COUNTRY REPORT ON THE STATE OF PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

SRI LANKA

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THE STATUS OF THE PGRFA IN SRI LANKA

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Note by FAO

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EXECUTIVE SUMMARY

Sri Lanka, a free, independent and sovereign nation with a population of around 20 millions is an island in the Indian ocean located between latitudes 5°55' and 9°51' N and longitudes 79°41' and 81°53' E.. Sri Lanka has a tropical climate with a mean temperature of 27.5°C over low lands while temperature in mountain region varies from 13°C-16°C. Sri Lanka receives mainly monsoonal and convectional types of rain. The country which has a land area of approximately 6.5 million hectares is divided into three main rainfall zones namely Dry Zone with an annual rainfall less than 1 500 mm, Intermediate Zone with a rainfall 1 500-2 500 mm, and Wet Zone which receives an annual rain fall more than 2 500 mm.

Sri Lanka is an agricultural country with a plantation and domestic agriculture sub-sectors. Plantation agriculture involves the large scale cultivation of tea, rubber, and coconut which are located mainly in the wet zone, and the intermediate zone of the country covering an area of around 0.8 million hectares. In addition, spices crops such as cinnamon, pepper, and beverage crops such as coffee and cocoa and sugarcane and cashew are also cultivated in around 75 000 ha.

Non-plantation domestic agricultural sector represents nearly 1.8 million rural farmers cultivating around 0.9 million hectares in relatively small parcels of lands averaging 0.5 ha. Paddy is the main crop cultivated in around 0.75 million hectares in the lowlands whereas other field crops such as maize, chilli, green gram, cowpea, vegetables etc. are grown in the uplands. There are about 35 fruits and 40 vegetable varieties in the horticultural crop sector which are grown across all agro ecological zones. Except for a few large scale fruit orchards, majority of fruits and vegetable crops are grown in small scale units.

Forest cover which stood at 44% of the land area in 1956, declined to 27% by 1981, and the present forest cover is estimated at approximately 23% of the land area.

Agriculture plays an important role in the economy of Sri Lanka.The share of the Agriculture sector (Agriculture, Forestry and Fishing) in GDP in 2005 was 17.2 percent,

Which is lower than the contribution by the other two sectors (Industry sector-26.5 percent and Services sector-54.5 percent).

Sri Lanka has been identified as one of the countries in Asia with a very high degree of biodiversity. The wide variation in temperature, rainfall, topography and soils in the country has provided a wide diversity of ecosystems resulting in a rich diversity of plant species, which the Sri Lankan farmers have been able to maintain over thousands of years. Thus, there are nearly 3400 species of flowering plants (26 percent endemic), 300 species of ferns and related species (57 percent endemic) 575 species of mosses, 110 lichens, 896 algal and 1920 fungal species. A considerable diversity also exists among the major crops cultivated in Sri Lanka. In the case of rice, there are around 4 000 accessions including wild relatives, Land races and old cultivars. The other crops in the domestic agricultural sector and the plantation sector too have a large number of accessions, and most of these have been characterized.

Genetic erosion of cultivated indigenous varieties and wild relatives of crop plant species in Sri Lanka has been occurring rapidly in natural habitats during the period of the last century. Hence, conservation of PGR is essential. Several programmes have been implemented towards *in situ* conservation of PGRFA and a reasonable progress has been achieved. The national herbarium at the Royal Botanical Gardens in Peradeniya and the herbarium at Hakgala and Gampaha have a large collection of about 132 000 plant specimens. Based on the information collected by PGRC, an atlas of 35 maps of collection sites of 46 crop species has been published. On-farm conservation programs and around 1.3 million home gardens in different agro-ecological zones also play important roles in *in situ* conservation of PGRFA.

The primary objective of maintaining *ex situ* populations are to help support the conservation of crop genetic resources, its genetic diversity, and its utilization on mutually agreed terms. *Ex situ* conservation of PGR of various crop species are carried out by several organizations. Plant Genetic Resources Centre (PGRC) is the focal point of national programs on *ex situ* conservation. Around 15 300 accessions are recorded in *ex situ* conservation centers The PGRC seed gene bank has about 10 000 accessions. Among these are rice and rice related species,

grain legumes, vegetables, oil crops etc. Field gene banks of a number of organizations also have effective *ex situ* conservation programmes.

Poverty is widespread in many parts of the country and increasing the agricultural productivity is crucial for poverty alleviation. Genetic improvement plays an important role in increasing agricultural productivity, and in this regard effective utilization of PGR is extremely important. A large number of new crop varieties have been developed by the Dept. of Agriculture and other research institutes, using PGR. Among these are varieties of rice of different age groups, fruit crops, plantation crops etc.

There are various projects and strategies, multilateral agreements and mechanisms for institutional/sectoral integration/coordination constituting main instruments that address various aspects of PGR conservation and use in the country today. The main contributors in these activities are the ministries related to agriculture, environment, plantation, indigenous medicine, lands, education and science and technology. In addition, several other affiliated national focal points carry PGR activities in different cross-cutting and cross-sectoral areas of biodiversity conservation. In view of the importance given to PGR conservation and use, many other related government/non government and private institutions have also addressed the conservation and use of PGR in their sectoral/business plans and programs, especially in the forestry, wildlife, food & agriculture, plantation & industrial sectors.

There are substantial amount of laws enacted to conserve Sri Lanka's environment. Many of these are directly or indirectly relevant to the conservation and sustainable use of biological diversity. Awareness programs to educate public on the importance of PGRFA as a part of biodiversity conservation, food security and farmers' role are important. However, the most challenging is finding the financial and technical assistance for improvement of these programs.

Sri Lanka has commitments to implement the several Multilateral Environmental Agreements adopted by international community and ratified by the Government. Among these agreements is Agenda 21 and Rio Principles of the United Nations Conference on Environment and Development (UNCED). Sri Lanka also has taken action to implement the obligation of the Convention on Biological Diversity which includes conservation, Sustainable use and Access and benefit sharing of PGR activities. In Sri Lanka Plant Genetic Resource Center (PGRC) has developed a Bi-lateral Material Transfer Agreement (MTA) for exchange of plant genetic resources with any interested parties on mutually agreed terms and conditions. In addition, MOU signed between CARP and India/ Pakistan in 1998 has also facilitated access to germplasm located in those countries. The international financial support for plant genetic resources activities in the country has increased during the past 10 years. International prgrammes conducted during the past and the on going programs under Coconut Genetic Resources Network, SL-USDA, IRRI, UNDP/GEP and CIMMYT networks have benefited in many ways.

According to the constitution of Sri Lanka, the genetic resources as well as all other resources are under the joint custodianship of the state and the people. However, PGR is increasingly becoming covered by intellectual property rights in some countries. The ITPGR has also accepted that plant genetic material can be the subject of intellectual property rights. Therefore, Sri Lanka finds it more and more difficult to access useful plant genetic resources from other countries even with recent agreements and MOUs signed. Only the germplasm available in international institutes such as CIMMYT, IRRI, ICRISAT and CIAT are available. Most of the plant genetic resources in Sri Lanka are available for exchange on mutually/bi-laterally agreed basis. However, a few native/indigenous plant genetic resources such as cinnamon are not permitted to be exported even under available agreements for exchange.

Compiling a directory of all privately and institutionally held species, varietal and clonal collections and establishing a set of guidelines that define their rights and obligations and formulating a national policy for germplasm conservation, and strengthening the capacity and scope of the Plant Genetic Resources Centre (PGRC) need consideration. Also, identification of critical species and strengthening the geographical distribution and facilities of the botanic gardens, arboreta and field gene banks to expand their *ex situ* conservation activities need to be considered.

More surveys and documentation, setting up of new laboratories/improvement to use new technologies for molecular characterization, assistance to equip laboratories at regional level, training of staff, provision of facilities to expand training facilities on conservation and sustainable use, establishment of policies and a system to give incentives for the expertise involved in PGRFA are essential for more effective use of PGRFA.

CONTENTS

CHAPTER 1

THE STATE OF DIVERSITY

The wide variation in temperature, rainfall, topography and soils in the country has provided a wide variation of ecosystems resulting in a rich diversity of plant species which the Sri Lankan farmers have been able to maintain over thousands of years. Sri Lankan food crop diversity has also been enriched by introduction of several crop plants of economic importance since historical times. The introduced types, depending on the time and the area also exhibit secondary genetic diversity.

A number of crop species, *viz.*, cereals, legumes, root & tuber crops, fruits and vegetables are of considerable importance in food security of the country. In addition, some crops (eg. Tea, rubber, coconut and spice crops) are cultivated for export.

1.1 Rice

Rice is the most important cereal cultivated in Sri Lanka, which exhibits a very high genetic diversity and now confined to genebanks amounting to about 4 000 accessions including wild relatives Land races, old cultivars etc. About 30% of the rice landraces cultivated in the past have not been collected and conserved. Failure to collect these could be due to loss of these materials. Five wild rice species *O.nivara, O.rufipogon, O.eichingeri, O.rhizomatis* and *O.granulata* are found in scattered places in the county and are in danger of extinct due to loss of habitats. Few accessions with resistance to brown planthopper and disease rice blast found in these wild species. High genetic diversity exists in these wild species. Therefore, it is an urgent need to conserve their natural habitats and also need further surveying, mapping and collection for seed conservation. About 50% of conserved accessions have been characterized and the rest need to be characterized.

Rice germplasm exhibit a wide diversity ranging from lowland to upland conditions and various types of grain qualities, while some have medicinal value. Work done at the International Rice Research Institute; Philippines identified Sri Lanka as one of the important geographical origins of many useful traits. The most outstanding are the cultivars with broad based resistance to East Asian biotypes of brown plant hopper, green leaf hopper, white-backed plant hopper, rice thrips and tolerance to salinity, iron toxicity, drought and other adverse soil conditions. At present, 99% of the extent cultivated with rice is under high yielding improved varieties. Even though the Department of Agriculture has recommended 62 improved rice varieties, only less than 10 varieties are very popular.

1.2 Other Cereals

Other important cereal crops are Finger millet (*Eleusine coracana*) Maize (*Zea mays*) and Sorghum (*Sorghum bicolor*). More than 5 300 accessions of cereals including rice, Maize, sorghum and millets, have been conserved in seed genebank of Plant Genetic Resources Center, Peradeniya. About 1% of them are wild relatives and 70% and 29% are landraces and advanced cultivars/breeding lines respectively.

Finger millet and maize are mainly grown in the Dry Zone and in the Intermediate Zone of the country. The significance of finger millet has lost due to change of food habit. Sorghum is cultivated to a very small extent as its potential as food or feed crop has not been fully exploited.

1.3 Legumes

Legumes play an important part in Sri Lankan diets, mainly as one of the protein sources. Among these legumes are cowpea and yard long bean (*Vigna unguiculata*) green gram (*Vigna radiate*) , black gram (*Vigna mungo*) horse gram (*Macrotyloma uniflorum*) soya bean (*Glycine max)* beans (*Phaseolus vulgaris*) and winged bean (*Psopocarpus tetragonolobus*). Substantial

genetic diversity exist in these species. However further exploration and characterization are necessary because only about 30% are so far characterized.

1.4 Root & tuber crops

Root and tuber crops provide supplementary food in rural areas. The major root & rubber crops are sweet potato (*Ipomea batata*), cassava (*Manihot esculenta*) and cocoyam (*Xanthosoma sagittifolium*). These species exhibit secondary genetic diversity.

1.5 Vegetables

The more important vegetable crops are Eggplant (*Solanum melongena*), Snake gourd (*Trichosanthes anguina*), Bitter gourd (*Momordica charantia*), Cucumber (*Cucumis sativus* & *Cucumis melo*), bottle gourd (*Lagenaria siceraria*), Pumpkin (*Cucurbita maxima*, & *Cucurbita moschata*), Okra (*Abelmoschus esculentus*, *Amaranthus hybridus* subsp. *Cruentus, A. dubius, A. tricolor, A. viridis* & *A.spinosus*), Ceylon spinach (*Basella alba*) Gotukola (*Centella asiatica*), Mukunuwanna (*Alternanthera sessilis*),Kankung (*Ipomea aquatica*) , Murunga (*Moringa oleifera*), Katurumurunga (*Sesbania grandiflora*), Tomato (Lycopersicom esculentum), B.onion (*Allium cepa* var. *cepa*) Red onion (*A. cepa* var. *aggeregatum*), Luffa (*Luffa acutangula*), Ash pumpkin (*Benincasa hispida*),Luffa (*Luffa aegyptiaca*), (Thumba karawila) *Momordica dioica*, Bread fruit (*Artocarpus incisus*). Nearly 2 500 accession of the vegetable crops have been conserved and about 40% of these have been characterized.

1.6 Spices & Condiments

The important spices and condiments are Turmeric (*Curcuma domestica*), ginger (*Zingiber officinale*), Cardamon (Elettaria cardamomum), black pepper (*Piper nigrum*), Cinamon (*Cinnamomum verum*), Cloves (*Eugenia caryophyllata*), Citronella (*Cymbopogon nardus*), tamarind (*Tamarindus indic*a), Java citronella (*Cymbopogon witerianus*), curry leaves (*Murraya koenigii*), rampe (*Pandanus amaryllifolius*), nutmeg (*Myristica fragrans*) mustard (*Brassica juncea*). Cinnamon is native to Sri Lanka and is cultivated mainly for export market. It has several wild relatives in Sri Lanka.

