Groundnut Genetic Resources at ICRISAT

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It is well known that the success of modern crop cultivars, the population explosion and the disturbance of the ecosystem have together tended to reduce the genetic variability in plant resources available to man. The grower, processor, distributor and consumer have demanded uniformity in crop varieties and food products. The plant breeder, to meet these demands, has reduced the genetic diversity in our major crop species and this has often resulted in their increased genetic vulnerability. In a way, plant breeders have become victims of their own success. With diversity existing in landraces being replaced by homogeneous improved cultivars, the danger of genetic erosion has become serious (USDA 1979). In groundnut, this process started as far back as 1875 when Holle introduced into Java the Waspada cultivar, maturing in 4-5 months, that completely replaced native cultivars maturing in 8-9 months (Hammons 1973).

With modernization and urbanization, the natural environs of wild and weedy species have been disturbed and some may become extinct. Natural habitat destruction, which occurs only slowly, can be seen happening today in South America as far as *Arachis* species are concerned. It is imperative that whatever genetic diversity remains should be assembled and *conserved.* This may be for immediate utilization in crop improvement, or for future utilization when the situation is expected to be even more alarming.

Arachis Genetic Resources

Groundnut ranks 13th in importance among the world food crops and is the most important food legume (Vamell and McCloud 1975). Compared to other oilseed crops and grain legumes, it is relatively daylength insensitive and has a high oil and protein content. As a crop it is well adapted and is readily accepted as a food. Groundnut is grown on about 20 million hectares, extending from tropical to temperate zones, in about 80 countries. The major production zones are in the semi-arid tropics. Average yields in the developed world are about 2000 kg/ha, but the world average is less than 900 kg/ha.

Arachis genetic resources include all the wild species and the cultivars under production. The genetic diversity in cultivated groundnut has been continuously eroded in the groundnut-growing countries since crop improvement work started in this crop. This process is very clear in India and in some African countries, where improved cultivars have been introduced, and the older landraces have almost completely disappeared. In some regions of many groundnut-growing countries, the process is slow and timely collection now would result in conservation of such landraces. In South America, where *Arachis* originated, much valuable material exists. The developmental activities in many of the countries in this region would soon result in the loss of this valuable germplasm (W. C. Gregory, personal communication). Hence there is an urgent need to collect and conserve *Arachis* germplasm from these countries.

Some efforts to collect and conserve germplasm have been done in a few places around the world in a fragmented manner. Some of the major known *Arachis* collections are listed in Table 1. There is, undoubtedly, a certain amount of duplication in these collections. Table 2 lists the catalogs known from various centers of conservation. From the list, one may take the vastness of the resources for granted. Gregory et al. (1973) have warned about such a possible misconception. These reserves are finite and exhaustible. Harlan (1976) has indicated the limitations of our potential genetic resources in the light of the possible genetic wipe out of the center of

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Table 1. Known sources of groundnut germplasm collections.

Country	Institute/organization
USA	a. Southern Regional Plant Introduction Station (SRPIS), Experiment, Georgia b. North Carolina State University, Raleigh c. University of Georgia, Tifton d. University of Florida, Gainesville e. Texas A&M University, Stephenville f. Oklahoma State University, Stillwater g. Tidewater Research Center, Suffolk
Argentina	a. University of the North-East, Corrientes b. National Institute for Agriculture and Technology (INTA), Cordoba
Brazil	a. Agronomy Institute, Campinas b. CENARGEN/EMBRAPA, Brasilia
Venezuela	CENIAP, Maracay
Senegal, Upper Volta Ivory Coast, Niger etc.	a. Oils and Oilseed Research Institute (IRHO), Paris, France b. Senegalese Institute of Agricultural Research (ISRA), Bambey, Senegal
Nigeria	Institute of Agricultural Research, Ahmadu Bello University (Samaru and Kano)
Malawi	Ministry of Agriculture and Natural Resources (Chitedze Research Station)
S. Africa	Department of Agricultural Technical Services, Potchefstroom.
Zimbabwe	Crop Breeding Institute, Salisbury
Sudan	Gezira Research Station, Wad Medani
Israel	a. Ministry of Agriculture, The Volcani Center, Bet-Dagon b. The Hebrew University of Jerusalem, Rehovot
Japan	Kochi University, Kochi-ken
China	National Academy of Agricultural Sciences, Beijing
Indonesia	Central Research Institute for Agriculture, Bogor
Australia	Department of Primary Industries, Kingaroy, Queensland
Malaysia	Malaysian Agricultural Research and Development Institute
India	a. Oilseeds Research Directorate, Hyderabad b. All India Coordinated Research Project on Oilseeds (AICORPO)

