No. 4

BASIC DESIGN STUDY REPORT ON THE RESEARCH INFRASTRUCTURE DEVELOPMENT PROJECT FOR PRESERVATION AND UTILIZATION OF PLANT GENETIC RESOURCES IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

NOVEMBER 1986

JAPAN INTERNATIONAL COOPERATION AGENCY

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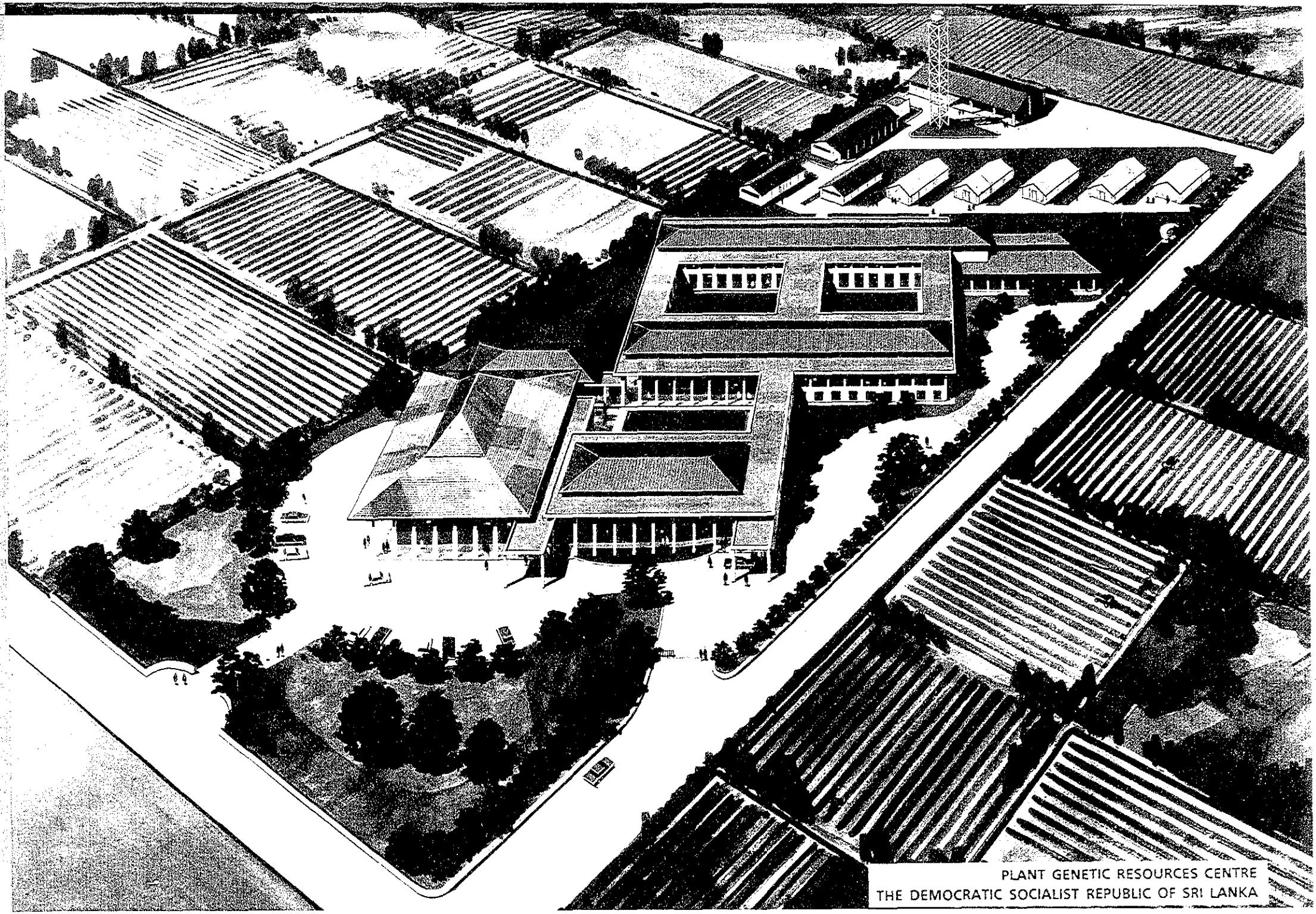