1.7 Fruits

Diversity exists in the following fruit crops. Melon - *Citrullus lanatus*, banana - *Musa*, papaya - *Carica papaya*, mango *Mangifera indica*, *Citrus* spp., guava - *Psidium guajava*, durian - *Durio zibethinus*, jack fruit - *Artocarpus heterophyllus*, cashew - *Anacardium occidentale*, *mangosteen - Garcinia mangostana*, *pomegranate - Punica granatum avacado - Persea americana*,and rambutan - *Nephelium lappaceum*.

In several perennial fruit crop species such as banana (*Musa*), mango (*Mangifera indica*); jack fruit (*Artocarpus heterophyllus*), citrus, avocado (*Persea Americana*); mangosteen (*Garcinia mangostana*), durian (*Durio zibethinus*), rambutan (*Nephelium lappaceum*), guava (*Psidium guajava*) and papaya (*Carica papaya*), the bulk of the genetic diversity is still conserved through home garden system, but is in danger of extinction. Under SL-USDA germplasm Development programme surveying, inventorying, collection, characterization of certain fruit species are being done in some districts. However it needs island wide surveys.

1.8 Native species

Several species namely, *Amaranthus* spp., *Momordica charantia, Solanum melongena, Basella alba, Solanum torvum, Centella asiatica, Lasia spinosa, Nelumbo nucifera, Trichosanthes cucumerina, Musa* spp., *Phyllanthus emblica, Flacourtia indica, Dialium ovoideum, Elaeocarpus serratus, Syzygium aqueum, Limonia acidissima* and *Cinnamomum verum* are native or have been cultivated for thousand of years in Sri Lanka and have developed significant secondary diversity. Further surveying, inventorying, collection and characterization are necessary to understand the diversity for conservation.

1.9 Underutilized and minor crop species - Species and genetic diversity

Sri Lanka is rich with around 60 varieties of underutilized crops. Most of these underutilized species have lost their significance among the present generation due to many reasons such as urbanization and changing food habits. There is no organized or proper cultivation of these crop species. Most of these underutilized plant species are fruit crops and they are found in wild or in home gardens, which are 100 m^2 to 1 000 m^2 in extent and are commonly found in many rural areas of Sri Lanka. As altitude increases, the extent of home gardens become smaller with greater diversity of plant species and lesser diversity within the species. Very little inventory work has been so far done on the state of diversity of crops in home gardens.

1.10 Underutilized fruits

As a result of baseline surveys, around 400 accessions, belonging to 25 species have been noted in home gardens. A great diversity of underutilized crops was found in fruit crops.

Citrus aurantium, Syzygium spp, *Baccaurea motleyana, Pouteria campechiana Flacourtia inermis Citrus reticulate Citrus grandis Atalantia ceylanica Pometia pinnata Annona reticulate, Dialium* spp, *Euphoria longana Manilkara zapota Ziziphus mauritiana, Garcinia quaesita, Citrus crenatifolia, Elaeocarpus serratus, Psidium cattleianum, Syzygium cumini, syzygium* spp, *anona* spp. *Limonia acidissim, Angle marmelos, Phyllanthus emblica.*

1.11 Species diversity and genetic diversity in other food crop species

Cereals

Panicum sumatrense, Paspalum scrobiculatum, Setaria italica and *Proso* millet, *Panicum miliaceum*.

Legumes

Macuna pruriens, Phaseolus lunatus, Vigna umbellata, Lablab purpureus, Canavalia gladiata. These are mostly found in home gardens.

Roots & Tubers

Dioscorea alata, D. bulbifera, D. esculenta, D. koyamae, D. oppositifolia, D. pentaphylla, D.spicata, D. tomentosa, D. trimenii, Colocasia esculenta, Alocasia Cucullata, Amorphophallus paeoniifolius, *Canna indica*. They are mostly found in home gardens and in danger of extinction.

Vegetables

Solanum macrocarpon, Solanum torvum, Solanum violaceum, Solanum capsicoides, Coccinia spp, *Celosia argentea, Talinum traingulare*. These also found in rural home gardens.

1.12 Wild Relatives of crop plants and wild plants for food production

The floristic diversity of around 240 species of wild relatives of crops in Sri Lanka has been identified todate. These species which are of agric-horticultural importance generally occur as members of disturbed communities within the major vegetation types. Open canopy forest areas, secondary forests, disturbed grass lands and shrub jungles are rich in these plants. However, the relatives of fruit plants are largely associated with semi-evergreen, intermediate and wet evergreen forests. There is a large number of wild species of agri-horticultural importance in different crop groups. The wild relatives recorded for the different genera are given below.

Cereals

Digitaria, Echinochloa, Eleusine, Hygroryza, Oryza, Panicum, Paspalum, Pennisetum, Setaria. Very valuable accessions are found in wild relatives of *Oryza; O.nivara, O.rufipogon* and *O.eichingeri,* which show high level of resistance to rice blast disease and insect pest in rice brown plant hopper.

Wild relatives of legumes

Vigna, Atylosia, Canavalia, Lablab, Macrotyloma, Mucuna, Trigonella. Surveying and mapping has been carried out in Vigna.

Vegetables

Abelmoschus, Aerva, Alternanthera, Amranthus, Asparagus, Cardiospermum, Chenopodium, Celosia, Centella, Citrullus, Coccina, Ctenolepis , Cucumis, Erythrina, Ipomoea, Lasia, Solanum, Trichosanthes, Woodfordia Curry leaves.

Root & Tubers

Alocasia , Canna

Oil Seeds

Sesame

Spices and Condiments

Alpinia, Cinnamomum, Curcuma, Kaempferia, Myristica, Zingiber, Capsicum.

Fruits

Musa, Mangifera, Citrus, Psidium, Durio, Syzygium, Artocarpus, Garcinia, Aegle, Annona ,Antidesma, Carissa, Drypetes, Diospyros, Elaeagnus., Elaeocarpus (7), Grewia Madhuca, Mimusop, Phyllanthus, Phoenix, Robus, Salacia, Spondias, Syzygium, Zizyphus, Passiflora.

Beverage crops

Theobroma

Sugar Crop

Saccharum, Erianthus.

1.13 State of diversity of crop varieties - modern varieties, land races and farmer saved varieties

The Department of Agriculture (DOA) develops and releases several food crop varieties recommended by its variety release committee. The seeds and planting materials of the recommended varieties are made available to farmers with necessary information and assistance by the DOA. In addition, there are other crop species grown but to date no improved varieties have been developed or selected from local or exotic germplasm for recommendation. The other crop institutes other than DOA also develop and release varieties for cultivation.

More than 60% of the recommended varieties in, cereals (except rice), legumes, vegetables, fruit crops, oil crops and roots and tubers are introductions and the rest are local selections or developed varieties. Seeds and planting materials production of these recommended crop varieties are done by the respective institutions and are made available to farmers.

Genetic erosion

Genetic erosion in rice is due to variety replacement from traditional varieties to a few high yielding short age varieties. In recent years, the area cultivated to millets has significantly reduced as a result of irrigation facilities and replacing millets with short age rice. Similarly in other crops too there is a variety replacement from traditional/landraces to high yielding varieties and also to exotic hybrids. Other major factors are deforestation and land clearing. In ancient times, Sri Lankans did not have enough rice to eat throughout the year. Therefore, they supplemented their food with other cereals like

millets and, yams, etc. But at present country is almost self sufficient in rice and hence cultivation of other supplementary food crops is neglected.

1.14 Future needs and Priorities

There are some gaps in the past surveying, inventorying and collection leading to incomplete coverage and missed land races and wild relatives in some crop species such as export crops, sugar cane, tea, underutilized fruit species, wild relatives of rice, vigna etc. Therefore, it is important to have further surveying and mapping to reduce the above gaps .

Characterization on morphological and at molecular level and also evaluation of plant genetic resources for other important agronomic characters is required for better utilization in crop improvement programmes.

A core collection of important species should be made for long term conservation. One of the other important aspect is conservation of a duplicate set of PGR in another genebank to be used in case of any catastrophe.

APPENDIX 1

Germplasm Accessions by crop

Grouping	Genus	GB holding	Type of accession %		
			WS	LR/OC	AC/BL
Cereals					
Rice	*Oryza*	4 004	1	75	24
Maize	*Zea mays*	697	1	35	64
Sorghum	*Sorghum*	131	2	38	60
Millets	Millets	471	1	86	13
Food Legumes					
Cowpea					
Green gram	*Vigna*	324	1	93	6
Black gram	*Vigna*	509	1	24	75
Soya bean	*Vigna*	62	6	70	23
Groundnut	*Glycine*	249		9	91
Lentil	*Arachis*	193	1	14	85
Chick pea	*Lens*	38		12	88
Pigeon pea	*Cicer*	77		10	90
Pea	*Cajanus*	61		2	98
Beans	*Pisum*	38			
Yard long bean	*Phaseolus*	225		10	9
Winged bean	*Vigna*	385		50	100
Other grain legumes	*Psophocarpus*	442			100
Other Vegetables & Legumes	Legumes	43		35	65
	Legumes	61	10	70	20
Vegetables					
Brinjal & other related vegtables	*Solanum*	311	6	77	17
Tomato	*Lycopersicon*	230	3	30	67
Chilli	*Capsicum*	546	18	27	55
Pumpkin	*Cucurbita*	251	2	92	5
Cucumber	*Cucumis*	89	-	87	13
Onion	*Allium*	26		4	96
Okra	*Abelmoschus*	296	3	73	24
Snakegourd	*Trichosanthes*	44	11	75	14
Luffa	*Luffa*	122	2	77	21

Grouping	Genus	GB holding	Type of accession %		
			WS	LR/OC	AC/BL
Bitter gourd	*Momordica*	108	8	85	7
Bottle gourd	*Lagenaria*	30	15	81	4
Amaranthus	*Amaranthus*	101	10	88	2
Oil crops					
Sesame	*Sesamum*	319	4	52	44
Mustard	*Brassica*	113	-	-	-
Fruits					
Water melon	*Citrullus*	36	-2	70	30
Melon	*Cucumis*	38		1	2
Banana	*Musa* sp.	200	2	92	6

WS = Wild species LR/OC = Land races /old cultivars AC/BL = Advance cultivars/breeding lines

Long term Research Programme -Genebank

1. Behavior of wild banana (Viability and germination) under different genebank storage conditions (From 2007-2011)
2. Brinjal viability behavior under different genebank storage conditions (2007-2011)
3. Behavior of recalcitrant seeds under different genebank storage conditions (2007-2011)
4. Protocol development for cryopreservation

Genebank improvement Programme

1. Conversion of CFC cooling system to CFC free system (2008)
2. Establishment of a cryopreservation unit (2008)

CHAPTER 2

THE STATE OF *IN SITU* MANAGEMENT

Sri Lanka has nearly 3 368 species of flowering plants (26 percent endemic), 314 species of ferns and related species (57 percent endemic) 575 species of mosses, 110 lichens, 896 algal and 1 920 fungal species. Genetic erosion of cultivated indigenous varieties and wild relatives of crop plant species in Sri Lanka has been occurring rapidly in natural habitats during the period of the last century.

The "conventional' *in situ* conservation program is used in Sri Lanka for the conservation of forest tree species and wild life eco-systems. Conservation of PGRFA is mostly limited to *ex situ* collections holding by the gene bank, botanical gardens and plant breeders etc. Some species of PGRFA are not sustainable under the *ex situ* conservation conditions and hence conservation of these species are possible only under the *in situ* management.

Several attempts have been made to launch programmes on *in situ* conservation of PGRFA in Sri Lanka. However, they were not usually within well defined objectives and appropriate conservation models.

2.1 Inventories and surveys

The need for national inventories of cultivated plants and their wild relatives, ecosystems, protected areas and indigenous knowledge associated with them has been recognized. Such inventories have been made with the data of surveys, description given in herbarium specimens, reports, maps, and information collected through villagers, NGO and various other organizations.

Eco-geographic surveys provide information of the existing genetic diversity of these species with their distribution and threatened habitats that need immediate actions for conservation. Plant Genetic Resources Center has made several attempts to prepare inventories of PGRFA after its establishment in 1989. Based on the information of collected germplasm during 1989-1998, an atlas of collection sites' with 35 maps of collection sites of 46 crop species has been published in 2000.

2.2 Conservation of Wild Plant Genetic Resources for Food and Agriculture in Protected areas

The total land area of Sri Lanka is 65 000 sq. km. of which 17 036 sq. km are reserved for forests and administrated by the Department of Forest (16.1%) and the Department of Wild life conservation (12.4%). At present, protected areas cover over 14 per cent of total land area in Sri Lanka and the Department of Forest manages 148 512 ha. for conservations. After the formulation of National Heritage Act in 1988, Sinharaja biosphere was declared as a National Heritage and Wilderness area for conservation of eco-systems, genetic resources and habitats. Subsequently, Sinharaja was declared as a Natural World Heritage site by the UNESCO. Sinharaja, Knuckles and 31 wet zone forests were classified as conservation forests under the management of Forest Department. There are 29 and 4 Man and Biosphere reserves in Sri Lanka under the management of Forest and Wild Life departments. Sinharaja and Hurulu are two International Biosphere Reserves in Sri Lanka. Generally, MAB has no higher protection, but 16 of them are located in protected area under the Forest Department and 4 situated in protected areas under the management of Wild Life Department.

