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64

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Cover photo: Traditional method of frightening birds away from sorghum fields in Ethiopia

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PLANT GENETIC RESOURCES NEWSLETTER

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Genetic Resources in the Triticeae

This article is based on the report of an IBPGR Workshop on the Triticeae held 6-8 August 1985 in Washington, D.C. The IBPGR is grateful for the assistance of those who participated.

The Triticeae is a large tribe of grasses which includes 4 major cereals, viz. wheat, barley, rye and triticale and a large number of forage species. The extension of the IBPGR's work into forages and the improving techniques for wide crossing work in the cereals has raised the need to consider the tribe as a whole as genetic resources for all these crops.

The size of the tribe (ca. 325 species, 75 annuals, 250 perennials) and its global distribution in the temperate areas has made taxonomic work difficult. Several classification systems are extant which can cause confusion in species naming. The classification shown here (Table 1) is based on that of Dewey (1984) which utilizes genomic information. Ideally, there would be 1 genus for each combination of genomes, but the extent of polyploidy and the existence of as yet unspecified genomes makes a consistent application of this principle difficult. The division into "annual" and "perennial" genera is largely for convenience; many contain both annual and perennial species.

The perennials are the species of most interest as forages, being useful under semi-arid and rangeland conditions. As a group they show wide adaptation and, depending on species, may be tolerant of saline and alkaline soils, and drought. Growth tends to be concentrated in the spring, so value is placed on types that remain green late in the growing season, cure well when they dry, and develop a good aftermath. Additionally, in the growing season, good seeders are needed for propagation.

Many of these species are out-crossing and interspecific and intergeneric hybrids occur naturally. Some of these may be useful as forages, but intraspecific variation is not yet fully exploited.

The annuals have a largely Mediterranean and Central-Asiatic distribution. As a group they are predominantly self-pollinating, which, combined with a range of seed dispersal mechanisms adapts them to disturbed environments. Compared to the perennials they have less polyploidy and show little natural intergeneric hybridization. Artificial hybridization among these genera is not difficult, but the chromosomes pair poorly indicating that the genomes are highly differentiated.

Wide crossing in the cereals is most developed for wheat which, being polyploid, is tolerant of alien additions and in which there are types carrying genes for easy crossability. It is possible also to induce translocations by manipulating the Ph gene controlling chromosome pairing and there is an aneuploid series which can be used to advantage. Apart from rye, most successes have been had with species of Thinopyrum and Leymus.

Wide crossing with barley and rye is not as developed. In part, this is due to less effort having been directed to these crops, but it also reflects the fact that they are diploid crops and so lack the genomic buffering and cytogenetic tools available in wheat. For all crops tissue culture may have a role in obtaining recombinants through somaclonal variation.

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Table I. The genera of the Triticeae

Genus	Genomes*	No. species or subspecies by ploidy level						Total
		2x	4x	6x	8x	10x	12x	
"PERENNIAL" GENERA								
Agropyron J. Gaertn.	P	5	13	1				19
Critesion Rafinesque	H	22	11	7				40
Elymus L.	SHY		92	27	4			123
Elytrigia Desvaux	SX			9	3			12
Leymus Hochst.	JN		25	1	8	1	1	36
Pascopyrum Löve	SHJN				1			1
Psathyrostachys Nevski	N	6						6
Pseudoroegneria Löve	S	9	10					19
Thinopyrum Löve	J-E	3	9	8	2	1		23
"ANNUAL" GENERA								
Aegilops	UDSMt UncM	9	9	4				22
Crithopsis Jaub. Spach		1						1
Eremopyrum Jaub. Spach	ABC	3	2					5
Haynaldia Schur		2	1					2
Henrardia C.E. Hubbard		2						2
Heteranthelium Hochst.		1						1
Hordeum L.	I	2	1					
Taeniatherum Nevski		2						2
Triticum L.	ABDG	2	2	2				6
Secale L.	R	6						6
Totals		75	175	59	18	2	1	326

* Genome symbols within the Triticeae are not yet fully standardized; the 'ABC' Eremopyrum are not the same as those of Aegilops/Triticum, nor the S genome of Aegilops the same as that of the perennial genera

The characteristics most often sought in wide crossing are disease resistance and stress tolerance. There have already been successes in transferring these to wheat, though so far only a limited range of germplasm has been used. The transfer of some quality traits would also be desirable.

The collections of the Triticeae, other than those of the cereals and their near relatives, appear to be limited, with only a few species well represented. Moreover, those collections that do exist are more in the nature of research collections than ones for genetic resources. The tendency of many species to outcross has presented problems in maintaining the genetic integrity of accessions.

The IBPGR has established priorities for collecting by species based on what is known about their potential in forage and cereal breeding, their representation in collections and the extent of genetic erosion. In particular, a number of species is threatened by coastal development. It is clear, however, that more information is needed, especially for species from South America, South Africa, Australia and New Zealand.

Proposals have also been made as to which organizations could do the collecting, which institutes might conserve collections and where the IBPGR could best place its support. Overall there is a need to collect and conserve more material and to gather more information on the tribe, both from the literature and that arising from new research. The IBPGR is to develop a programme on the Triticeae starting early in 1986.

Reference

Dewey, D.R. 1984. The genomic system of classification as a guide to intergeneric hybridization with the perennial Triticeae. pp. 209-279 In, (J.P. Gustafson, ed.) Gene Manipulation in Plant Improvement.

RESUME

Les Triticeaes sont une large tribu des graminées qui inclut 4 céréales majeures (blé, orge, seigle et les triticales) et un grand nombre d'espèces fourragères. L'extension des activités du CIRP aux cultures fourragères et l'amélioration des techniques de croisements dans les céréales a suscité le besoin de considérer les ressources génétiques de cette tribu comme un tout. Cet article, basé sur un rapport d'un atelier du CIRP sur les Triticeaes, résume le statut des ressources génétiques de cette tribu.

RESUMEN

Las Triticeae son una gran tribu de gramíneas que incluyen 4 cereales importantes (trigo, cebada, centeno y triticales) y un gran número de especies forrajeras. La prolongación de las actividades del CIRF a las plantas forrajeras y a la mejora de las técnicas de cruzamiento en cereales, ha creado la necesidad de considerar los recursos genéticos de esta tribu como un todo. Este artículo, basado en el informe de un Grupo de Trabajo del CIRF sobre las Triticeae, resume el estado actual de los recursos genéticos de la tribu.

Impact of IARCs on Plant Genetic Resources

Hawkes, J.G. 1985. Plant Genetic Resources. The Impact of the International Agricultural Research Centers. CGIAR study paper No. 3. The World Bank, Washington, D.C.

At its annual meeting in November 1983 the Consultative Group on International Agricultural Research (CGIAR) commissioned a wide-ranging impact study of the results of the activities of the international agricultural research organizations under its sponsorship. An advisory committee was appointed to oversee the study and to present the principal findings at the annual meetings of the CGIAR in October 1985. The impact study director was given responsibility for preparing the main report and commissioning a series of papers on particular research issues and on the work of the centres in selected countries. This paper is one of that series.

Triticeae Species in Xinjiang, China

Dong Yushen and Zong Ganyan 1/

Xinjiang is the largest Province in China with a total area of about 1,600,000 km^2. Distant from oceans and surrounded by mountains, it is situated in northwest China in the centre of the Euroasian continent. Since moist air from the ocean is effectively blocked by high mountains, the Province has a dry, temperate climate. The Tianshan Mountains divide the Province; the Taklimakan Desert lies to the south and Gurbantunggutt Desert to the north. The climate is extremely dry, annual rainfall in most agricultural areas being below 100-200 mm. The eastern part of the Province is even drier; in some places there is no rain at all.

It has a very cold winter and extremely hot summer. Both the lowest temperature (-58°C in Fuyun County) and the highest one (48°C in Turpan County) in China occur in Xinjiang Province. Local wheat cultivars therefore, are extremely cold resistant and drought tolerant.

Many members of the Triticeae are found in Xinjiang Province. Several investigations were carried out in 1982 and 1983 involving travel of over 20,000 km to almost every main natural area in the Province. The aim was to make a general survey of Triticeae species and gather samples both for further study and for utilization in germplasm improvement programmes.

Species identified and their distribution

Previously 10 genera, 61 species and 17 subspecies of Triticeae had been recorded in Xinjiang Province. During 1982-1983 expeditions 10 genera, 39 species and 4 subspecies were collected. Among them, Aegilops tauschii had not been reported before. Table 1 shows the names, distribution and chromosome number of the collected genera and species.

1. Psathyrostachys Nevski: P. juncea and P. lanuginosa. The distribution and habitat of both species are basically the same. They are scattered in the Tianshan and the Altay Mountains, grow in gravelly southern slopes and valleys with elevations from 800 to 2200 m. They are a component of mountain steppes and semi-desert steppes. Both species are adapted to a cool climate and have the characteristics of cold resistance and poor-soil tolerance.

2. Hordeum L.: Two species and 4 subspecies in this genus are found. The wild species have 2 distribution areas: H. bogdanii grows widely in moist grasslands in both southern and northern plain oases. It is adapted to damp and waterlogged conditions. The other species and subspecies are mainly distributed in mountainous areas of the Tianshan and Altay Mountains. Most of them grow at an elevation of more than 1500 m, and are the main components of mountain meadows.

3. Elymus L.: This genus has 5 species distributed in various areas of the Province. They are important components of mountain meadows. With the exception of E. nutans, growing mostly in mountainous areas at more than 2000 m, the other species occur at a rather wide range of elevations.

4. Leymus Hochst.: This genus has 10 species with extremely wide distribution and strongly expressed characters in Xinjiang Province. Their distribution in

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1/ Crop Germplasm Resources Institute, Chinese Academy of Agricultural Sciences, Beijing, China

Table I. Sites of occurrence of Triticeae species in Xinjiang Province, China

Genus	Species or subspecies	Elevation	Vegetation of distribution area	Chromosome number 2n
Psathyrostachys Nevski	P. juncea (Fisch.) Nevski	1450-1700 m	meadow steppes	14
	P. lanuginosa (Trin.) Nevski	1450-1700 m	meadow steppes	14
Hordeum L.	H. bogdanii Wilensky	835-2380 m	plain oasis, meadows	14
	H. brevisubulatum subsp. nevskianum (Bowd.) Tzvel.	1180-2400 m	subalpine meadow steppes	
	H. brevisubulatum subsp. violaceum (Boiss. et Huet) Tzvel.	1180-2380 m	subalpine meadow steppes	
	H. brevisubulatum subsp. brevisubulatum (Trin.) Link	850-2380 m	meadow, steppes	14,28
	H. brevisubulatum subsp. turkestanicum (Nevski) Tzvel.		forest meadows	
	H. vulgare L.	850 m	plain oasis	
Elymus L.	E. tangutorum. (Nevski) Hand-Mazz.	850-1200 m	plain oasis, valley, forest meadows	14,28
	E. dahuricus Turcz.	700-1800 m	valley meadows	28,42
	E. sibiricus L.	2170-2400 m	plain oasis, forest meadows	28
	E. nutans Griseb.	2400 m	forest meadows	42
	E. cylindricus Franch.			
Leymus Hochst.	L. secalinus (Georgi) Tzvel.	600-2200 m	plain oases subalpine meadows, sandy lands in river valleys	28
	L. racemosus (Lam.) Tzvel.	500-550 m	sandy lands in river valleys	
	L. angustus (Trin.)	500-1300 m	meadows and sandy lands in river valleys	

Table I. Sites of occurrence of Triticeae species in Xinjiang Province, China (Continued)

Genus	Species or subspecies	Elevation	Vegetation of distribution area	Chromosome number 2n
Leymus Hochst. (continued)	L. ovatus (Trin.) Tzvel.	480-1300 m	meadows in river valleys	
	L. tianshanicus (Drob.) Tzvel.	1500-1900 m	mountain steppes	
	L. paboanus (Claus) Bilg.	700 m	meadows in river valleys	42
	L. chinensis (Trin.) Tzvel.	1300 m	plain oasis	28
	L. multicaulis (Kar. et Kir.) Tzvel.		plain oasis	28
	L. bruneostachyus N.R. Cui	500 m	meadows	
	L. karelinii (Turcz.) Tzvel.			
Roegneria C. Koch	R. kamoji Ohwi	2000-2370 m	valley meadow	42
	R. abolinii (Drob.) Nevski	1680 m	mountain steppes	28,42
	R. mutabilis (Drob.) Hyl.	1750-2400 m	forest meadow, valley meadow	28,42
	R. viridula Keng et S.L. Chen	1180-2710 m	subalpine meadow steppes	28
	R. stricta Keng	1180-1650 m	subalpine meadow steppes	28
	R. gmelinii (Ledell) Kitag	1180-1700 m	subalpine meadow steppes, mid-mountain meadow	28
	R. nutans Keng	770-2590 m	plain oasis mountain steppes	28
	R. tschimganica (Drob.) Nevski	2000 m	meadow steppes	28,42
	R. breviglumis Keng	2400 m	forest steppes	
	R. ugamica (Drob.) Nevski	2170 m	valley meadows	

Table I. Sites of occurrence of Triticeae species in Xinjiang Province, China (Continued)

Genus	Species or subspecies	Elevation	Vegetation of distribution area	Chromosome number 2n
Elytrigia Desv.	E. repens (L.) Desv.	480-1920 m	meadows in river valleys, plain oasis	28,42
	E. alatavica (Drob.) Nevski	1300 m	fields in valley plains	42
Eremopyrum (Led.) Jaub. et Spach	E. triticeum (Gaertn.) Nevski	900 m	artemisia sub-deserts	14,28
	E. distans (C. Koch) Nevski	900 m		
Secale L.	S. cereale L.	890 m	weed in wheat fields	14
Agropyron J. Gaertn.	A. cristatum (L.) Beauv.	910-2590 m	meadow steppes	14,28,42
	A. mongolicum Keng	640 m	subdesert steppes	
	A. desertorum (Fisch. et Link) Schult.	850 m	subdesert steppes	
	A. pectinatum (M. Bieb.) Beauv.		subdesert steppes	14
Aegilops L.	A. tauschii Cosson	900-1650 m	steppes, subdesert steppes	14

elevation, type of vegetation and ecological environments vary greatly. L. racemosus grows only in partially-settled dunes along the low terraces of the Ertix River in the Altay Mountain areas with an elevation of about 600 m. Its habitat is dry and has poor growing conditions. L. tianshanicus, preferring cool environments, is distributed in grasslands and meadows in the Tianshan Mountains at 1500-1900 m. L. secalinus has a very wide distribution. It grows in various ecological environments, mostly in damp places, and also in dry environments or highly saline soils. For example, in the Altun Mountains, L. secalinus grows in a saline soil containing 6% total salt in the 0-10 cm surface layer. L. angustus, L. ovatus, L. paboanus and L. bruneostachyus grow mainly in valley meadows, whilst L. chinensis and L. multicaulis occur mostly in plain oases.

