
Mucuna pruriens	
Phoenix dactylifera	Nakhla, date palm
Sanseveria sp.	Za'af-el-feel, bowstring hemp
Sesbania spp.	Saisaban
Sida spp.	Nyada
Vigna ungiculata	Luba hilu, cowpea
Wissadula rostrata	

APPENDIX 6
Important Forage Crops and Natural Range Plants in Sudan

Important Cultivated Forage Crops:

1. *Chloris gayana*
2. *Clitoria ternata*
3. *Dolichus purpureus*
4. *Medicago sativa*
5. *Pennisetum purpureum*
6. *Phasealus trilobus*
7. *Sorghum bicolor*
8. *S. Sudanense*
9. *Zea mays*

Important Natural Range Plants:

1. *Andropogon gayanus*
2. *Aristida spp.*
3. *Atriplex farinosa*
4. *Blepharis ciliaris*
5. *B. liniariifolia*
6. *Brachiaria eruciformis*
7. *Cadaba rotundifolia*
8. *Cenchrus ciliaris*
9. *C. pennisetiformis*
10. *C. setigerus*
11. *Chrozophora brochiana*
12. *Crotalaria senegalensis*
13. *Dactyloctenium aegyptium*
14. *Indigofera spp.*
15. *Ipomoea spp.*
16. *Panicum turgidum*
17. *Salsola spp.*
18. *Scindicus hirsutus*
19. *Suaeda sp.*
20. *Stylosanthes flavicans*
21. *Zornia glochidiata*

APPENDIX 7

Medicinal and Poisonous Plant and Spices Species Indigenous in the Sudan

n°	Medicinal Plants	Medical Use
1.	*Abrus precatorius*	leaves as demulcent & seeds as purgatives
2.	*Acacia albida*	bark against diarrhoea
3.	*A. gerrardii*	leaves for stomach pains
4.	*A. nilotica*	pods for cough and as a gargle for tonsillitis
5.	*A. nusica*	leaves as poultice for swellings
6.	*A. polyacantha*	bark for jaundice and bilharzia
7.	*Acanthospermum hispidium*	whole plant for bilharzia
8.	*Achyranthes aspera*	roots as antiseptic for wounds
9.	*Adansonia digitata*	fruits pulp for stomach pains
10.	*Albizzia amara*	bark for jaundice and mouth inflammations
11.	*A. anthelmintica*	bark as vermifuge
12.	*Alternanthera nodiflora*	whole plant as a poultice for swellings
13.	*Annona senegalensis*	fruits as a poultice for lice
14.	*Aristolochia bracteolata*	root against scorpion stings
15.	*Asparagus flagellaris*	root as fumigant against rheumatism
16.	*Azadirachta indica*	leaves against snake wounds, scorpion stings, roots against intestinal spasm
17.	*Balanites aegyptiaca*	fruit pulp as anthelmintic and purgative
18.	*Bauhinia rufescens*	leaves against diabetes
19.	*Blepharis linariifolia*	whole plant as a general tonic
20.	*Blumea aurita*	leaves against jaundice
21.	*Boscia angustifolia*	bark as anthelmintic
22.	*B. senegalensi*	roots against bilharzia and leaves as a poultice for muscle pains
23.	*Boswelli papyrifera*	bark for jaundice
24.	*Cadaba glandulosa*	stems as fumigant against rheumatism
25.	*Cadasa farinosa*	whole plant as taeniafuge
26.	*C. glandulosa*	leaves as poultice for swellings
27.	*Calotropis procera*	latex against scorpion stings and roots for jaundice