So far, very little work has been carried out for surveying and inventorying of PGRFA in protected areas compared to tree species and wild animals. However, available information indicate that the protected areas in the dry zone are rich in wild species of cereals, vegetables and under utilized fruit crops while protected areas in the wet zone are dominant in wild species of fruit crops, cinnamon, pepper and orchids.

2.3 Ecosystem management for conservation of PGRFA and Crop associated biodiversity out side the protected area

The number of ecosystems present in a country gives a relative idea of genetic diversity one could expect a high genetic diversity of a species if it is found in different ecosystems. Even though it's small in size, Sri Lanka has a high ecosystem diversity due to the varied climate and topography. It is understood that wild genetic resources are best conserved in their ecosystems within the community of which they form a part. However, most PGRFA are located outside the existing protected areas in ecosystems such as forest borders and traditional villages. Some of these areas are private lands and most of them are subjected to influence by human activities, Hence it is difficult to conserve these areas as habitats. All of these areas require special management approaches to develop as sustainable conservation sites.

2.4 On-farm management and improvement of PGRFA

Continuous maintenance of land races and farmers' varieties in farmers' fields or areas nearby under the management of the farmer is known as "on-farm conservation'. This allows the process of natural and artificial selection to continue. At present, except for a few programs, there are no well defined "On-farm conservation' programs in Sri Lanka to conserve PGRFA National program on plant genetic resources now involves on-farm conservation. The traditional home gardens in Sri Lanka, numbering 1.3 million in different agro-ecological zones, have well defined structure and play a key role in conservation of PGRFA, this process has prevented the possible extinction of most of the economically important plant species. In general, home gardens consist of coconut and fruit trees in the outer perimeter and spices crops and vegetables and indigenous yams occupy the inner zone in well drained areas. Leafy vegetables are usually in poorly drained zone. The genetic diversity present in most of the fruit crops is still conserved in home gardens in Sri Lanka.

Some farmers prefer to cultivate indigenous varieties in their farms for various reasons due to the difficulty in finding appropriate planting materials for cultivation because the indigenous varieties have been wiped out from their farm lands during the last two decades. Also, they could not receive any incentives for on-farm management of PGRFA. Following actions will be carried out to strengthen on-farm management of PGRFA in the country.

1. Inventory and data base will be developed for locally adapted varieties with their areas of cultivation.
2. Maintenance of complete *ex situ* collections of local varieties at least at national level.
3. Farmers will be supported to develop and improve their varieties.
4. Establishment of on-farm conservation location for indigenous varieties of Sri Lanka
5. Promotion of on-farm seed production programme by providing seed materials from the gene bank.
6. Seed exchange mechanism among the on-farm management sites will be assisted.
7. Compilation of the indigenous knowledge, cultural practices and traditional farming systems of the country

2.5 Assisting Farmers in Disaster Situations

Serious genetic erosion has occurred in the north and eastern provinces of the country due to the prevailing war situation which has caused forced migration of some ethnic groups from their villages. Local varieties are in danger of extinction in these areas due to the disruption of farming systems. There were no major natural disasters except occasional drought and floods in the country until Tsunami affected in year 2004. However, so far country has not well established mechanism for PGRFA rehabilitation in such situations. It was reported that some planting materials were received from other countries for cultivation in Tsunami affected areas. In this context, *ex situ* collections can provide traditional varieties to national programmes, NGO and farmers' organizations for multiplication and distribution among farmers for their direct use.

2.6 Constrains for surveys

There are some constraints to improve existing information of survey and inventories for PGRFA in Sri Lanka. The major problem is inaccessibility to some areas in north and eastern provinces in Sri Lanka due to the prevailing terrorism. Therefore, present genetic and ecological diversity of these areas are not well known. Least priority given to survey activities, lack of transportation facilities and lack of trained staff such as taxonomist, insufficient funding and difficulty in getting permission to enter the protected areas from the relevant authorities are the other major constraints of survey and inventories of PGRFA in Sri Lanka.

2.7 Priorities for future inventories and survey of plant genetic resources

According to the available database of GPA, only few programs are being addressed for making inventories and surveying of plant genetic resources in future. These programs are summarized as follows:

1. ***In Situ* conservation of crop wild relatives through enhanced information management and field application. Exploration, collection and exchange of germplasm of selected crops and their wild relatives.** Preparations of distribution maps of selected crops and their wild relatives.
2. **Germplasm exploration and collection in north and eastern provinces of Sri Lanka** - Preparation of inventories of Germplasm availability in north and eastern provinces of Sri Lanka
3. **Germplasm exploration and collection in protected areas** - Preparation of maps and inventories for germplasm distribution in protected areas.
4. **Exploration, collection and Introduction of Plant Genetic Resources** - Surveying and inventorying of PGRFA for collection gaps and recollection areas.

2.8 Assessment of major needs for *in situ* management of PGRFA

Several needs can be recognized for *in situ* management of PGRFA where they occurred, especially in outside the protected areas. However more attention is needed *in situ* management inside protected areas as they are neglected at present.

2.8.1 Inventories and surveys

In general, inventories made so far are not fulfilling the requirements for better *in situ* management. Also there is no proper documentation system for the indigenous knowledge on traditional varieties and preparation them as a food. Therefore, it is necessary to include ethno botanical information of PGRFA in to the inventories

2.8.2 Awareness

It is more effective if several awareness programs are conducted for the local communities, before starting any on-farm or *in situ* conservation programme in rural areas for better management and to access to PGRFA with benefit sharing. Media campaign on *in situ* conservation should be addressed to policy makers, University students, school children and general public.

2.8.3 Research needs

Still, less attention has been paid to scientific research on *in situ* conservation of PGRFA until recent past.

Research on *in situ* conservation is needed with regard to population dynamic, socio-economics, farmer management of PGRFA in relation to ecological aspect.

2.8.4 Funds

Availability of funds for *in situ* conservation activities of PGRFA is very limited. Providing sufficient funds for research and other activities of *in situ* conservation enhances the security of PGRFA.

2.8.5 Conservation network

Conservation network should be established among the Department of Agriculture and its institutes, Department of Wild life, Department of Forest, Universities, institutes under the ministry of environment and NGO etc. This work should be coordinated by the National focal point.

2.8.6 Establishment of participatory habitat conservation sites

At present, participatory habitat conservation programme is conducted only for wild species of rice and *vigna* out side the protected areas. This type of program should be extended to other PGRFA and areas which will help to identify and to establish new protected areas and better conservation approach.

2.8.7 On-farm management

More facilities should be given to on-farm management of PGRFA. Production of the On-farm, received a recognition and higher price than other because they are rare and artificial modification is very low. Also mechanisms should be developed to share economic benefits from commercialized PGRFA with farmers or communities who protect and maintain them.

2.8.9 Policy framework and legal framework

Sri Lanka already has a number of legislation to protect and manage biological resources. These legislations are generally developed for conservation purpose, but not for utilization or regulating the access to the resources. Legislations should be supported by the intuitional responsibility on *in situ* conservation and mechanism to support farmers by providing access to PGRFA.

2.8.10 Rehabilitation programme

The present mechanism of reintroduction is not at a satisfactory level when the national requirements are considered. Therefore, a mechanism is required to enable rapid reintroduction of planting materials, and diverse germplasms to farming systems that have suffered natural disasters and/or civil disturbances.

2.8.11 *In situ* and *Ex situ* approaches

Both *in situ* and *ex situ* conservation methods should enhance the relative advantages of the other. Sustainable use of materials from both systems has to be increased for the value of both conservation systems and to sustain plant diversity in the nature for a long period.

PGRC Seed Conservation Unit Action Plan for 5 years

Programme	2007 No. of acc/samples		2008 No. of acc/samples		2009 No. of acc/samples		2010 No. of acc/samples		2011 No. of acc/samples	
	Jan -June	July-Dec	Jan -June	July-Dec	Jan -June	July-Dec	Jan -June	July-Dec	Jan -June	July-Dec
• Germplasm maintenance/ Conservation (base and active)	11 700	12 100	12 500	12 900	13 300	13 700	14 100	14 500	14 900	15 300
• New additions to genebank	400	400	400	400	400	400	400	400	400	400
Germination/viability test	900	900	900	900	900	900	900	900	900	
• Multiplication/ rejuvenati on	500	500	500	500	500	500	500	500	500	500
• Characterization										
1. Cereals	200	200	200	200	200	200	200	200	200	200
2. legumes	100	100	100	100	100	100	100	100	100	100
3. oil crops	100	100	100	100	100	100	100	100	100	100
4. vegetables	150	150	150	150	150	150	150	150	150	150
• Germplasm exchange/ distribution	300	300	300	300	300	300	300	300	300	300

CHAPTER 3

THE STATE OF *EX SITU* MANAGEMENT

Ex situ conservation involves collecting, handling and management (including research) of germplasm, its storage, regeneration, characterization/evaluation, documentation and dissemination to users. However, it must be emphasized that this involves a temporary set of living germplasm preservation techniques that are usually applied as choices of last resort.

In Sri Lanka, *ex situ* conservation activities on various species of crops and crop wild relatives are carried out by several organizations using Seed Gene Banks (PGRC, RRDI, HORDI, RARDC (Makandura, Bandarawela, Bombuwela), Field Gene Banks (PGRC, HORDI, BMARI, CRI, FCRDC, DEA, FCRDI, GLORDC, SRI, RARDC {Makandura, Bandarawela, Aralaganwila, Bombuwela}, TRI, DNBG, CIC), *In vitro* Gene Banks (PGRC), Department of National Botanic Gardens (DNBG) and Arboreta (DNBG, SRI).

3.1 Status of *ex situ* collections

A total of 15 294 accessions are recorded in the *ex situ* conservation centers in Sri Lanka. These accessions constitute 52 wild species, 117 traditional cultivars and landraces, 2 mutants, 2 breeder lines, 58 advanced/improved cultivars, 4 weedy species and 121 non-categorized species. Of the accessions only 1 618 are safety-duplicated. Almost all accessions in the SRI and TRI are duplicated.

Except for PGRC all *ex situ* conservation collections of seed and tissue material are using short term storage facilities. However, even at the PGRC, the minimum temperature at the seed stores is 1o C. The minimum humidity level is 25-30%. Stock invento 900 ries of almost all *ex situ* collections are checked and the viability is monitored regularly. However, the genetic integrity is monitored only at RRDI, SRI and RARDC (Bombuwela).

There are only about 20 publications related to *ex situ* collections and among them are seven characterization catalogues and two catalogues of passport information published by the PGRC. SRI publications are on selection criteria and quantitative genetics of sugar cane and regeneration guidelines.

3.2 Gene banks - Institutional set up

Ex situ conservation in its current form was started in Sri Lanka with the establishment of Royal Botanic Gardens at Peradeniya in 1821. However, the nodal organization dealing with *ex situ* conservation of crop genetic resources in Sri Lanka today is the Plant Genetic resources Centre (PGRC) at Gannoruwa which was established in 1988.

Over 10 000 accessions of more than 100 plant species are presently conserved in the PGRC seed gene bank. The major collection conserved in 2006 include: rice and related species (4 173), Other cereals and related species (1 367), Grain legumes and related species (1 843), Vegetable legumes (1 148), *Solanaceous* vegetables, Condiments and related species (1 138), Cucurbit vegetables (712), Brassicaceae vegetables (30), *Alliums* (17), Other vegetables (341), Leafy vegetables (143), Root and tubers (9), Mustard and related species (121), Oil crops (373), Fiber crops (66), Medicinal Plants (22) and Fruits (162). PGRC collection also includes 152 accessions of wild types, 4 824 accessions of traditional varieties. Over 300 accessions of different crops, namely, potato (152), sweet potato (93), cassava (65), Dioscorea (13), and aroids (6) are being also maintained *in vitro* at the PGRC. Nearly 5 000 accessions of crop germplasm (landraces and breeder's stocks) were received for conservation.

3.3 Role of Botanic Gardens

Botanic Gardens are uniquely suited to undertake research on the cultivation requirements, the reproductive biology and the propagation of individual plants. Such information is essential to be able to reintroduce the plants back into the wild and to provide material for restoring and rehabilitating natural habitats.

There are three national botanic gardens in Sri Lanka (Peradeniya, Hakgala and Gampaha). These gardens today contain over 8 000 plant species. The Royal Botanic Gardens, Peradeniya alone contains an estimated 4 500 species of plants of which over 90% are exotic. The current geographical imbalance in the locations of botanic gardens could be remedied if more gardens are established in other parts of the island specially in the dry zone, low country wet zone, sub-montane and in the intermediate zone.

