Genetic Resource of Crop Plants, and Other Important Plant Species in Sri Lanka

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Abstract

Sri Lanka, though a small island, exhibits a mosaic of ecological diversity which is reflected in a rich floristic diversity and high endemism. This wide spectrum of species diversity is associated with an even greater intraspecific genetic diversity. The per unit area biodiversity expressed in Sri Lanka is higher than that of other countries in the South Asian region and for some crops, the country qualifies as a secondary center of ecogenetic diversity.

The Plant Genetic Resource Centre established in 1989 with financial and technical support from the Government of Japan is carrying out a systematic programme in genetic resources management and research. A total of nearly 10,000 accessions representing 137 species, including wild relatives of crops, have been assembled and their distribution mapped. Genetic resources management includes *ex situ* conservation approaches-seed genebank, *in vitro* genebank, field genebank networks-complemented by *in situ* conservation for wild relatives using the existing Strict Nature Reserves. Nearly 30% of the assembled germplasm has been characterized and is being evaluated for desirable traits. Computerized data management system facilitates germplasm use. Biotechnology approaches are being applied for the conservation of genetic resources but mainly for improving germplasm to help breeders use the assembled germplasm efferctively.

Introduction

Sri Lanka though a small island, exhibits a diverse topography with edaphic and climatic variation, resulting in an array of ecosystems which sustain a wealth of plant genetic resources. These genetic resources exhibit unique species diversity of great significance in an island flora. They have provided crop plants, fuelwood, timber, medicinal herbs, and ornamental plants to mankind for generations, resulting in better quality of life.

Sri Lanka as a center for eco-genetic diversity

The island is characterized by a rich floristic diversity of over 3,650 species of flowering plants, of which 879 species in 342 genera and 103 families are endemic (Bandaranaike and Sultanbawa, 1991). Sri Lankan flora contains floristic elements from Indo-Sri Lankan, Himalayan, African regions, in addition to plants characterized by pantropic and cosmopolitan distribution (Abeywickrama, 1955). Thouth a large part of the Sri Lankan plants also occur in peninsular India, a high concentration of diversity and endemicity is exhibited in Sri Lanka. The diversity of flowering plants per unit area of land is estimated to be greater in Sri Lanka than is any other Asian countries (Fig. 1).

As for the climate, the country is divided into a wet zone in the southwestern quarter of the island (about 23%), a dry zone in the northern, north central, north western, eastern and in parts of the southern sector (about 64%) and an intermediate zone in between these two zones. These zones are further subdi-

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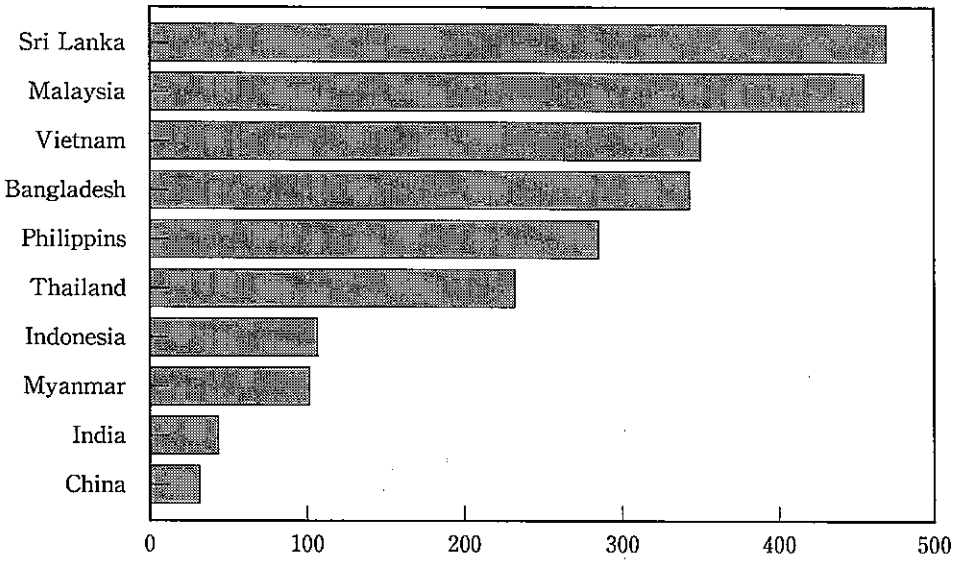


Fig. 1 Density of flowering plant species in Asian countries (per 10,000 km²) (Adapted from Malcolm and Baldwin, 1991)

vided into 22 well-defined agro-ecological regions, each with its unique combination of rainfall pattern, elevation, land form, types of soils, and temperature ranges which determine the prevailing land use, cropping pattern, production constraints, and development potentials.