PLANT GENETIC RESOURCES CENTRE
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

PREFACE

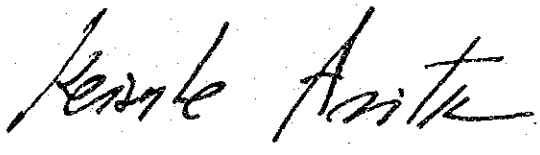
In response to the request of the Government of the Democratic Socialist Republic of Sri Lanka, the Government of Japan has decided to conduct a basic design study on the Research Infrastructure Development Project for Preservation and Utilization of Plant Genetic Resources and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Sri Lanka a study team headed by Dr. Hiroshi Ikehashi, Genetic Resources Information Officer, National Institute of Agrobiological Resources, Ministry of Agriculture, Forestry and Fisheries, from 26th July to 14th August, 1986.

The team had discussions on the Project with the officials concerned of the Government of the Democratic Socialist Republic of Sri Lanka and conducted a field survey in the Kandy area. After the team returned to Japan, further studies were made, a draft report was prepared and, for explanation and discussion of it, a mission headed by Mr. Yoshihide Teranishi, First Basic Design Study Division, Grant Aid Planning and Survey Department, JICA, was sent to Sri Lanka from 28th October to 6th November, 1986. As a result, the present report has been prepared.

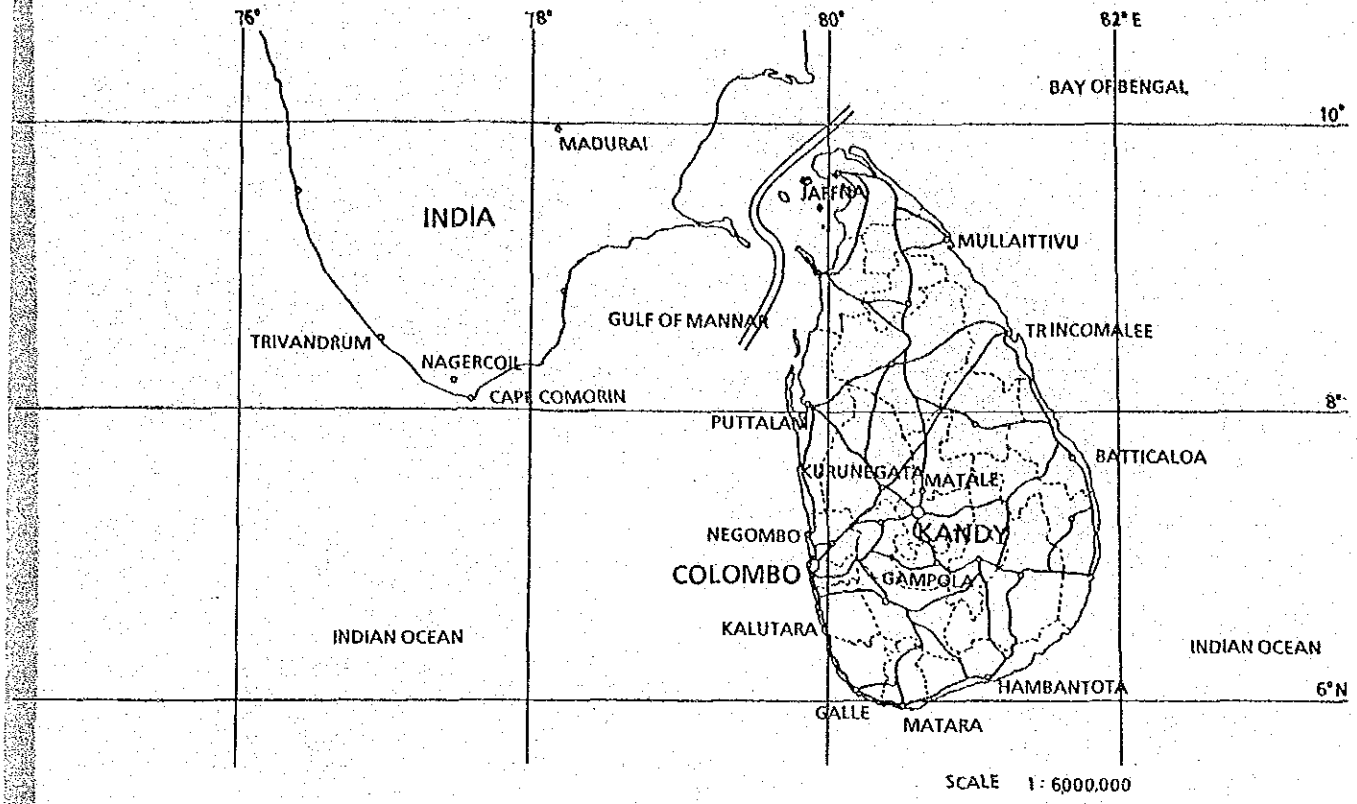
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Democratic Socialist Republic of Sri Lanka for their close cooperation extended to the team

