

GENETIC CONSERVATION AND OUR FOOD SUPPLY

The Problem

Over the last several decades, Sri Lanka has made a sustained effort to achieve self sufficiency in rice and to increase the output of other food crops. Opening of new land, provision of irrigation, mechanisation of agricultural operations, introduction of high yielding varieties, artificial fertilizers, agro-chemicals etc. have been the means used to achieve these objectives.

In spite of a significant increase in output, none of these measures have come anywhere near the establishment of national food security. On the contrary, with the recent removal of subsidies on fertilizer, the trend in production appears to have been reversed. Therefore, it is necessary to analyse the reasons for this state of affairs with a view of locating feasible options.

Rationale

In natural eco systems, risks are minimised and uncertainties countered through biological diversity.

In man made agro-eco systems, the productive cultivars are unable to withstand changing environmental pressures due to the thin elasticity of cultivated genetic diversity.

Today, we have reached the saturation point in the exploitation of available resources such as land. Therefore, it is not possible for us to increase food production through the familiar methods adopted so far.

Solution

From the above facts, it will be seen that the key to national food security lies in the promotion of ecological security.

In natural eco-systems ecological security is achieved through biological diversity. Therefore, it is reasonable to conclude that if an agricultural system is to be sustainable, it should mimick natural systems as far as possible.

We have seen that the major characteristic of natural eco-systems which ensures their survival is genetic diversity - a feature that tends to decrease in man made systems. Although hybridisation and genetic recombination increase biological diversity in such systems, a negative impact is exerted through features such as genetic erosion, genetic vulnerability and genetic wipe out. In contrast to natural systems, the second group of features produce more powerful, more adverse effects than the first in man made systems.

Therefore, it is evident that a long term sustainable system of agriculture could be built mainly through the establishment of genetic diversity in cultivated crops.

The achievement of such an objective depends on the availability of suitable germplasm that can produce the greatest yield with the smallest amount of land and energy. At the same time it is necessary to devise ecologically sound methods of deployment of germplasm.

Assurance

Repeated use of select cultivars by breeders in their attempts to secure high yields tends to narrow the genetic base of such cultivars and thereby increase genetic vulnerability.

Therefore, if genetic diversity is to be assured, cultivars of different genotypes should be replaced frequently. Such a step would prevent the build up of pests capable of attacking specific, but widely grown uniform cultivars.

Application of this principle requires a reserve of genes and the desired features of this pool of material can be transferred to uniform genotypes with beneficial results. Appropriate technology for this task has already been developed.

The use of heterogenous cultivars and the cultivation of different species are normal features in small home gardens. Systems such as these also help to preserve genetic diversity.

Through these methods, genetic diversity over time and space can be assured and utilised to bring about a significant improvement in the yield of cultivated crops.

Protecting an Invaluable Heritage **- Conservation of Forest Genetic Resources in Sri Lanka**

Where the Real Wealth is

Tropical forests are the richest, the most complex and diverse ecosystems in the world. They are store houses of a fantastic array of genetic resources with unlimited potential. In this sense, Sri Lanka's forests are the most invaluable natural heritage we possess. Priceless nature of our forests can be well understood if we consider the fact that out of the 3360 species of flowering plants in Sri Lanka, around 24% are endemic to this country. Therefore, the indiscriminate removal of forest cover can lead to serious environmental and ecological problems in Sri Lanka, through the loss of genetic diversity and the consequent extinction of many valuable species.

The Threat

Unfortunately, over the last several decades our forests have been exposed to a serious threat of rapid depletion. Between the years 1956 and 1985 Sri Lanka lost 1.15 million hectares of forest cover. The average annual deforestation in this country has been estimated at 42,000 hectares.

The main reason for deforestation is the pressure of population growth and the resultant demand for new lands for agriculture, village expansion, development, establishment of export crops and so on.

Although with the completion of the Mahaweli scheme and due to the efforts of the Forest Department, the rate of deforestation has been

reduced to a great extent, so long as population is on the increase, we cannot expect a fall in demand for new land.

The Need

In the context of the above scenario there is a need to maintain sufficient forest cover and to manage it on a sustainable basis. Therefore, Sri Lanka's national forest policy has been formulated with the following objectives.