n°	Medicinal Plants	Medical Use
28.	*Capparis decidu*	stems against jaundice and as a poultice for swellings
29.	*Carissa edulis*	fruits as anthelmintic
30.	*Cassia italica*	leaves and pods as laxatives
31.	*C. fora*	seeds against ring worm
32.	*C. nigrcans*	whole plant for stomach pains
33.	*Celosia argenti*	leaves as anthelmintic
34.	*C. trigyna*	whole plant against worms
35.	*Celtis infegrifolia*	bark for stomach pains
36.	*Chozophora plicata*	whole plant to enhance wound healing
37.	*Citrullus colocynthis*	fruits as laxative
38.	*Cissus quadraaugularis*	roots against scorpion stings
39.	*Clerodendron capitatum*	roots for general tonic
40.	*Cliasmanthera dependens*	roots against colic
41.	*Combretum aculeatum*	roots as a poultice for skin tuberculosis
42.	*C. hartmannianum*	bark for jaundice
43.	*Commicarpus africanus*	roots against jaundice
44.	*Cordia sinensis*	bark to enhance wound healing
45.	*Cucumis dipsaceus*	whole plant as anti-emetic
46.	*C. metiliferus*	fresh fruits against stomach pain
47.	*Dalbergia melanoxylon*	stems as fumigants against rheumatism
48.	*Dicoma tomentos*	whole plant as tebrifuge
49.	*Diospynos mespiliformis*	roots blend with other species against leprosy
50.	*Echinops longifolius*	roots against bites
51.	*Echium arenarium*	whole plant as a poultice against tumors
52.	*Fagonia cretica*	whole plant as a poultice against tumors
53.	*Gardenia lutea*	fruits for bilharzia and roots for infective hepatitis and splenomegaly
54.	*Geigeria alata*	whole plant as a fumigant for muscular pains

n°	Medicinal Plants	Medical Use
55.	*Grewia flavescens*	roots for skin tuberculosis
56.	*G. tenax*	fruits as a tonic
57.	*Guiera senegalensis*	leaves as antidiabetics
58.	*Hygrophilia auriculata*	whole plant as a poultice for back pains and swellings
59.	*Kigelia africana*	bark against dysentery
60.	*Lasiosiphon iraussianus*	whole plant as a poultice for swellings
61.	*Leonotis neplifolia*	fruits as antispasmodic
62.	*Leptadenia arborea*	roots against gonorrhoea
63.	*Leucas martinicensis*	whole plant as anthelmintic and for jaundice
64.	*Lonchocarpus laxiflorus*	bark as anthelmintic
65.	*Momordica balsamina*	fruits as antispasmodic and leaves as a purgative
66.	*Nauclea latifola*	roots against dysentery and fruits for cough
67.	*Ocium basilicum*	leaves against jaundice
68.	*Physostigma mesopondicum*	tuber against bilharzia and constipation
69.	*Plumbago zeylanica*	whole plant as a wash against leprosy
70.	*Rogeria adenophylla*	whole plant against diarrhoea
71.	*Soba florida*	leaves against stomach pains
72.	*Sclerocarya birrea*	bark against diarrhoea
73.	*Sterculia stigera*	bark against jaundice and bilharzia
74.	*Stereospermum kunthianum*	roots as a gargle for tonsillitis
75.	*Stylochiton grandis*	roots as anthelmintic
76.	*Tamarindus indica*	fruits pulp as laxative, for febrifuge and for malaria
77.	*Tephrosia obcordata*	whole plant as anthelmintic
78.	*T. uniflora*	roots against tooth ache
79.	*Terminalia laxiflora*	leaves as eye-wash
80.	*Vernonia amygdalina*	roots against skin infections and as anthelmintic

n°	Medicinal Plants	Medical Use
81.	*V. adoenis*	roots against scorpion stings
82.	*Vitex doniana*	roots as a poultice against swellings
83.	*Waltheria indica*	leaves against ulcers and diarrhoea
84.	*Withania somnifera*	bark against stomach pain and root against
85.	*Ziziphus spina-christi*	roots against gonorrhoea

Wild Poisonous Species:

1. *Abrus precatorius*
2. *Aregemone mexicana*
3. *Clematis insico-dentata*
4. *C. glaucescens*
5. *C. simensis*
6. *Convolvulus arvensis*
7. *Datura innoxia*
8. *D. metal*
9. *D. stramonium*
10. *Euphorbia spp.* (~ 35 *spp.*)
11. *Hyoscyamus muticus*
12. *Linum strictum*
13. *Nicotiana rustica*
14. *Oxalis anthemintica*
15. *O. corniculata*
16. *O. obliquifolia*
17. *Ranunculus multifidus*
18. *R. oreophytus*
19. *Ricinus communis*
20. *Rumex abyssinica*
21. *R. nepalensis*
22. *R. nervosus*
23. *R. vesicarius*
24. *Solanum spp.* (~ 19 *spp.*)
25. *Withania somnifera*

Spices Commonly Cultivated in Sudan:

1. *Atapina galanga*
2. *Brassica alba*
3. *B. nigra*
4. *Capsicum Annum*
5. *C. frutescens*
6. *Carum carvi*
7. *Coriandrum sativum*
8. *Cuminum cymerium*
9. *Eugenia caryohillata*
10. *Foeniculum vulgare*
11. *Pimpinella anisum*
12. *Thymus vulgaris*
13. *Zingiber officnale*

APPENDIX 8
Some Indigenous Ornamental Plant Species and their Locations

1. Trees and Shrubs

Shrubs	Locations
Dodonea Viscosa	Erkawit
Salvadora persica	Eastern, Western, North Sudan
Olea Chrysophylla	Erkawit, Jebel Marra
Ximenia americana	Widespread
Oncoba Spinosa	Gallabat, Bahrelghazal.
Adenium Obesum (A. honghel)	Nuba Mountains, J.Marra
Carissa edulis	Widespread
Delonix alata (Poinciana)	Red Sea Hills

Trees	
Parkinsonia aculeata	Widespread
Tamarindus indica	Central Sudan
Albizzia zygia	Equatoria
Andira inermis	Equatoria
Ficus salicifolia	Central Sudan, on hillsides
F. populifolia	Central & S.Sudan
F. dekdekena	Central & S.Sudan
Combretum hartmannianum	Central Sudan
Dracaena ombet	Red Sea Hills
Securidaca longpedunculata	Blue Nile-hillsides

2. Bulbous Plants

	Locations
Gloriosa simplex	Red Sea Hills, Central & S. Sudan
Scilla sp.	Eastern,Central Sudan,Equatoria
Crinum jagus	S. Sudan
Crinum abyssinica	Funj District
Haemanthus multiflorus	Central & S. Sudan
H. rupestris	Kordofan
Gladiolus psittacinus	Central & S. Sudan
G. unguiculatus	Equatoria

3. Cacti and Succulents

Aloe sinkataria	Red Sea Hills, Sinkat
Kalanchoe glaucescens	Erkawit
Bryophyllum pinnatum	Equatoria
Crassula pentandra	Red Sea Hills
Umbilicus botryoides	Red Sea Hills, J. Marra
Rhipsalis cassutha	Equatoria
Cissus quadrangularis	Red Sea Hills, Nuba Mts.
Euphorbia candelabrum	Central & S. Sudan
E. abyssinica	Red Sea Hills
E. tirucalli	Central Sudan
E. venefica	Central & S. Sudan
E. Nubica	North & Central Sudan

4. Palms

Ancistrophyllum secundiflorum	(Climber) Equatoria
Borassus aethiopum	Central & S. Sudan
Calamus deerratus	(Climber) Equatoria
Hyphaene thebiaca	North & Central Sudan
Medemia argum	North Sudan-Nubian desert
M. abiadensis	White Nile
Phoenix reclinata	J. Marra,S. Sudan
Rhaphia monbuttorum	Equatoria

5. Vines

	Locations
Clitoria ternata	Widespread
Hippocratea ritchardiana	Central & S.Sudan
Phaseolus augustifolia	Eastern Sudan
Canavalia ensiformis	Western Sudan
Ipomoea cairaca	Central & S. Sudan
Capparis tomentosa	Central Sudan