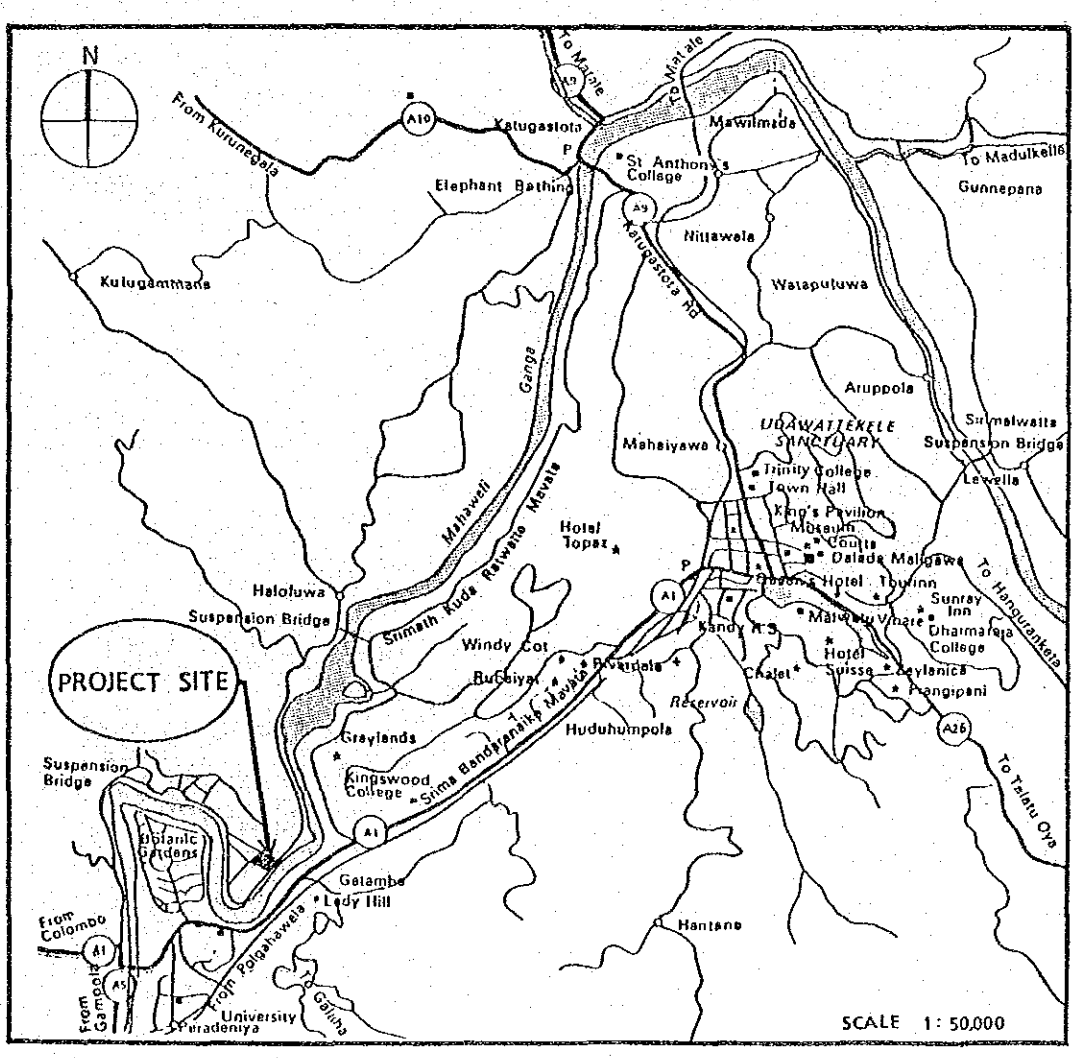
November, 1986



Keisuke Arita
President
Japan International Cooperation Agency



MAP OF SRI LANKA



MAP OF KANDY

SUMMARY

Agriculture occupies an important position among the various fields of economic activities. Thus, the Government of Sri Lanka's policy is to continue to further promote the expansion of agricultural production.

Sri Lanka, because of its diverse climatic and topographic conditions, has many varieties of flora ranging from tropical to temperate. These, coupled with its long history of crop cultivation, have brought to Sri Lanka an abundance of plant genetic resources including not only locally adapted native breeds but wild type or weed type crop species.

The pursuit of high yielding varieties of genetic uniformity based on the policy of increasing rice and other food crop production, however, has expelled locally adapted native breeds and replaced the old varieties with new ones all at once with remarkable speed which has resulted in narrowing the genetic base of many crop species. In addition, the reclamation and development of new farmland is causing the loss of genetic resources, such as the perishing of wild species and allied species. For the development of new varieties which the country must undertake in order to promote expansion of agricultural production, the development of an organized system to urgently collect and preserve useful domestic plant genetic resources which are disappearing from the country and to evaluate and utilize them as breeding materials is an urgent task.

In view of the circumstances, the Government of Sri Lanka has planned to establish a plant genetic resources centre for such purposes as storage and evaluation of plant genetic resources of food crops (such as rice, coarse grains, pulse crops, root and tubers, vegetables, and fruit trees) and development of technology including biotechnology as the means for breeding, and has requested the Government of Japan for its grant aid for the provision of relevant facilities and equipment necessary for research and also for subsequent technical cooperation.