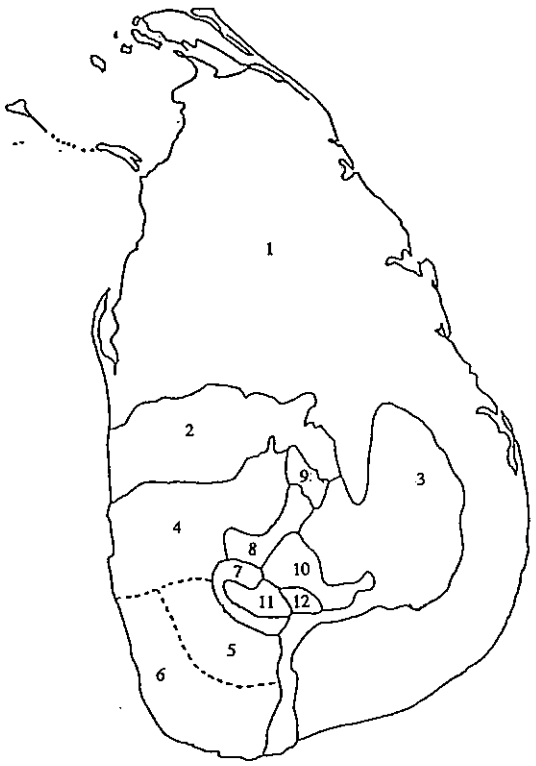
Ashton and Gunatilleke (1987) delineated fifteen floristic regions for the island (Fig. 2). Their studies on species diversity conducted in selected locations revealed a high species variety in wet lowland sites (Gilimale, Kanneliya, and Kottawa) compared to the intermediate (Moneragala and Barigoda) and the dry zones (Ritigala). The wet zone climax forests are considered to have evolved slowly over a very long period of time. De Zoysa *et al*. (1987), observed that the endemic species are more concentrated in the canopy and sub-canopy layers of rain forest. Though the wet zone forest has dwindled by 10% of the original extent, it is still the richest in all South Asia in terms of biodiversity (Malcolm and Baldwin, 1991). Of these, the Sinharaja forest is unique and contains more than 70% of endemic flora. The nearest counterparts are in Madagascar and Sumatra. The Sinharaja forest assumes the function of a genetic repository for some of the Asia's most important economic plant groups.

Cultivated resources and their wild relatives

The diverse agro-ecological regions of Sri Lanka have sustained a rich germplasm of crop plants which are unique to this country. In addition to the varied environments, continuous selection by the farmers and maintenance of promising types over a long period of time, have resulted in a large number of agro-ecotypes which are adapted to the various agro-ecological regions and growing conditions. Although Sri Lanka is not considered as a Vavilovian center for the origin of many crop plants, the variety of its genetic resources qualifies it as a secondary center of ecogenetic diversity for some crops in which a large amount of genetic variability is expressed.

The variety of our rice germplasm is exemplified by the rare sources of resistance to bacterial leaf blight, blast, brown planthopper biotypes, leaf roller, as well as tolerance to iron toxicity, phosphorus deficiency, submergence, salinity, cold and drought. Several genes for resistance to the brown planthopper including the genes Bph_3 and Bph_4 have originated from our varieties (Khush, 1977). Some of the landraces have special food value specially for convalescents. The Heenati group of varieties which are variants of the normal indicas are only recorded in Sri Lanka. They display certain morphological and physiological characteristics different from typical indicas (Abeyratne, 1952).

Wild and weedy species of *Oryza* are found in various ecological niches throughout the country, viz. *O. refipogon*, *O. nivara*, *O. granulata*, *O. eichingeri*, and *O. rhizomatis*. Of these *O. rhizomatis* is endemic



1. Dry and arid lowlands
2. Northern and intermediate lowlands
3. Eastern intermediate lowlands
4. Northern wet lowlands
5. Sinharaja and Ratnapura
6. Southern lowlands and hills
7. Foothills of Adam's Peak and Ambagamuwa
8. Kandy and upper Mahaweli
9. Knuckles
10. Central mountains, Ramboda-Nuwara Eliya
11. Adam's Peak
12. Horton Plains

Fig. 2 Floristic regions of Sri Lanka (adapted from Ashton and Gunatilleke, 1987)

to Sri Lanka. Over 2,300 accessions of native landraces, primitive cultivars, selections through breeding efforts, and wild weedy forms have been collected throughout Sri Lanka and conserved.

1 Coarse grain cereals/millets

Various types of millets have been grown in Sri Lanka from historical times. Of these, the predominant one grown in all the ecological regions is finger millet (*Eleusine coracana*) which shows a wide genetic diversity and ecosystem adaptability. Sorghum, foxtail millet (*Setaria italica*), common millet (*Panicum miliaceum*) and Kodo millet (*Paspalum scrobiculatum*) are cultivated in most of the ecological ranges of the dry and intermediate zones. Wild forms such as *Echinochloa frumentacea*, *Coix lachrymajobi* are also growing.