Until recently, botanic gardens have been underutilized in maintenance of threatened species and conservation of genetic resources. Although they contain a large proportion of the native flora, the gardens have traditionally not been integrated into overall biodiversity conservation programmes.

3.4 Sustenance of *ex situ* accessions

Only PGRC, DEA and SRI are carrying out effective regeneration of *ex situ* collections. PGRC, SRI and DEA have regenerated 7 216, 1 040, 58 accessions respectively. To reduce genetic changes or loss of genetic integrity during storage PGRC, RRDI, DEA and SRI are keeping their accessions in a suitable regeneration environment with adequate population size and adequate isolation. PGRC carry out timely viability testing of the accessions. No research activities on loss of genetic integrity or genetic change are carried out at the moment. However, some information are found in the characterization catalogues published by the RRDI and PGRC.

There are several publications that address methods and technologies to identify gaps in existing *ex situ* collections of crop genetic resources in Sri Lanka. The SRI has published information on RAPD techniques and selection criteria for clonal evaluation of sugar cane. HORDI publications center mostly on the agronomic practices needed for healthy growth of fruit varieties. TRI has published information on genetic resources originating from tea estates.

Except for DNBG, and PGRC almost all other *ex situ* conservation centers are not geared for conservation centered research programs.

3.5 Germplasm movements

Sri Lanka Council for Agricultural Research Policy (CARP) has signed MOUs on exchange of germplasm with Indian Council for Agricultural Research (ICAR) and Pakistan Agricultural Research Council.

However, Sri Lanka already has a range of regulations to manage and protect biological resources. These legislations are generally meant for conservation purpose, but not for utilization or regulating the access to the resources. It is needed to develop an efficient and effective system to regulate the access to genetic resources, and to ensure fair and equitable sharing of the benefits arising from the use of these resources.

Therefore, the national expert committee on biodiversity has suggested some actions to be taken: develop a consultative process and conduct a public consultation on regulatory mechanisms for access to genetic resources, conduct surveys, workshops and studies to gather necessary data and information, prepare model agreements and guidelines related to impacts and access to genetic resources, develop MTA, PIC's, *sui generis* systems and benefit sharing mechanisms, appoint a team of experts to review international and multilateral access negotiations, review IU regarding *ex situ* collections of international centres prior to the CBD, review TRIPS, CITES UPOV etc in relation to access and benefit sharing, establish monitoring mechanisms for commercial uses of genetic resources, compile information and case studies on EIA related to exploitation of genetic resources, organize human resources development programmes to ensure a critical mass of trained scientific personnel to assess and monitor access and benefit sharing related issues, ensure incorporation of access and benefit sharing issues in school and university curricula and seek funding and expertise from agencies such as UNEP to assist HRD and promote research

3.6 Collecting

The PGRC is the foremost institute in Sri Lanka which conducts a regular plant collecting and exploration program focusing crop genetic resources. PGRC has collected over 4 000 accessions of 104 species over the years. Some work has been done on the propagation and agronomy of collected species in the field. Other institutes are also conducting collecting programs subject to availability of resources.

3.7 Constraints for expansion of *ex situ* collections and major *ex situ* needs

The geographical representation of the collections is not adequate. Many of the important local races are not represented in the collections. Poor institutional collaboration and lack of integrated approach, resource availability and awareness are some of the obstacles hindering the expansion of collections.

Inadequate co-ordination among institutions involved in *in situ* and *ex situ* activities is a major constraint. The other constraints include, a) lack of financial and human resources to launch realistic *ex situ* conservation activities, b) shortage of public awareness programmes, and c) lack of monitoring programmes.

Infrastructure facilities at all *ex situ* centers need upgrading. Institutional policies need to be changed to accommodate *ex situ* conservation. Staff training, upgraded facilities for long term preservation are essential. In some institutes, such as CRI, expansion is limited due to lack of land.

Due to inadequate characterization facilities, it has become a problem to detect duplications at some *ex situ* conservations centers such as SRI. Therefore, it is vital to introduce molecular technology for characterization. CRI lacks protocols for tissue culture of coconut. Better cold room facilities, data base development, proper maintenance (protection) standards, improved irrigation methods, and cryopreservation techniques can also be immensely helpful.

At present there is no clearly defined policy legal framework (only a draft legal framework is available) to regulate access to genetic resources. It is also necessary to set up a public consultative process for a legal framework. Human resources to handle issues related to access regulations and IPR issues need to be assessed and awareness programmes on the strategic and economic values of genetic resources need to be developed. Failure to identify agencies to assist farmers in accessing genetic resources and the lack of widespread awareness of available mechanisms to promote utilization of genetic resources for economic benefits are some of the issues that need to be addressed.

Policies and programmes to promote farm-based participatory research are lacking. Absence of the recognition to incorporate traditional knowledge on biological resources into IPR systems or legislative systems is also hindering research and development on genetic resources.

Many obstacles remain in the quest to provide a secure source of germplasm. First is a lack of information. Secondly, the high cost of *ex situ* collections, particularly when seed is stored at very low temperatures can force some seed banks to cut back or shut down. The high storage costs mean that funds for describing the germplasm present in the banks, a necessity for making the germplasm useful to plant breeders, can be minimal. Thirdly, a serious problem associated with *ex situ* collections involves gaps in coverage of important species, particularly those of threatened and endangered habitats. The most worrisome gaps are in the coverage of species with recalcitrant seeds and wild species.

The PGRC's gene bank facilities are for only medium and short-term seed storage at +1° C and 35% relative humidity, and + 5 °C and 35% relative humidity respectivelywhich are far below international standards. It is recommended that PGRC should obtain the necessary equipment to conserve in original samples at least in one or two gene bank modules at -20°C. It is also advisable to strengthen smaller *ex situ* conservation facilities as safeguards.

3.8 Priorities

The top priorities in *ex situ* management of crop genetic resources are fillings the gaps in existing collections, provision of adequate funding and infrastructure, improved management standards, safety duplication and regeneration with both national and international efforts subject to national legislation on access to genetic resources, low cost conservation techniques and an integrated approach.

Sustained studies on cryopreservation have not been possible at PGRC owing to the lack of a steady liquid nitrogen source. Investigation of the possibility of cryopreservation of vegetatively propagated crop material and seeds and other material of crops where seed viability decreases rapidly under normal storage conditions should be considered a priority.

3.9 Recommendations

The primary objective of maintaining *ex situ* populations are to help support the conservation of crop genetic resources, its genetic diversity, and its utilization on mutually agreed terms.

Compiling a directory of all privately and institutionally held species, varietal and clonal collections and establishing a set of guidelines that define their rights and obligations needs serious consideration. Formulating a national policy for germplasm conservation, and strengthening the capacity and scope of the Plant Genetic Resources Centre (PGRC) needs adequate consideration

Identification of critical species and strengthening the geographical distribution and facilities of the botanic gardens, arboreta and field gene banks to expand their *ex situ* conservation activities need to be considered.

In reviewing the current status, certain gaps were identified: These gaps are

1. Identifying *ex situ* conservation as a part of an overall integrated program,
2. Reviewing the information provided to develop an investment proposal for strengthening identified
3. centres such as gene banks,
4. Monitoring the efforts of private sector organizations to
5. propagate commercially important indigenous threatened species using biotechnology,
6. Compiling a directory of all privately and institutionally held species, varietal and clonal collections,
7. Identifying critical species and develop conservation strategies by NSCAG and oversee their implementation,
8. Formulating a national policy for germ plasm conservation and utilization,
9. Strengthening the capacity and scope of all institutes dealing with *ex situ* conservation,
10. Strengthening the geographical distribution and facilities of the botanic gardens to expand their *ex situ* conservation activities, and
11. Human resource development related to *ex situ* conservation, Involvement of school children

To address these issues some recommendations can be made: Establish more *ex situ* facilities, strengthen the existing facilities, and encourage the development of more field gene banks and botanic gardens in Sri Lanka to ensure fuller representation of the varied climatic and ecological systems, Set guidelines that define the rights and obligations for privately held species, Identify habitat requirements and transit zones or areas for reintroduction, Establish refuges for biodiversity conservation in appropriate places, Ensure the survivability of endangered species through breeding programmes and *ex situ* conservation.

CHAPTER 4

THE STATE OF USE OF PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE

In the past, we have met the demand for increased Agricultural productivity by a combination of genetic improvements, greater farming inputs (fertilizer, pesticide and water) and cultivation of more land with dwindling fresh water reserves and petroleum resources (on which fertilizer and pesticides are based) and increased problems caused by environmental pollution, we can hardly expect to increase or even maintain our current levels of Agricultural inputs. Similarly, much existing farmlands is falling victims to urban expansion and it is unlikely that new farmland will become available in the near future. That leaves the genetic improvement of crops as the most viable approach by which food production can attempt to keep face with the anticipated growth of the human population for the genetic approach to be succeeded, we must harness the wealth of genetic variation provided by the nature and currently warehoused in our seed repositories. Untill now we have been only moderately successful in utilizing these resources for plant improvement.

Gene bank collection should enable users to respond to new challenges and opportunities. Typically, most gene bank accessions have not been well characterized and evaluated, a situation that leads to the under use of collection and failure to utilize their full value, resulting in higher conservation cost in relation to derived benefits.

While it is important to collect and preserve genetic variation in seed banks, these activities are not sufficient to ensure the future productivity of agriculture. The establishment and maintenance of seed bank must be coupled with the ability to actively utilize the materials in those collections. In this regard, we have fallen far short of expectation. While there is a general belief that genes useful for improving crops are contained in these seed banks, the reality is that plant scientists have been largely unsuccessful in finding and extracting such genes. The vast majority of the accessions in gene bank make no contribution to modern varieties, particularly with respect to complex traits such as yield and nutritional quality. As a result, crop improvement is still practiced on a narrow genetic base.

New findings from genome research indicate that there is tremendous genetic potential locked up in seed bank that can be released only by shifting the paradigm from searching for phenotypes to searching for superior genes with the aid of molecular linkage maps. Genetic linkage map based on molecular markers have now been developed in developed countries for most major crop species.

4.1 Importance of utilization

Crop domestication and plant improvement have been extremely successful at increasing the frequency of beneficial alleles for yield at many loci. As a result, breeders have persisted in making crosses among closely related, high yielding varieties unable to rationalize a search for yield enhancing genes in low ancestral types. Yet considering how many genes are likely to influence yield, it is unlikely that modern cultivars have the best alleles for all yield related loci. Many beneficial alleles have undoubtedly been left behind because of the bottlenecks imposed by the domestication coupled with many years of modern breeding and selection within adapted gene pools. Thus, although wild and exotic germplasm, is perceived to be a poor bet for the improvement of traits based on phenotypic expression, it is quite possible that some favorable genes (alleles) lie buried amidst thousand of accessions maintained in gene bank, which if they could be found, might be of great value to the crop improvement. Implementing strategies for finding those genes requires a major shift in the paradigm for using our genetic resources.

4.2 Utilization of crop genetic diversity

Productivity of rice (*Oryza sativa* L.) crop is affected by several biotic and abiotic stresses. The genetic variability for some of these stresses is limited in the cultivated rice germplasm. Moreover, changes in insect biotypes and disease races are a continuing threat to increased rice production. There is thus an urgent need to broaden the rice gene pool by introgression of genes for such traits from diverse sources. The wild *Oryza* species representing AA, BB, CC, BBCC, CCDD, EE, FF, GG and HHJJ genomes are important reservoirs of useful genes. However, low crossability and limited recombination between chromosomes of cultivated and wild species limit the transfer of such genes. However, at IRRI, a series of hybrids and monosomic alien lines have been produced through embryo rescue following hybridization between rice and several distinctly related species. Cytoplasmic male sterility and genes for resistance to grazy stunt virus and bacterial leaf blight have been transferred from AA genome wild species into rice. Similarly, genes for resistant to BPH, BLB and blast have also been intogressed across crossability barriers from distinctly related species into rice. Some of the introgressed genes have been mapped via linkage to molecular markers. Although we have many wild rice germplasm at PGRC, we are far behind with respect to transfer of such important traits using the wild species. However, our breeders were successful in transferring many of those characters using the cultivated rice as sources of donors for such traits.

4.3 Contribution of rice germplasm for Food and Agriculture

It is heartening to note that some relatively smaller National Agricultural Research Systems, such as those in Sri Lanka, have been very successful in contributing to the release of varieties. Sri Lanka provided 25 varieties, which were released in other Asian, African, and Latin American countries. One of the Sri Lankan varieties, BG 90-2, has been recommended and released in many countries which include Guinea Bissau, Sierra Leone, Tanzania, Zambia, Benin, Gambia, Ghana, India, Cote d'Ivoire, Kenya, Myanmar, Nepal, Nigeria, PR China, Sierra Leone and Tanzania. Furthermore, large number of traditional ("Rathu Heenaty", "Babawee" etc.) as well as breeding lines (Bg 34-8, BG 90-2, etc.) have been used as parents in developing rice varieties in other countries. In addition to this, several rice varieties have been developed using the local and introduced germplasm and released for regional and island wide cultivation by the Department of Agriculture. Some of the varieties derived utilizing the PGR as indicated in the Table (4.1) depicts the contribution of PGR for food and Agriculture.