Table 2. Groundnut catalogs available at ICRISAT.

Index Seminum Varieties d'arachide (*Arachis hypogaea*)	ISRA, CNRA, Bambey, Senegal
List of Groundnut Germplasm, Potchefstroom	DATS, Republic of S. Africa
Catalog of Seed Available at the SRPIS, Georgia, USA	ARS-USDA, USA (1974 & 76)
Cultivated Germplasm Catalog-Peanuts	NCSU, Raleigh, USA
Germplasm Screened at Delhi, Ontario, Canada	University of Guelph, Guelph, Canada
Groundnut Germplasm Bank in India	AICORPO (ICAR), India
Catalogo Analitico de Poblaciones de Mani	INTA, Argentina
Groundnut Seed Stored at NSSL	NSSL, Fort Collins, USA
Partial List of Groundnut Available at CBI, Zimbabwe	CBI, Salisbury, Zimbabwe
Peanut Accessions	NPGRL, Laguna, Philippines
List of Introductions from 01/61 to 08/76	The Hebrew University of Jerusalem, Rehovot, Israel
List of *Arachis* Germplasm	EMBRAPA-CENARGEN, Brazil

diversity and Hawkes (1979) clearly described the ways in which such a wipe out may occur. It is clear to everyone concerned that there is an urgent need to collect and conserve *Arachis* genetic resources if we are, indeed, to cope with the present and future groundnut improvement problems. Realizing this urgency, ICRISAT has been designated by the Consultative Group on International Agricultural Research (CGIAR) as a major repository *for Arachis* germplasm and has been charged with the responsibilities of genetic resources activities.

Arachis Genetic Resources at ICRISAT

The work in the groundnut improvement program was initiated at ICRISAT in 1976. Simultaneously the genetic resource activities also commenced. The objectives are collection, maintenance and evaluation *of Arachis* genetic resources and documentation and distribution of seed material and information. During 1979, the genetic resources work was reorganized with the creation of the new Genetic Resources Unit which took over the germplasm work in all five ICRISAT mandate crops. This did not change the basic scope and objectives of groundnut germplasm work. Figure 1 shows the basic activities of the Genetic Resources Unit.

Collection and Assembly

Present Status

Initially the major available resources were identified. Top priority was given to acquiring collections available at various known centers for ICRISAT. All the available collections from various research institutes in India were donated to ICRISAT and about 5000 accessions have been obtained in this manner (Table'3). This material, which has been obtained with the excellent cooperation of many institutions and in particular with the Indian Council of Agricultural Research (ICAR), consists of many intro-