2 Grain legumes

Cowpea, green gram, black gram, soybeans, pigeon pea, chick pea, etc. are grown. Wide variations exist for cowpea, and many wild relatives of pigeon pea can be observed. Four species of *Atylosia*, two species of *Dunbaria* and twelve species of *Rynchosia* have been assembled. *Atylosia scarabacoides* commonly found in the dry zone, is a potential source for insect resistance through introgressive hybridization. Chickpea was successfully introduced as a new crop in 1980 through the IBPGR programs (Ganashan and Vander Mason, 1981).

3 Oil seeds

Among the oil seeds, appreciable variation exists in sesame which has been cultivated for a very long time. Varieties with specific adaptability to various ecoedaphic conditions are grown in the dry zone. The other crops which were mostly introduced are groundnut, sunflower, and castor. However, landraces of groundnuts are found in the eastern region of Sri Lanka. Wild forms of sunflower and castor are still available in most of the abandoned site.

4 Root and tuber crops

Cassava and sweet potato were originally introduced to this country and are now acclimatized to the different ecological zones and contribute to the national food production programs. *Xanthosoma*, five species of *Dioscorea* (yams), aroids such as *Colocasia*, and *Alocasia* and *Amorphophallus* spp. form the indigenous germplasm.

5 Vegetables

Among the vegetables, a wide range of native diversity and wild forms can be found for bitter gourd (*Momordica charantia*), snake gourd, smooth gourd, eggplant and okra. Well adapted ecotypes occur in pumpkin, luffa, cucumis, wild bitter gourd (*Momordica dioica*), *Trichosanthes anguinea*, wild *Solanum* species such as *S. trilobatum*, *S. torvum*, *S. macrocarpon* and *S. virginianum* occur in many areas and their fruits (berries) are used locally as vegetables. Among the leguminous types much variability is observed in *Vigna unguiculata*, *Phaseolus vulgaris*, and *Phaseolus lunatus*. Wild *Amaranthus* types have also been recorded during collection missions. Native leafy vegetables such as *Centella asiatica*, *Ipomoea aquatica*, and mukunuwenna, gotukola and kankun exhibit a greater variability.

6 Fruit crops

The diverse agro-ecological conditions in the country have supported a wide variety of fruit crops. The spread of the fruit crops which are grown as different agro-climatic groups is shown in Table 1. Specific varietal adaptability to the various climatic zones can be observed in some fruit crops. Among the fruit crops, banana is cultivated in most part of the country, primarily as a home garden crop. There are about 32 indigenous cultivars, most of which exhibit clonal variations within cultivars, probably due to continuous selection by growers in different localities over a long period of time. The most popular cultivars are locally known as Embul (Sour type), Kolikuttu, Amban, Anamalu, Poovalu, Hondarawalu, Suwandel, and Bim-kehel (dwarf type). Another cultivar Seeni-kehel can withstand drought conditions and is also resistant to most of the pests and diseases. Both the wild progenitors of the cultivated banana *Musa acuminata* (A genome) and *Musa balbisiana* (B genome) are found in natural state in Sri Lanka. The hybrid clones with B genomes are hardier and more drought-tolerant, which could be observed in Seeni-Kehel and Alukehel (a cooking type) both with ABB genome.

Citrus, mango, avocado, jak, etc. exhibit a considerable genetic diversity. In *Citrus*, the diversity observed is higher in *C. aurantifolia* and *C. sinensis* than in *C. limon*, *C. grandis* and *C. medica*. Mango exhibits a wide variability in the dry zone. Wide variability in the desert type jak is found in the north-eastern sector of Sri Lanka where deep latosol soil type predominates.

Feronia limonia (wood apple) found mostly in the semi-wild form in the dry zone exhibits a large diversity for various growth characteristics and fruit quality. The fruit pulp is used for jam preparations, and the plant offers a good rootstock for grafting of sweet orange. Diversity is also observed in *Aezle marmelos* (Beli fruit) found in the dry and wet zone lowlands. Wild forms of *Tamarindus indica*, *Emblica officinalis*, *Euphoria longana*, *Dialium ovoideum*, *Garcinia quaesita* offer promise for improvement.

Important fruit crops have been introduced by the Department of Agriculture since its inception. Promising local selections and introductions were maintained in government farms, evaluated and superior cultivars were recommended for general cultivation.

A large number of germplasm samples was introduced between 1981-1984 under the FAO/UNDP funded Horticultural Research and Development Projects, and in 1993 under the Diversified Agricultural Research Project of the USAID (Table 2).