TABLE 4.1
Recommended rice varieties of different age classes by the DOA for general and regional cultivation

Variety	Yield potential (Mt/Ha)	Variety	Yield potential (Mt/Ha)	Variety	Yield potential (Mt/Ha)
3 months		BW 351	7.5	BW 361	5.0
BG 300	7.0	BG 352	6.0	AT 362	7.0
BW 272-6 B	4.0	AT 353	6.5	BW 363	10.0
BW 302	5.0	LD 354	5.0	BW 363	10.0
AT 303	5.0	BG 357	4.5		
BG 304	7.4	BG 358	9.5	4 Months	
BG 305	8.0	BG 359	9.5	BW 400	4.0
AT 306	5.5	BG 359	7.0	AT 401	5.0
3 ½ Months		BG 360	6.5	AT 402	7.5
BG 94-1	8.5	BW 361	5.0	BG 403	8.0
BW 267-3	3-5-4.0	AT 362	7.0	AT 405	5.6
BG 350	8.5	BG 360	6.5	BG 407H	6.2-10.0

4.3.1 Contribution of vegetables and other field crops for food and agriculture

Starting from January 2005 to April 2006 a total of 725 germplasm accessions belonging to crops *Amaranths* (1), Beans (13), Bitter gourd (28), Bottle gourd (4), Brinjal (17), *Capsicum* (18), Cotton (1), Groundnut (9), Luffa (1), Maize (223), Mustard (27), Okra (19), Rice (276), Sesame (3), Soybean (7), Tomato (64), Wild rice (4), Wild *vigna* (8) and Winged bean (2) have been issued to researchers for crop breeding and other research activities.

In addition to the afore said germplasm, PGRC took the initiative to introduced 24 rice, 58 soybean, 17 groundnut, 18 tomato, 12 okra, 12 maize, 3 sorghum, and 6 potato accessions from international institute such as IRRI, IITA, AVRDC, CIMMYT, NBPGR, and ICRISAT to facilitate the breeding and evaluation activities of various breeders of the DOA, With respect to fruit crops, 5 mango and 10 guava accessions have been introduced from India. Utilizing the germplasm obtained from PGRC as well as the introductions from various other sources, several vegetables and field crop varieties have been developed and released for general and regional cultivations. Some of such varieties are Sweet potato (Ama, Dhawala), Brinjal (Amanda, Anjali) Jack (Hirosa , Mandoor), Winged bean(Krishna), Tomato(Lanka sour), Manioc (Shani, Suranimala), Beans (Sanjaya), and Garcinia (Weerapana).

4.3.2 Contribution of fruit crops for food and agriculture

Among the fruit crops cultivated in Sri Lanka, banana is the main fruit crop. Recent introductions from INIBAP as well as the local germplasm selections work carried out by our scientists were able to release five banana varieties, Nadhee (Embul banana, ABB), Kandula (dual purpose, AABB), Pulathisi (Coking type), Prasad, and Agra (silk banana) for island wide cultivation. In addition to the above, two papaw varieties Rathna and Solo, three orange varieties Bibile sweet, Bibile seedless, Arogya, three passion fruit varieties Rahangala hybrid, yelleow selection, Mani, 5 mango varieties, Malwana, Vellaikolomban, Willards, Peter prasad, Tom EJC, 5 grape varieties, Muscat, Cardinal, French MI, Israel blue, Isabella, 3 jack varieties Father long, Maharagama selection, Kothmale selection, 2 durian varieties, Kasun, Ambatenna selection, a strawberry variety Chandler, Mandarin variety Madhu, pear variety Rahangala selection, 3 rambutan varieties, Malwana selection, Malaysian red, Malaysian yellow, 5 guava varieties Kanthi, Horana rathu, Horana sudu, Pubudu, Bankok giant, two pomegranate varieties Daya, Nayana, and 5 avocado varieties, Pollock, Furete, Booth -7, Simmonds and Tower have been recommended and released.

Though we have a database at PGRC, there is no proper recording system to show that how many accessions conserved in the gene bank have been used in breeding programs. Similarly, there is no clue as to what extent they have contributed to develop new varieties though we have issued a fair number of germplasm accessions to various institutes. Lack of feed back from the germplasm users, especially the plant breeders is one of the main obstacles to have such information in our database. However, some of the PGRC accessions serve as parents to develop hybrid brinjal varieties as well as several other crop varieties. In addition, there are direct released of PGRC accessions as varieties after evaluating them in multi-location field trials. Finger millet (“Rawana“), Durian (“Kasun“), Jack (“Hirosa“), Winged bean (“UPS 122“), Luffa (“Asiri“), and Carambola (Honey sweet) are some of them.

4.3.3 Contribution of plantation crops for food and agriculture

As a consequence of economic importance, researchers have focused due attention on plantation crop sector and many commercial varieties have been released. CY 9, DG 7, DG 7, DN, DT 1, KEN 16/3, N 2, PK 2, TRI 2022, TRI 2023, TRI 2024, TRI 2025, TRI 2027, TRI 2043, TRI 3019,TRI 3025, TRI 3055, TRI 3069, TRI 3072, TRI 4006, TRI 4042, TRI 4046, TRI 4053, TRI 4067, TRI 4078 are some of the tea cultivars originated from Tea Research Institute, Thalawakele. Similarly, many coconut cultivars have been developed and released by Coconut Research Institute of Lunuwila, which include CRIC65, CRISL 98, Kapruwana, and CRIC60. Sugarcane Research Institute was also successful in developing and releasing many *Saccharum* hybrid such as, SL 6301, SL 7103, SL 7130, SL 8306, SL 8613, SL 88116, SL 891673, SL 924918, SL 924997, SL 925588 and SLT 88238 for commercial cultivation.

4.3.4 Contribution of exports agricultural crops for food and agriculture

Department of Export Agriculture was also successful in developing and releasing several varieties of different crop species using the available PGR. *Elettaria cardamomum* varieties, EC 100, EC101, EC102, EC201, EC400, Malabar, Mysore and Vazukka, Piper betle varieties, Galdalu, Gerandi maneru, Getathodu, Kalu, Mahamaneru, Metipala, Nagawalli, Rata dalu, and Welbulath and *Piper nigrum* varieties Kuchin, Paniur and Swarnalanka are among them.

4.3.5 Future directions

With respect to rice, we have achieved near self-sufficiency. However, improvement of quality aspects has not been fully addressed. If we are aiming at exporting rice, we should go for varieties with intermediate amylose content (20%), intermediate gelatinization temperature and intermediate gel consistence along with the long slender or long medium translucent white grains. The local community prefers samba grain type. BG 360 is one of the best samba varieties, which possesses intermediate amylose content and intermediate gelatinizartion temperature.

With respect to vegetable crops, the present trend is to go for high yielding hybrid varieties. Hence developments of high yielding, pest and diseases resistant varieties are very important. Improvement of quality aspect as well as incorporation of pest and diseases resistance to economically important pests and diseases is a priority for horticultural crops. Similarly, improvement of yield, quality and pest and diseases resistance is a priority for the plantation and export agricultural crops too.

4.4 Utilization and enhancing the use of plant Genetic Resources

Recently our scientists have undertaken several research activities towards improved utilization of PGR. Some of these activities include:

1. Pyramiding of genes for resistance to bacterial leaf blight, brown plant hopper and gall midge
2. Thrips (*Stenchaetothrips biformis*) resistance in traditional rice varieties and its transfer to cultivated rice
3. Development of rice varieties tolerant to salinity
4. Molecular characterization and evaluation of tomato germplasm with respect to bacterial wilt resistance and heat tolerance
5. Exploration, collection, characterization and propagation of under utilized fruit crops:
   Sri Lanka is rich in many naturally grown traditional fruit crop species. These species show seasonality in bearing and consequently fruit availability is seasonal in the markets. These species have versatile uses such as food, medicine, fodder and fuel but rarely exploited for such varieties. Thus, they are under-utilized fruit crops, as their cultivation and marketing systems are not well organized. The exploration and collection missions undertaken by PGRC scientists revealed the existence of about 20 under-utilized fruit crop species and vast genetic diversity among them. The collection included elite germplasm of Beli (*Aegle marmelos*), Goraka (*Garcinia*), Mandarin (*Citrus reticulata*), Jambu (*Syzygium* spp.) and Pumelo (*Citrus maxima*) with a promise for cultivation. The field gene bank (*ex situ* conservation) has been established with 300 accessions of 23 species.

4.5 New crops

Introduction and evaluation of new crops should also be carried out to find out the economically feasible crops that can be introduced to the country. Dragon fruits and macadamia nut are some of the potential candidates in this respect.

4.6 Increase genetic enhancement and base-broadening effort

Broadening the genetic base of crops can contribute to increasing stability and performance of crops. This could be achieved by introgression of useful traits identified through characterization or evaluation into locally adapted or elite material for future use in breeding programmes.

This approach is been used in rice, sugarcane, mango and tea breeding programmes. A few attempts have been made to transfer the useful genes from crop wild relatives. Inter-specific cross between *Abelmoschus esculentus* L. and *Abelmoschus angulosus* L., wide cross compatibility of okra and brinjal with their wild relatives, and disease resistance and genetic variation of wild relatives of okra (*Abelmoschus esculentus* L.) are some of the research projects undertaken with regard to the above aspects.

4.7 Constrains for improved use of plant genetic resources

Numerous obstacles have led to limited utilization of conserved materials. Among these, following points can be considered more important.

4.7.1 Lack of information and evaluation data to identify suitable materials

Though characterization of conserved accessions has been accomplished to a greater extent, evaluation data is very much lacking for the germplasm. With respect to under utilized fruit crops, neither characterization nor evaluation data are available for the following crops; i.e. Wax apple (*Syzygium* spp.), Gaduguda (*Baccaurea motleyana*), Lavulu (*Pouteria campechiana*), Lovi (*Flacourita inermis*), Sapota (*Achras sapota*) and Beli (*Aegle marmelos*). Unavailability of such information might have led to the poor utilization of these crops in commercial scale.

4.7.2 Non-availability of core collection

Plant breeders and most other uses are interested in having a manageable number of genotypes that possess or are likely to possess the traits needed in their breeding programmes. Identification of these traits through characterization, and the establishment of core collections (a subset selected to contain the maximum available variation in a small number of accessions) are measure that can encourage greater and more efficient use of collections. Core collections have not been prepared for any of the collected crop species in the PGRC gene bank. Hence this will hinder the maximum utilization of the conserved germplasm.

4.7.3 Insufficient human resources for plant breeding activities

Training on molecular characterization will be a priority area. Financial support for this kind of project activities is required. Duplication of accession can be avoided with the use of molecular markers. Availability of such molecular data will be useful in preparing core collections.

4.7.4 Difficulty in obtaining PGR from other countries with proven sources of resistance for required traits

- Resistant sources for yellow mosaic virus for beans, blackgram (*Vigna mungo*) and green gram (*Vigna radiata*), Bruchid resistant sources for grain legumes, Bacterial wilt resistant sources for potato (*Solanum tuberosum*), Resistant sources for chilli (*Capsicum annum*) leaf curl virus complex, Resistant sources for purple blotch in onion (*Allium cepa* L.), and Pod borer resistance for brinjal (*Solanum melongina*) are some of the very important prerequisites to fulfill the breeding objectives of those crops.
- Identified proven parents and proven genetic combinations based on general and specific combining abilities of the accessions of respective crops in the gene bank is the priority for expanding the utilization.

4.7.5 Lack of laboratory facilities for employing new techniques

Laboratory facilities should be upgraded to perform biotechnological research including gene transfer and gene sequencing etc.

4.8 Supply of seed and planting materials

The national policy on seeds and planting materials production is to expand research and development for the production of high quality seed and planting material, safe import of high quality seed and planting materials, and make them readily available in the market, remove unnecessary impediment in quarantine procedures, supply of such seeds at fair prices, increase private sector involvement in the seed sector and encourage selected farmers attract an agrarian service center level for seed production. Goverrnment has played an important role in the production of seeds of a large number of crops as indicated in Tables 4.2 and 4.3.