5. Roegneria C. Koch.: Ten species of this genus show a wide distribution in both southern and northern Xinjiang Province. They grow in various xeric, mesophytic and cold environments of grasslands, forests and wet meadows, mostly at elevations more than 1000 m and sometimes above 2000 m. Among them, R. kamoji has the widest distribution, growing throughout the Province. It grows on mountain slopes and in damp meadows, at 1650 to 3200 m. The remaining species are distributed in the Tianshan and Altay Mountains at about 2000 m.

6. Elytrigia Desv.: There are only 2 species, E. repens and E. alatavica. The

former is found in river valley meadows, fields and orchards at an elevation below 2000 m, whilst the latter occurs in southern gravelly slopes at 2300 - 3000 m.

7. Eremopyrum (Led.) Jaub. et Spach: Two species of this genus, E. triticeum and E. distans, are distributed only in semi-desert areas covered with Artemisia at low elevations in northern Xinjiang Province. It is a typical genus in semi-desert vegetation and species have a short life cycle in early spring.

8. Agropyron Gaertn.: A. cristatum grows widely in various areas of the Province from elevations of 800 to 3200 m. Another 3 species are distributed mainly in the Tianshan and Altay Mountains, growing in semi-deserts near mountains and on southern slopes of semi-desert steppes. This genus, known for its marked drought resistance, is an important component of the steppes in the Province.

9. Secale L.: There is only 1 species in the genus growing in the Tianshan Mountains. It is a weed in winter wheat fields.

10. Aegilops L.: Only 1 species, A. tauschii Cosson, is found in the grasslands along the Yi li River Valley at 600-1500 m.

Characteristics of Triticeae in Xinjiang Province

As compared with other provinces, the wild wheat grasses of Triticum in Xinjiang comprise a greater number of species in larger amounts and over a wider distribution, and there exist some unique types. For example, the following species have not yet been found in other provinces of China: the 2 species of Psathyrostachys; Leymus racemosus, L. multicaulis, L. ovatus and L. bruneostachyus; Roegneria viridula, R. mutabilis, R. tschimganica and R. ugamica.

The large number of species of Triticeae occurring in Xinjiang Province may result from, firstly, its proximity to southwest and middle Asia, the centre of diversity of Triticum and its relatives. In western Xinjiang Province, there are rivers and mountain passes linking the Uzbekistan and Kazakhstan Socialist Republics of the USSR, and southwestern Xinjiang Province is bounded by India, Pakistan and Afghanistan. This has resulted in dissemination of Triticeae members into Xinjiang Province. Secondly, Xinjiang Province, which extends across 12 degrees of latitude, has within its boundaries many mountains, marshes, meadows, and flooded land forests, providing diverse ecological environments for the existence of various intruded species. The Triticeae in the Province may provide valuable germplasm for stress tolerance. Most plants occurring there are highly resistant to cold and drought. For example, Eremopyrum spp., Agropyron desertorum, etc., can complete their life cycles without any rain at all. On the southern slopes of the Tianshan Mountains with no snow cover in winter, some species of Leymus, Roegneria, Elytrigia and Agropyron can survive under a severe temperature of -30°C. Most of the rivers in Xinjiang Province are inland waterways which originate from melted snow on mountains. They flow into deserts and disappear there. The soil is highly saline, and thus it is likely that a great number of plant species, e.g. Leymus secalinus, L. sacemosus, Hordeum brevisubulatum subsp. brevisubulatum etc., have acquired an inherent resistance to salt.

RESUME

Une vaste prospection a été faite dans la province du Xinjiang, en Chine, en 1982-83, pour recueillir des spécimens de plusieurs genres et espèces de Triticeae. Des informations sont données sur la distribution de 39 espèces, appartenant à 10 genres. Cette province présente un intérête particulier pour les recherches sur les ressources phytogénétiques en raison de son climat extrême et de la forte salinité du sol. Par exemple, les cultivars locaux de blé sont extrêmement résistants au froid et tolérants à la sécheresse.

RESUMEN

En la provincia de Xinjiang, China, se realizó en 1982-83 un amplio estudio y una recolección de géneros y especies de triticeas. La información sobre la distribución de 39 especies y 10 géneros figura en una lista. La provincia reviste interés para la labor sobre recursos genéticos porque tiene climas extremos y suelos muy salinos. Los cultivares locales de trigo, por ejemplo, son muy resistentes al frío y a la sequía.

Horticultural Germplasm of Northern Sudan

A.A. Genief, M.K. Ahmed, S.A. El Hussein and H.M. Dinar [1]

In March 1985, a mission in the northern region of the Sudan collected indigenous horticultural germplasm in the region. This was the third phase of a joint project between IBPGR and the Agricultural Research Corporation (ARC) of Sudan with these objectives:

a) Collection of the local horticultural material to save it from loss due to the increasing use by farmers of improved introduced cultivars; and

b) Characterization, multiplication and conservation of material of national and international interest and for breeding programmes.

The first phase was devoted to collecting crops from the central and eastern regions [2] and the second phase for collecting from Kordofan and Darfur Regions [3].

The northern region of Sudan (25-32°E/16-23°N) is desert and semi-desert with negligible rainfall except at the southern and southeast part of the region where the annual amount rarely exceeds 100 mm. It is characterized by a hot summer (April-September), dominated by frequent dust storms and a long dry winter where the temperatures are the lowest in Sudan but seldom drop to freezing (October-March).

Soils are alluvial and of varying fertility in the Wadis (valleys) and on riverbanks. These soils are generally free of salt and are non-alkaline due to frequent flooding by irrigation water from the Nile River. Cultivated land not directly flooded by the river consists mainly of heavy clays and in certain areas is highly saline. High terraced soils away from the Nile consist mainly of sand interrupted by rocky areas; however, some can be reclaimed and put under cultivation.

Natural vegetation is extremely scarce particularly in areas without rainfall and far from the Nile. The vegetation consists of sparsely scattered desert shrubs and short *Acacia* trees along the Nile and southern part of the region.

The following crops are grown on alluvial soils entirely irrigated by the Nile: wheat, legumes, spices, lucerne, onions, certain vegetables, date and citrus. Farmers distinguish 3 cropping periods: winter (October-March), summer (April-August) and the flooding season (August-September). Cropping intensity is highest during the winter season. Sorghum, maize, and okra are grown during the summer flooding seasons.

Hudeiba and Shendi Agricultural Research Stations were established in the region with the objective of improving agricultural production and to help with related activities.

Sites and sampling procedures

Both random and specific site sampling methods were used. Sampling was done from local markets, farmers' stores, at research stations and from the field. The local date and citrus cultivars in the

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1/ Agricultural Research Corporation, Horticultural Research Section, Wad Medani, Sudan

2/ See FAO/IBPGR Pl. Genet. Resources Newsl., 56:33-40

3/ See FAO/IBPGR Pl. Genet. Resources Newsl., 59: 4-11

Table I. List of samples collected

Latin name	Common name	Local name	No. of samples collected
A. Vegetables:			
Lycopersicon esculentum	Tomato	Tamatim	13
Allium cepa	Onion	Basal	31
Abelmoschus sp.	Okra	Bamia	36
Corchorus olitorius	Jew's mallow	Molikhia	18
Eruca sativa	Rocket	Girgeer	25
Citrullus vulgaris	Watermelon	Bitikh	5
Portulaca oleracea	Purslane	Rigla	10
Cucumis sativus	Cucumber	Agour	11
Cucurbita maxima	Pumpkin	Gara	4
Phaseolus vulgaris	Bean	Fasulia	22
Vicia faba	Broadbean	Ful masri	31
Vigna unguiculata	Cowpea	Luba hilu	15
Lupinus termis	Lupine	Tormos	7
Pisum sativum	Pea	Pisla	8
Cajanus cajan	Pigeonpea	Adasi	8
Dolichos lablab	Hyacinth bean	Luba afin	10
Cicer arietinum	Chickpea	Homos	13
Capsicum frutescens	Hot pepper	Shatta	8
Raphanus sativus	Radish	Figil	9
Others			12
Total			296
B. Fruits:			
Phoenix dactylifera	Date	Balah	8
Citrus aurantium	Sour orange	Laringa	3
Citrus aurantifolia	Lime	Lemoon	4
Psidium guajava	Guava	Goava	3
Total			18
C. Spices and medicinal plants:			
Cuminum cyminum	Cumin	Shamar	10
Coriandrum sativum	Coriander	Kasbara	16
Anethum graveolens	Dill	Shabat	8
Trigonella foenum-graecum	Fenugreek	Hilba	10
Pulicaria spp.	-	Rabul	7
Hibiscus sabdariffa	Roselle	Karkade	9
Others			17
To be identified			14
Total			91

Table 1. List of samples collected (Continued)

Latin name	Common name	Local name	No. of samples collected
D. Other crops:			
Sorghum bicolor	Sorghum	Dura	13
Arachis hypogaea	Groundnut	Ful sudani	4
Medicago sativa	Lucerne	Berseem	5
Hordeum vulgare	Barley	Shaeer	4
Zea mays	Maize	Thura Shami	14
Triticum sp.	Wheat	Gamih	3
Pennisetum sp.	Millet	Dukhn	2
Helianthus annuus	Sunflower	Abad shams	1
Total			46

region have been collected prior to this mission and they are included in variety trials for evaluation at Hudeiba Agricultural Research Station. These materials are thus considered part of the collected germplasm and could be utilized wherever needed.

Genetic erosion

A total of 455 samples of vegetables, fruits medicinal and aromatic plants were collected (Table 1). The old horticultural practices in the region and the search by farmers for superior cultivars led to an early and continuous introduction of exotic materials. Accordingly, a great loss has resulted in the local types of many traditional vegetables including tomato, watermelon, pumpkin and okra. Variability found in the remaining local stocks was, therefore, relatively narrow. A different situation, however, was found in the case of onion. Due to the market superiority of the indigenous types, almost all onions grown are local and wide variaoility was found in this crop.

Variability in samples collected

(a) Vegetables

(i) Onion: Variability was observed mainly in bulb colour, shape and size. Colours of the local types fall in a range of white, yellow, red and purple-red. Shapes range from globe to oblate with different intermediate forms. All local onions are characterized by a high degree of pungency.

(ii) Tomato: Besides the very few local tomatoes, some types derived from foreign cultivars introduced many years ago were also collected. Variability was observed in fruit shape, size, colour and taste. The local types have oblate fruits with bright red colour and rich flavour. Globe, deep globe and deep oblate shapes were common among types derived from introduced cultivars. Fruits show considerable variation in firmness, ranging from very soft to fairly firm.

(iii) Okra: Variability was detected in different characters of the pod including: shape, number of ridges, colour, thorniness and size. Pod colours observed included: whitish-green, green, dark green and light pink. Some local lines of okra were known as suitable for winter conditions, while most other lines are only productive during the warm or hot periods of the year. The wild types of okra common in other regions of the country were not observed.

(iv) Pea: Although peas were originally introduced, a local line characterized by

very small seed was collected. It is locally called "orraig" and both seeds and leaves are eaten.

(v) Broadbean: It is a very important crop in the region, and there are many local types. Many samples were collected and variability was observed in seed size, shape, colour of seed coat and cooking quality.

(b) Fruits

(i) Guava: There is wide variation in fruit colour, shape, size, seediness and taste. The dominant flesh colours are white and red.

(ii) Date: It is a dominant fruit tree in the region and tremendous differences exist among cultivars. Certain types produce soft and semi-dry fruits, e.g. mishrig wad-laggai, mishrig wad-khateeb, medina etc., while others produce dry fruits e.g. barakawi, gondeila etc. Variation in fruit colour, shape and taste are very defined.

Spices, medicinal and aromatic plants

The northern region is a chief producer of spices such as cumin, coriander in addition to umbelliferous seeds used in local medicine (anise, caraway etc.). Argel leaves used chiefly in folk medicine are also produced in this region. Observable variability was encountered with caraway (e.g. a 1.5 m tall perennial plant), roselle (different calyx colours) and *Pulicaria* spp. (distinctly varying aroma). Chemical analysis might reveal more variability than that observed morphologically.