Table 1 Distribution of fruit crops grown in Sri Lanka, by agro-climatic groups

Commom name	Botanical name	Agro-climatic group			
		A	B	C	D
Ambarella	*Spondios pinnata*	x			
Anoda	*Annona reticulata*	x	x		
Apple	*Malus pumilla*		x	x	
Apricot	*Prunus Armeniaca* L.		x		
Avocado	*Persea gratissima*	x	x		
Banana	*Musa sp.*	x	x		x
Bell fruit	*Aezle marmelos*	x			x
Bitter orange	*Citrus aurantium* L.		x		x
Bread fruit	*Artocarpus altilis*	x			
Cherimayer	*Annona cherimola Mill*		x		
Custard apple	*Annona squamasa*	x			
Durian	*Durio zibethinus Murr.*	x			
Granadilla	*Passiflora quadrangularis*		x	x	
Grape	*Vitis vinefera*		x	x	x
Grapefruit	*Citrus paradisi*		x		x
Guava	*Psidium guajava* L.	x	x		
Jackfruit	*Ariocarpus heterophyllus Lam.*	x			x
Lemon	*Citrus limon Burmf.*		x		
Lemonima		x			
Lime	*Citrus aurantifolia*		x		x
Loquat	*Eriobotrya japonica, Lindl.*		x		
Mandarin	*Citrus reticulata*		x		x
Mango	*Mangifera indica*, L.	x			x
Mangosteen	*Gercinia mangostana* L.	x			
Nelli fruit	*Phyllenthus embilica*				x
Orange	*Citrus sinensis*		x		x
Pomegranate	*Punica granatum* L.				x
Papaya (Papaw)	*Carica papaya* L.	x	x		
Passion fruit	*Passiflora edulis* Sims.	x	x		x
Peach	*Prunus persica Batsch*			x	
Pear	*Pyrus serotina* & *P. communis*		x	x	
Persimmon	*Diospyros virginiana*		x		
Pineapple	*Ananas comosus Merr.*		x	x	
Plums	*Prunus domestica* L.			x	
Rambutan	*Nephelium lappaceum* L.		x		
Sapodilla	*Achras zapota* L.		x	x	x
Soursop	*Annona muricata*		x	x	
Strawberry	*Fragaria vesca*			x	
Woodapple	*Feronia limonia*				x

7 Fiber crops

Kenaf and cotton are cultivated in areas in which both native and introduced cultivars were grown. Kenaf is also used for paper pulp in the paper industry. *Sansevieria* leaves are traditionally used for making mats while the fibers are used for making brushes and other fiber products.

8 Condiments

Hot pepper (chilli), shallots (small onions), garlic, and mustard are grown and many wild species oc-

Table 2 Varietal introduction in fruit crops

	Crop species	No. of varieties introduced	
		1981–1984 Horticulture Project	1993 DARP Project
01	Avocado	19	—
02	Citrus (a) Orange —Exotic	08	02
	Local	02	
	(b) Mandarin—Exotic	18	07
	—Local	03	
	(c) Lemon	08	02
	(d) Tangerine	03	01
	(e) Grape fruit	08	03
	(f) Kum Quat	01	
	(g) Lime	01	
	(h) Tangelo	03	
	C. grandis		04
	Citrus Rootstocks	31	
03	Peaches and Nectarines	12	06
04	Guava	17	02
05	Date Palms	02	
06	Pomegranate	02	05
07	Longan	04	04
08	Loquat	04	—
09	Carambola	04	08
10	Persimon	01	01
11	Macademia	07	—
12	Anora	03	—
13	Grapes	57	05
14	Litchi	07	06
15	Pineapple	13	—
16	Durian	01	06
17	Rambuttan	01	—
18	Banana	01	09
19	Strawberry	02	—
20	Apple	04	02
21	Pears	02	06
22	Plum	04	02
23	Jak	—	04
24	Passion fruit	—	03
25	Mango	—	14
26	Mangosteen	—	01
27	Custard apple	—	02
28	Sapodilla	—	03
29	Barbados cherry	—	01
30	Blueberry	—	02

Note : *A = low country wet zone; B = up country dry zone; C = up country wet zone; and D = dry zone

Courtesy : Mr. M.A.U. de Zoysa, Export Development Board, Sri Lanka.

cur in hot pepper.

9 Plantation crops

Tea, rubber and coconut are plantation crops of economic importance. Their habitats have been transferred in most of the fertile lands within the last 150 years. Tea and rubber plantations have denuded large portions of wet zone flora in less than 150 years of their existance. The germplasm of tea initially introduced from Assam has undergone clonal selection for local adaptability and the selected genotypes are maintained at various breeding stations and tea estates. The selected clones exhibit a high yield, resistance/tolerance to biotic and abiotic stresses and high rate of fermentation. More than clones of rubber and a variety of hybrids of coconut have been developed.

10 Spices

Spices were the main export crops before tea and rubber plantations were established. They are locally called export agricultural crops, and consist of cinnamon, cardamom, pepper, vanilla, clove, nutmeg, citronella, lemon grass, coffee and cocoa. They are grown in small monocultures, in home gardens and in forest gardens with adequate soil moisture. Some of them are also intercropped on tea, rubber and coconut lands. The Department of Export Agriculture was set up in 1972 to boost the development of these crops for export purposes. There is a large for cinnamon, cloves and cardamom.