6. Foliage

Pandanus sp.	Equatoria
Adiantum sp.	Blue Nile, S. Sudan
Colocasia antiquorum	Central and S. Sudan
Caladium hybrida	Bahr Elgahazal
Andset ventricosum	Red Sea Hills
Coleus barbatus	J. Marra
Coleus darfurensis	S. Sudan
Hydicium coronavia	S. Sudan
Thabia weiwitshii	Central & S. Sudan
Asparagus filagellaris	Central & S. Sudan
A. nacemosus	Central & S. Sudan
Commolina sp.	Central & S. Sudan

7. Ground Covers

Cynodon dactylon	Widespread
Mentha loongifolia	J. Marra
Indogofera sp.	Central & S. Sudan
Trifolium sp.	Red Sea Hills
Anagalis sp.	Central & S. Sudan

APPENDIX 9

Some Wild Species Used as Famine Foods

Botanical Name	Local Name	Parts Used
Adansonia digitata	Tabaldi	fruits, leaves
Balanites aegyptiaca	Hijleej	fruits, leaves
Borassus aethiopium	Dalaib	fruits, sprouts
Boscia senegalensis	Mokhait	fruits, seeds, leaves
Brachiaria obtusiflora	Um chirr	grains
Cassia obtusifolia	Kawal	leaves
Cenchrus biflorus	Haskaneet	grains
Dactyloctenium aegyptium	Koraib	grain
Diospyros mespiliformis	Joghan	fruits
Dobera roxburghii	Maikih	fruits, seeds
Dombeya multiflora	Gregdan	fruits
Echinochloa colona	Difra	grains
Ficus sycamorus	Jimaiz	fruits
Fimbistylis bisumbellata	Dign-il-tais	fruits
Grewia mucronata	karno	fruits, seeds
G. tenax	Goddaim	fruits
Gynadropis gynandra	Tamalaika	leaves
Hyphaene thebaica	Dom	fruits, sprouts
Maerua pseudopetalosa	Kordak	fruits
Nauclea latifolia	Karmadoda	fruits
Oryza punctata	Roz-el-wadi	grains
Randia genipaeflora	Karkar	fruits
Sclerocarya birrea	Hommaid	fruits
Sorghum sudanense	Adar	grains
Tamarindus indica	Aradaib	pods, leaves
Tribulus terrestris	Diraisa	fruits
Ximenia americana	medaika	fruits
Ziziphus spinachristi	sidir	fruits, seeds

APPENDIX 10

A. Tanin-Production trees of the Sudan

Species name	Local name
Acacia albida	Haraz
A. farnesiana	Fitna
A. mellifera	Kitr
A. mollisima	-
A. nilotica	Sunt
A. polycantha	Kacamout
A. polycantha var. campylcantha	Umsineina
A. senegal	Hashanb
A. seyal var. seyal	Talih
A. sieberifana	Kuk
A. tortillis	Seyal
Adansonia digiatata	Tabaldi
Albizia amara	Arad
A. lebbeck Dign	Elbasha
Anacardium occidentale	-
Anogeissus leiocarpus	Sahab
Azadirachta indica	Neem
Balanitus aegyptiaca	Higleeg
Bauhinia refescens	-
Cassia auriculata	-
C. fistula	-
C. siamea	-
C. sieberiana	-
Casuarina equisetifolia	-
Combretum hartmannianum	Habil
C. nigricans	Habil
Entada africana	-
Eucalyptus camaldulensis	Ban, Kafur
E. triticornis	Ban, Kafur
Ficus capensis	Labakh
Moringa oleifera	Shagarat el Rawag
Pterocarpus erinaceus	Papilonaceae
Sclerocarya birrea	Anacridaceae
Tamarindus indica	-
Tamarix aphylla	Tamaricaceae
Terminalia brownii	Combretaceae
Ximenia americana	Olacaceae
Ziziphus spina-christi	Rhaminaceae