Following this collecting mission, samples will be grown out for the purpose of characterization and duplication. The characterization is intended to be performed at Wad Medani, Hudeiba and Sennar. Duplicates will be sent to institutes recommended by the IBPGR.

RESUME

Une mission a été organisée dans le nord du Soudan en mars 1985 pour recueillir des souches génétiques de plantes horticoles autochtones. Elle constituait la troisième phase d'un projet conjoint du CIRP et de l'Agricultural Research Corporation (ARC) du Soudan. Au total, 296 échantillons de légumes, 18 de fruits, 95 d'épices et de plantes médicinales et 46 d'autres plantes ont été récoltés. Des duplicatas seront envoyés aux institutions recommandées par le CIRP, pour la conservation en lieu sûr.

RESUMEN

En marzo de 1985 se inició en la región septentrional del Sudán una misión para recoger germoplasma hortícola indígena. Se trataba de la tercera fase de un proyecto conjunto del CIRF y la Corporación de Investigaciones Agrícolas (ARC) del Sudán. Se recogió un total de 296 hortalizas, 18 frutas, 95 especias y plantas medicinales y otras 46 plantas. Para asegurar la conservación, se enviarán duplicados a institutos recomendados por el CIRF.

Collection of Chayote and Its Wild Relatives

L.E. Newstrom [1/]

Chayote, Sechium edule (Jacq.) Schwartz (Cucurbitaceae), is one of the most important indigenous economic plants of Mexico and Central America. A high diversity of cultivars and the closest wild relatives are found in Mexico; yet, only the states of Puebla and Vera Cruz had been extensively collected prior to this mission (Cruz and Querol, in prep.) [2/] The author collected cultivars and wild relatives in midwestern and southern Mexico from 10 October to 12 December 1984. The 90 collection sites included family gardens, markets and commercial plantations in the states of Guanajuato, Michoacan, Jalisco, Vera Cruz, Oaxaca, Tabasco and Chiapas. The mission added 225 accessions of chayote and 6 accessions of its wild relatives to the genebank at Instituto Nacional de Investigaciones Agricolas (INIA) in Celaya, Guanajuato and a duplicate set to the genebank at the regional centre of the Universidad Autonoma Chapingo at Huatusco, Vera Cruz.

Importance and distribution of chayote

Chayote is an important staple food in Mexico, Central America, West Indies and parts of South America especially Brazil and Colombia. It is also known as guisquil, patastilla, chuchu, tayote, cidrayote, mirliton, christophine and many other names. It is now grown throughout the tropics and sub-tropics in Malaysia, Australia, New Zealand, India, southern Europe, Africa and southern USA. It is one of the cheapest vegetables available to low income groups. Chayote is the fifth most important commercial vegetable in Brazil where 170,000 tons were produced in 1978 (Lopez, 1979). Mexico produced 12,265 tons in 1978 (Coria and Engleman, 1983). Costa Rica produces less but is the leading exporter of chayote. Exportation from Costa Rica increased from 1104 tons in 1978 to 4617 tons in 1982 (Ministerio de Agricultura y Ganaderia, 1983). It is estimated that US$ 1.5 million worth of chayote are exported per year from Costa Rica (Ing. E. Valverde, pers. comm.).

Every part of the chayote plant is useful. The fruit, used as a table vegetable, has nutrition comparable to summer squash (Esquinas and Gulick, 1984). They are easily digestible and low in calories; they may be useful for infant, invalid or reducing diets. Cooked fruits are sold as snacks in local markets of Mexico and Gautemala. Their flavour varies from bland to slightly sweet as well as a delicate starch taste that is similar to that of a new potato. Bland varieties of chayote fruits are used as an industrial food filler for pastes such as tomato ketchup and baby food. They are also used industrially to simulate apples in pies and tarts. In Jamaica, people have been adding lime juice to chayote fruits to make pies and tarts for many years (Cook, 1901); the seeds are considered a delicacy by some (Hoover, 1923).

The tuberous roots, commonly sold in rural markets of Mexico and Guatemala, are a valuable source of easily digestible starch. The shoots and young leaves are a popular pot-herb particularly high in vitamins A and C, calcium, iron and B vitamins (Medina, 1974; Ruberté and Martin, 1975). Medicinal uses of chayote are for relief of urinary calcifications,

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2/ See also FAO/IBPGR Pl. Genet. Resources Newsl., 63:2-5

hypertension, arteriosclerosis, intestinal and skin inflammations as well as for cauterizing wounds (Morton, 1981).

Chayote fruits, tubers and leafy vines are used as fodder and forage for poultry, cattle, and hogs. The flowers are an excellent source of nectar for honey bees (MacGregor, 1976). In countries such as Italy, the plant is used as an ornamental due to its rapid growth and good cover. The only inedible part, the tough fibrous stems, are used to make a silvery white straw called "paille de chouchou" used for hats and baskets. Ille de Reunion exported such hats and baskets to France but the industry has declined since World War I due to the cost of hand labour (de Sornay, 1921).

Origin and cultivation

Historical documents show that chayote probably originated in Mexico and Central America and was spread to other parts of the world by the Spanish (Whitaker and Davis, 1962; and Cook, 1901). The most widely used name, chayote is derived from the Mexican Nahuatl word "chayotl" (de Candolle, 1886). Variation in chayote is highest in Mexico and Central America (J. Leon, pers. comm.). The closest wild relatives of chayote are found in Mexico and Guatemala (Newstrom, 1985). These lines of evidence suggest that chayote originated in Mexico and northern Central America.

The plant is a large perennial, monoecious vine with a single seeded fruit. The seed regularly germinates in the fruit; often while still on the vine. This feature, known as true vivipary, is rare in the plant kingdom. Chayote is grown between 0 and 2800 m altitude and flourishes best between 300 and 2000 m (Casseres, 1980, Messieaen, 1979). It requires high humidity (80 to 85%), rainfall between 1500 and 2000 mm per year (or irrigation), and mild temperatures of 20° - 25°C, (with limits of 12°C and 28°C) (Bukasov, 1963, Casseres, 1980, and Messiaen, 1979). The best soil is rich well-drained sandy loam. A trellis support must be provided for optimum growth. Chayote is susceptible to several fungus diseases and nematodes, as well as red spider mite (E. Valverde, pers. comm.).

Collecting activities

The first part of the mission explored southern Guanajuato, Michoacan, and Jalisco, beginning 10 October 1984. The exploration of southern states of Oaxaca, Tabasco, and Chiapas began on 6 November 1984. Major vegetation regions explored (Fig. 1.) were the tropical deciduous forest and the pine-oak forest according to the categories of Rzedowski (1978). With the exception of Lake Chapala and vicinity, a high degree of diversity in the cultivars was found in Michoacan areas. Around Lake Chapala, where many commercial farms are located, the family gardens and markets tended to have only commercial cultivars. The diversity of chayote was also wide in Chiapas. In general, more family gardens in moist cool mountainous regions had chayote compared to hot dry and hot wet regions. Few cultivars of chayote are adapted to hot wet climates.

Variability of cultivars

Compared to other cucurbitaceous crops, chayote had not been subjected to intense selection for commercial production until recently. Classifying the collections of this mission on the basis of the size (Fig. 2), colour, spininess and shape of the fruit, the author estimates that there are from 50 to 100 cultivars of chayote in Mexico. A preliminary descriptor list for external fruit characters is given in Table 1.

Internal fruit characters are quantity, distribution and length of fibres around the seed and consistency of flesh and flavour. These characters are not predictable from the external appearance of the fruit. The consistency of flesh ranges from watery to solid. Taste trials were conducted on boiled fruits. Flavour categories were difficult to establish; however, the following can be recognized: insipid, bland, sweet, starchy.

Collection of wild relatives

Truly wild populations of chayote have not been previously reported except for one allusion by Reich (1921) to some in Puebla, Mexico. The report by Brücher (1977) to one in Venezuela probably refers

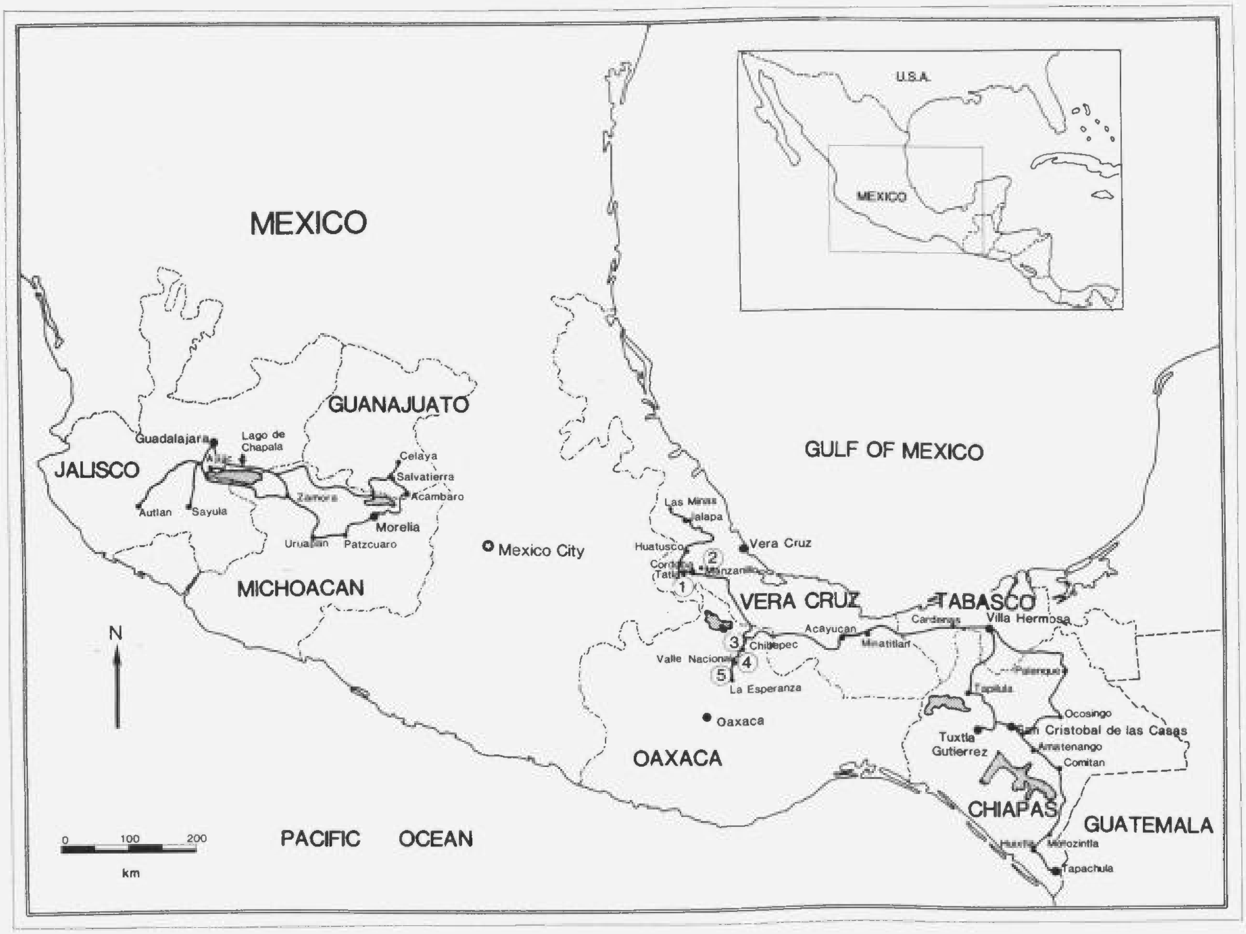

Fig. 1. Route followed to collect cultivars and wild relatives of chayote. Nos. 1-5 indicate locations of the 5 wild populations of chayote (No. 1 at Tetla, Vera Cruz, No. 2 at Manzanillo, Vera Cruz, No. 3 at Chiltepec, Oaxaca and Nos. 4 and 5 at Valle Nacional, Oaxaca)

to a garden escape since chayote was introduced to Venezuela (Pittier, 1926). Cruz Leòn discovered 2 wild populations of chayote in 1982 at Manzanillo and Tetla in Vera Cruz, Mexico (Cruz Leòn, in prep.). During this mission, the author discovered 3 additional wild populations at Valle Nacional and Chiltepec, Oaxaca (Fig. 1). The sites were moist steep hillsides in canyons or along roadside cliffs. These wild populations all have bitter fruits and large tuberous roots. They may represent hybrids with related wild species, mutations of domesticated varieties gone wild, or authentic wild ancestors of the cultivated chayote.

One of the closest wild relatives of chayote is Sechium compositum (Donn. Sm.) C. Jeffrey (=Ahzolia composita (Donn. Sm.) Standl. et Steyerm.). The species distribution extends from Mexico through Guatemala (Jeffrey, 1978). Two populations of S. compositum were found at Motozintla, Chiapas. The fruit is bitter and has spines along the 5 to 10 ridges (Fig. 2). The latter character is not found in cultivars of chayote seen so far. The large tuberous roots are used for soap. The habitat is similar to that of the wild populations of chayote, moist steep hillsides in canyons or along roadside cliffs.

Status of germplasm

This mission added duplicate collections of 225 introductions to the INIA and Chapingo genebanks in Mexico where evaluation of the collections is being conducted. Prior to this mission, the Chapingo Regional Centre at Huatusco, Vera Cruz held 140 introductions of chayote from the states of Puebla and Vera Cruz (Cruz y Querol, in prep.). In Celaya, the INIA genebank previously contained 15 plants of chayote from Guanajuato and surrounding states.