- (a) To maintain conserve and create forests for preservation and amelioration of the environment, soil and water resources, and for the protection of the local fauna and flora when they are required for aesthetic, scientific, historical and socio-economic reasons.
- (b) To ensure and increase, as far as possible the supplies of small wood for agricultural requirements and fuel wood for domestic consumption.
- (c) To maintain as far as possible, a sustained yield of timber and other forest produce for general housing, industrial, communication and defence requirements of the country.
- (d) To work the forest to the highest possible economic advantage as in consistent with the foregoing objectives.
- (e) To involve the local community in the development of private woodlots and forestry farms through a programme of a Social Forestry.

To achieve these policy objectives, the Forest Department has already created the necessary organisational structure and is launching very comprehensive programmes of action covering the

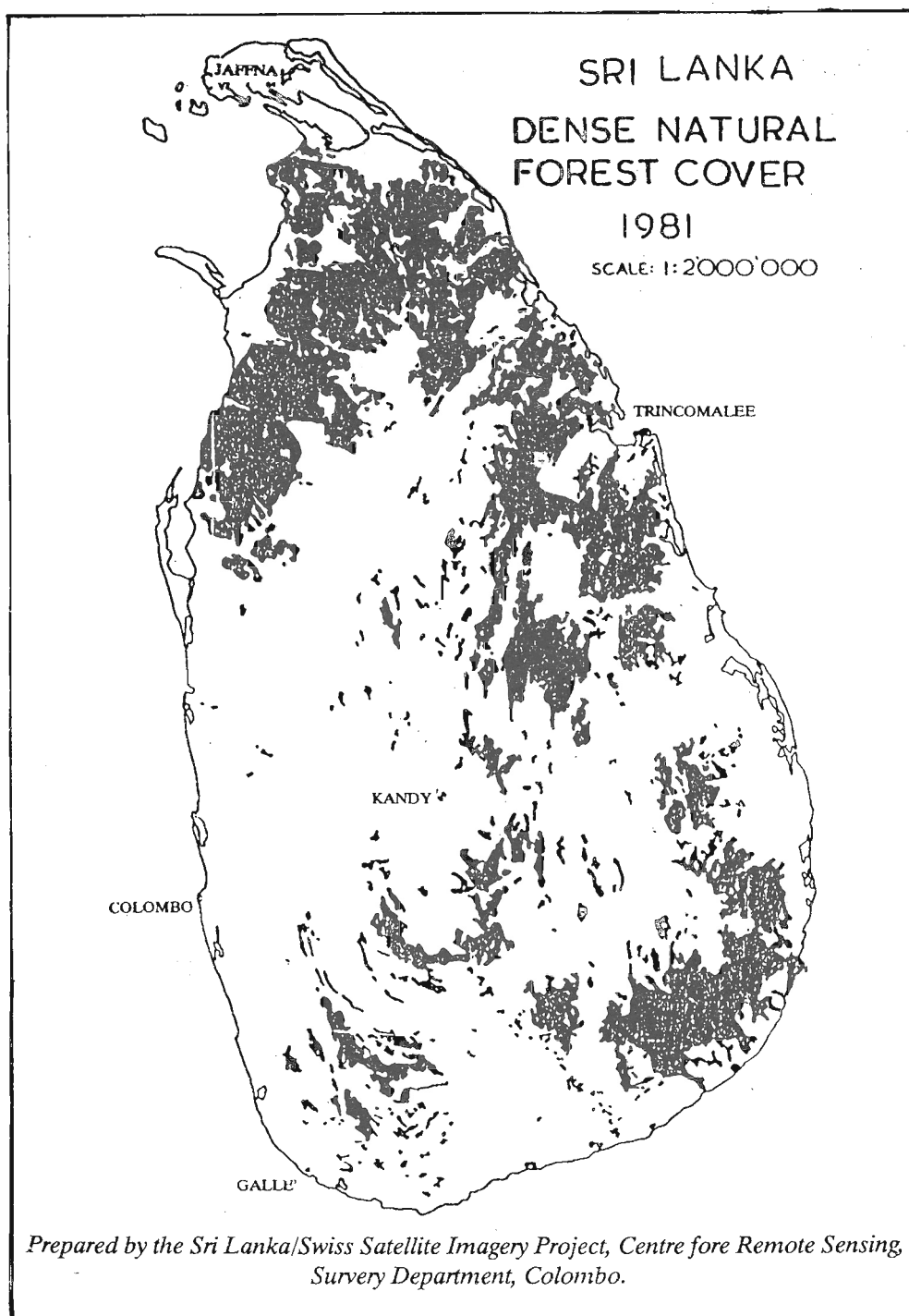


Figure 1: A reduction of the Forest Cover Map to the scale of 1:2,000,000
(original scale - 1:5,000,000).

fields of intensive forest management, forestry research, reforestation and afforestation, forest protection, forest conservation, agroforestry and participatory forestry.