Of the six species of cinnamon, it is considered that *Cinnamomum zeylanicum* originated in Sri Lanka and has been cultivated since early periods, while *C. sinharajense* has been identified recently. Wild species of cinnamon are found in the wet zone forests. Ten wild races of cardamom have been collected from the Sinharajah and adjoining forests.

There is a considerable genetic diversity in cultivated and wild pepper. The cultivated species are *P. longum*, *P. betle*, and *P. nigrum*. The wild species are *P. siriboa*, *P. hymenophyllum*, *P. churya*, *P. sylvestre*, *P. walkeri*, *P. trineuron* and *P. zeylanicum*. About 500 local selections from the cultivated types are available.

Germplasm of *Citronella* comprises *Cymbopogon nardus*, *C. winteranus*, and the wild type *C. nardus*.

Of late tobacco, sugarcane (State Sugar Corporation) and cashew have assumed importance in the plantation sector.

Palmyrah palm (*Borassus flabelifer*) predominates mainly in the sandy planis. Palmyrah Development Board was established in 1978 to promote the development of this crop.

11 Medicinal plants

Sri Lanka's natural resources of medicinal plants consist of more than 625 species belonging to 90 families. Several other plants are becoming sources of pharmaceuticals in modern medicine. Well over 1,000 plants are used in the ayurvedic system of medicine and most of them are indigenous. Local requirements are met by collecting them from wild areas, which has resulted in the dwindling of some species, which are not found in abundance. Periodically, a large quantity of processed medicinal plants is also exported. *Saraba asoca* which is indigenous and used for medicinal purposes is rarely seen. *Rubia ordifolia* (locally called Val matheta) which grows at elevations above 5,000 feet in the Haggla area is now scarce and has to be protected. Other species which are over-collected for medicinal purposes are: *Munronia punla*, *Raxivolifa serpintina*, *Gloriosa superba*, *Dioscorea* spp., etc. Pharmacological properties of certain plants such as *G. superba*, are assuming increasing importance.

12 Ornamental plants

One hundred and seventy species of orchids are found in Sri lanka, of which 99 are considered to be rare, 7 vulnerable and endemic, and 13 species are likely to become extinct if protection is not afforded (Sumithraarachchi, 1986). *Dendrobium* and *Vanda* species and foliage plants can be found in most of the natural forest habitats. Plants used for cut flowers are mainly: Orchid, Anthurium, Carnations, Roses, Gerbera, Hibiscus, Gardenia, Gypsophila and Statice.

Foliage plants are also becoming increasingly important, with a great demand in foreign countries. The following foliage plants are grown for export: *Adiantum*, *Aglonema*, *Alocasia*, *Aralia*, *Areca*, *Asple-*

nium, *Caryota*, *Codiaeum*, *Cordline*, *Dieffenbachia*, *Dizygotheca*, *Dracaena*, *Ficus*, *Ixora*, *Kalanchos*, *Licula*, *Livistoma*, *Maranta*, *Pandanas*, *Philodendron*, *Phoenix*, *Ploemele*, *Polysia*, *Schefflera*, *Syngonium* and *Yucca*. *Ficus benjamina*, as a miniature plant has a great value in Japan. *F. microcarpa* is also gaining popularity as a foliage ornamental.

13 Important forest trees

The natural forests provide timber for furniture and construction purposes. Furthermore about 20% of the fuelwood requirement is also derived from these forests. On the basis of annual rainfall and elevation, four natural forest types can be identified.

1. Tropical dry mixed evergreen forests

These are dry zone forests and mostly of secondary growth. Valuable timber trees such as *Manilkara hexandra*, *Diospyros ebonum* (Ebony), *Berrya cordifolia* (*S. halmilla*), *Chloroxylon swietenia* (Satin), *Pleurostylia opposita* are predominant in these forests.

2. Tropical humid semi evergreen forests

Forests of the intermediate zone fall to this category, including the Kurunegala group of forests dominated by *Artocarpus*, *Vitex pinnata* and *Filicium* and the Moneragala forests which are drier than the former group.

3. Tropical lower and upper montane forests

These forests are found above 1,000 meter elevation from the upper areas of the Ratnapura district, Maskeliya and the Knuckles Range to the forests of Horton Plains and Hakgala.

4. Tropical wet evergreen forests

The forests of the low-country wet zone below 1,000 meter elevation fall into this group. These forests contain the tallest tree stands, with the largest number of tree species and the greatest complexity. These wet zone climax forests have evolved over a very long period of time.

14 Mangrove forests

Mangrove forests are widely distributed along the coastal belt of Sri Lanka in the inter-tidal zone. The vegetation consists predominantly of *Rhizophora*, *Bruguieta* and *Sonneratia* which when in close stand protect the coast from strong winds and decelerate tidal flows. The barks of *Rhizophora* and other species which are rich in tannin are used for dye fishing nets and boat construction as the timber is resistant to insect attacks due to the presence of tannin in the wood.