B. Gum producing plants of the Sudan

Plant name	Family name
Abrus pulchellus	*Papilionanceae*
Acacia abyssinica (Hechst ex)	Benth *Mimosaceae*
A. albida Del.	"
A. asak (Forsk.) Wild.	"
A. drepanolobium (Harms. ex.) Sjest.	"
A. ehrenbergiana Hayne.	"
A. farensiana (L.) Wild.	"
A. flava Schw.	"
A. gerrardii Benth.	"
A. kirikii Benth.	"
A. hockii De Wild.	"
A. laeta (R. Br. ex) Benth.	"
A. macrostachya (Reichb.) DC.	"
A. mellifera (Vahl.) Benth.	"
A. nilotica (L.) (Wild ex.ex.) Del	"
A. nubica Benth	"
A. polycantha Wild *subsp. campylacantha*	"
A. senegal Wild. var. senegal Brenan	"
A. seyal Del. var. seyal Brenan	"
A. seyal Del. var. fistula (Schweinf) Oliv	"
A. sieberana DC.	"
A. tortillis (Fresk.) Hayne.	"
Ailanthus excelsa Roxb.	*Simaroubaceae*
Albizia amara (Roxb.) Boiv. subsp. *sericicephala Brenan*	*Mimosaceae*
Albizia anthelmintica Brong.	"
A. lebek (L.) Benth.	*Mimosaceae*
A. procera (Roxb.) Benth.	"
A. zygia (DC.) J.F. Macbr.	"
Adansonia digitata L.	*Bambaxaceae*
Afzelia africana pers.	*Caesalpinaceae*
Anacardium occidentale L.	*Anacaridaceae*
Anogeissus leiocarpus (DC.) Guill. et. Perr.	*Cobretaceae*
Antiaris africana Eng.	*Moraceae*
Azadirachta indica H. Juss.	*Meliaceae*
Balanites aegyptiaca (L.) Del.	*Balanitaceae*
Bauhinia purpurea linn.	*Caesalpiniaceae*
Bauhinia fassoglensis kotschy.	"
Bombax malabaricum DC.	*Bomacaceae*

Species name	Local name
Borassus aethiopum Mart.	*Palmae*
Boswellia papyirfera (Del) Hochst.	*Burseraceae*
Burkea africana Hook.	*Caesalpiniaceae*
Butyrospermum pardoxum (Gaertn.f.) Hepper	*Sapoteaceae*
subsp. parkii (G.Don.) Hepper var.	
nilotica (kotschy) Prerre ex Engler.	
Canarim schweinfurthii Engl.	*Burseraceae*
Cassia fistula L.	*Caesalpiniaceae*
Cassia sieberana DC.	"
Cedrela toona Roxb.	*Meliaceae*
Ceiba pentandra (L.) Gaertn.	*Bombacaceae*
Ceratonia siliqua L.	*Caesalpiniaceae*
Chlorophora excelsa (Welw.) Benth.	*Moraceae*
Cola cordifolia (Cav.) R.Br	*Sterculiaceae*
C. gigantea A. chev.	"
Combretum binderianum ketschy.	*Combretaceae*
C. elliotii Engler & Diels.	"
C. ghasalense Schweinf.	"
C. glytinosum Perr. ex. DC.	"
C. gueingii Sond.	"
C. hartmannianum Schweinf.	*Combretaceae*
C. glutnosium Engler and Diels.	"
C. sericeum Don.	"
C. verticillatum Engler.	"
Commiphora africana Engl.	*Burseraceae*
C. erythraea (Ehrenb.) Engl.	"
C. opabalsamum (L.) Englar.	"
C. pedunculata Engl."	
Cordia rothii Roem. and Schult.	*Boraginaceae*
Cordyla richardii Planch.	*Papilionaceae*
Crataeva adonsonii DC.	*Capparidaceae*
Combretum ghasalense Schweinf.	*Combretaceae*
Combretum gultinosum perr. ex DC.	"
Combretum gueingii Sond.	"
Combretum hartmannianum Schweinf	"
Combretum cordofanum Engler & Diels.	"
Combretum sericeum Don.	"
Combretum verticillatum Engler.	"
Commiphora africana Engl.	*Burseraceae*
C. erythraea (Ehrenb.) Engi.	"
C. opabalsamum (L.) Engiar.	"