Protection for Plant Life

Conservation of forests implies their management in such a way so as to ensure their greatest sustainable benefit to present generations and maintain their potential for the future generations.

One of the methods adopted for this purpose is the "in situ" conservation of forests. By this term we mean the maintenance of samples of forests in their natural environment. This is an ideal method of conservation for a range of species found in tropical rain forests of Sri Lanka because of the complexity and inter-dependence of species in these forest eco-systems. Such protected areas (for both forest and wild life) are selected on the basis of their characteristics in the natural undisturbed state. They are either rich in species or contain many endemic species. Sinharaja bio sphere reserve, Horton Plains nature reserve and Peak Wilderness sanctuary are examples for in situ conservation.

Protection for Wild Life

Protected areas coming under the jurisdiction of the Department of Wild Life comprise four types: Natural parks, Strict Natural Reserves, Nature Reserves and Jungle Corridors. There are 65 protected areas coming under these types covering a total of 780,920 hectares. This amounts to 12% of the total land area of the country or 32% of the total forest area. (See table below).

TABLE 1 : Extent of National Reserves and Sanctuaries in Sri Lanka

Category	Number	Extent(ha)
1. National Parks	11	459570
2. Strict Natural Reserves	3	31587
3. Nature Reserves	2	32562
4. Jungle Corridor	1	10364
5. Intermediate Zone	0	-
6. Sanctuaries	48	246837
7. Total extent of National Reserves and Sanctuaries		780920
8. As a percentage of total forest area of the country		32%
9. As a percentage of total land area of the country		12%

Source: Department of Wildlife Conservation

Protection for Environment

In recognition of the role played by forests in the conservation of natural environment, the UNESCO launched the International Biological Programme in 1969, with the objective of bringing about rational use and conservation of the environment. In 1970, it was renamed Man and Biosphere Programme.

Under the auspices of this programme, a sectional committee was formed in Sri Lanka and it decided to demarcate 50 acres in each forest in the main bio climatic zones and to exclude them from any form of timber exploitation. The chain of forests was extended and today there are 47 forests covering a total of nearly 120,000 hectares. (See table below).

TABLE 2 : Man and Biosphere (MAB) Reserves in Sri Lanka

Bioclimatic Zone	Number	Extent(ha.)
Low country Wet Zone	14	19170
Up country Wet Zone	10	25037
Intermediate Zones	6	1170
Dry Zone	17	74505
Total	47	119882

Issues and Problems

There are several issues that needs to be addressed in conservation of forest genetic resources in Sri Lanka which are briefly discussed here.

1. Selective Logging

In the low country wet zone, almost all the Forest Reserves, Proposed Forest Reserves and other state forests have been selectively logged at least in part to meet the timber requirements of the country. Although it is done on scientific lines in order to achieve a sustained yield and cause minimum damage to the existing vegetation, it has been observed that a considerable amount of damage is caused to certain species of flora and their regeneration. However, selective logging has been identified as one of the major causes of the biological degradation of forests, particularly in the low country wet zone of Sri Lanka.

11. Conversion of Forests for Other Land Uses

With the rapid increase of population in the country demand of forest land for other uses such as agriculture, urban and village expansion etc., was increased and large tracts of forest areas were released and converted to other land uses. The forest area so far cleared for Mahaweli Development Scheme alone is around 80000 ha. Large areas of natural forests in the low country wet zone were

converted to other land uses under various development schemes. Several decades ago, there was a category of forests maintained in the whole country called "village forests", but now, these forests have practically disappeared due to land alienation, encroachments and shifting cultivation.

Inland marsh forests of the lowland wet zone, which have associations of plant species exclusive to them, have almost completely disappeared as they are ideal sites for paddy cultivation (Gunatilleke, 1985). The mangrove forests which are confined to the coastal belt and river estuaries have been heavily degraded due to land reclamation, agriculture, construction of prawn hatcheries, collection of firewood etc. Another important change in land use which causes biological degradation of natural forests in the wet zone is cultivation of cardamoms under the natural forest canopy. Cardamoms have been cultivated under the natural forest cover in the Knuckles and Rakwana Deniyaya ranges.