A good collection with wide phenotypic representation of chayote is held in the genebank at Centro Agronomico Tropical de Investigacion y Ensenanza (CATIE) in Turrialba, Costa Rica. The collection is described in a catalogue by Maffioli (1981) and in a study of the variation by Engels (1983). The collections were made from 1975 to 1980 throughout Central America with emphasis on Costa Rica and Guatemala. Of the 201 entries that were in the living collection in 1981, 111 were still alive in 1985.

The Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA) genebank at Brasilia, DF, Brazil holds 55 introductions collected in 1978 from various states of Brazil (Lopez, 1979).

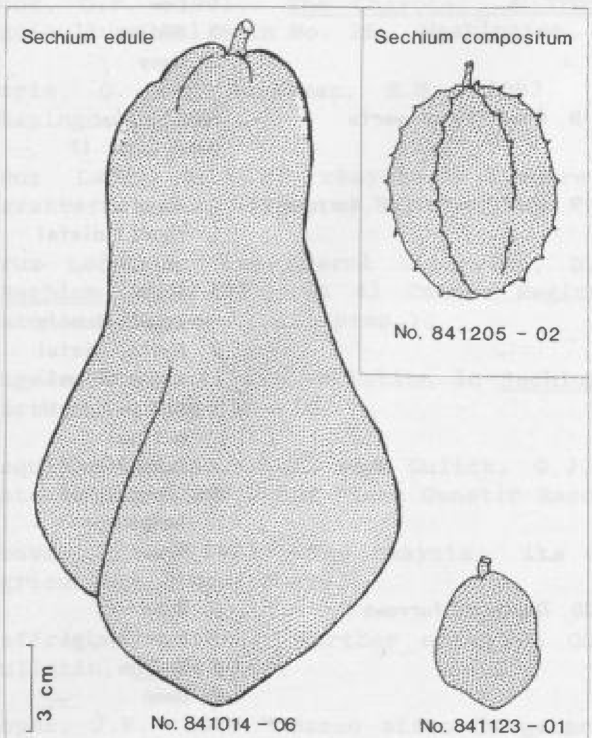

Fig. 2. Size differences between the largest and smallest chayote, Sechium edule, collected during the mission. Insert shows the distinctive spines along ridges of the fruit of S. compositum, one of the closest wild related species to chayote

Genetic erosion

Genetic erosion of chayote in its native regions is expected due to rapidly increasing commercialization and exportation of the crop. Areas near commercial plantations or serviced by markets selling commercial cultivars show a decline in the frequency of occurrence and amplitude of variation of chayote in home gardens. Those that do occur in home gardens in these regions are usually the commercial cultivars. Two commercial cultivars, (1) medium-sized light-green smooth pear-shaped and (2) small white smooth round-shaped, are preferred by consumers so that any other cultivar cannot compete. This was noted in Jalisco and Michoacan near the Lake Chapala commercial farms and in cities such as Guadalajara, Jalisco and Cardenas, Tabasco. In Cardenas, the chayote fruits are imported from Puebla. In areas remote from commercial plantations in Mexico, especially rural areas with a high proportion of indigenous peoples, the genetic variability seems to be less threatened.

In Costa Rica, the markets are flooded by the commercial cultivars which are rejected fruits from the export business. In the last 5 years, consumer demand has so greatly favoured the commercial varieties that other varieties have been disappearing from the market. As a result of this, it is estimated that most of the original 151 collections from Costa Rica in the genebank at CATIE, of which 87 remain living today, can never be collected again (J. Leon, pers. comm.).

Since the 2 commercial cultivars are preferred by consumers in both Mexico and Costa Rica as well as the importing countries, the genetic erosion is likely to continue increasing. Without conservation in genebanks consumers will soon be dependent on only these commercial cultivars.

Table I. Preliminary descriptor list for external fruit characters of chayote

No.	Descriptor	Descriptor states
1	Maximum length	mm
2	Maximum width	mm
3	Maximum depth	mm
4	Minimum width at neck	mm
5	Length from apex to min. width at neck	mm
6	Length from apex to max. width	mm
7	Weight	g
8	Volume	ml
9	Colour of skin	1 White 2 Cream 3 Yellow cream 4 Very light green 5 Light lime green 6 Dark lime green 7 Medium green 8 Dark green
10	Longitudinal profile	1 Tear-shaped 2 Narrow pyriform 3 Wide pyriform 4 Spheroid 5 Oblong 6 Cylindrical 7 Ovoid 8 Broadly ovoid 9 Ellipsoid
11	Cross-sectional profile	1 Round 3 Oval 5 Flattened
12	Quantity of spines	0 None 3 Few 5 Medium 9 Many
13	Distribution of spines	0 None 1 Distal only 3 Proximal only 5 Lines only 7 Covering entire fruit
14	Length of spines	mm
15	Size of base of spine	0 Absent 1 Small 5 Medium 9 Wide
16	Flexibility of spine at maturity	0 No spines 1 Flexible 2 Hard
17	Quantity of lenticels	0 None 1 Few 5 Medium 9 Many
18	Quantity of warts	Same as for descriptor 17
19	Distribution of furrows	0 None 1 Short, distal only 3 Short, proximal only 5 Short, distal and proximal 7 Medium length but not total fruit 9 Long, total length of fruit
20	Depth of furrows	0 None 1 Superficial 5 Medium 9 Deep
21	Prominence of ridges	0 None 1 Slight 5 Medium 9 Prominent

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S. Montes of INIA and D. Martinez of Chapingo provided invaluable assistance in the field. J. Laborde and F. Cardenas of INIA, Mexico assisted with advice and logistical support. A. Cruz Leòn of Chapingo provided logistical support and contributed 2 sites for populations of wild chayote that he had discovered in Vera Cruz. J. Leon of Universidad de Costa Rica provided guidance for pre-trip planning and post-trip evaluation of collections. D. Querol Lipcovich also aided in pre-trip planning. Logistical support was received from E. Bentazos Mendoza, J. Silva Contreras, H. Esparza Martinez and J.J. Velazquez, all of INIA.

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RESUME

La chayote (Sechium edule) est l'une des principale plantes économiques indigènes du Mexique et de l'Amérique centrale. Durant une mission de prospection exécutée en octobre-novembre 1984 dans l'ouest et le sud du Mexique, 225 échantillons de chayote et 6 échantillons de plantes sauvages apparentées ont été recueillis. Ils ont été déposés à la banque de gènes de l'Instituto Nacional de Investigaciones Agricolas (INIA) à Celaya (Guanajuato), et des duplicatas ont été envoyé à la banque de gènes du Centre régional de l'Universidad Antonoma Chapingo (Vera Cruz).

RESUMEN

El chayote (Sechium edule) es una de las plantas económicas indígenas más importantes de México y América Central. Durante una misión de recolección efectuada en la zona meso-occidental y meridional de México en octubre-noviembre de 1984, se recogieron 225 muestras de chayote y seis de sus variedades silvestres. Se depositaron en el banco de genes del Instituto Nacional de Investigaciones Agícolas (INIA) en Celaya, Guanajuato, y se envió un duplicado al banco de genes del centro regional situado en la Universidad Autónoma Chapingo, en Veracruz.

Collection of Sorghum and Millets in Uganda

N. Maxted 1/, J.P. Esele 2/ and B.W. Khizzah 2/

The sorghum and millets section of the Serere Research Station, Uganda, with IBPGR sponsorship and assistance, collected and conserved germplasm of sorghum (Sorghum bicolor), finger millet (Eleusine coracana) and bullrush millet (Pennisetum typhoides), with their wild relatives from throughout Uganda. The first part of the project - collection of material from the northern region - was undertaken during September and October 1984. The objective was to sample and assess variability of the germplasm available, to estimate the present degree of genetic erosion and thus propose strategies to promote conservation, and to use the germplasm collected in active sorghum and millet breeding programmes.

Geography and agriculture

The northern region is bounded by Lake Kioga in the south, the Sudanese border to the north, the Zairian border in the west and the Karamoja Region of northeast Uganda. This area may be subdivided into 2 geographical zones, the East African tableland and the basin of the Nile Valley. Both zones exhibit an equatorial climate tempered by altitude, though in the Nile Valley itself where altitude decreases, conditions are hot and dry. Annual rainfall varies with location, but is relatively heavy for East Africa at 128-180 cm, falling in 2 seasons. Soils are generally fertile but liable to erosion. The altitude of collecting sites varied between 920 and 1480 m.

Uganda is a country dominated by agricultural, with 50% of the population involved in subsistence farming. The most important crop is maize followed by finger millet and sorghum. Bullrush millet is of less importance and is found only in the extreme north of the country around Kitgum and Arua. Cultivation of sorghum and millet is most commonly undertaken using traditional methods and hand tools. Mixed cropping is generally practised, with mixtures of sorghum and finger millet being common.

Sampling procedures

The objective was to collect the maximum allelic variation present in the population sampled. Both biased and random sampling procedures were used, depending on the local information available, the land utilization and degree of cooperation of the local farmers. In general 15-20 km were allowed between sampling sites, unless local genetic variation warranted more intensive collection. The material of wild crop relatives sampled was usually taken from areas near crop sample sites, but special collections were also made. Samples were obtained from fields, backyard gardens, stores, markets and drying grounds though as the collecting trip coincided with the end of harvest most material was sampled from drying grounds.

During sampling the seed was obtained from as many plants as possible with interesting "off-types" being collected as separate samples. The sample size was in certain cases limited by general food shortages in the particular area. Samples along major roads were avoided, and were generally taken from small communities along minor roads and tracks.

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Germplasm collection

Germplasm was sampled from 177 locations throughout northern Uganda. Each accession collected was given a unique collection number and passport data were recorded using the standard IBPGR collection form. During the mission 311 *Sorghum* spp., 342 *Eleusine* spp. and 22 *Pennisetum typhoides* accessions were collected.

Included in the above figures for *Sorghum* and *Eleusine* are the collections of wild species allied to the crop plants. Accessions of the wild relatives *S. arundinaceum*, *E. indica* and *E. africana* were collected throughout the region travelled. These wild species were found alongside the crop in the field, along roadsides or on the edges of villages. All 3 wild species collected were found relatively commonly in all the areas visited. For each of the wild accessions sampled a voucher specimen was taken to aid subsequent identification.

Accession processing

All accessions were dried, threshed and divided into duplicate samples; one set was left at Serere Research Station for further evaluation and incorporation into its plant breeding programme, while a duplicate of the material was forwarded to the Royal Botanic Gardens, Kew, UK, for distribution to genebanks. Three copies of the accessions passport data were made and are held at Serere Research Station, Kew and the IBPGR regional office in East Africa. Duplicates of the voucher specimens taken are held in the herbarium of the University of Nairobi, Kenya and at the IBPGR regional office for East Africa (the latter specimens will soon be forwarded to Kew).

Diversity of material collected

The mission discovered a wide range of genetic variability available for both sorghum and finger millet. Comparatively few bullrush millet accessions were collected, due to its rarity in the collection area, and these proved phenotypically similar.

Major variation was found in the following sorghum characters: plant height; inflorescence compactness and shape; glume colour; grain colour; grain number per panicle; grain form, single or twinned; 100-seed weight and apparent pest and disease resistance. The degree of variability was not as highly pronounced in the finger millet material collected, but there was still distinct variation in the following characters: plant height; thumb presence; finger length and size; grain colour; 100-seed weight and apparent pest and disease resistance.

Discussion

The mission provided a unique chance to assess the amount of genetic diversity and erosion to be found in the country today. The degree of diversity is large, and the mission did not exhaust the potential genotypes currently available in northern Uganda. The fact that 675 distinctive accessions were collected in a relatively short trip indicates the amount of diversity. Ugandan sorghum and millets germplasm does not face any immediate threat of large-scale genetic erosion; however, due to the promotion by the Ugandan Agricultural Reconstruction Programme (Ministry of Agriculture) of higher yielding cultivars it is likely that in the longer term genetic variability will decrease. It is important, therefore, to continue collection and conservation work while variability remains high.

Sorghum and finger millet were found to be of relatively equal importance in northern Uganda making up a large proportion of the staple diet, but bullrush millet is only rarely grown and is restricted to the extreme north of the region. This position may alter, however, as the Agricultural Reconstruction Programme is promoting bullrush millet in dryer areas over sorghum and finger millet because of its greater ability to withstand drought.

Acknowledgements

The mission owes its success in part to the collaboration provided by the Ugandan Agricultural Reconstruction Programme (Ministry of Agriculture) in supplying local guides and interpreters; the authors express their grateful appreciation. Lastly the authors also thank the Ugandan farmers who, even where food was scarce, generously allowed sampling of their germplasm.

RESUME

La station de recherche de Serere, en Ouganda, a récolté des spécimens de sorgho (Sorghum bicolor) d'éleusine (Eleusine coracana) et de petit mil (Pennisetum), ainsi que des spécimens de plantes sauvages apparentés, dans la région nord du pays, en septembre-octobre 1984. Cette prospection constituait la première étape d'un projet s'entendant à l'ensemble du pays qui a été entrepris pour échantillonner et évaluer la variabilité du matériel génétique disponible, déterminer le degré actuel d'érosion génétique et mettre le matériel génétique récolté au service de programmes effectifs de sélection. Ce matériel sera examiné à la station de recherche de Serere et incorporé dans les programmes de sélection.