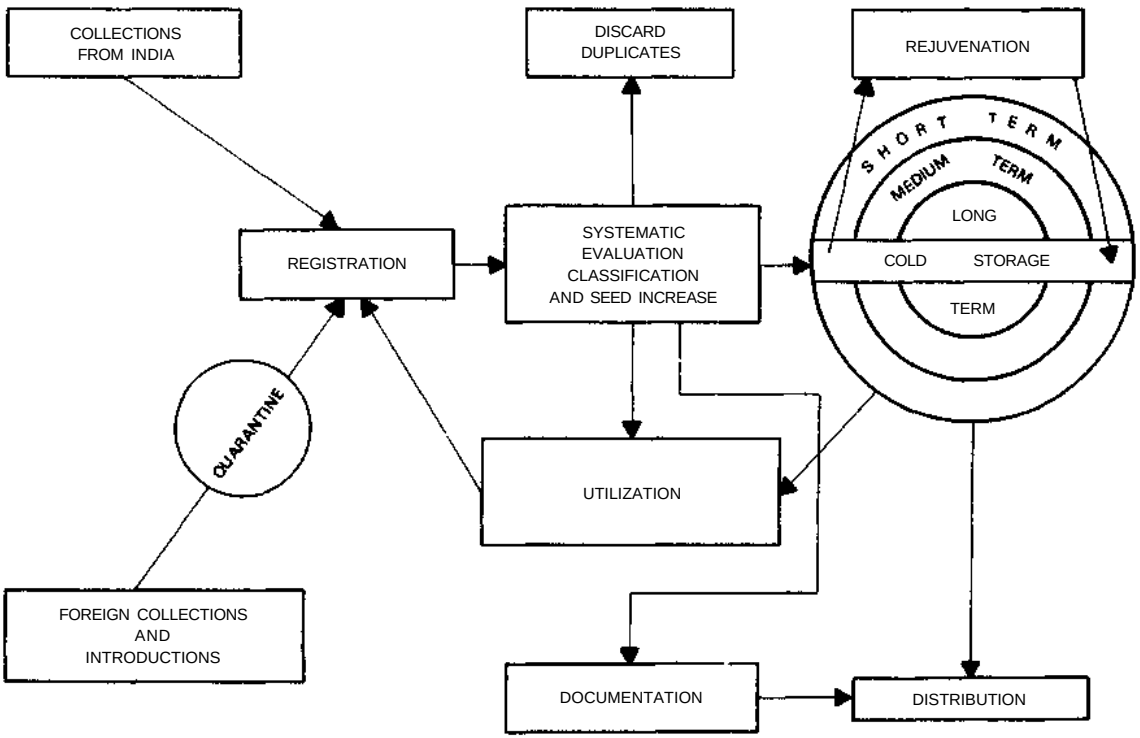

Figure 1. Genetic Resources Unit, ICRISAT — Operational flow chart.

ductions, reselections from such introductions, and experimental types developed within India. Similarly about 3000 accessions have been obtained from the USA, Japan, United Kingdom, Senegal, Malawi, USSR, Nigeria, Zimbabwe, South Africa and China (Table 4). ICRISAT has initiated a contractual arrangement with North Carolina State University, Raleigh, USA for the supply of groundnut germplasm held at that center.

In addition, ICRISAT has undertaken several collection expeditions within India and abroad, and a total of 598 accessions have been obtained so far (Tables 5 and 6). Generally random sampling technique is used for collection of seed from farmers' fields and seed is collected from as many plants as possible. During collection trips, apartfrom collection of seed material, information on cultivation practices, location, pests and diseases is also collected. For this purpose, a germplasm collection data sheet has been developed.

Table 3. Transfers from Indian centers.

Institute/location	Accessions
Andhra Pradesh Agricultural University, Kadiri & Karimnagar	1364
Rajendra Agricultural University, Ranchi	103
Mahatma Phule Krishi Vidyapeeth, Jalgaon	263
G.B. Pant University of Agriculture and Technology, Pantnagar	11
Agricultural Research Station, Durgapura	58
All India Coordinated Research Project on Oilseeds, Tindivanam and Pollachi	681
Gujarat Agricultural University, Junagadh	1154
Oilseeds Experiment Station, Tindivanam	368
Punjab Agricultural University, Ludhiana	495
National Bureau of Plant Genetic Resources, Amravati	159
Bhaba Atomic Research Center, Bombay	9
Punjabrao Krishi Vidyapeeth, Akola	112
Regional Wheat Rust Research Station, Mahabaleswar	5
Tamil Nadu Agricultural University, Coimbatore	29
Others	67
Total	4969

Table 4. Tansfers from centers abroad.

Country	Accessions
USA	2066
Japan	74
United Kingdom	20
Malawi	263
Senegal	16
USSR	3
Zimbabwe	151
South Africa	33
Nigeria	103
China	5
Total	2724

Table 5. Collection of local cultivars — India.