TABLE 4.2

Contribution of the government sector for the production of basic and certified seeds of other field crops (Average over 2001-2005)

Crop	Average Production (Kg)			Average seed requirement (Kg)	% Supply from the requirement
	Basic	Certified	Total		
Black gram	2 297	7 566	9 863	157 340	6.3
Chilli	216	334	550	16 627	3.3
Cowpea	2 170	2 640	4 810	531 140	0.9
Sesame	253	1 157	1 410	36 927	3.8
Green gram	4 587	13 541	18 128	279 525	6.5
Ground nut	2 772	11 666	14 438	1 013 860	1.4
Finger millet	1 420	1 234	2 683	30 126	8.9
Maize	11 063	59 199	70 262	513 004	13.7
Soybean	3 440	2 849	6 289	70 829	8.9
Pigeon pea	15	0	12		
Grand Total	**28 233**	**100 215**	**123 693**	**2 649 423**	**6.0**

TABLE 4.3

Government sector contribution to the production of vegetable seeds (Average over 2001-2005)

Crop	Average Production (Kg)			Average seed requirement (Kg)	% Supply from the requirement
	Basic	Certified	Total		
Beans	1 431	7 249	8 681	401 920	2.2
Bitter gourd	137	818	955	22 450	4.3
Brinjal	8	449	456	3 480	13.1
Bushitao	475	2 178	2 653	-	-
Capsicum	0	395	395	2 770	14.3
Cucumber	17	293	310	2 670	11.6
Luffa	157	333	489	-	-
Mae	233	1 231	1 463	-	-
Okra	333	3 711	4 045	30 370	13.3
Snake gourd	87	1 277	1 359	10 870	12.5
Pumpkins	10	53	63	6 730	0.9
Radish	0	847	847	12 500	6.8
Tomato	84	431	515	2 130	24.2
Winged bean	49	391	440	-	-
Spinach	0	271	271	-	-
Sweet melon	1	24	25	-	-
Potato	-	-	75 000	15 000 000	5

According to the tables, the government sector contribution for supplying quality seeds to the farmers is very less when compared to the demand. However, in many instances seed and planting material division is unable to sell the entire amount of seeds produced by them as a result of poor marketing systems, farmer-to-farmer seed exchange and use of their own seeds for the crop cultivation. Sri Lankan government has spent approximately 765 million Rs and 131 million Rs respectively during the years 2002 and 2003 for the importation of 12.060 Mt of potato and 15.247 Mt of maize as seed materials. On the other hand, the government policy is to encourage private sector in seed production. At the moment, private sector is also involved especially in providing rice and the hybrid seeds of vegetables crops. There are ten Co-operative societies and 11 private companies registered in seed producers' association of Sri Lanka.

4.9 Other activities that are undertaken to enhance the use of plant genetic resources

The Department of Agriculture is promoting joint research with the academicians of the universities to enhance the use of PGR for agricultural development. This activity will also help in better conductance of research activities as it provides wider interaction among researchers and also it helps the sharing of physical resources among them.

Under the supervision of DOA scientists, undergraduate and postgraduate students of universities carried out the following research projects and submitted the dissertations:

- Biochemical and morphological studies on inter-specific hybrids between *Solanum torvum* and *S. melongina*.
- Characterization of wild and cultivated *Solanum melongina* using isozyme and RAPD techniques.
- Organogenesis in tissue culture of Brinjal (*Solanum melongina* L.).
- Screening of *Lycopersicon* species for tomato yellow leaf curl virus resistance and evaluating their differences at the molecular level by RAPDs.
- Evaluating progeny lines of *L. esculentum* x *L. hirsutum* against TYLCV and detecting putative molecular markers for virus resistance using RAPDs.
- Another culture and genetic analysis of anther derived rice plants (*Oryza sativa* L.)
- Screening of two traditional rice varieties ("Dahanala" and "Suduru samba") using micro satellites.
- Somatic embryogenesis of papaya (*Carica papaya* L.)
- Assessment of brown plant hopper resistance in rice
- Detection of variation of *Xanthomonas oryza* pv *oryzae* at molecular level and virulence level.
- RAPD analysis of genetic relationship of wild and cultivated *vigna* species
- Molecular characterization of selected wild and improved tomato accessions using RAPDs and analysis for the TYLCY resistance.
- Molecular characterization of *Abelmoschus* species using RAPDs.

CHAPTER 5

THE STATE OF NATIONAL PROGRAMMES, TRAINING NEEDS AND LEGISLATION

National commitments to conservation and sustainable utilization of PGR and its policy, institutional and legal framework has a long-reaching history dating back to over two millennia especially during pre-colonial times. Concern for the environment and for the judicious management of Biological Diversity had characterized the policies of the ancient kings of Sri Lanka. This is seen in the creation of Royal Preserve - "Forbidden Forests" which can be incorporated into the concept of modern protected area and field gene banks.

5.1 National Programmes

There are various projects plans, strategies, policies, laws & regulations, multilateral agreements, memorandum of understandings (MOU), national level committees and institutional mechanisms for coordination and integration of biodiversity management constituting main instruments that address various aspects of PGR conservation and use in the country today.

The ministry of Environment and Natural Resources and the Department of Agriculture are executing several collaborative donor - funded projects and programmes on PGR conservation and use. The government of Sri Lanka is also committed to develop national programmes for PGR conservation and sustainable use in adopting Agenda 21 and Rio Principles, implementing the Millennium Development Goals (MDGs) , Biodiversity 2010 Target, Ecosystem Approach and Precautionary Principles and monitoring at a national level with the support of various Ministries Departments and UN agencies.

In view of the importance awarded to PGR conservation and use, many other related government/non government and private institutions have also addressed the conservation and use of PGR in their sectoral/business plans and programmes, especially in the forestry, wildlife, food & agriculture, plantation & industrial sectors.

There is no single centralized national institute in the country responsible for comprehensive national PGR management system covering all aspects of PGR conservation and use. Government coordinates and develops National PGR activities in various national conservation agencies, departments and institutions comes under different line ministries.

At present, the Plant Genetic Resource Center (PGRC) can be identified as the formal national institute for the management of PGRFA activities in the country, includes exploration, collection, conservation, utilization, evaluation, database management, documentation and distribution of plant genetic resources.

The main actors are the Ministries related to Agriculture, Environment, Plantation, Indigenous Medicine, Lands, Education and Science and Technology. Several national focal points can be identified in the country giving mandates in different cross-cutting and cross-sectoral areas of biodiversity conservation such as *in situ ex situ*, access to genetic resources, information management to carry out PGR programmes.

Most of which are concerned with *in situ*/on-farm and, *ex situ* conservation, while genetic enhancement, crop improvement and supporting seed production are seen as important programmes in utilization of PGR. Plant Genetic Resources Centre (PGRC) and the National Botanic Gardens are the focal institutions of PGR national programmes on *ex situ* conservation and main repository of crop germplasm. Government research institutes such as Coconut (CRI), Tea (TRI), Sugar (SRI), Forestry (FRI) and Indigenous Medicine (BMARI) are also involved in management of respective PGR. Several NGO based community organizations in the country are involved in on-farm conservation of PGRFA.

In addition, institutional mechanisms are established and these are under relevant ministries, focal points for coordination and integration biodiversity and PGR matters to take policy and planning decisions. These cover various aspects of biodiversity conservation, sectoral integration and action on various multilateral biodiversity agreements to address country obligations. There are national level steering committees for all major projects undertaken by the relevant agencies on PGR activities.

Ministry of Environment and Natural Resources is becoming the focal point for the development of national policies, strategies and action plans for PGR *in situ* conservation as the national focal point to the Convention on Biological Diversity (CBD). The Biodiversity Conservation Action Plan included both plant and animal genetic resources conservation and sustainable utilization and is primarily follow up and implementation of Convention on Biological Diversity.

In the recent past protection of PGR within the National Protected Area System has mainly been identified as conservation action of genetic resources. The forestry sector master plan and the forestry policy 1995 and the recent Addendum to the Biodiversity Conservation Action Plan 2006 have emphasized the need to focus on the sustainable use of genetic resources considering the fact that the bulk of biodiversity and genetic resources is found outside of national parks and gene banks.

Government has ratified number of Multilateral Environmental Agreements. Several of them have direct or indirect impact on biodiversity conservation including PGR activities. These include the Convention on Biodiversity (CBD), ratified by Sri Lanka in 1994. A number of activities and programmes have been taken place to facilitate obligations under each convention.

Highest number of GPA activity areas covered by national projects and programmes, are identified within the utilization of plant genetic resources of which increasing genetic enhancement and expanding the characterization of core collections are the key activities involved in most projects and programmes followed by *ex situ* conservation activities, education training and awareness and *in situ*/on-farm conservation. Very few projects and programmes are recorded in developing monitoring and early warning systems, assisting farmers in disaster situations and promoting networks for PGRFA activities.

There is an urgent need to develop central database and national information sharing mechanism on PGR as available information is scattered and isolated among several institution agencies and individuals. Present GPA-NISM and CWR information management system provides good opportunities to achieve these constraints. This also plays an important role to collate information on PGR research carried out under various institutions.

Increasing trend of developing new projects and programmes and institutional strengthening, capacity building for covering above PGR activities including germplasm exchange, expanded markets, modern molecular techniques, incentives, policy and advocacy for local farmers and foreign financing for PGR conservation and use have identified in the GPA-NISM as future challenges need, constraints and opportunities for successful PGR programmes.

Few NGOs are involved in PGRFA activities. These NGOs are associated with the contribution of local community and farmer groups through on-farm conservation for the use and maintenance of PGR. According to the BCAP 1999 one of the major problems in involving non NGOs in biodiversity conservation and other similar PGR activities is inadequate institutional capability. It is widely recognized that NGO participation can substantially enhance the PGR conservation and use activities especially in on-farm level. However their institutional capability is to be strengthened and they are provided with more policy initiatives and legal backup. NGO participating in the development of national PGR programmes and policies through national coordination mechanisms is new trend and government encourages such exercise.

Few private sector organizations are identified involving PGR activities in the GPA-NISM. They are mainly confined to seed production and supplies. New trend is immerging on establishment and maintenance of field gene banks by the private sector too. Development of such enterprises should be promoted by the Government.

Hardly any projects or programmes are found in the GPA-NISM concerning the importance of indigenous knowledge for conservation and use of PGR activities.

Bandaranaike Memorial Ayurvedic Research Institute (BMARI) has a great potential to develop such indigenous knowledge associated ethno-botany project. Biodiversity Secretariat of the Ministry of Environment is being formulated policy initiatives to address this shortfall. It is surprised that the GPA-NISM main activity areas are not covered such issues.

With the present conflict situation in the country financing for environment conservation including PGR activities would be the greatest problem. Therefore like most developing countries Sri Lanka has recognized the need for more financial support to ensure sustainability of the National PGR programmes since government has committed to pay co-financing components of the projects and programmes.

Most of the above projects and programmes covering GPA activity areas are directly contributed to the recommendation and activities identified in the National Development Plans of the country such as sustainable development, maintenance of biodiversity, food security, poverty alleviation, nutrition and health care, sustainable agriculture, agro-tourism, bio economic prospecting, information management, national inventories and marketing. International conventions, agreements, protocols and other GPA areas such as CBD, MDG, 2010 biodiversity targets and Millennium Ecosystem Assessment (MA) have also obliged the achievement of the above purposes.

5.2 Training

The need of training and capacity building is strongly emphasized in all national development programmes including Biodiversity Conservation Action Plan. In addition government has committed to carry out training and capacity building to fulfill the obligations of international conventions and agreement ratified subject to the relevant focal points. GPA-NISM shows that the existing training and education opportunities in PGR conservation and use are inadequate in the country. Unavailability of central national training infrastructure fully devoted for PGR is a great concern.

Several institutions mandatory to implementing PGR activities have their own training institutes to train their officers. However, further improvements are needed to accommodate very specific training on PGR by these training centres. In contrast other institutions have no formal staff training facilities other than training programmes generated through various projects programmes and external resources. Main reason for this is the allocation of insufficient funds for biodiversity conservation by the treasury annually. This brings a continuous dependency on external project funds.

There are several natural resources management related courses at postgraduate level initiated by the national universities and postgraduate institutes affiliated to them which promote enhance skills for biodiversity conservation. However in the national university system found very few degree courses on PGR at both under graduate and post graduate level, other than the specific modules design for PGR is a fact that needs considerable attention. Faculties of agriculture and science of all universities, undergraduate students are given a basic knowledge on biodiversity, plant genetic resources and crop improvement. Post Graduate Institute of Agriculture (PGIA) University of Peradeniya conducts M.Sc course on PGR. However number of students enrolling to this course is decreasing, due to high specificity of the subject to cater the present employment opportunities in the country. Therefore the country has to develop a effective curriculum and financial mechanism for sustaining the post graduate course in PGR.

Research programmes and specific trainings carried out by national universities play an important role in national PGR activities. Universities also play a significant role in representing national biodiversity and PGR coordinating mechanisms.

Majority of institutions are found in the GPA-NISM involved in research activities followed by, education, seed production, plant breeding, administration and policy and extension Many institutions promote biodiversity research in the country. Government Ministries, Departments Universities Research institutions are the main among them. Especially Tea Research Institute (TRI), Coconut Research Institute (CRI), and the Sugarcane Research Institute (SRI) under the Ministry subject to Plantations deal with research and development of their respective food crops and the protection of crop germplasm.

The national agricultural research policy was promulgated in early 1980 for the promotion and development of the agricultural research in the country, while the Sri Lanka Council for Agricultural Research Policy (CARP) established to provide legal and institutional basis. The National Science Foundation (NSF), the National Research Council (NRC), The Forest Department (FD) and The Department of Wild Life Conservation (DWLC) have their institutional mechanisms to facilitate and support biodiversity research and training needs by any institutions and scientists with the aim of enhanced the biodiversity research in any thematic areas including agro biodiversity and PGR. The National Science Foundation, a semi-government institution has their several research grant schemes with donor assisting and national budget allocations that supports capacity building in research and development.