RESUMEN

En septiembre-octubre de 1984, un grupo de la Estación de Investigaciones de Serere (Uganda) recogió sorgo (Sorghum bicolor), mijo africano (Eleusine coracana), mijo perla (Pennisetum) y sus respectivas variedades silvestres de la región septentrional del norte del país. La misión representaba la primera etapa de un proyecto que abarcaba a todo el país muestras y evaluar la variabilidad del germoplasma disponible, estimar el grado actual de erosión genética y utilizar el germoplasma recogido en programas de mejoramiento genético activo. El material se evaluará en la Estación de Investigación Serere y se incorporará en programas de mejoramiento genético.

Botanic Gardens Declaration at Gran Canaria

At a meeting 1/ of the International Union for Conservation of Nature and Natural Resources in association with the Gobierno de Gran Canaria sponsored by World Wildlife Fund in Las Palmas 26-30 November 1985 the following 2/ was putatively agreed on 30 November 1985:

"For centuries, Botanic Gardens have been major centres for the scientific study of plant diversity, providing a mechanism for introduction and assessment of plants for agriculture, horticulture, forestry and medicine. They attract more than 100 million visitors a year, according havens of beauty and tranquillity for an increasingly urban society, and a spiritual link with the plant world on which we all depend. They inform and educate; they are showcases for the living world, and are places where science and people meet.

"For historical reasons, most Botanic Gardens are in the cooler, more industrialized countries of the world, but two-thirds of all plant species occur in the tropics and subtropics. More than 60,000 species risk extinction within our lifetimes because of the destruction and degradation of the earth's vegetation which is the basis of human survival. Recently, many of the world's Botanic Gardens have mobilized their resources for conservation action to avert this threat. They are conserving plants in the wild, cultivating them in the gardens themselves and preserving them in genebanks. Recognizing that they can only succeed in achieving these objectives if they work together, Botanic Gardens throughout the world are uniting to apply the World Conservation Strategy to the special predicament of plants. Basing their efforts on this global plan for sustainable development and conservation of living resources, they will produce, adopt and implement a Botanic Gardens Conservation Strategy.

"This declaration is the result of the 1985 Las Palmas Conference on Botanic Gardens and the World Conservation Strategy, involving more than 200 leading specialists from countries throughout the world. They as a body assert their determination to work together to defend plant life for the benefit of all people now and in the future. They call upon Governments to provide the necessary support and resources, in accordance with their responsibilities."

1/ International Conference on Botanic Gardens and the World Conservation Strategy
2/ Original in English

Methods of Storing Tropical Root Crop Germplasm with Special Reference to Yam

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The edible species of true yam (Dioscorea spp.) provide an important source of carbohydrate and protein throughout the tropics, especially in the Caribbean, on Pacific Islands and in areas of West Africa. Other species of yam are an important source of diosgenin used in the production of steroidal drugs. Different species of yam are utilized for food and medicine and have also assumed importance in different parts of the world according to the distribution and origin of the major species (Table 1).

There is a large amount of germplasm of the different species of Dioscorea in areas where they have been widely cultivated for centuries. There are also several wild species which have been used for the production of diosgenin and also as a source of food in times when the normal food source is scarce. Some of this germplasm has already been collected and is being maintained and utilized in crop improvement programmes, but large amounts still need to be collected. Substantial collections of yam germplasm are listed in Table 2 (IBPGR, 1986). A survey of the status of germplasm collections made recently by Lyman (1984) showed that approximately 8200 accessions existed in collections of which 3000 were thought to be distinct. A high percentage of both wild and cultivated types still remains uncollected but only a moderate number are endangered.

Available methods for conservation of root and tuber crops

Several approaches have been used for the storage of root and tuber crop germplasm, depending on the environmental conditions, facilities and expertise available. Different methods of conservation can be used alone or in combination. At this stage in the development of suitable storage techniques for vegetatively propagated crops, it is not advisable nor useful to rely solely on one method, but rather to use a combination of methods according to the needs of the programmes in individual centres.

1. Field genebanks

Field genebanks as defined by the IBPGR are centres where clonally propagated materials are maintained as living collections. This has been the traditional method of storing root and tuber crop germplasm, mainly because in the past it was the only available method for storage of specific genotypes for long periods. The advantage of this method lies in its wide application to all species and its simplicity. Plants are available for characterization, to provide new planting material by way of tubers and vines for rapid propagation, and frequently to produce flowers or pollen for immediate use in the newly developed yam improvement programmes based on inter-specific hybrids. However, conservation of germplasm in field genebanks does have disadvantages. The plants are at risk from pests and diseases, are subject to environmental constraints, such as drought or flooding, and are also expensive to maintain and manage.

Although the term 'field genebank' has been clearly defined, the practical aspects and standards of management of the plants within a field genebank are crop specific and have not been enumerated. When establishing a field genebank certain basic requirements must be taken into

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Table I. List of major species of Dioscorea

Dioscorea Species	Common name	Centre of origin	Major area of cultivation	Produces seeds*	Cultured *in vitro**
		FOOD YAM			
D. abyssinica		Africa	East Africa		
D. alata	Greater yam	Indochinese - Indonesian	West Africa	+	+
D. bulbifera	Potato or aeriel yam	Indochinese - Indonesian and Africa	Asia and Africa	+	+
D. cayenensis	Yellow Guinea yam	Africa	West Africa	+	
D. dumentorum	African bitter or cluster yam	Africa	Africa	+	
D. esculenta	Lesser yam	Indochinese - Indonesian	Asia and the Pacific Is.		+
D. hispida	Asiatic bitter yam	Indochinese - Indonesian	Asia		
D. nummularia		Indochinese - Indonesian	SE Asia and Oceania		
D. opposita	Chinese yam	Chinese - Japanese	China, Korea and Japan	+	+
D. pentaphylla		Indochinese - Indonesian	Indonesia and Oceania		
D. preussi		Africa	(Wild species)	+	
D. rotundata	White Guinea yam	Africa	West Africa	+	+
D. trifida	Cush-cush yam	South America	Caribbean	+	+
		MEDICINAL YAM			
D. composita		Central America	Central America	+	+
D. deltoidea		India	India	+	+
D. elephantides	Elephant's foot yam	Africa	Southern Africa		
D. floribunda		Central America	Central America	+	+
D. mexicana		Central America	Central America		
D. prazeri		India	India		
D. sylvatica		Southern Africa	Southern Africa		

* See references in text

consideration. An appropriate area of land will be required in a suitable environment relatively free from pests and diseases. Several environments may be necessary for widely cultivated crops such as yam because the clones may be selectively adapted ecotypes and have different requirements.

The correct spacing between plants, methods of staking, irrigation, weeding, fertilizer requirements and insecticide and fungicide dosage and application all require careful consideration to keep the plants in good condition. Local expertise and cultural practices can also prove very useful in management decisions. The cost of management is considerable and these maintenance costs should be taken into consideration when establishing field genebanks.

The nature and use of collections affect management decisions. Duplication both within and between field genebanks is necessary. Since the materials are clonally propagated, one plant can adequately represent a genotype but a single plant is a greater risk and limits the amount of vegetative material available for distribution. What amount of duplication would be acceptable within a field genebank? A compromise has to be found between the high cost of maintenance and limited space available and the needs for safety and distribution. An acceptable level for duplication of Dioscorea genotypes would be a minimum of 5 and a maximum of 10 plants of each distinct genotype within the field genebank. Duplication between genebanks is also necessary to allow for security of the collections and encourage breeding and research. For seed samples it has been considered that duplication in at least 2 base collections is necessary to guarantee security. Ideally, accessions should be replicated in at least 3 different field genebanks.

Exchange of vegetative propagules entails more quarantine problems than either seeds or sterile cultures. However, with careful cleaning and packing of the material, controlled growth in isolation and checking by quarantine officials, these problems can be minimized. Obviously potential users should first determine if material is available from collections within their own countries before requesting the material from outside.

For yam the type of material distributed can either be in the form of tuber setts or vine cuttings, representing clones, or seeds for more varied material. The type of material available depends on the season and the species. Tuber setts are less easily damaged than vines during shipping because they are not so fragile. Parts of mother tubers can be carefully removed and used for distribution without damaging the growing plant of D. rotundata (Nwoke and Okonkwo, 1978). Plants of D. alata, D. bulbifera and D. pentaphylla also produce aerial tubers or bulbils (Wickham et al., 1982) and these can be used for vegetative propagation and distribution. Vine cuttings have also been shown to be suitable for propagation of D. alata, D. rotundata and D. dumentorum (Okoroda and Okonmah, 1982) but these must be cut before the stems become woody and care must be taken during transportation.

The supply of material for distribution within any year is obviously limited unless many plants are maintained. Some practical limitations therefore apply to distribution, although the material is freely available. The number of requests answered and the priority with which they are filled must be decided upon by each genebank on an individual basis and, if necessary, requests should be re-directed to other institutes known to maintain the genotype.

2. Seed genebanks

The possibility of conserving seeds of root and tuber crops is limited to those species which produce seeds with good storage characteristics. Some crops which readily produce seeds are already being stored in traditional seed genebanks, e.g. potato and cassava. Seed storage provides a safe and simple method of genetic conservation for those species with seeds which can withstand desiccation and storage for long periods without loss of viability. The storage of seeds of yam has been limited because not all species are known to produce viable seeds. Research is required on development, physiology and storage characteristics of seeds of most species before any progress can be made. The disadvantage of seed storage for the maintenance of clonally propagated crops is that the seeds produced are usually heterozygous and do not represent the original genotypes. However, in genetic conservation where the

Table 2. Collections of Dioscorea germplasm of more than 100 accessions (IBPGR, 1986)

Country	Institute	Major Dioscorea Species	Material
Benin	Département de la Recherche Agronomique, Cotonou	D. alata, D. cayenensis, D. rotundata and other species	plants and seeds
Burkina Faso	IBRAZ, Ouagadougou	D. alata, D. cayenensis and other species	plants
Costa Rica	CATIE, Turrialba	D. alata, D. bulbifera, D. cayenensis, D. esculenta, D. trifida and wild species	plants
Fiji	Koronivia Research Station, Nausori	D. alata and D. esculenta	plants
France	INRA, Guadaloupe	D. alata, D. bulbifera, D. cayenensis, D. dumentorum, D. esculenta, D. pentaphylla, D. rotundata, D. trifida and other species	plants and some in vitro
Ghana	Crops Research Institute, Bunso	D. alata, D. cayenensis, D. dumentorum, D. rotundata and others	plants
India	Central Tuber Crops Research Institute, Kerala	D. alata, D. esculenta and D. rotundata	plants
	National Bureau of Plant Genetic Resources	Unspecified species	plants
Indonesia	Lembaga Biologi Nasional, Bogor	Unspecified species	plants
Ivory Coast	Université d'Abidjan, Abidjan	D. abyssinica, D. alata, D. bulbifera, D. cayenensis, D. esculenta and wild species	plants
	ORSTOM, Abidjan	D. alata, D. bulbifera, D. cayenensis, D. dumentorum, D. esculenta and wild species	plants
	IDESSA, Bouaké	D. abyssinica, D. alata, D. bulbifera, D. cayenensis, D. dumentorum, D. esculenta, and wild species	plants
Malaysia	MARDI, Selangor	D. alata, D. bulbifera, D. esculenta, D. hispida, D. pentaphylla and other species	plants
Nigeria	IITA, Ibadan	D. alata, D. bulbifera, D. dumentorum, D. esculenta, D. rotundata and other species	plants, some seeds and in vitro
	National Root Crops Research Institute, Umuahia	Dioscorea species	plants
Papua New Guinea	Department of Primary Industry, Konedobu	D. alata, D. esculenta and other species	plants
Philippines	Philippine Root Crop Research and Training Centre, Leyte	D. alata, D. esculenta, D. hispida and other species	plants

Table 2. Collections of Dioscorea germplasm of more than 100 accessions (IBPGR, 1986) (Continued)

Country	Institute	Major Dioscorea Species	Material
Solomon Is.	Dodo Creek Research Station, Honiara	D. alata, D. bulbifera, D. esculenta, D. nummularia, D. rotundata and other species	plants
Sri Lanka	University of Peradeniya, Peradeniya	D. alata, D. bulbifera, D. esculenta and other species	plants
Vanuatu	Chapuis Research Station, Santo	Dioscorea species	plants

aim is to conserve genetic variation, this is of less significance than in breeding programmes which may require distinct genotypes.

Although the standards for the management and storage of orthodox seeds in genebanks have been very clearly defined (IBPGR, 1985a) there is little information on the storage characteristics of seed of the different species of yam. In addition some species of yam rarely produce viable or fertile seeds. Their long history of cultivation by vegetative means may have caused unconscious selection for sterile plants. Yam is dioecious and it was observed that in D. rotundata the percentage of female flowering plants and number of flowers produced per plant were higher in populations produced from seeds than those produced from vegetative propagules (Sadik and Okereke, 1975a). This increase in flowering and fruiting did not reduce tuber yield. Selection of plants from seeds increases the amount of flowering without unduly affecting yield characteristics and therefore could be used to increase seed production for storage purposes.

Although most of the major species of yam have now been recorded as producing seeds, seed production is limited and artificial pollination may be necessary to obtain good seed set (Akoroda, 1983; Martin et al., 1963). Among the edible food yams, seeds are produced by D. alata (Coursey, 1967), D. bulbifera (Coursey, 1967; Sadik, 1977), D. cayenensis (Degras et al., 1977), D. dumentorum (Coursey, 1967), D. hispida (Singh, 1982), D. opposita (Yakuwa et al., 1981), D. rotundata (Sadik, 1976) and D. trifida (Sadik, 1977; Degras et al., 1977). The medicinal yams which produce seeds are D. composita (Cruzado et al., 1964; Delpin and Martin, 1970), D. deltoidea (Sharma, 1976; Mascarenhas et al., 1976) and D. floribunda (Cruzado et al., 1964; Delpin and Martin, 1970).