In response to this request, the Government of Japan has dispatched preliminary study teams on grant aid cooperation and technical

cooperation, on whose recommendations it has decided to conduct a basic design study for this project. The Japan International Cooperation Agency dispatched its basic design study team to Sri Lanka from July 26 to August 14, 1986.

The team discussed the contents requested by the Government of Sri Lanka with the concerned authorities in Sri Lanka, and reconnoitred the proposed construction site, investigated the conditions of relevant infrastructure and circumstances of construction work, collected necessary data and materials.

Upon reviewing the survey findings and analyzing the information and data since then, draft report on the project describing the basic design of facilities and equipment, maintenance plan, etc. has been compiled, and a team for a basic design confirmation and follow-up study was dispatched to explain the said draft report from October 28 to November 6, 1986.

The purpose of this project is to establish a Plant Genetic Resources Centre (to be abbreviated as PGRC) for exploration, collection, preservation, multiplication, distribution, evaluation and data management of plant genetic resources of rice, coarse grains, pulse crops, root and tubers, fruit trees and others, to secure and preserve plant genetic resources in Sri Lanka and utilize them for the promotion of crop improvement programmes. As a national centre of plant genetic resources management and research in Sri Lanka, the proposed Centre is expected to push forward joint and collaborative activities with the Department of Agriculture and other departments of the Ministry of Agricultural Development and Research and research institutes of other Ministries and universities.