It is a common concern that there are staff inadequacies in terms of both numbers and capacity of skills at all national institutions mandatory to PGR, both head quarters and field offices. Staff cadres for relevant positions for PGR are not adequately established. Lack of trained scientists is also a main constraint in the development of future PGR activities.

A long-term investment in staff training is necessary for inbuilt professionalism in the PGR for all these institutions identified. GPA-NISM has identified the capacity building through skills training is required at all levels to meet the demands of modern PGR conservation and use approaches to meet the global requirement.

It has been also identified that the strengthening of skills of the relevant personnel is required for germplasm characterization, molecular techniques systematics and taxonomy plant breeding and seed technology, GM testing, GIS modeling and interpretation, medical ethnobotany, plant quarantine, seed certification and red listing and IPR procedures and developing monitoring and early warning systems.

Training at individual level is required, for propagation of endangered species and commercially important species, especially for tissue culture involving laboratory work and biotechnology to enhance crops using indigenous and under utilized genetic resources.

All administrative and policy institutions have required enhancing technical capacity to evaluation of biodiversity conservation policies and laws and sustainable use, access to PGR and benefit sharing. The Ministry of Environment and Natural Resources as the main actor in this scenario lacks technical and infrastructure ability to meet this demand.

In addition PGR economic prospecting and valuation, and information management skills need to be strengthened for the preparation of polices, strategies, action plans.

At present the Biodiversity Secretariat (BDS) has low capacity to establish an access to PGR and benefit sharing regime, and establishment of biodiversity clearing house mechanism (CHM). BDS is being involved in vital functions of co-ordination, monitoring and evaluation to implement the Biodiversity Conservation Action Plan.

In addition Sri Lanka has an agriculture training and extension program for farmers which are primarily focused on training of farmers for *in situ* on-farm management of PGR which includes CWR and underutilized crops too.

On site training for farmers is essential for successful on-farm PGR conservation programmes. In this case NOGs are required to have skills in participatory environmental education at the formal and non-formal level. Some institutions need very specific trainings for PGR that cannot be met in the country and could be provided by way of international and regional exposure through M.Sc /P.hD courses and technical exchange programmes. Most of these programmes are supported by foreign funded donor project. However, clear picture about individual promotional prospectus in their intuitions and adequate incentives to achieve new skills and technical capacity for career achievement are an essential requirement to be fulfilled by the responsible institutions for successful PGR training achievements in the country.

5.3 National Legislation for PGR conservation and Use

There are substantial amount of laws enacted to conserve Sri Lanka's environment. Many of these are of directly or indirectly relevant to the conservation and sustainable use of biological diversity including PGR. The Fauna and Flora Protection Ordinance (FFPO) amendment Act No. 49 of 1993 and the Forest Ordinance (FO) amendment Act No, 23 of 1995 form the direct legal framework pertaining to biological resources, including genetic resources, as at present. Environmental Impact Assessments (EIAs) for prescribed projects was introduced in 1984 through a Cabinet decision under the National Environmental Act (NEA) No. 47 of 1980 which can be considered as the first comprehensive legislation on environmental management in Sri Lanka. Several other acts enacted for plant protection are also of relevant for the conservation of indigenous crops and their wild relatives' genetic resources.

With regard to the access and movement/exchange of genetic resources in line with the Convention on Biological Diversity Article 15 including the regime of Prior Inform Consent (PIC) and Mutually Agreed Terms (MAT), the main laws governing are the Fauna and Flora Protection Ordinance (FFPO) as amended and the Forest Ordinance (FO) as amended. These laws can adequately control the access to genetic resources, prevent illegal access and protection against commercial exploitation.

Ownership of the genetic resources is protected in the Constitution of the Democratic Socialist Republic of Sri Lanka in both Articles 27 and 28. The Fauna and Flora Protection Ordinance of 1937 and its amendments also announced that the state holds responsibility over all genetic resources and holds ownership of such resources.

The National Heritage Wilderness Area Act No. 3 of 1988 and the Fisheries and Aquatic Resources Act No. 2 of 1996 also have provisions to protect wild genetic resources. However, above laws are not consistencies with equitable sharing of benefits from genetic resources as stated in the CBD.

There is a gap in the absence of a Cabinet approved policy on Access to Genetic Resources to strengthen the national legal framework on Access to Genetic Resources and Benefit Sharing (ABS) regime in the country especially implement the Article 15 of the CBD. However proposed National Policy on Access to Genetic Resources and Benefit Sharing and the proposed act on Plant Breeders Right will necessary to ensure fair and equitable benefit-sharing and secure farmers'/ breeders' rights. Material Transfer Agreements (MTAs) (bi-lateral) are used to exchange of genetic materials by the relevant institutions (PGRC) for their development works. Recent expertise idea on the MTAs reveals that the common MTA should be in place, operating through a central governing body.

The Plant Protection Act No. 35 of 1999 in makes provision against to prevent the introduction and spread of any organism harmful to or injurious to plants or destructive to plants found in Sri Lanka. This act can be used to prevent the import of any GMO that could be potentially damaged to native plants or crops. Similarly the Water Hyacinth Ordinance No 09 of 1909 can be used to control any noxious weed or plant that could be harmful to native plants in Sri Lanka. These laws facilitate the national quarantine service to implement the national quarantine regulations The Plant Quarantine Service fulfils the Quarantine and Phytosantary requirements of imported and exported plants and plant products and seeds.

National Seed Policy 1996 and the National Seed Act of 2003 focus on enhancing the production and marketing of high quality seeds. The Agrarian Services Act No. 58 of 1979 in make provisions to enhance the scope of agricultural insurance activities for assisting farmers in disaster situations. This Act can be used to regularize ownership of land and to

create better ownership of land among farmers, and to empower local farmer organizations involved in the agricultural sector.

Sri Lanka has also enacted the Intellectual Property Act No. 36 of 2003. This law relates to all the different types of intellectual property rights in Sri Lanka and provides the procedures of registration, control and administration of such rights. It is also relevant for granting IPR protection in the use of genetic resources and for genetic engineering techniques and their products. This can be used for the protection of IPR over use of genetic resources of indigenous species. However IPR issues over genetic resources associated traditional knowledge need to be further covered. In parallel to the agreement on WTO-TRIPS, Intellectual Property Office in Sri Lanka has decided to introduce new enactment to the exiting law.

5.4 Promoting Public Awareness and Value of PGRFA

Awareness programmes to educate public on importance of PGRFA as a part of biodiversity conservation, food security and farmers' role are important. However, the most challenging is finding the financial and technical assistance for improvement of these programmes. NGOs role for promoting awareness has not been considered.

5.5 International Commitments to PGR conservation and Use

Sri Lanka has commitments to implement the various Multilateral Environmental Agreements adopted by international community and ratified by the Government. These include to International Agreements, Protocols, Conventions and Targets and Goals. Sri Lanka is committed to implement Agenda 21 and Rio Principles of the United Nations Conference on Environment and Development (UNCED) during the Rio Earth Summit in 1992. Sri Lanka has taken action to implement the obligation of the Convention on Biological Diversity which includes conservation, sustainable use and access and benefit sharing of PGR activities.

The government is also committed to implement of Millennium Development Goals (MDGs) and the Biodiversity 2010 Target at a national level. Sri Lanka is also in pending for signing the International Treaty on Plant Genetic Resources (ITPGR). The legal implications of this exercises is being processed with the FAO assistance on access issues and the impact of the Intellectual Property Rights and Plant Breeders' Rights.

As a signatory to the WTO Agreement on Sanitary and Phytosantary Measures Sri Lanka is bound to establish appropriate legal framework to meet the WTO obligations and ensure the successful implementation of the terms of these agreements. In these circumstances, Department of Agriculture serves as the National focal point to comply with the conditions in this agreement.

Similarly in order to implement the WTO/TRIPS obligations, the Intellectual Property Office in Sri Lanka with the consultation of Department of Agriculture has drafted a law on Plant Varity Protection (or Plant Breeder's Rights Act) which is based on International Union for the Protection of New Varieties of Plants (UPOV) 1991.

CHAPTER 6

REGIONAL AND INTERNATIONAL COLLABORATION

Collaboration of activities related to plant genetic resources at regional and international level is important for the food security of present and future generations. Therefore, there is a need to sustain the existing *ex situ* collections and *in situ* habitats of plant genetic resources to maintain genetic diversity which help breeders, end users and indigenous and local communities.

6.1 Surveying and Inventorying PGRFA

For the improvement and effective utilization of PGRFA, it is necessary to carry out surveys and documentation activities on plant genetic resources. Therefore, there is a need to establish a national and regional network to strengthen linkages as well as to intensify collaborative work with other institutions involved on PGRFA.

6.2 Supporting on-farm management and Improvement of PGRFA

The conservation and protection of plant genetic resources available in different regions in the world are important. As most of the genetic resources are presently under threat by different biotic and abiotic factors, the necessity has arisen to protect them on-farm for future use. In this regard it is necessary to provide assistance to protect field gene banks. Steps have to be taken to provide incentives to the owners and make available human resources, and also to promote or support appropriate farmers and local communities for on-farm conservation of PGRFA.

6.3 Assisting farmers in Disaster Situations to Restore Agricultural Systems

The recent global development activities, industrial expansion and other natural global changes are affecting drastically on plant genetic resources. Some of the genetic resources have already become extinct due to such events happening globally. Therefore, to protect the existing genetic resources it is essential to maintain a regional database on locally adapted crop species cultivated in different parts of the respective countries and need to preserve the existing germplasm in several locations.

6.4 Promoting *in situ* conservation of crop wild relatives and wild plants for food production

Crop wild relatives consist of enormous and elite genes and are playing an important role in the agricultural systems in the world, and greatly help to improve the research and development activities of agricultural crops. Therefore, there is a need to develop institutional and legislative mechanisms for conservation of biodiversity by establishing *in situ* and *ex situ* gene banks for wild relatives, promoting *in situ* conservation of crop wild relatives, and wild plants for food production and a sound monitoring system.

6.5 Sustaining Existing *Ex situ* Collections

The enormous existing collection of plant genetic resources in various national, regional and international organizations are providing resource materials for research and development activities for the improvement of agricultural systems. In this regard, it is essential to provide facilities, to improve the attention on adequate documentation, characterization, evaluation and transfer techniques and strengthen collaborative activities.

6.6 Regenerating threatened *ex situ* accessions

Some of the accessions conserved at *ex situ* conditions are facing threats due to various internal and external factors. Attention has to be paid to conserve and protect such PGR by removing these unfavorable factors and to make available such genetic resources for future effective usage. Therefore, identification of negative factors, improvement to the *in vitro* propagation techniques applied at present, training of people, assistance for regeneration, development of infra structure facilities and co-operation to develop an efficient and sustainable system of *ex situ* conservation is essential.

6.7 Supporting planned and targeted collecting of PGRFA

The collection of genetic resources with wider variability and proper conservation of such valuable germplasm for future research and development programmes as well as for supplying the situations like disasters, are very vital for sustainability of PGRFA.

6.8 Expanding *ex situ* conservation activities

For the expansion of *ex situ* conservation activities, assistance are needed at regional level for expansion of infra structure facilities, technology improvements, institutional and man power development.

6.9 Expand the characterization, evaluation and number of core collections to facilitate use of PGRFA

Expansion of characterization and evaluation activities and increase of core collection of genetic resources are necessary for proper utilization of PGRFA. For this purpose it requires assistance to strengthen existing research and development activities to facilitate the dissemination of elite accessions, need to provide funds for infrastructure facilities.

6.10 Increasing Genetic Enhancement and base broadening efforts

To develop better and sustainable crop varieties, wider diversity is required. Acquisition of new genetic resources can be done by exploring conserved areas or by exchanging from other regional or international bases. Therefore, it is necessary to broaden the genetic base of crops and increase the range of genetic diversity of crops available to farmers.

6.11 Promoting Development and Commercialization of Under-Utilized Crops and Species

Some crops species still exist in wild habitats and are not fully utilized or commercialized though they possess many advantages. It is necessary to initiate rapid multiplication programmes of these crops to explore the possibility of domesticating these crops.

6.12 Supporting seed production and distribution

Seeds play a significant role in all the activities related to PGR programmes. Therefore, support extending to seed production and distribution system will immensely help the sustainable use of PGRFA. Research activities are to be conducted to assess the germination and viability of some specific crop seeds. Assured assistance is necessary to fund training, purchase of equipments, and improved germplasm and also for research and development.

6.13 Developing new markets for local varieties and diversify products

Improvement and expansion of local plant varieties directly help to increase the diversity of genetic resources. There is a need to conduct research and development activities for popularizing traditional foods, products and food habits.

6.14 Building strong national programmes

Establishment of a mechanism for capacity building, participation and empowerment of farmers through policy, advice, legislative measures and strengthening of farmer's societies will help for the proper functioning of the plant genetic resources programmes.

6.15 Promoting networks for PGRFA

International networks on PGRFA will help to protect and exchange PGR as well as for better utilization of genetic resources and finally to improve the agricultural productivity nationally as well as internationally. In this connection it is very important to establish effective linkages with international organizations.

6.16 Constructing comprehensive information systems for PGRFA

Assistance for improvement and establishment of internet facilities at regional level centres and development of data bases for crop wild relatives and under utilized fruit species is essential. An information sharing system at national, regional and international level is required to be set up.