111. Lack of Staff and Training Facilities

The total strength of the Forest Department is only 825 officials for protection of 1.86 million ha. of forests, and for other activities such as reforestation, extension forest inventory, management, research etc. The present staff availability in the Forest Department is totally inadequate for satisfactory protection of forest resources for their biological value. Lack of training facilities particularly for the field staff of the Department of Wildlife Conservation is another serious constraint in the management of National Parks and other Wildlife Reserves.

IV. Shifting Cultivation

Shifting cultivation is an important factor for causing forest degradation in the whole country. Past assessments indicate that shifting cultivation is one of the major causative factors for deforestation in Sri Lanka.

V. Lack of Awareness of the Biological and Environmental Importance of Natural Forests

Biological importance of natural forests, their potential for medicinal plants, food and agricultural species, their influence on the environment etc. are not properly understood by the public. To the general public, conservation seldom appears to offer immediate benefits. It is very important that decision makers should be familiar with the interests of conservation and they should be aware of environmental and genetic benefits which can be derived from the protected forest areas.

VI. Lack of Understanding of Biological Importance of Natural Forests

The full potential of the species in our natural forests for medicine, food, horticulture etc. is still not completely understood.

VII. Review of the Present Network of Protected Areas

In view of the present rate of degradation and loss of forest cover, it is necessary to review the present status and the network of protected areas in the country. A series of protected areas should be established to cover the whole range of variations of tropical ecosystems and the genetic resources of species of socio-economic value. A few examples of such ecosystems are: Mangrove forests, Savannah forests, Patana grasslands etc.

Steps in the Right Direction

The primary objective of forest management is to maintain and conserve forests for preservation and amelioration of the environment, conservation of soil and water resources and for the protection of local fauna and flora while maintaining a sustained yield of timber and other forest products. Keeping this objective in mind the Forest Department and

Forestry Section Development Project are adopting the following strategies for conservation of natural forests in Sri Lanka:

1. Master Plan for Forestry Sector Development

The Forestry Master Plan was prepared by the Forest Resources Development Project with assistance from the World Bank in 1986. The operational goal of the Master

Plan takes into account the production aim, protection and conservation aim, social and economic aims.

11. Conservation Review

At later stages some of the original recommendations of the Forestry Master Plan were considered environmentally damaging, particularly with respect to conservation of genetic resources. To overcome this problem the government has now decided to review the Forest Management Plans in the Wet Zone forests in order to identify areas of importance to maintain biological diversity and endemism. Such areas will be excluded from any form of logging and maintained under protection in order to preserve genetic resources of the natural forests in the Wet Zone.

111. Environmental Management in Forestry

Another important step towards the conservation of Forest Genetic Resources is the decision to incorporate an Environmental Management component within the Forestry Sector Development Project under which a separate division to be formed within the Forest Department. The primary objective of setting up this Environmental Management Division is to ensure that all conservation issues, including the maintenance of biological diversity are adequately addressed in all forest related planning and management activities carried out by the Forest Department,

Department of Wildlife Conservation, State Timber Corporation and other agencies (IUCN, 1989).

IV. National Conservation Strategy

National Conservation Strategy for Sri Lanka prepared in 1988 on the directive of His Excellency the President, has examined the rapid depletion of natural resources in Sri Lanka. It has recommended to cease the haphazard alienation of natural forests in the country and also future alienation must be subject to evaluation by the (proposed) National Land Use Authority.

V. Environmental Impact Assessment

As natural resources are exploited with increasing severity, National Conservation Strategy recommends and it is also included in the National Environmental Act that all development programmes must be subject to Environmental Impact Assessment (EIA). In future, all forestry projects including Forestry Sector Development Project will be subject to Environmental Impact Assessment prior to Project approval and this will be a safeguard for adverse environmental consequences if there is any.

VI. Establishment of Forest Plantations

Establishment of forest plantations is done in order to meet the deficit of industrial and fuelwood in the country. It has been proposed to raise some 150,000 ha. of forest plantations before the year 2000 and this could supply considerable amount of wood to cover the deficit in order to minimize the exploitation of natural forests.