Species name	Local name
C. pedunculata Engl.	"
Daniellia oliveri (Rolf.) Hutch. and Dalz.	*Caesalpiniaceae*
Delonix regia Raf.	"
Detarium senegalensis Gmel.	"
Dicharostachys cinerea (L.) Wight. and Arn. *subsp. cinerea* Chiev.	*Mimosaceae*
Diospyros mespiliformis Hochst. ex DC.	*Ebanaceae*
Entada africana Guill. and Perr.	*Mimosaceae*
Erythrophoeum africanum (Benth.)	*Caesalpiniaceae*
E. guineense Don.	"
Eucalea schimperi (A.DC.) Dandy Cemb. Nov.	*Ebenaceae*
Haermatostaphis barteri Hooks. f.	*Anacardiaceae*
Isoberlinia doka Craib. and Stapf.	*Caesalpiniaceae*
Khaya senegalensis A. Juss.	*Meliaceae*
K. grandifolia C. DC.	"
Lannea barteri Engl.	*Anacridaceae*
L. kerstingii Engler and Krause	*Anacridaceae*
L. fruticosa Engl.	"
Maba abyssinica Hiern.	*Ebenaceae*
Mangifera indica L.	*Anacridaceae*
Melia azedarach L.	*Meliaceae*
Moringa oleiferi Lam.	*Moringaceae*
Nauclea latifolia Sim.	*Rubiaceae*
Paullinia pinnata L.	*Sapindaceae*
Pileostigma reticulatum (DC.) Hochst.	*Caesalpiniaceae*
P. thonningii Milne-Redh.	"
Piptadenia africanum	*Mimosaceae*
Pithecellobium dulce (Roxb.) Benth.	"
Prosopis chilensis Stunts.	"
P. africana (Guill. and Perr.) Taub.	"
Pseudocedrela kostchyi (Scheinf.) Harm.	*Meliaceae*
Pseudospondia microcarpa Engl.	*Anacridaceae*
Psorospermum guineenze (L.) Hocher.	*Hypericaceae*
Pterocarpus lucens Guill. and Perr.	*Papilionaceae*
Samanea saman (Jacq.) Merr.	*Mimosaceae*
Sclerocarya birrea (A. Rich.) Hochst.	*Anacardiaceae*
Sterculia setigera Del.	*Sterulaceae*
S. africana (Lour.) Fiori.	"
Tamarindus indica L.	*Caesalpiniaceae*
Terminalia cattapa L.	*Combretaceae*
T. macropera Guill. and Perr.	"
Tetrapleura tetraptera (schum.) Taub.	*Mimosaceae*
Trichilia roka (Forsk.) Chiov.	*Meliaceae*
Woodfordia uniflora Koehne.	*Lythraceae*

APPENDIX 11
Available Resource and Requirements of the PGR UNIT/ARC

1. Available resources

a. Personnel:

- One research scientist with an M.Sc. in PGR.
- One assistant researcher, already undertaking his M.Sc. programme.
- One technical officer with a diploma in Agriculture

b. Equipments:

- Seven deep-freeze chests with a capacity of 600 litres each.
- A 37 KVA generator.
- One dehumidifier for seeds.
- One incubator.
- One oven.
- Two sealing machines for aluminium packets.
- One precision top balance.
- Two sealing machines for aluminium packets.
- Two sets of sieves.
- 50 petri dishes.
- 50 Aluminium dishes.
- One microcomputer with printer.

c. Buildings:

- A laboratory room accommodating all the above-mentioned equipment.
- A newly constructed building for cold storage with three compartments, two with a volume of 45 m3 each and the third is 30 m3. This building is lacking compressors.
- A newly constructed seed processing laboratory with an attached office.