Little information is available on storage of seeds of different species of Dioscorea. However, it seems that the seeds are orthodox and can withstand desiccation and could be expected to survive storage at low temperatures in seed genebanks for considerable periods. Experiments on the storage of seeds of D. composita, D. floribunda and D. spiculiflora showed that the seeds maintained more than 80% germination during storage at low moisture contents for three years (Cruzado et al., 1964). Seeds of D. opposita stored for 2 - 3 months in a desiccator with silica gel showed considerable seed dormancy but almost 100% of the embryos excised from non-germinated seeds produced plantlets in vitro (Yakuwa et al., 1981). When seeds of D. rotundata were stored for up to 1 year, cold storage combined with desiccation and storage at 25°C with desiccation were found to reduce percentage germination and also time to germinate, whilst storage at 25°C without silica gel resulted in the highest germination (Sadik, 1977). However, the low germination after cold storage could be due to prolonged dormancy which has been reported in seeds of D. rotundata (Sadik and Okereke, 1975b). Eastwood and Steele (1978) reported that yam seeds of

undefined moisture content can be kept for several months in sealed containers at 2°C, so it would seem unlikely that viability was adversely affected by low temperature. Further research to clarify how seeds of the different species behave during storage in traditional genebanks should be encouraged in the future.

3. In vitro genebanks

Two types of in vitro genebank are recognized by the IBPGR. Active in vitro culture genebanks are those where materials are maintained as tissue cultures under minimal growth conditions. Base in vitro genebanks are those where the materials are maintained as tissue cultures under cryopreservation (IBPGR, 1985b). The possibility of using in vitro techniques for conservation of germplasm has been reviewed extensively (Henshaw, 1981, 1982; Roca et al., 1982; Singh, 1981; Staritsky, 1982; and Withers, 1980). The establishment of these types of genebanks is expected to become more important in the future as technical problems of storage, genetic stability and regeneration from in vitro cultures are resolved.

Storage of root and tuber germplasm in the form of in vitro cultures has the advantage that materials can be kept in relative safety in a small area and distribution is often simpler because quarantine officials are more ready to accept the import of sterile cultures than other forms of living material. However, it is not yet clear if all species of Dioscorea can be cultured successfully (Table 1) nor is it certain how long the cultures can be stored without loss of genetic stability.

The scientific principles for the management of in vitro genebanks have been considered in some detail (Withers, 1980, IBPGR, 1985b) and sufficient information is available to conclude that scientifically these genebanks are feasible for the medium- and long-term storage of germplasm. However, no large in vitro genebanks have been established and therefore practical details still require consideration. The most suitable culture methods for both active and base in vitro genebanks are being determined on a species basis but experimental work is not sufficiently advanced to accurately determine the storage period of many species.

Collections in active in vitro genebanks will be maintained by sub-culturing tissues under conditions which result in slow growth, but do not adversely affect viability or genetic stability. Growth retardants or minimal growth conditions may be necessary. The plant tissue selected for the initial culture is also important to avoid the risks of genetic mutation and somaclonal variation. For this reason the use of shoot tip cultures and non-adventitious systems is preferred and the cultures must be monitored for stability and viability during storage. It is suggested that sub-cultures would be necessary approximately every 2 years.

Collections in base in vitro genebanks will be maintained by cryopreservation for long periods, although sub-samples will need to be monitored for stability and viability at regular intervals (rather like seeds in traditional genebanks) and sub-cultures will be required infrequently for multiplication and regeneration.

The amount of duplication required to meet the demands of distribution and for security purposes is an important consideration. For security, each genotype should be replicated within each genebank in sufficient numbers to ensure against loss from breakdown of equipment, contamination and genetic instability and also replicated on an international basis to ensure adequate and free availability of the germplasm. It has been suggested that for clonal materials 5 replicate samples should be taken from the parent plants and for heterogeneous population samples, approximately 100 would be necessary to represent the diversity. Five replicate cultures of each sample would be necessary as a security against loss. Duplication in other locations, preferably in other countries, is also necessary and each accession should be maintained in a minimum of 2 genebanks. It has been recommended that whenever possible active in vitro genebanks should be located in major regions of primary or secondary diversity and be linked with existing efforts of collecting and conservation of the crop in question (IBPGR, 1985b).

There has been little work on the in vitro storage of edible yam species and the feasibility of this type of storage requires further research. Active in vitro storage has been carried out by the

use of minimal growth storage of shoot tip cultures of D. rotundata by controlling the osmolarity of the medium with the addition of 0.2M mannitol, which slows normal growth rates yet allows a return to normal morphological growth when the cultures are restored to standard media (Henshaw, 1982). Research on slow growth in vitro storage for active genebanks is currently being carried out on D. rotundata and D. alata in IITA, Nigeria and Wye College, UK and on D. composita in University of Calgary, Canada. Cryopreservation of yam in vitro cultures has not been reported, although research is being carried out on cryopreservation of D. deltoidea in the USSR Academy of Sciences, Moscow.

There is a clear potential for the in vitro storage of other species of yam. There have been reports of the successful in vitro culture of single node stem cuttings and leaf tissue of D. alata and D. bulbifera (Ammirato, 1982) and bulbil explants of the same 2 species (Asokan et al., 1983). Culture of shoot node segments of D. rotundata and D. alata have also been reported by Mantell et al. (1978) and of D. bulbifera by Forsyth and Van Staden (1982). These reports all indicate that successful culture is possible and that plantlets can be obtained and transplanted to the field to form mature plants. Further research on slow growth storage is still required on many species for the successful establishment of active in vitro genebanks of yam.

Research on the in vitro culture of the species of yam used for medicinal purposes is more common because of the possibility of using cultures for the commercial production and extraction of diosgenin. Leaf and tuber segments of seedlings of D. deltoidea have been successfully cultured and plantlets formed (Mascarenhas et al., 1976). Nodal extracts of D. composita (Datta et al., 1981) and single node and leaf cuttings and stem cuttings of D. floribunda have also been successfully cultured (Ammirato, 1984).

Practical approaches for conservation of root and tuber crops

A combination of methods must be used for the adequate security conservation of crops such as yam. With the current status of scientific research, it is difficult for 1 method to adequately fulfil all the requirements and therefore methods will vary in each separate genebank, according to the crop and type of collection stored. For active collections field genebanks are most able to fulfil the requirements of having vegetative material available for distribution from tubers and vine cuttings, and having plants in the field for characterization and evaluation. However, in vitro storage can play an important complementary role as a back-up collection, holding large amounts of germplasm at relatively low cost in little space, avoiding risks in the field, assisting distribution by minimizing quarantine problems and providing material for rapid propagation. Both methods could be used to provide material for distribution and propagation, depending on specific requests and needs of the genebank.

Base in vitro genebanks and seed genebanks could in the future provide complementary methods for long term security storage. Cryopreservation of in vitro cultures will provide secure storage of specific genotypes (clones) and seed storage will allow the maintenance of wide variability for future use.

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RESUME

Plusieurs méthodes sont utilisées pour conserver les souches génétiques de plantes racines et de tubercules, selon les conditions de milieu, les installations et les compétences techniques disponibles. Il convient d'employer une combinaison de techniques de conservation pour les plantes multipliées par voie végétative, plutôt que de miser sur une seule méthode. L'auteur examine diverses techniques de conservation - notamment banques de gènes sur le terrain, banques génétiques de semences et banques de gènes in vitro, en se référant spécialement à l'igname (Dioscorea spp.)

RESUMEN

Para almacenar germoplasma de raíces y tubérculos se utilizan diversos métodos según las condiciones ambientales y los medios y conocimientos disponibles. En el caso de los cultivos de propagaciòn vegetativa es conveniente utilizar una combinación de técnicas de almacenamiento en lugar de depender de una sola. Entre las técnicas en este sector que son objeto de examen, con especial referencia al ñame (Dioscorea spp.), figuran los bancos de genes conservados en el campo, los de genes en semillas y los de genes in vitro.

Cotton Collecting in Continental Ecuador and Galapagos Islands

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This report deals with a portion of a multi-phase cotton collecting mission. Past phases (1980-1982) took place on Caribbean Islands, and in French Guiana, Venezuela, Colombia, Peru and Mexico 4/. This phase was conducted in Ecuador, both on the continent and the Galapagos Islands, and was carried out during September and October, 1983. One of the authors (Ano) returned to the Guayaquil area of Ecuador in December, 1983 to collect at sample sites which were found earlier, but at which no open bolls were found at that time.

The year was characterized in Ecuador (both continental and insular) as one of excessive rainfall. The normal wet season was extended, in some areas, by as much as 3 mo due to the "El Niño" current shifting further south than normal. Blooming and fruiting were delayed, making it difficult to find and collect mature seeds in some areas.

Continental Ecuador

The sole endemic species, Gossypium barbadense L., was the only cotton species observed except for some cultivated fields of G. hirsutum L. (upland cultivars). The collecting route appears in Fig. 1.

A. Dooryard-feral types (sample numbers AS 801-827, AS 830-831, AS 837-845, AS 1018-1020, AS 1063-1064). Samples were collected in dooryards or near habitations along roadsides. They consisted usually of only a few plants, represented by a small swarm and in some cases by only a single plant. Seed-cotton yield was usually reduced; plants were attacked by Dysdercus spp., Pectinophora spp., and Anthonomus spp. This type was abundant in southern Ecuador, but not in the southwestern part of this area where examples were dispersed or nonexistent over long distances. Phenotypic variability is low; plants are always green, with petal spot. A characterisitic feature is pilosity of stems and leaves (as found in Colombia on a previous expedition) which is not found in those commercial cultivars presently grown. Fibre is generally white, short, and coarse, and seeds mainly naked.

B. Wild types (sample numbers AS 828-0829, AS 832-836, AS 1004-1017, AS 1021-1062). No wild types of G. barbadense were found on the coastal side in southern Ecuador near the Peruvian border where they had been found during previous explorations (Stephens and Phillips, 1966). However, exploration was limited because much of this area is now a restricted military zone.

1. In western Ecuador, wild types are abundant and were found in 2 quite different areas.

(a) Around Playas and just south of El Morro in the Province of Guayas, wild cotton is abundant and grows intermingled within xerophytic vegetation; its persistence does not appear to be threatened.

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3/ United States Department of Agriculture, Cotton and Grain Crops Genetics Research, P.O. Drawer DN, College Station, Texas 77841, USA

4/ See FAO/IBPGR Pl. Genet. Resources Newsl., 54:2-10 and 57:32-37

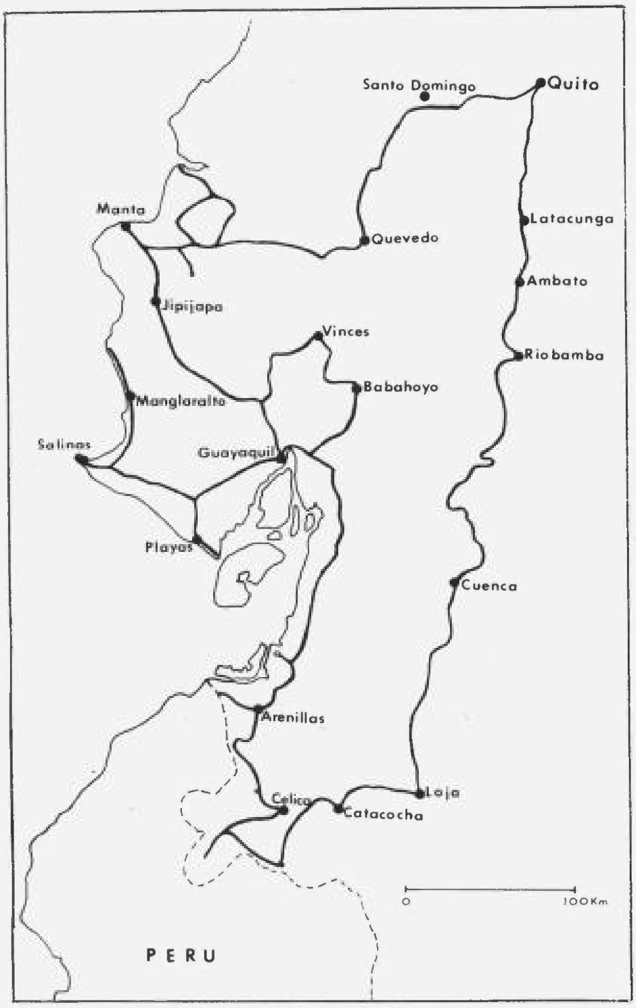

Fig. 1. Collection route followed in Ecuador

(b) Northwest of Playas which also is a dry area, cotton was found close to the littoral zone on sand dunes, inland, and on the banks of washes. Its dispersal is both towards and away from the sea: towards the sea inland by rainfall runoff, and away from the sea by strong blowing winds. Birds use the cotton fibre to make nests, and must also be involved in its dispersion. In much of this area, wild cottons are threatened by the encroachment of urban development.

2. North of Guayaquil, between Pascuales and Daule, also in the Province of Guayas, is another area where wild cottons are found. Ecologically this is a wet zone situated at the convergence of several rivers and is an area where rice is extensively grown. Here cotton was found on elevations such as mounds and dikes which make habitats more open and drier.

These 2 areas are separated by about 50 km and it is not certain whether the Daule area is a relict of a much larger distribution or if the area is a result of a more recent introduction of cotton by man.