15 Grasslands

The undulating and rolling grasslands of Maha Oya, Bibile and Gal Oya are covered with populations of *Terminalia chebula*, *Terminalia belerica* and *Phyllanthus embilica*. Because of this distinct association of tree species with the savanna type of grassland these are referred popularly as "aralu-bulu-nelli" forests. These grasslands are distinctly different from the other lowland grasslands "villus" in the coastal flood plains and "talawas" on the highlands.

The mountainous patana grasslands are found mainly in the south-central highlands within the triangle formed by Nuwara Eliya, Bandarawela and Badulla. *Rhododendron* appears to be the only tree species to be able to become established in this area which is characterized by inadequate rainfall, strong wind and a hard pan of rock below a few inches of soil.

Pasture and forage crops consisting of 14 legumes and 27 grasses are maintaind by the Veterinary Research Institute at Peradeniya.

Genetic erosion

During the beginning of the twentieth century it was estimated that the dense forest cover occupied about 75% of the land. This forest cover gradually dwindled to 42% in 1985 (Forest Inventory for Management Planning, FAO/UNDP, 1987). The natural forest cover is now further reduced to about 25%. Clearing of natural forests for human settlement, construction of dams and inundation of land for irrigation reservoirs, village expansion, urbanization, etc. are threatening the survival of the native flora lead-

ing to loss of species and genetic diversity. Selective exploitation of plants of economic value, illicit felling of timber trees and burning of scrub jungle for hunting further aggravate and threaten the survival of many species. Several species are now considered to be endangered, and over one hundred plant species are facing extinction. Abeywickrama (1987) pointed out that nearly 16% of the flowering plants and 28% of the ferns and fern allies are being threatened, a total of 480 species of fowering plants including 228 endemic and 252 non-endemic species.

Before the 1950 s farmers cultivated a large number of traditional rice cultivars. The adventa of the green revolution and the need to increase rice yields have resulted in the cultivation of a few improved varieties with a narrow genetic base, in nearly 95% of the land area, displacing the traditional cultivars. Most of these traditional varieties are now conserved in the gene bank. The wide use of fewer rice varieties has resulted in the narrowing of the genetic diversity, and increase of the vulnerability to insect and disease epidemics. The same trend in the elimination of local varieties with the release of high-yielding varieties could be observed in the other food crops.

The genetic diversity in lime (*Citrus aurantifolia*), and sweet orange (*C. sinensis*) and other citrus species was rapidly depleted during the past few decades, due to drought, virus (Tristeza) and fungal diseases. Certain banana clones have disappeared. Collection and conservation of the endangered species, and the existing fruit crop germplasm are essential.

Selective removal of timber trees such as Calamander *Diospyros quaesita*, Satinwood *Chloroxylon swietenia*, Ebony *Diospyros ebenum*, Nadun *Pericopsis moonjana*, *Diospyros oppositifolia*, etc. has resulted in a drastic reduction in their population, although they were abundant in the last century.

With the replacement of most of the mangrove forests of the wet zone by paddy fields in the western and southern parts of the island, the population of *Sonneratia apetala* has been reduced. *Vatica obscura* in the wet zone is only found now in the riverine forests of the Eastern Province.

Over-exploitation and indiscriminate deforestation have depleted the commercially important rattan species (*Calamus thwaitesii*, *C. pseudotenius* and *C. ovoidueus*). Of the available species, 7 show a restricted distribution, 3 are endangered, and 3 more are vulnerable. Indigenous medicinal plants such as *Saraca asoca*, *Rauvolfia serpentina*, *Strychnos nux-vomica*, *Capparis moonii*, *Woodfordia frucicosa*, *Rubia cor-*