Month	Year	State	Accessions
Mar/Apr	1976	Bihar, Orissa, and Tamil Nadu	11
Nov/Dec	1976	Tamil Nadu, and Andhra Pradesh	23
Sept/Nov	1977	Rajasthan	7
Sept/Oct	1977	Karnataka (south)	35
Oct/Nov	1977	Andhra Pradesh	92
Apr	1978	Andhra Pradesh	4
Oct	1978	Maharashtra	1
Oct	1978	Karnataka (north)	151
Apr	1979	Andhra Pradesh	6
Apr/May	1979	Karnataka (south) and Andhra Pradesh	101
May	1979	Maharashtra	1
Aug/Sept	1979	Maharashtra and Gujarat	19
Oct	1979	Uttar Pradesh	1

Table 6. Collection of local cultIvars - abroad.

Month	Year	Country	Accessions
Mar/Apr	1979	Bolivia	12
Apr	1979	Nepal	13
Apr	1979	Malawi	33
Aug/Sept	1979	Somalia	5
June	1980	Zambia	83

Table 7. Yearly acquisitions.

Year	Accessions	Total
1976	2443	2443
1977	3565	6008
1978	925	6933
1979	1216	8149
1980 (August)	349	8498

Up to mid-1980, about 8500 accessions had been assembled and Table 7 gives the yearly acquisition of this material. Table 8 presents the available germplasm, by country. Apart from this, 1536 accessions from various countries are currently under quarantine inspection (Table 9).

ICRISAT has a special interest in the wild species of *Arachis* for cytogenetic and resistance breeding work. Some species (Table 10) have already been obtained from the Tamil Nadu Agricultural University, Coimbatore, India; North Carolina State University, USA; and Reading University, U.K. and have been established at ICRISAT. The collection from Reading University consists of material originally from North Carolina State University, Raleigh; Oklahoma State University, Stillwater; Texas A & M University, Stephenville; ARS-USDA, Tifton, Georgia, and the Division of Food Crops, Campinas, Brazil. More material is still being transferred. At the moment the wild species material is maintained jointly by the Genetic Resources Unit and Groundnut Cytogenetic Program.

Future Priorities

The IBPGR/ICRISAT ad hoc Committee on Groundnut Germplasm (September 1979) has assigned the following priorities for immediate collection:

Region	*Countries*
South Asia	Burma
Southeast Asia	Indonesia
Meso America	Mexico, Central America, and Caribbean Islands
West Africa	Senegal, Nigeria, Upper Volta, and Gambia
East Africa	Mozambique
South America	Brazil, Argentina, Peru, Bolivia, and Paraguay

Gregory et al. (1973) have described the distribution of the genus *Arachis* in South America, where more intensive collecting is necessary to obtain valuable germplasm. Efforts are being made to launch expeditions in collaboration with the IBPGR and CENARGEN/EMBRAPA (Brazil).

Quarantine

The importation of exotic groundnut material is subject to strict quarantine regulations laid down by the Government of India in order to prevent the entry of new pests or diseases into the country. ICRISAT obtains the seed in the form of shelled seed accompanied by regular phytosanitary certificates. The seed is planted in plastic pots in the screen house at the Central Plant Protection Training Institute (CPPTI), Rajendranagar. CPPTI has been authorized by the Ministry of Agriculture, Government of India, to conduct quarantine work for ICRISAT mandate crops. The seedlings remain under close examination for 6 weeks. Then the material is transferred, and transplanted, in the Post Entry Quarantine Isolation Area (PEQIA) which is located in an isolated corner of the ICRISAT farm. The seedlings are inspected every week by a joint CPPTI-ICRISAT team and any plants showing suspicious symptoms are uprooted and destroyed. At maturity, the seed is harvested from the healthy plants and is released. These procedures allow an excellent working relationship between the Genetic Resources Unit and the quarantine authorities.

For export, seeds from healthy plants are collected. The seed is examined by the Indian quarantine authorities and is then despatched

Table 8. Groundnut germplasm — source countries (August 1980).