Locations of samples collected appear in Figs. 2, 3 and 4.

Galapagos Islands

Situated on the equator at about 1000 km from the west coast of Ecuador, there are 13 main islands, 6 smaller islands, and 42 islets. They are all volcanic, the oldest being about 5 million years old (White and Epler, 1982). The fauna and flora that exists on these islands was able to cross the ocean barrier and to establish itself in this ecologically peculiar environment. The distance of the archipelago from the continent, and also the distances between some of the islands, has permitted animal and plant populations to evolve in relative isolation. In an evolutionary sense, man's influence is presumed to be negligible or at most minor, since island colonization is recent and limited in space. Nevertheless, the ecological balance has been disturbed on some islands by the introduction of donkeys, goats, pigs, and rats. Since these animals have no natural predators, their rapid multiplication has caused a

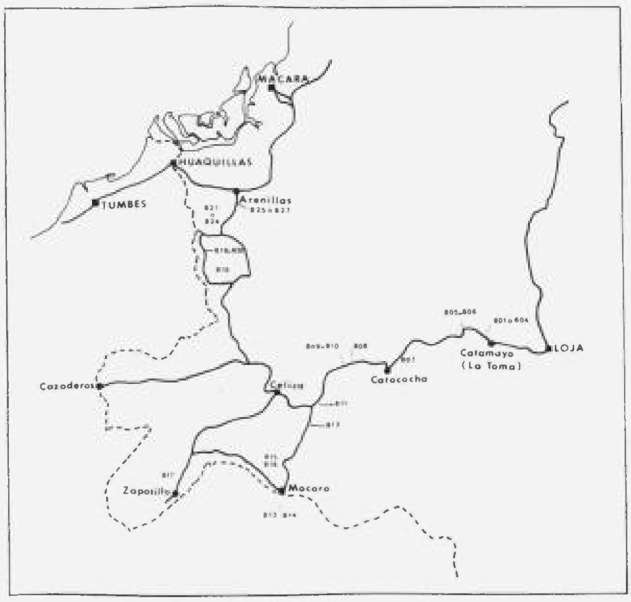

Fig. 2. Collected sample locations southern Ecuador

great deal of harm to some of the plant life. An example of this depredation was the damage to cotton bolls found on the island of Eden adjacent to the western coast of the main island of Santa Cruz. All the samples of G. barbadense that were collected on Eden had been partially eaten by rats, even though they all seemed to be heavily glanded, a phenomenon that would in other parts of the world deter rodents.

Although situated on the equator, these islands do not have a typical tropical climate due to the Humboldt Current which cools the water and air around them. Differentiation in vegetation is due to altitude which affects rainfall.

Cottons are found only in the littoral and arid zones, in rather bushy, mostly open habitat, and do not extend above 300-400 m in altitude. Xerophytic plants predominate, and this kind of vegetation, including cotton, is able to withstand long, dry periods. Two species of cotton are found on these islands.

1. G. barbadense var. darwinii (Watt) J.B. Hutch., 1947 (or G. darwinii Watt, 1907), is a "wild" tetraploid, generally represented by large populations. One hundred and nine samples were collected. Insular variation for certain morphologic characters was observed in this species as reported from previous explorations (Wiggins and Porter, 1971).

Differences were observed in leaf shape and size, petal spot intensity and size, fuzz density, pubescence density, and fibre length and colour. The authors also found the same phenomenon observed by

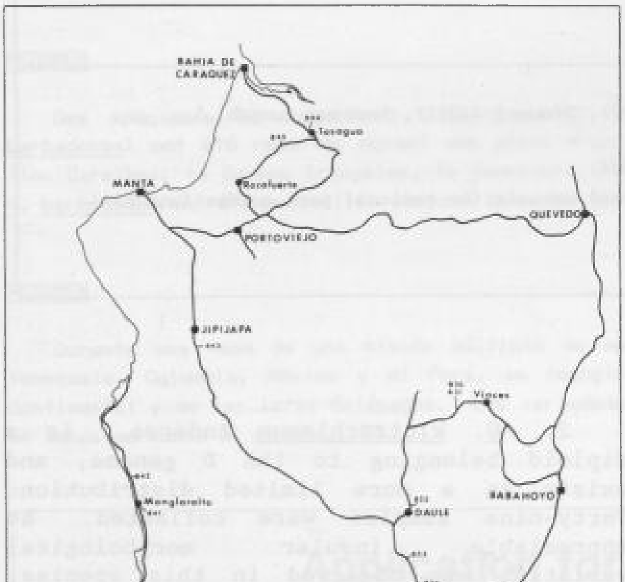

Fig. 3. Collected sample locations
southwestern Ecuador

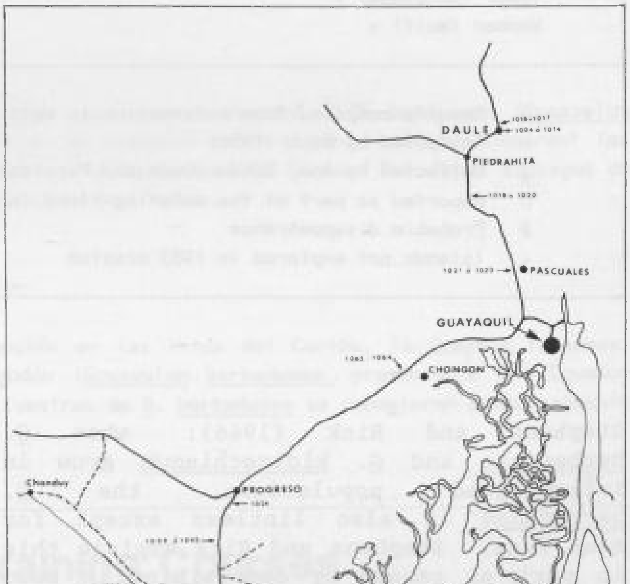

Fig. 4. Collected sample locations
Guayaquil area

Table I. Collection results from the 1983 and previous explorations

Islands	*G. klotzschianum*	*G. barbadense* var. *darwinii*
Abingdon (Pinta) +		●
Albemarle (Isabela) +	●	● × 0
Barrington (Santa Fe)		●
Bindloe (Marchena) +	●	
Charles (Floreana)	●	● × *
Chatham (San Cristobal)	● × *	● × *
Culpepper (Darwin) +		
Duncan (Pinzon)		● × #
Eden		× *
Gardner near Hood (Gardner near Española)		● × *
Hood (Española)		●
Indefatigable (Santa Cruz)	● × *	● × *
James (Santiago)		●
Jervis (Rabida)		● × *
Narborough (Fernandina) +		
South Seymour (Baltra)		●
Tower (Genovesa) +		
Wenman (Wolf) +		

● Results compiled from information in Watt (1907), Stewart (1911), Kearney (unpubl.)
× Collected by Rick (1956)
* Collected by Ano, Schwendiman and Percival (1983)
0 Reported as part of the existing flora in current manuals for national park guides (unpubl.)
Probable disappearance
\+ Islands not explored in 1983 mission

Stephens and Rick (1966): when *G. barbadense* and *G. klotzschianum* grow in intermingled populations, the *G. barbadense* is also lintless except for seed fuzz. Stephens and Rick explain this in part as caused by competition in seed dispersal. This phenomenon was found to be true except for single accessions found on each of the islands of Santa Cruz and Floreana. On the island of San Cristobal both linted and lintless *G. barbadense* were found growing with *G. klotzchianum*, which may be explained by the fact that commercial *G. barbadense* has been grown on this island in the past and is either an escape from cultivation (feral) or introgressed with the endemic type or both. The excessive rainfall of 1983 retarded maturity in several localities and limited collecting. However, this unusually wet year seems to have allowed the establishment of many young plants.

2. *G. klotzschianum* Anderss., is a diploid belonging to the D genome, and exists in a more limited distribution. Forty-nine samples were collected. No appreciable insular morphological variation was observed in this species, except for slight differences in seed fuzz density.

This species is precocious compared to *G. barbadense*, and thus there were no problems in collecting mature seed. Table 1 lists the 2 cotton species as found by this and other plant explorations.

It is pointed out that on several of the islands where cotton was previously reported, the authors were not able to locate any. Hopefully, cotton is growing on these islands in places where the authors were unable to penetrate.

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RESUMEN

Des spécimens de cotonniers endémiques de l'Equateur continental et des îles Galapagos (Gossypium barbadense) ont été récoltés durant une phase d'une mission de prospection en plusieurs étapes couvrant les îles Caraïbes, la Guyane française, le Venezuela, la Colombie, le Mexique et le Pérou. Des types sauvages de G. barbadense ont été recueillis surtout dans les terres proches de l'océan.

RESUMEN

Durante una fase de una misión múltiple de recolección en las islas del Caribe, la Guayana francesa, Venezuela, Colombia, México y el Perú, se recogió algodón (Gossypium barbadense) proveniente del Ecuador continental y de las islas Galápagos. Las variedades silvestres de G. barbadense se recogieron principalmente en zonas cercanas al océano.

Application for Training Courses

The Japan International Cooperation Agency (JICA) initiated an annual group training course in plant genetic resources in 1982. For 1986 this course is scheduled for the period 28 April to 6 July. Applications should be submitted by the Government of the proposed candidate to the nearest Japanese Embassy or alternatively to:

Japan International Cooperation Agency
Office for International Training Centres
Training Affairs Department
Japan International Cooperation Agency (JICA)
P.O. Box 216, Shinjuku Mitsui Bldg.
2-1, Nishi-Shinjuku, Shinjuku-ku, Tokyo 160
Japan
Phone: Tokyo 03-346-5130
Cable address: JICAHDQ TOKYO
Telex: J22271

Los Recursos Fitogeneticos de Paraguay

J. T. Esquinas-Alcázar 1/

Generalidades

Paraguay, a pesar de sus 400.000 km^2, es uno de los países más pequeños de su región. La inmensa mayoría de su territorio está cubierto de monte bajo, bosques y praderas, y sólo el 5% está dedicado a la agricultura, siendo sus principales cultivos: algodón, arroz, caña, maíz, soja, tabaco y trigo. Entre sus recursos fitogenéticos nativos presentan interés las especies de los géneros Arachis, Capsicum, Cucurbita, Gossypium, Ipomoea y Phaseolus, así como numerosas especies forrajeras, frutales y palmas nativas. Las actividades de recolección y conservación de germoplasma en Paraguay son relativamente recientes y se han llevado a cabo de manera sistemática en algunos cultivos como el maíz y la yuca. En otros como el mani y las forrajeras nativas, las recolecciones han sido esporádicas y no siempre se mantuvieron duplicados en el país. En los demás casos los esfuerzos han sido muy escasos o nulos. La parte más colectada ha sido la Región Oriental situada entre los ríos Paraguay y Paraná, donde se encuentran las zonas agrícolas más importantes; mientras que la zona más descuidada ha sido la Región Occidental que incluye el Chaco Paraguayo.

Prioridades

Durante la Reunión de Recursos Fitogenéticos de Interés Agrícola en el Cono Sur, que tuvo lugar en Brasilia en Octubre de 1983, Paraguay definió sus prioridades por cultivos. Estas prioridades están basadas en la diversidad genética existente, el grado de erosión genética, las colecciones ya realizadas y el interés económico y social de los cultivos. Las prioridades dadas fueron:
Prioridad alta: Capsicum spp., Manihot esculenta, M. spp., y Zea mays.

Prioridad media: Avena sativa, A. strigosa, Axonopus spp., Citrullus lanatus, Citrus spp., Cucumis melo, C. sativus , Cucurbita ficifolia, C. maxima, C. moschata, C, pepo, Gossypium spp., Ilex spp., I. paragüariensis, Lablab purpureus, Nicotiana spp., N. tabacum, Oryza sativa, Panicum spp., Pennisetum spp., Phaseolus vulgaris, Pisum sativus, Setaria spp., Triticum aestivum, Vigna unguiculata.

Estructura organizativa

Hasta ahora no existe en Paraguay ningún organismo que asuma oficialmente la responsabilidad de promover y coordinar las actividades relacionadas con los recursos fitogenéticos del país. Sin embargo, el Instituto Agronómico Nacional (IAN) y el Centro Regional de Investigaciòn Agrícola (CRIA), ambos dependientes del Ministerio de Agricultura y Ganadería, se ocupan activamente de la salvaguarda y utilización del germoplasma nativo. También la Universidad Católica y la Universidad Nacional han contribuido con acciones específicas.

Colecciones existentes

La mayoría de las colecciones de germoplasma que se conservan en Paraguay

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FAO/IBPGR Plant Genetic Resources Newsletter, 64:38-41

1/ Oficial Agrícola para Recursos Genéticos, CIRF
Gran parte de la información utilizada para la redacción de este artículo procede del informe presentado por los Sres. R. Casacia y M. Mayeregger en la Reunión Regional sobre Recursos Fitogenéticos de Interés Agrícola en el Cono Sur, celebrada en Brasilia, (Brasil), en octubre de 1983. Estos informes serán publicados pronto por el CIRF. También se han utilizado para la confección de este artículo informaciones procedentes de otras fuentes o recogidas directamente por el autor en el país.