VII. Participatory Forestry

Greater participation of local communities in the development and implementation of

forestry activities through programmes of social forestry are anticipated. Local community involvement and consultation through village organisations, socio-economic surveys etc. is being done in the process of planning and decision making in conservation forestry programme.

1X. Environmental Education and Awareness Programmes

Environmental education and awareness programmes are being conducted by the Forest Department for the public and school children.

X. Expansion of Research Activities

Forestry research activities should be expanded to cover all the important fields of forestry research including conservation research. These research activities could be carried out by a number of institutions such as Forest Department, Department of Wildlife Conservation, Universities etc. under national programmes on internationally co-ordinated programmes such as Man and Biosphere (MAB) programme.

RECOMMENDATIONS FOR IMPLEMENTATION

- i. The areas identified from the conservation review, for conservation of forest genetic resources should be included under MAB programme.
- ii. The present network of MAB reserves in the country should be reviewed in order to cover the whole range of variations of ecosystems and genetic resources of species of socio-economic value.
- iii. MAB reserves should be given legal recognition and legislation should be made to prohibit felling and exploitation and release of these lands under any circumstances other than by an Act of Parliament.

- iv. Advantage should be taken of those occasions when public comes into contact with nature. Extension materials and sign boards etc. should be available in National Parks, some MAB resources such as Singharaja, Botanical Gardens and Zoological Gardens etc. to explain conservation objectives and their contribution to human survival and wellbeing.

Providing a Safe Haven

"Botanic Gardens and Ex-situ Conservation"

The Ideal and the Reality

High plant diversity is a unique feature in the tropics. It is at its most complex level in tropical areas and decreases gradually with increasing latitudes. Among the tropical forests too, diversity is also high on lateritic soils where sub optimal conditions exist.

Plant diversity is a major foundation for the evolution and maintenance of animal diversity. Thus, the conservation of plant and animal life 'in situ' (on the actual location) is definitely the ideal policy to be followed in genetic conservation.

However, in practice, there are serious constraints that limit the widespread implementation of such a policy and a multi faceted approach is needed for effective results. Today, a considerable body of knowledge and expertise has been built with regard to genetic conservation. The international organisations involved in this field concentrate their attention on high priority species and it is assumed that "the responsibility for the genetic conservation of the gene pools of the thousands of wild species that are endangered, are of local economic potential such as medicinal and aromatic, or are of ecological importance or of scientific interest, rests with the botanic gardens community. It is here that botanic gardens must play a role."

What is a Botanic Garden?

A Botanic garden is a place where plants are grown for scientific or botanical research, education, exhibition and recreation.

The aspect of exhibition and recreation are also embodied in public parks. They are not botanic gardens! Scientific research and education are similarly found in research and breeding collections. They are also not botanic gardens. Botanic gardens serve a searching scientist, a dreaming artist, a romantic couple and children with equal facility and intensity.

Thus, it will be seen that a botanic garden combines many functions. It is this very combination which makes them a powerful tool in conservation.

Botanic Gardens in the Past

The earliest known botanic gardens were from Europe. During 16th and 17th centuries they were Physic Gardens or Medicinal Gardens often attached to faculties of medicine. The first of such a garden was in Pisa (1543) in Italy. There were many similar gardens later established in France, Switzerland, England, Germany and Holland.

18th Century showed a change with the introduction of a system of plant classification. Most botanic gardens became institutions of plant exploration, classification and collections and a large number of important herbaria were developed. This was associated with the development of colonies. Professional taxonomy was a major theme in the 18th and 19th centuries. These centuries can be considered as the era of flora.

In Sri Lanka

Botanic gardens in Sri Lanka were originally established in Colombo and were shifted to

Agalawatta after a few years. It came to stay in Peradeniya in 1821. Hakgala was established in 1861 and Henerathgoda in 1876. Two other botanic gardens were established in Anuradhapura in 1833 and Badulla 1886. Their role was to explore the local flora, introduce new plant species suitable and useful to the economy, environment and beautification of the island. As a result all the main economic crops were introduced to Sri Lanka by the botanic gardens.

Cinchona	- 1861
Tea	- 1868
Rubber	- 1876
Cocoa	- 19th century
Spices	- 20th century
Floricultural crops	- 20th century

Changing Role

Over the years, botanic gardens in the world grew in numbers, size, collections, visitors and so on. Sri Lanka was no exception. It is estimated that over a million people visit botanic gardens in Sri Lanka. Worldwide, the number of visitors is estimated to be over 100 million.