Country	Accessions
AFRICA	
Angola	2
Dahomey	6
Egypt	5
Gambia	5
Ghana	6
Guinea	2
Ivory Coast	24
Kenya	28
Liberia	10
Libya	1
Madagascar	8
Malawi	65
Mali	9
Mauritius	7
Morocco	5
Mozambique	10
Nigeria	167
Senegal	85
Sierra Leone	7
South Africa	42
Sudan	674
Tanzania	110
Uganda	57
Upper Volta	10
Zaire	11
Zambia	10
Zimbabwe	377
Others	84
	1827
N.C. AMERICA	
Cuba	11
Costa Rica	1
Honduras	3
Jamaica	1
Mexico	6
Puerto Rico	19
USA	1240
	1281
SOUTH AMERICA	
Argentina	195
Bolivia	56
Brazil	243
Chile	12
Ecuador	2
Paraguay	101
Peru	62
Uruguay	20
Venezuela	8
Others	114
	813
ASIA	
Burma	16
China	162
Cyprus	5
India	1715
Indonesia	25
Iran	6
Israel	31
Japan	44
Malaysia	13
Philippines	6
Sri Lanka	17
Taiwan	20
Turkey	3
	2063
EUROPE	
Bulgaria	2
Greece	4
Holland	5
Spain	1
	12
OCEANIA	
Australia	45
Fiji	1
	46
USSR	49
Unknown	1991

Table 9. Accessions under quarantine.

Country	Accessions
Burma	5
China	10
Indonesia	60
Italy	27
Malawi	6
Malaysia	56
Nepal	1
Senegal	341
South Africa	133
USA	814
Zambia	83
Total	1536

Table 10. *Arachis* spp at ICRISAT.

A. duranensis	*A. glabrata*
A. batizocoi	*A. repens*
A. correntina	*A.* sp (10038 LL & SL)
A. chacoense	*A.* sp (C 565-66)
A. cardenasii	*A.* sp (C 9990, 9993, 10002)
A. villosa	*A.* sp (Man. 5)
A. stenosperma	*A.* sp (Man. 8)
A. monticola	*A.* sp (30008)
A. pusilla	*A.* sp (30098)
A. paraguariensis	*A.* sp (30093)
A. villosulicarpa	*A.* sp (30011)
A. rigonii	Many accessions of *Rhizomatosae*
A. hagenbeckii	

to the consignee with phytosanitary certificate issued by the Government of India. This work is carried out at thequarantine laboratory situated in the ICRISAT Center under the supervision of CPPTI personnel.

Maintenance

The procedures followed in conservation, maintenance, and storage present many problems. In maintaining the genetic purity of the conserved accessions, problems may arise due to differential survival in storage, selection during rejuvenation, out-crossing with other entries, and genetic drift (Allard 1970). Good storage conditions coupled with proper grow-outs are expected to reduce the effects of such problems.

At ICRISAT all the cultivated groundnut accessions and seed producing wild species are maintained by growing out In the case of the cultivated groundnut, only pods attached to the plants are harvested. In the case of seed producing wild species material, which are considerably space planted, all the pods are collected. The rhizomatous and nonseed producing wild species are maintained in either brick chambers or concrete rings to prevent contamination. Rejuvenation is carried out by rooting stem cuttings and rhizomes. As the long-term cold storage facilities are still under construction, about one-third of the collection is planted every year for multiplication and rejuvenation during the postrainy season when there is less incidence of pests and diseases.

Types of Collection

Though there is no recommendation regarding the types of groundnut collections to be maintained at ICRISAT, it is envisaged that the following types would be maintained:

ACCESSIONS COLLECTION. This includes all the available groundnut accessions at ICRISAT. It will be maintained in long-term cold storage.

WORKING COLLECTION. (BASIC COLLECTION) This includes lines chosen and stratified by botanical variety, geographical distribution and ecological adaptation. This would represent the genetic diversity available in the groundnut germplasm.

WILD SPECIES COLLECTION. This includes all the wild species of *Arachis* which have to be maintained separately due to problems of handling.