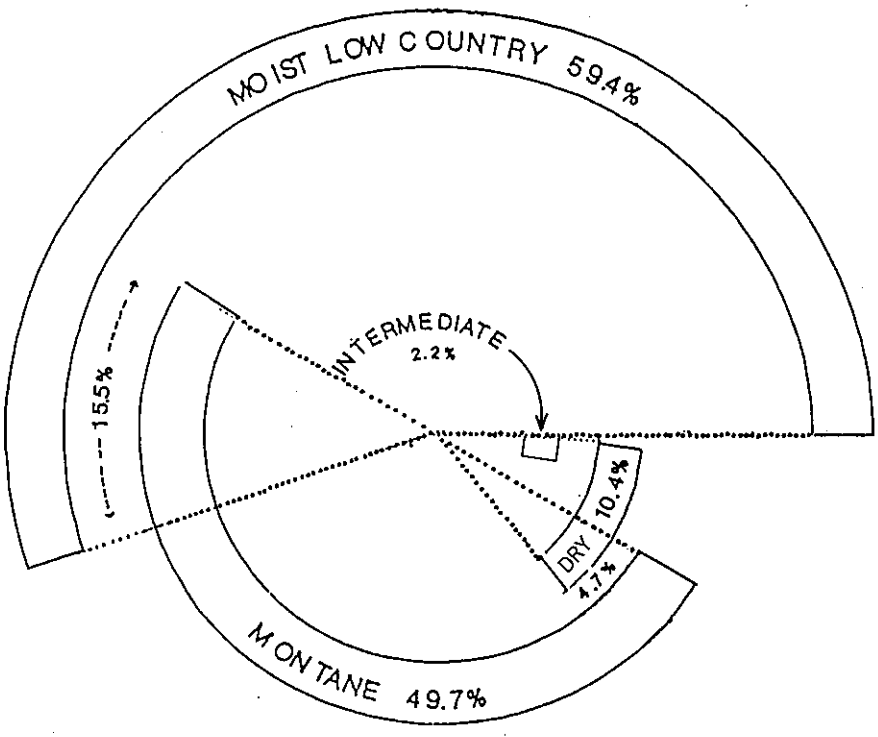


Fig. 3 Distribution of endemic flowering plants of Sri Lanka
Source : Peeris, 1975

difolia, and *Coscinium fenestratum* are over-exploited. In recent years, about 200,000 hectares of natural habitat have been cleared for agriculture and settlement-related development under the Accelerated Mahaweli Development Project, affecting these habitats and the wild relatives of crop plants which may have been lost.

Trends in germplasm collection, evaluation and conservation

Since the early 1950 s, the Department of Agriculture made concerted efforts to develop promising rice varieties, as rice formed the staple crop. Initially landraces, and primitive rice cultivars were collected, evaluated and pureline selections were made. Several rice introductions were promoted and hybridization and selection programs were undertaken to develop high-yielding cultivars. All the collected germplasm samples of rice and other annual food crops were maintained by growing them annually in purity maintenance plots. Large number of local rice germplasm samples with different growth durations were evaluated for important characteristics (Imai and Ganashan, 1967). Further collection of remaining rice germplasm and wild relatives was promoted under the CARI/IRRI collaborative program from 1976. From 1978, Sri Lanka participated in the IBPGR programs, and implemented local field collection and plant introduction programs, and since 1980 emphasis has been placed on the collection of millets, grain legumes and other cereals. Introduction of a new crop, chickpea, to certain ecological regions using more adaptable cultivars was undertaken in 1980 (Ganashan and Vandermeson, 1981).

Establishment of plant genetic resources center

A facility for conservation of plant genetic resources was a long-felt need of the Department of Agriculture. Requests were made to IBPGR in 1981 and a preliminary mission under the leadership of Prof. Izuka visited Sri Lanka in 1983 to assess the needs. Based on the recommendations of the IBPGR team a request was made to the Goverment of Japan in 1984 seeking assistance to establish a Plant Genetic Resources Center in Sri Lanka. The project was approved in 1987 and the center became operational in 1989. The PGRC is in charge of the promotion and co-cordination of crop genetic resources activities of the Department of Agriculture, to ensure that the genetic diversity of food crops and other economic species is adequately collected, satisfactorily conserved, evaluated, documented and made available to breeders. A program framework has been developed to meet these objectives and accommodate future directions and priorities. The necessary backup research has also been identified and initiated. Major functional components of PGRC's program structure are :

1 Genetic resources management

1. Germplasm acquisition and exchange
2. Germplasm characterization and evaluation
3. Germplasm conservation
4. Germplasm information
5. Genetic resources network
6. Training

2 Genetic resources research

1. *In vitro* culture research
2. Genetic diversity research
3. Seed conservation research

PGRC programs are carried out in collaboration with the Regional Agricultural Research Center especially for germplasm characterization and evaluation.

PGRC aims at developing research collaboration with the international genetic resources networks based on equal partnership. Primarily this collaboration aimed at promoting the exchange of germplasm and related information including access to basic research on germplasm conducted at different IARCs.

Achievements

The highlights of the PGRC activities are outlined in the following paragraphs.

1 Exploration and collection

The PGRC conducted 24 independent exploration missions and 8 joint missions organized with international institutes. The total number of accessions assembled is given in Table 3. Germplasm accessions were introduced from international institutes and 6 foreign countries.

2 Evaluation

The major part of germplasm characterization is carried out by the evaluation unit of the PGRC. To meet the needs of different ecological criteria, evaluation work is conducted with the collaboration of RARC established in the different ecological zones of the country. Accessions are evaluated for useful agronomic traits such as resistance to important pests and diseases with the cooperation of breeders, entomologists and pathologists of the RARCs and valuable gene sources are identified.