Along with this, there also came a slow expansion of the nature and functions of the botanic gardens. From being mere collections of plants, they began to get involved in agriculture, forestry and such related subjects. Increasing activities in these activities, led to the creation of specialised institutions in many fields. Thus, in Sri Lanka, the Forest Department was established in 1887 and the Department of Agriculture in 1912. However, the botanic gardens continue to work in their own specialised fields of research.

The vast knowledge and experience gathered by botanic gardens in the world have been put to good use on an international level. For example, the first international discussion on vanishing flora were held in Paris (1923) and the second in 1931. An important decision arrived here was that:

"Rare or endemic plants threatened with extinction should be cultivated and placed in reserve in Botanic Gardens."

Many congresses followed and the concern for plant conservation involving botanic gardens was becoming a key issue. Numerous conferences were held and many papers have been written.

One of the important conferences held in USSR in 1975 where 26 countries participated came up with the following recommendations:

The botanic gardens all over the world should:

- intensify their studies of the biology and ecology of rare and disappearing species of plants, both in the field and in cultivation;
- develop methods for and take a leading role in cultivating rare species;
- in combination with studies of local floras, protect vulnerable habitats; and
- develop, by all possible means, conservation awareness of the public.

Similar conferences were held in the years that followed;

e.g. 1975 & 1978 at the Royal Botanic Gardens, Kew, England. In 1980, World Conservation Strategy was published by the IUCN.

In 1985 one of the most important commitments was made by the WWF/IUCN/FAO/UNESCO and UNEP. More than 200 experts from 39 countries, students and other participants interested in plants and botanic gardens were at this congress. Some important recommendations were made as a result of this congress.

The Present Task

Recommendations made by the congress of 1985 elucidate the task expected of botanic gardens. A

summary of these recommendations and decisions as applicable to Sri Lanka is given below:

1. Activates Ex-situ Conservation Activities

It is beyond the capacity of botanic gardens to maintain in their living collections extensive populations as gene pools. This has to be done in-situ. Therefore, the botanic gardens must get involved in ex-situ conservation of plant species. Along these lines many plant species were found as last surviving members at botanic gardens. At present a centre for threatened plants of Sri Lanka has been established in botanic gardens Peradeniya

whose role is to collect data for ex-situ cultivation of plants.

2. Spreading the Message

Use the millions of visitors to botanical gardens to look into the botanical shop window and deliver the message on the importance of conservation of plants; and to conduct educational programmes.

3. Building the Capacity to Conserve

This is done by the staff involved in botanic gardens developing capabilities and giving

TABLE 1: NUMBERS OF SPECIES IN THE MAJOR PLANT GROUPS

Kingdom	Division	Common name/ examples	Approx. no. of species
Monera		Bacteria	2500 archaeobacteria prob. 200 cyanobacteria
Fungi		Fungi	100,000
Protista	Rhodophyta	Red algae	4000
	Phaeophyta	Brown algae	1500
	Chlorophyta	Green algae	7000
	Chrysophyta	Chrysophytes, diatoms	6650
	Pyrrhophyta	Dinoflagellates	1100
	Others	Water moulds, slime moulds	1800
Plantae	Bryophyta	Liverworts, mosses, hornworts	16000 6000 liverworts 100 hornworts
			9500 mosses
	Psilopsida	Psilopsids	Several
	Lycophyta	Clubmosses	1000
	Sphenophyta	Horsetails	30
	Pteridophyta	Ferns	12,000
	Coniferophyta	Conifers	550
	Cycadophyta	Cycads	100
	Ginkgophyta	Ginkgo	1
	Gnetophyta	Gnetophytes, Gnetum	70
	Anthophyta	Flowering Plants	235,000 - 250, 000

knowledge to students and the public. Both in-house development and extension activities are in progress.

4. Conserving Wild Plants of Economic Use

Recognition of wild relatives and their distributions. Preservation in gene banks and in seed storage activities.

CONCLUSION

The challenge of the future before us can be stated in a simple - single sentence:

WE JUST DO NOT KNOW THE MAGNITUDE OF BIOLOGICAL HERITAGE WHICH IT IS OUR RESPONSIBILITY TO SAFEGUARD.