NAMED CULTIVAR COLLECTION. All the cultivars named and released by public and private institutions will be included in this collection.

GENETIC STOCK COLLECTION. This collection includes all the sources of resistance to pests and diseases, lines with specific desirable traits and stocks with known genes.

Storage

At present the collection is stored as unshelled pods in airtight containers in temporary stores which are not airconditioned. The medium-term cold storage facility which has been recently completed, with 4°C temperature and 35% relative humidity, is now available for storing groundnut germ plasm. The long-term facility (- 18°C) has been approved for construction and should be completed by the end of 1981.

Evaluation and Utilization

Collection, maintenance, and conservation have significance in elucidating taxonomic status and evolutionary relationships between and within the species. But the main justification for genetic resource conservation is for utilization in crop improvement. The key to successful utilization of variability from broad genetic pools requires the knowledge of desirable traits available in the germplasm. This requires a systematic evaluation of the germplasm. At ICRISAT, a multidisciplinary approach is followed and the available groundnut collection is evaluated by all the groundnut scientists.

The preliminary evaluation is carried out in the PEQIA and during the first grow out for multiplication. The material is evaluated for about 32 morphological and agronomic characters. Promising material is then evaluated by other disciplines. Table 11 gives some of the sources selected for resistance to pests and diseases. These lines are being extensively used in the breeding program to incorporate and improve the existing cultivars. Lines identified elsewhere as early maturing and high yielding, and which are in the ICRISAT collection are also being used in the respective breeding programs.

In the near future, germplasm will also be evaluated for other useful attributes such as drought tolerance, high oil content and sources of resistance to other pests and diseases. It is also intended that in future, multilocation testing of some of the germplasm lines will be carried out. At present, part of the ICRISAT groundnut germplasm is being evaluated in Vertisols in Junagadh, Gujarat, in collaboration with National Research Center for Groundnut.

Table 11. Promising groundnut germplasm lines.

Character	Promising lines	
	Cultivated (ICG Nos)	Wild species
Leaf Spot (*Cercosporidium personatum*)	2716, 7013, 4747, 6340, 6022	PI 338280 (*A.* sp HLK-410), PI 338448 (*A. pusilla*), PI 276233 (*A.* sp 10596), PI 276235 (*A. chacoense*) *A. chacoense* x *A. cardenasii*, *A. glabrata*
Rust	1697, 7013, 2716, 4747, 6340, 6022, 1703, 1705, 1704, 1707, 1710, 6280, 4746	PI 219823 (*A. duranensis*), PI 331194 (*A. correntina*), PI 262141 (*A. cardenasii*), PI 276235 (*A. chacoense*) *A. chacoense* x *A. cardenasii* PI 338448 (*A. pusilla*), PI 262848 (*A.* sp 9667), PI 276233 (*A.* sp 10596), *A. villosa*, *A. villosulicarpa*,

Continued

Table 11. *Continued*

Character	Promising lines: Cultivated (ICG Nos)	Promising lines: Wild species
		A. glabrata PI 298639 (A. *batizocoi),* PI 338280 (A. sp HLK-410)
Leaf Spot and Rust	2716, 7013, 4747, 6340	PI 338280 (A. sp HLK-410), PI 338448 (*A. pusilla*), PI 276233 (A. sp 10596), PI 276235 (*A. chacoense),* *A. chacoense* x *A. cardenasii* *A. glabrata*
Aflaroot rot	1326	Not tested
Collar rot	3263, 1326	Not tested
Aspergillus flavus	1326, 4749, 4750	Not tested
Pod rot	3336,3334,2951, 1326, 1711,2031	Not tested
Tomato Spotted Wilt Virus	1656,799	PI 262848 *(A.* sp 9667), PI 338448 *A. pusilla*), *A. glabrata,* PI 276233 (*A.* sp 10596)
Peanut Mottle **Virus**	2716, 4747 (Virus present in the plants but does not go to the seed)	Not tested
Clump Virus	7677,5123,5118, 8030, 3894, 6313, 5210, 949	Not tested
Thrips and Jassids	5042, 5044, 5041 5043, 5045, 5040, 2271	PI 276235 (A *chacoense*), PI 298639 (A *batizocoi*)
Aphids	Single plant selections from 5040	PI 276235 *(A. chacoense*), PI 298639 (*A. batizocoi*)
Termites	5045, 5929, 5040, 5143, 2316, 1326	Not tested
Leaf miner	1697, 1703, 1704, 5075, 2283, 2349	Not tested
Nodulation and BNF capacity	1561,2405,404	Not tested