3 *Ex-situ* conservation

Base and active collections of all assembled samples are continuously being incorporated in the gene bank. Fig 4 outlines the progress as at the end of June 1993. Encouraging results have been obtained in perfecting protocols for *in vitro* conservation under minimal growth conditions. A total of 273 accessions are now being maintained under these conditions. Requests for germplasm show an increasing trend. International exchange is performed on a bilateral basis and through joint germplasm collection programs.

4 *In-situ* conservation

PGRC is conducting ecogeographic surveys in collaboration with the Forest Consevation and Wild Life Conservation Departments with regards to the conservation of wild relatives of crops *in situ*. The aim is to incorporate genetic management aspects into the management of natural reserves and sanctuaries.

5 Data management

An information management system using Infromix SQL and 4 GL has been developed to meet the specific requirements of PGRC. The database consists of passport data, characterization data, evaluation

Table 3 Germplasm collections from 1986 to 1993

Year	Exploration and collection	Collected from RARC's	Introductions	Local rice germplasm returned from IRRI	Total
1986-1988	1,394	—	145	—	1,539*
1988	140	—	195	—	335
1989	200	829	258	1,862	3,149
1990	331	955	96	—	1,382
1991	922	382	648	—	1,952
1992	307	369	73	—	749
1993**	247	450	14	—	—
Total	3,541	2,985	1,429	1,862	9,817

* Germplasm introduced from following institutions/countries.
* *up to March 1993
Institutions — AVRDC, CIMMYT, CIP, ICARDA, ICRISAT, IITA, SAPPRAD
FAO — Seed Exchange and Information Center
Countries — Thailand, Japan, USA, China, Argentina, Vietnam

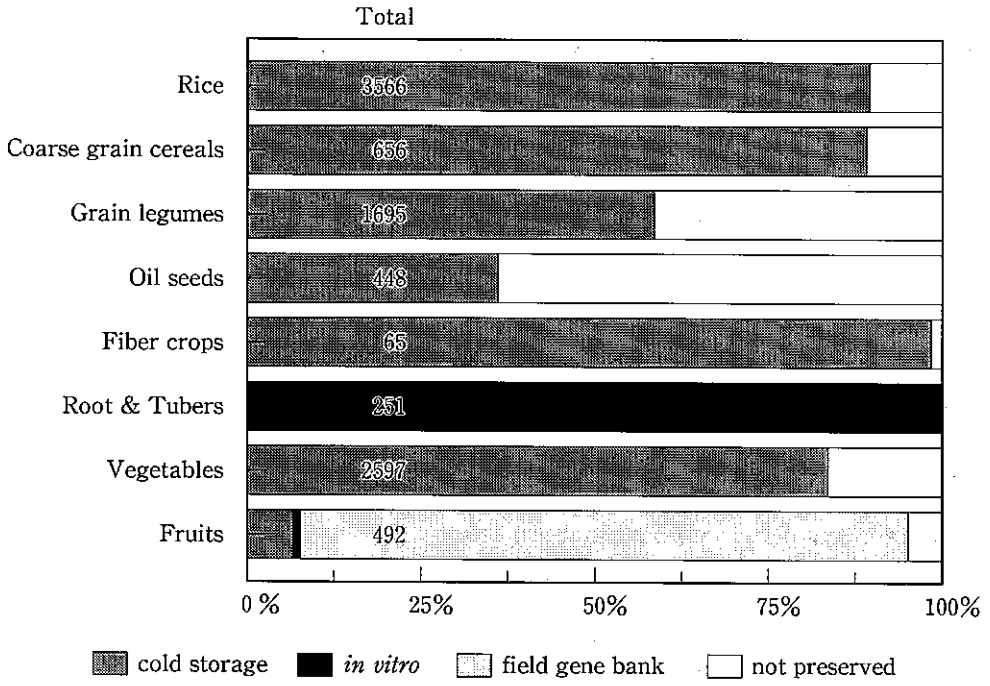


Fig. 4 Status of genetic resources conservation at PGRC

and conservation data.

6 Research programs

The overall objective is to provide information to back up the scientific and technological basis of germplasm collection, conservation, and evaluation. The main areas of research include genetic diversity, seed conservation, *in vitro* conservation, regeneration/evaluation strategies and enhancement of germplasm for beeders' use. Genetic diversity maps for different crop species are under preparation by cross-matching the field collectors' observations. A herbarium of all the collected species in Sri Lanka is maintained.

7 Awareness programs

PGRC makes limited efforts to educate the public on the importance of genetic conservation. The center conducts seminar programs for staff of government departments, NGOs, teachers and university students.

Discussion

Sogkran Chitrakon (Thailand): Do you preserve rattan *in situ*? Which methods of preservation do you use?

Answer: The wild population of rattan (*Calamus* sp.) is dwindling due to exploitation which cannot be prevented easily. *In situ* conservation is not practiced. As a rescue measure, the Institute of Fundamental Studies at Kandy has embarked on the application of *in vitro* techniques for micropropagation of the important economic species of *Calamus* for repopulating them in their natural habitats.