The proposed project site is located at Peradeniya, Gannorwa which is adjacent to Kandy, the country's old capital in the centre of Sri Lanka. It is situated in the central highland zone about 500 m in elevation and is about 120 km northeast of Colombo.

The site is a flat land of about 25,000 m^2 within the premises of the Central Agricultural Research Institute (CARI) of the Research Division, the Department of Agriculture, the Ministry of Agricultural Development and Research, and is now used as a experimental field of CARI. As for infrastructure, electricity and telephone can be easily led in, but water supply and drainage facilities must be constructed anew on the site.

The facilities under this project consist of laboratory buildings including storage facilities for seeds, administration building, outdoor field-related facilities building and utilities buildings. As for experimental fields, about 0.5 ha for exclusive use of this Centre and about 2 ha for joint use with CARI will be allocated out of existing fields.

The scale of overall facilities and outline of equipment established under the basic design are as follows.

1. Scale of facilities

   (1) Laboratory building: Consists of seed storage facilities, laboratories for preservation, exploration and collection, evaluation, vegetatively propagated plants, data management, development, etc. .....3,553 m^2

   (2) Administration building: Consists of Director's room, administration office, specimen exhibition corner, conference hall, etc. .....1,741 m^2

   (3) Outdoor field-related facilities building: Consists of a field management building, workshop building, screen houses, etc. .....1,026 m^2

   (4) Utilities building: Consists of electric facilities building, pump house, etc. .....203 m^2

   Total 6,523 m^2

2. Equipment

   (1) Equipment for storing plant genetic resources

   (2) Equipment for carrying out exploration, collection, seed storage, clonal preservation, evaluation and data management

(3) Equipment for test cultivation and regeneration of plant genetic resources collected

(4) Equipment for promotion and administration or research activities

The project cost to be borne by the Government of Sri Lanka necessary for implementation of leading -in work of electricity and telephone, outdoor structure construction, landscaping work, and procurement of furniture, etc. is estimated to be about Rs. 2.9 million.

The period necessary for the implementation of this project is considered to be 24 months after the exchange of official notes between the two governments, consisting of four months for basic design, two months for tendering and contracting, and 18 months for construction.

The executing agency of the Government of Sri Lanka responsible for this project is the Department of Agriculture, the Ministry of Agricultural Development and Research.

The annual administration and maintenance expenses of the facilities under this project are assumed to be about Rs. 4.7 million for manpower costs and about Rs. 2.1 million for the operation and maintenance of facilities and equipment.

The implementation of this project will enable Sri Lanka to systematically preserve its valuable plant genetic resources which are gradually being lost, and through effective utilization of these resources, to develop crop breeding programmes which play quite an important role in agricultural production. Also, in the longer range, the improvement in agricultural productivity brought about by the development of new varieties will, in turn, bring about such benefits as stable supply of food and expansion of agricultural product exports.

In view of the effects of this project on the Sri Lankan side as above, this project is considered most benefitting as an object of Japan's grant aid cooperation.

Since the Government of Sri Lanka is fully aware of the significance of this project and has already arranged for implementation and operation of this project, its early implementation is earnestly desired.

In order to ensure effective functioning and operation of the facilities and equipment to be provided under this project, the establishment of a system for administration and research, a system for operation and maintenance, and improvement of research techniques under the technical cooperation of Japan are desired.