Cuadro 1. Principales colecciones de germoplasma vegetal conservado en Paraguay

Especie*	Institución**	No. de entradas	Tipo de germoplasma***	Origen o procedencia
CULTIVOS				
Ananas comosus (L.) Merr. (Piña)	IAN	3	C	Brasil y P. Rico
		1	C	Paraguay
Arachis hypogaea L. (Maní)	IAN	25	C	Varios
		5	C	Paraguay
Citrus aurantifolia (Cristm. et Panz.) Swing (Lima)	IAN	2	Co	Argentina y Brasil
		1	C	Paraguay
Citrus limón (L.) Burm. (Limón)	IAN	4	Co	Brasil y EE.UU
		1	Co	Paraguay
Citrus paradisi Mac Fad. (Pomelo)	IAN	3	Co	EE.UU.
Citrus reticulata (Mandarino) Blanco	IAN	5	Co	EE.UU
		1	Co	Paraguay
Citrus sinensis (L.) Osbeck (Naranjo)	IAN	8	Co	Varios
		1	Co	Paraguay
Fragaria spp. (Frutilla)	IAN	18	Co	EE.UU
Glycine max (L.) Merr. (Soja)	CRIA	250	C y M	Amer. Lat. y EE.UU
	IAN	200	C y M	Amer. Lat. y EE.UU
Gossypium spp. (Algodón)	IAN	39	C	Varios
		1	C	Paraguay
Hordeum vulgare L. (Cebada)	IAN Cau-cupe	25	M	--
Ipomoea batatas (L.) Poir. (Batata)	IAN	2	C	P. Rico
Lycopersicon esculentum Mill. (Tomate)	IAN	39	C	EE.UU
Mangifera indica L. (Mango)	IAN	6	Co	EE.UU
Manihot esculenta Crantz (Mandioca)	IAN	184	Cp	Paraguay
Manihot spp. (M. anómala, M. c.f. anómala, M. coerulenscens, M. grahami, M. populefolia, M. tripartita, M. c.f. guaranatica, M. c.f. hassleriana)	IAN	29	S	Paraguay

Cuadro I. Principales colecciones de germoplasma vegetal conservado en Paraguay (Continuación)

Especie*	Institución**	No. de entradas	Tipo de germoplasma***	Origen o procedencia
Musa sp (Banana)	IAN	5	Co	Brasil
Nicotiana tabacum L. (Tabaco)	IAN	57	C	Varios
Oryza sativa L. (Arroz)	CRIA	100	C y M	Amer. Lat. y EE.UU
	IAN	225	C y M	Amer. Lat. y EE.UU
Phaseolus vulgaris L. (Habilla)	IAN	17	C	Varios
Saccharum officinarum L. (Caña de azúcar)	IAN	60	C	Amer. Lat. y EE.UU
Stevia rebaudiana (Kaá y hé) Bartoni	IAN	42	Clones	Paraguay
Triticum spp. (Trigo)	IAN	2500	M	Brasil y varios
Vitis vinifera L. (Vid)	IAN	50	C	Brasil y Uruguay
Zea mays L. (Maiz)	CRIA	90	Cp	Paraguay
	IAN	34	Cp	Paraguay
FORRAJERAS				
(Gramíneas)	IAN	108	Varias especies	Varios
		23	Varias especies	Varios
(Leguminosas)	IAN	126	Varias especies	Varios
		26	Varias especies	Paraguay
FRUTALES NATIVOS	IAN, CRIA ASAPA y VFMC	-	25 especies	Paraguay

* Nombre latino y nombre más común en Paraguay

** IAN: Instituto Agronómico Nacional. Caacupé
CRIA: Centro Regional de Investigación Agrícola. Capitán Miranda, Itapúa.
ASAPA: San Lorenzo
VFMC: Vivero Forestal de la Municipalidad de la Capital. Asunción.

*** Co: Cultivares comerciales
Cp: Cultivares primitivos
C: Cultivares
S: Poblaciones silvestres
M: Líneas de mejora

están en el IAN y algunas en el CRIA. El cuadro 1 proporciona información sobre las principales colecciones del país. Muchas de estas están vinculadas a programas de mejora están compuestas de material introducido y líneas de mejora.

Erosión genética

La erosión genética de las especies cultivadas se está produciendo sobre todo en el sudeste de Paraguay, donde la agricultura está más tecnificada. Sin embargo, la erosión genética es baja donde se mantienen aún sistemas de agricultura tradicional, como en el Norte del país. En las especies silvestres los riesgos son generalmente menores. Sin embargo, se ha observado recientemente que algunas especies silvestres como el Manihot c.f. hassleriano, también están gravemente amenazadas.

Conservación

Tanto en el CRIA como en el IAN han sido construidas cámaras de almacenamiento de semillas que no han podido entrar en funcionamiento por falta de presupuesto. El CRIA cuenta con cuatro pequeñas cámaras prefabricadas, con una capacidad total de 100 m^3, y el IAN con dos cámaras de aproximadamente 30 m^3. En ambos casos está previsto que funcionen manteniendo una humedad relativa de un 40-50% y una temperatura de unos 5°C. La falta de almacenamiento adecuado en el momento actual obliga a multiplicar las semillas de las especies conservadas cada uno o dos años, con la consiguiente pérdida de diversidad, debida a la selección indeseada y a la deriva genética. El germoplasma de Manihot se mantiene actualmente en Caacupé, tanto en el campo, como en el laboratorio de cultivos de tejidos.

Evaluación y documentación

Sólo una parte de las colecciones de maíz han sido evaluadas para los descriptores recomendadas por el CIRF. En los otros cultivos, las únicas evaluaciones realizadas han sido las necesitadas para los programas de mejora. El sistema de documentación es actualmente manual con libros de campo, fichas e inventarios. En 1983, el INTA de Argentina publicó un catálogo que recoge los datos de pasaporte y de evaluación de las colecciones de maíz mantenidas en Paraguay.

Personal entrenado

La mayor parte del personal relacionado con las actividades de recursos fitogenéticos en el país, tiene su capacitación en el área de agronomía y mejora genética, y sólo alguno ha seguido cursos cortos en el área de recursos genéticos.

Intercambio de germoplasma

No existe ninguna limitación legal a la exportación de germoplasma y las únicas limitaciones a su importación son las establecidas por el departamento de sanidad vegetal, con el fin de prevenir la entrada de plagas y enfermedades que no existen en el país.

Actividades del CIRF en Paraguay

El Consejo Internacional de Recursos Fitogenéticos (CIRF) ha apoyado desde 1978 un número limitado de proyectos de recolección de germoplasma de maíz, Manihot (en cooperación con CIAT) y mani (a través de organizaciones extranjeras). El CIRF ha contribuido también, dentro del contexto de un programa regional, a la evaluación y documentación de las colecciones nacionales de maíz de Paraguay. Por último, el CIRF ha permitido a algunos estudiantes postgraduados participar en cursos cortos organizados en la región sobre recursos fitogenéticos.

SUMMARY

This article describes the current situation of plant genetic resources activities in Paraguay, providing information on national crop priorities, existing collections, conservation facilities, evaluation and documentation and other activities.

RESUME

Le présent article décrit les activités actuellement entreprises en Paraguay en matière de ressources génétiques végétales et contient des renseignements sur les cultures prioritaires, les collections existantes, les mesures de conservation, l'évaluation, la documentation, etc.

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More News About Crops

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Phaseolus

(85/183) Trip report to Mayaguez, Puerto Rico, 23-27 April 1985 by D.G. Debouck, CIAT, Colombia: During a 3-day visit to Dr. G. Freytag, of the Tropical Agriculture Research Station, it has been possible to obtain more precise information on some of his previous Phaseolus explorations in the Mesoamerican centre. The current research activities of his laboratory were reviewed, especially the ones related to a future taxonomic revision of the genus Phaseolus. Some of their implications in germplasm management and use are also discussed in the report.

Arachis

(85/184) Interim report on the collection of cultivars and landraces of peanuts and their associated species of Rhizobium in Peru, 6-17 March 1985, Texas A & M University, Stephenville, USA: This collecting mission, which forms part of the joint IBPGR/Texas A & M project on Arachis, was carried out by Dr. D.J. Banks (USDA, Stillwater, Oklahoma) in collaboration with national scientists in Peru. Seed collections were made of 35 samples of cultivated Arachis hypogaea, including market samples. Rhizobium collections were made from living plants.

Eleusine

(85/185) Report on Phase I of the Eleusine germplasm collecting mission to Kenya, K.W. Hilu, Virginia Polytechnic Institute, Blacksburg, USA (September 1985): This report briefly describes the visit of the author to the herbaria in Kew (Royal Botanic Gardens) and Nairobi, to examine herbarium specimens of Eleusine from East Africa. The data obtained will be computerized, copied to the IBPGR Secretariat and will serve as a guide for future collecting missions.

Prunus

(85/186) Final report on exploration, collection, conservation and exchange of

hexaploid *Prunus domestica* and *P. insititia* in Yugoslavia, June 1983-June 1985, Prof. Dr. S.A. Paunovic, University of Svetozar Markovic, Cacak, Yugoslavia: A total of 64 plum cultivars and clones (mainly *P. domestica* and *P. insititia*, but also *P. cocomilia* and *P. prostrata*) were collected. The collected materials have been described for 91 characteristics.

Conservation

(85/187) Interim report on the establishment of seed storage facilities in Cuba, Academia de Ciencias de Cuba, Havana, Cuba (in Spanish): Difficulties were experienced in using the IBPGR-grant for seed storage facilities due to the absence of trained personnel. Scientists from Cuba therefore undertook study tours to the German Democratic Republic and the USSR, and on their return a detailed plan for the genebank was developed. Equipment has now been ordered and the seed storage facility should soon be operational. In addition the report provides information on current activities on crop genetic resources in Cuba.

In vitro

(85/188) Final report on conservation of citrus germplasm using tissue culture *in vitro* techniques, IVIA, Valencia, Spain (October 1985): This report describes the results of a preliminary screening of techniques and methods for *in vitro* conservation of citrus germplasm carried out by the Instituto Valenciano de Investigaciones Agrarias (IVIA). These indicate that at present conservation is possible only using slow-growth techniques, while experiments on storage in liquid nitrogen have not so far produced positive results. The project will continue with national funding.

Ecogeographic survey

(85/189) Ecogeographic surveys and collection of germplasm of forage plants, July-September 1985. National Biological Institute, Bogor, Indonesia: This is a brief summary of the work carried out by Dr. K.L. Mehra, IBPGR Forages Collector, which describes among others the collection of forages from Flores (174 samples) and Lombok/Sumbawa (136 samples).

Dioscorea

(85/193) Final report on exploration and collection of *Dioscorea* native to Thailand, Thailand Institute of Scientific and Technological Research (TISTR), Bangkok, Thailand: This is the final report of a project carried out in 1980/1982 and details have previously been reported in IBPGR Annual Reports. As a consequence of disastrous floods in 1983, much of the collected material has been lost and only 16 *Dioscorea* cultivars and 32 accessions of wild *Dioscorea* species are maintained in a field genebank.

Cucumis

(85/194) Interim report on the documentation of the genus *Cucumis*, Escuela Técnica Superior de Ingenieros Agrónomos (ETSIA), Universidad Politécnica, Valencia, Spain (in Spanish): In 1984 a joint IBPGR/ETSIA project was initiated for the establishment of a global data base for *Cucumis*. The current report describes the activities carried out during the first year of the project, whereby emphasis was given to documenting the material already available in Spain.

Vegetable crops

(85/197) Progress report on collection of vegetable crops and onion genetic resources, April-September 1985, Horticultural Research Institute, Cairo, Egypt: A substantial amount of vegetable germplasm was collected in the period from 24 April to 21 May 1985 during the visit of an IBPGR consultant. In addition the Horticultural Research Institute collected melon germplasm in the period July/ September 1985. A total of 114 of the collected samples were planted in September for multiplication, characterization and evaluation.

The Editors of the Plant Genetic Resources Newsletter will be pleased to consider reports, notes and news from anyone working with genetic resources. Reports should be limited to approximately 1200 words; the editors reserve the right to edit to meet space limitations.

Please send manuscripts, typed in double space. Relevant photographs would also be greatly appreciated but only high quality black and white prints rather than colour prints or slides. Colour photographs will reproduce, but not without a considerable loss of quality.

The Newsletter will also review salient books, scientific papers and other publications.

All contributions should be sent to the Editors, AGPG, FAO, Via delle Terme di Caracalla, 00100 Rome, Italy.

Les Editeurs du Bulletin des ressources génétiques végétales seraient heureux d'avoir connaissance des rapports, notes et nouvelles émanant de quiconque s'occupe de ressources génétiques. Les rapports devraient se limiter à environ 1200 mots; les Editeurs se réservent le droit de réduire le texte en cas de manque de place.

Prière d'envoyer les manuscrits dactylographiés en double interligne, accompagnés le cas échéant de photographies, de préférence sous forme de bonnes épreuves en noir et blanc plutôt que de tirages en couleurs ou de diapositives. Les photographies en couleurs peuvent être reproduites, mais risquent d'y perdre beaucoup en qualité.

Le Bulletin passera en revue les ouvrages, communications scientifiques et autres publications les plus marquants.

Adresser toute communication à la Rédaction du Bulletin, AGPG, FAO, Via delle Terme di Caracalla, 00100 Rome, Italie.

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Agradeceríamos el envío de los trabajos mecanografiados a doble espacio. También apreciaríamos el envío de fotografías relacionadas con la materia, que deberán ser de buena calidad, preferiblemente en blanco y negro. Las fotografías en color sólo pueden ser reproducidas con una apreciable pérdida de calidad.

El Noticiario también hará revisiones de libros, trabajos científicos y otras publicaciones.

Todas las contribuciones deben ser enviadas a los editores, AGPG, FAO, Via delle Terme di Caracalla, 00100 Roma, Italia.

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