2. Requirements:

Taking in consideration the available resources, the following is required for a national PGR centre (NPGRC):

a. Personnel:

- Manager
- Exploration and collection specialist.
- Conservation specialist.
- Multiplication, regeneration and evaluation of PGR specialist.
- Documentation specialist.
- 4 college graduate technicians.
- 4 technical assistants (graduate of secondary schools).
- 2 typists.
- 2 drivers.
- Labour.

b. Buildings:

In addition to the present cold storage room laboratory, the following extra buildings are required:

- 3 store rooms to accommodate deep freezers; dimensions of each is 14 x 6 metres.
- 2 Laboratories with attached office rooms.
- Documentation room.
- Seed drying room.
- Store.
- Green house: Bamboo shed.

c. Transport facilities:

- 2 station wagons: four wheel drive.
- 2 pickups: four wheel drive.

d. Equipments:

- Cooling machines (compressors) for the three cold storage compartments.
- 50 deep freeze chests for base collection (600 litre each).
- 2 Sealing machines.
- 2 precision top balances.
- 2 ovens.
- One seed drying machine.
- Aluminium filing system for the deep freezers.
- Mobile shelving system for the cold room.
- Water proof cartons for the cold room.
- 2 mini - seed threshers.
- 2 seed grinders.
- 10 desiccators.
- 300 Aluminium dishes.
- 300 Petri dishes.
- 200 Plastic boxes.
- Two microcomputers with printers and electricity stabilizers.
- One Photocopier.

e. Consumables:

- Laminated aluminium foil packets.
- Filter paper and paper towelings.
- Diskettes.
- Stationery.
- Silica gel.

f. Training:

Training is important for successful implementation of the national PGR programme in Sudan.

Training requirements for the NPGRC can be summarized in:

1. Training of four graduates up to the level of M.Sc. and/or Ph.D. in PGR.
2. Short training courses in exploration and collection of PGR for other scientists involved in this programme.
3. Short training courses in the different aspects of PGR for technicians.

g. Urgent requirements:

There is an urgent need for:

1. Viability testing for the seeds of 1,500 accessions of horticultural crops which have been stored for about 8 years in the PGR Unit.
2. Regeneration of the material which have reached low levels of viability.
3. Regeneration of 2,092 Sudanese sorghum accessions.
4. Collection of some local genetic resources which are most likely to be lost in few years if no measures are taken.

Such urgent programme necessitates provision of the following requirements:

1. Filter papers for seed germination tests.
2. Financing sorghum regeneration tests.
3. four-wheel drive vehicle for the germplasm collecting programme.
4. Completion of present cold storage room by providing:
   - Compressor (s)
   - Mobile shelving system
   - Waterproof cartons
5. Seed containers: Laminated aluminium foil packets.

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  Dr. **Hassan Muzamil Ali Dinar**

  Dr. **Gamaleldin A/Hai Hamid**

  Dr. **Daoud Hussein Daoud**

- **Cotton:**

  Dr. **Ahmed Salih Fadlalla**

- **Range and forage plants:**

  Dr. **Alawia Abdalla**

- **Weeds:**

  Dr. **Abdul Gabbar Gumaa**

- **Medicinal, aromatic and poisonous plants:**

  Dr. **Gamaleldin Ghazali**

- **Ornamental plants:**

  Dr. **Idris Abdel Rahman**

- **Roselle:**

  Professor **Mohamed O. Khidir**

- **Guar:**

  Professor **Mahmoud Ahmed Mahmoud**

- **Famine foods and other useful wild plants:**

  Dr. **Nadir Mohamed Awad**

  Professor **Mahmoud Ahmed Mahmoud**

- **PGR unit/ARC:**

  El Tahir Ibrahim Mohamed

- **International Professor Abdel Moneim B. El Ahmadi Collaboration:**

  Mohamed Abdalla Ali