6.17 Developing Monitoring and Early Warning Systems for loss of PGRFA

There is a need to develop institutional and legislative mechanisms to support conservation of genetic resources of agricultural biodiversity under *in situ* and *ex situ* conditions. A proper system for monitoring of PGRFA, and early warning for the loss of PGRFA needs to be set up.

6.18 Expanding and improving education & training

Setting up of new laboratories/improvement to use new technologies for molecular characterization, assistance to equip laboratories at regional level, training of staff, provision of facilities to expand training facilities on conservation and sustainable use, establishment of policies and a system to give incentives for the expertise involved in PGRFA is essential.

6.19 International Programmes

The international financial support for plant genetic resources activities in the country has increased during the past 10 years. International prgrammes conducted during the past and the on going programmes under Coconut Genetic Resources Network, SL¬USDA, IRRI, UNDP/GEP and CIMMYT networks have benefited in many ways.

6.20 International agreements

Sri Lanka has signed the following international/regional agreements, treaties, conventions or trade agreements during the past 10 years:

- Bio-safety protocol
- Convention concerning the protection of the world cultural and natural heritage
- Convention on Biological Diversity (CBD)
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
- Convention on wetlands of international importance especially as waterfowl habitat (RAMSAR)
- International Plant Protection Convention (IPPC)
- Plant Protection Agreement for Asia and Pacific Region
- United Nations Convention to Combat Desertification in those countries experiencing serious drought and/or desertification, particularly in Africa (UNCCD)
- United Nations Framework Convention on Climate Change (UNFFC)
- WTO Agreement on Trade-Related Aspects of Intellectual Property Rights

CHAPTER 7

ACCESS TO PLANT GENETIC RESOURCES AND SHARING OF BENEFITS DERIVED FROM THEIR USE AND FARMERS' RIGHTS

Past and present situation on access to plant genetic resources, fair and equitable sharing of benefits of the use of plant genetic resources, and implementation of farmers rights will be discussed in this chapter as an attempt to make recommendations to maintain or improve access to plant genetic resources within and outside the country.

7.1 Access to Plant Genetic Resources

7.1.1 International legal and policy framework

Sri Lanka is signatory to the International Convention on Biological Diversity (CBD) since 1992 and has ratified it in 1994. So far we are not a signatory to the international treaty on Plant Genetic Resource for Food and Agriculture, but it is under consideration. In addition, Sri Lanka has signed MOU with India and Pakistan in 1998 through Sri Lanka Council for Agriculture Research Policy (CARP) and also for SL-USA germplasm exchange programme in order to facilitate access to plant genetic resource between Sri Lanka and those countries.

7.1.2 National legislations

According to WTO agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) for which Sri Lanka is a signatory, it is required to provide a legal frame work for breeders rights as soon as possible. There are two options namely plant patents and a sui generis (unique) law. Sri Lanka has opted for the sui generis law and is in the process of finalizing the draft act prepared by Intellectual Property Office in Sri Lanka with the consultation of Department of Agriculture and other Agriculture related government and non government organizations in Sri Lanka. This will be the 1st national legislation in Sri Lanka which would help the development of new varieties as well as access to plant genetic resources.

7.1.3 Management action to facilitate access to plant genetic resource located outside the country

In Sri Lanka Plant Genetic Resource Center (PGRC) has developed a Bi-lateral Material Transfer Agreement (MTA) for exchange of plant genetic resources with any interested parties on mutually agreed terms and conditions. In addition, MOU signedbetween CARP and India/Pakistan in 1998 has also facilitated access to germplasm located in those countries.

7.1.4 Status of access to Plant Genetic Resource outside the country

According to the constitution of Sri Lanka, the genetic resources as well as all other resources are under the joint custodianship of the state and the people. However, PGR is increasingly becoming covered by intellectual property rights in some countries. The ITPGR has also accepted that plant genetic material can be the subject of intellectual property rights. Therefore, Sri Lanka finds it more and more difficult to access useful plant genetic resources from other countries even with recent agreements and MOUs singed. Only the germplasm available in international institutes such as CIMMYT, IRRI, ICRISAT and CIAT are available according to the understanding.

7.1.5 Access of plant genetic resource from other countries during last 10 years

Presently, adequate access to rice plant genetic resource is available through various programmes such as IRRI coordinated International Network for Genetic Evaluation of Rice (INGER) nursery programme to support our agriculture, food security and development goals. However, access to plant genetic resources of other crops such as vegetable field crops and fruit crops is not adequate. A total of 954 accessions of different crops/species were received by Sri Lanka from different countries such as Philippines (450), Australia (06), Taiwan (56), India (401), Japan (19), Maxico (15), and Other (07). during last 10 years to use as germplasm. (Source: Sri Lanka PGRC data base & FCRDI, Maha Illuppallama).

7.1.6 Restricted access to plant genetic resource

Most of the plant genetic resources in Sri Lanka are available for exchange on mutually/bi-laterally agreed basis. However, a few native/indigenous plant genetic resources such as cinnamon are not permitted to be exported even under available agreements for exchange.

7.2 Fair and equitable sharing of the benefits of the use of plant genetic resource

Sri Lanka is getting benefited by using plant genetic resources in many ways. Development of varieties with high yield, increased resistance to pest and diseases and environmental stresses and better quality are some direct benefits. Increased average yield and farmer income are major indirect benefits. For an example, average yield of rice increased by 15 % during last 10 years. Presently, in Sri Lanka there is no direct benefit sharing system but most of the farmers are indirectly benefited by availability of newly developed high yielding and disease resistant varieties for their use. However, there is no system for us to pay any incentives or share profit with other party or country for utilizing their plant genetic resources. Breeding activities in Sri Lanka are mainly done by government owned research stations and the outcome as varieties are becoming available in the public domains. However, with the implementation of proposed PBR act, it will be possible and necessary to bring relevant provisions to implement a mechanism to share the results of research and development and the benefits arising from the commercial utilization of plant genetic resources with the contracting party and with the farmers if their varieties have been used.

7.3 Implementation of farmers' rights

We have clearly understood the importance of safeguarding farmers' rights in access to germplasm, but so far we have not subscribed to any international agreements in this regard. However, presently we are preparing the draft act for the protection of new plant varieties (Breeder rights) in which we have suggested following to safeguard farmers rights for their contribution by maintaining required land races or genetic materials to utilize for breeding purposes.

1. To allow farmers to use sow, re-sow, exchange, share or sell their farm produce including seed of a variety protected under the proposed act, but not as "branded seed"
2. To disclose the information in the application for Plant Variety Protection, when a breeder is using any genetic material conserved by a farmer or a farmer group for developing a new variety.

7.4 Financing Plant Genetic Resources activities

Presently over 90% of the financing for PGR activities in Sri Lanka is by the government of Sri Lanka and projects such as "Sri Lanka - USA cooperative germplasm development programme" and: *In situ* conservation of crop wild relatives through enhanced information management and field application" are contributing for the balance.

CHAPTER 8

THE CONTRIBUTION OF PGRFA MANAGEMENT TO FOOD SECURITY AND SUSTAINABLE DEVELOPMENT

Plant Genetic Resources (PGRs) consist of a diversity of the genetic material contained in traditional varieties, landraces, advanced breeding lines, primitive cultivars and modern cultivars grown by farmers and wild relatives of crops and other wild plant species. These PGRs are the biological basis of the world food security, and support the sustenance of people on earth. These resources serve as the most important raw materials for plant breeders, and the most essential input of the farmers. The erosion of the genetic resources experienced in the past pose a threat to the world's food security in the long run, and hence, there is a growing interest in protecting the plant genetic diversity as an irreplaceable asset, which needs to be managed to meet the challenges in the unpredictable future. The varied eco-geographical conditions, combined with a long established agricultural production systems have contributed to the evolution of the Sri Lanka's rich biodiversity and plant genetic resources which is subjected to various threats. This chapter addresses the contribution of PGRs and its management in food security, alleviating poverty and economic development and sustainable agricultural development.

8.1 Formal Management of Genetic Resources

Management of genetic resources include several steps such as exploration of collection, characterization, evaluation, conservation, documentation and database development and management, and finally their sustainable utilization. In Sri Lanka, these events mainly take place through the PGRC of DOA at Gannoruwa, Peradeniya. However, other institutes such as CRI, TRI, RRI, SRI, Department of Export Agricultural Crops, VRI, BMARI, are also involved in the management of respective genetic resources. If properly managed, these precious genetic resources will never be depleted. However, in reality, the erosion of the plant genetic resources is a common phenomenon. There is also a scarcity of documented information on the non-formal collection and management of PGR by farmers and NGOs.

8.2 Plant Genetic Resources and Sustainable Agricultural Development

Agricultural growth is a pre-requisite in most countries to achieve overall economic growth. Major advances in plant breeding, based on an increased use of plant genetic resources, will continue to be a pre-requisite to achieve increase in food production necessary to feed the rapidly growing world population. The agricultural sector in many low income countries such as Sri Lanka is large, neglecting its adverse affect on the rest of the economy. Better use of plant genetic diversity will be required in order to produce varieties adapted to the adverse environments of the low productivity areas. With the need to combine productivity with sustainability, and the concomitant pressures to reduce the use of agrochemicals and improve the efficiency of utilization of limited water and nutrient resources, there is likely to be an increased reliance on the diversity found in high productivity areas. In this respect, plant genetic resources play two important areas:

1. as resources, genes and genotypes are valued for the particular characteristics they provide including agronomic characteristics such as pest resistance, drought tolerance, and plant stature providing important characteristics to all modern varieties; and
2. genetic resources per se are important because they provide insurance against future uncertainties, thus providing stability to farming systems at the local, national and global levels.

However, throughout the world the diversity of agroecosystems is being rapidly eroded due to the neglect of indigenous knowledge, institutions and management systems, promotion of monoculture systems and uniform technologies, the quest of the transnational corporations that marketing agricultural inputs and processed food and fibres for commercial profits and control over production, inequitable access to and control over land, water, trees and genetic resources on the part of local people, market pressures and the undervaluation of agricultural biodiversity, and demographic factors. In addressing the requirements for both conservation and development, it is clear therefore, that ways must be found to allow agricultural development while conserving diversity.

8.3 Plant Genetic Resources and Food security

Agricultural production and productivity is linked to genetic resources and food and nutritional security (in case of cereals, pulses, root and tuber crops, horticultural crops etc.). However, without a strategy to combat rural poverty, increasing total food production per se would not be adequate. In this regard, investment in agriculture is a proven way of not only improving food supply and nutritional status, but also of alleviating poverty of some of the poorest groups of the world. Areas of highest rural poverty often coincide with areas of great crop genetic diversity. Where possible, efforts to combat poverty should aim to exploit this diversity in local production systems, while maintaining resources of global significance. The available germplasm can be incorporated into the diverse ecosystems based on their adaptability, and also in attempts to diversify the farming strategies in the agroecosystems. The long-term nutritional security, health, income and cultural identity of communities in the region depend on conserving and making the most of these differences. This diversity should overcome current production problems and new ones as they arise in the future, and thus ensure the sustainability of agricultural production to safeguard food and nutritional security.

8.4 Plant Genetic Resources and Alleviating Poverty

As stated earlier, better use of plant genetic resources is critical to meet the challenges of increasing food production and alleviate poverty. All countries depend on plant genetic resources originating beyond their borders, thus indicating that international cooperation is essential to secure continued access to these resources. International agreements are also necessary to guarantee their conservation. Both aims can be achieved only if there is an effective mechanism for sharing benefits with the countries that maintain these resources to alleviate poverty.

8.5 Plant Genetic Resources for Economic Development

Knowledge in genetic resources could enhance economic development in several areas including sustainable land use, economics and trade, quarantine and regulatory strategies as well as public health and tourism. There are several opportunities and uses that could provide major developmental interventions via PGRs. The importance of these resources to the economy, the basis of and source of livelihood for most of the country's people as well as being a source of substantial foreign exchange, cannot be underestimated. The use of PGR in the field of medicine and public health, is probably placed at the highest profile. Knowledge of those plants of medicinal importance plays a major role in generating revenue and in some cases earning foreign exchange for the traditional leaders or the governments for rural development. Novel approaches to develop medicinal products through sustainable utilization of the PGRs, and the use of PGR in crop improvement and product development activities and in bioremediation and environmental pollution control would add to the economic benefits of this precious natural resource bases found in the country. Through these activities, formation of small and medium scale enterprises (SMEs) by organizing the farming communities and approaching the niche markets in the region would no doubt be a booster for national development.

8.6 Needs

Gap Identification, cooperation among Countries, capacity building on sustainable management of genetic resources, the effective implementation of relevant parts of the International Conventions and Treaties, mechanisms to use the existing Plant Genetic Resources, prioritization of highly impacted species for conservation and utilization, regional Collaboration

on Improvement of germplasm, evaluation of collected germplasm for improved productivity, development of bio-prospecting protocols, and education and training on PGRs have been identified as needs to achieve food security, poverty alleviation, and sustainable economic and agricultural development in Sri Lanka using PGRs.