Apart from this, the germplasm lines are evaluated systematically for yield and other attributes. Substantial amounts of such germplasm are being utilized in various breeding projects which would help to broaden the genetic base of the *material that* goes out *of* ICRISAT. Some of the earlier selections made from some accessions such as Robut 33-1, have been supplied to the breeders and promising lines have been selected from this material.

Documentation

Progress in the field of plant genetic resources is related to the conservation of eroding genetic resources and utilization of this material for crop improvement work. Success partly depends on the availability of information on the material being conserved. Withtheformation of international institutes, information exchange has assumed global importance, necessitating a certain amount of uniformity in data collection, recording, storage, and retrieval. The International Board for Plant Genetic Resources (IBPGR) is expected to play a key role in bringing an understanding among the workers in many countries on these aspects and in the international exchange of information.

A common descriptive language is imperative. Attempts *to* develop such a descriptive language for groundnut (genus *Arachis)* is under way, in close collaboration with IBPGR. The IBPGR/ICRISAT ad hoc Committee on Groundnut Germplasm which met during September 1979 appointed a subcommittee to finalize the descriptors for groundnut. The subcommittee met during July 1980 and has evaluated a list of critically prepared descriptors and a final draft for the approval of the members is under preparation. This list contains 32 descriptors for passport information and 40 descriptors of a morpho/agronomic nature. Descriptors on disease and pest reaction are to be added to this list. After approval the descriptors will be circulated among groundnut workers and then a finalized list will be published. A list of the descriptors used for groundnut germplasm at ICRISAT is shown in Table 12.

Since the descriptive language is under preparation, the data recorded during the last few evaluations in ICRISAT site have not been stored on the computer. However, these evalua-

Table 12. List of the descriptors used for groundnut germplasm at ICRISAT.

Passport Data:

1. ICG number
2. Synonym number - 1
3. Synonym number - 2
4. Synonym number - 3
5. Synonym number - 4
6. Sample type
7. Collector's name and number
8. Collection date
9. Sample source
10. Donor
11. Pedigree
12. Species, subspecies and variety
13. Cultivar
14. Pedigree
15. Origin
16. Province/state and nearest village
17. Altitude, latitude, and longitude
18. Local name
19. Soil type
20. Remarks

Morphological Data:

1. Branching pattern
2. Growth habit
3. Stem color
4. Stem hairiness
5. Peg color
6. Standard petal color
7. Standard crescent
8. Standard size
9. Leaf color
10. Leaf shape
11. Leaf size
12. Pod type
13. Pod beak
14. Pod constriction
15. Pod reticulation
16. Pod length
17. Pod size
18. Number of seed/pod
19. Seed color
20. Seed size
21. Seed shape

Agronomic Evaluation Data:

1. Date of planting
2. Days to emergence
3. Seedling vigor
4. Days to 50% flowering
5. Plant height (cm)

Continued

Table 12. *Continued*

6. Plant width (cm)
7. Total mature pods/plant
8. 100 seed weight (g)
9. Yield (g/plot)
10. Date of harvest
11. Days to maturity

Table 13. Distribution of groundnut germplasm.

Scientists in India	5383
Scientists abroad	3262
Scientists in ICRISAT	4914

tions, which used many of the proposed descriptors, can be computerized as soon as the descriptors and descriptor states are finalized. The computer file forms the base for a live catalog and only special lists will be published.

Distribution

The seed despatch to the scientists in India and abroad is one of the important activities undertaken by the Genetic Resource Unit Table 13 gives the details of seed distributed so far.

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