Abbreviation

ADA	Agricultural Development Agency
ADR	Ministry of Agricultural Development and Research
APCC	Asian and Pacific Coconut Community
CARI	Central Agricultural Research Institute
CRBS	Central Rice Breeding Station
DA	Department of Agriculture
DMEC	Department of Minor Export Crops
E.O.	Experimental Officer
FAO	Food and Agriculture Organization of United Nation
IBPGR	International Board of Plant Genetic Resources
ICAR	Indian Council for Agricultural Research
IDRC	International Development Research Centre
IITA	International Institute of Tropical Agriculture
IRRI	International Rice Research Institute
IWI	International Winged-bean Institute
MCI	Ministry of Coconut Industries
MFP	Ministry of Finance and Planning
MLLD	Ministry of Lands and Land Development
MPI	Ministry of Plantation Industries
M Plan I	Ministry of Plan Implementation
MRD	Ministry for Regional Development
NIPM	National Institute of Plantation Management
PGIA	Postgraduate Institute of Agriculture, University of Peradeniya
PGRC	Plant Genetic Resources Centre
R.A.	Research Assistant
RARC	Regional Agricultural Research Centre
R.O.	Research Officer
RRI	Rubber Research Institute
RTWG	Regional Technical Working Group
SPC	State Plantations Corporation
SRI	Sugarcane Research Institute
TRI	Tea Research Institute
UNDP	United Nations Development Programme
UPFA	Faculty of Agriculture, University of Peradeniya
USAID	United States Agency for International Development

CONTENTS

CHAPTER 1
INTRODUCTION

CHAPTER 1 INTRODUCTION

1. Circumstances which led to the present request

Sri Lanka is a tropical island located at the southern tip of the Indian sub-continent. It covers a land area of 65.61 thousand km^2 and is an island that abounds in plant resources.

Its population as of 1983 is about 15.6 million. Among its various economic activities, the agricultural sector accounts for 27% of GNP, 58% of total exports and 45% of the total employed population, thus constituting an important sector even from the national viewpoint. Breeding and spreading of high yielding varieties of rice have made progress under government leadership to the extent that lately supply has finally come to satisfy demand. However, another serious food shortage is foreseeable when the demand for rice in 1991 is forecast on the assumption of a population growth of 2.6% per annum. Being an island where civilization had flourished since ancient times, already about 44.7% of its land is planted with short-lived food crops and such perrenial crops as tea, rubber and coconuts. The room for a crop production brought from new farmland developed is being decreased year by year.

In view of the foregoing situation, the government of Sri Lanka positions the expansion of agricultural production as an important economic policy and adopts the policy of aggressively extending the fruits of breeding efforts, that is, the development of new varieties, as one of the major driving forces for promoting agricultural production. For attaining this purpose, the government of Sri Lanka is planning to establish a new plant genetic resources centre for collection and preservation of useful domestic plant genetic resources, which are gradually being lost, in order to evaluate and utilize them as breeding materials, and has requested the Government of Japan to provide its grant aid and technical cooperation in implementing such a plan.

The natural features of Sri Lanka are consisted of its complex distribution of rainfalls and raining pattern and the diversity of soil

distribution which are due to its climatic and topographic conditions. These natural features have endowed Sri Lanka with a wide variety of flora ranging from the typically tropical to the temperate and this, coupled with its long history in crop cultivation, has helped bring about an abundance of crop genetic resources, including not only the locally adapted indigenous species but the wild type or the weed type species as well.

It may be claimed that local breeds of traditional field crops generated as above are not the cultivated crop species in the modern sense but including many genetic deversities . It was not only the variations among crop species but the genetic variations within species as described above which had played an important role until modern methods of cultivating food crops began to be adopted in Sri Lanka. Population growth, however, has pressured Sri Lanka into relying even more heavily on high yielding crop varieties, and the spread of modern agriculture has expelled the locally adapted native breeds. The replacement of old varieties with new ones has resulted in a narrowing of the genetic base of many crop species. Particularly the introduction of disease resistant genes by reverse crossing or otherwise has evidently caused the common genetic composition to be used in many varieties. Such a modern breeding method and selection criterion that pursue high yielding ability and uniformity have decreased the genetic variations of crops and lowered the compensating ability of crops against obstacles, and resulted in inviting genetic vulnerability. In addition, the development of new farming land is causing vanishment of genetic resources through loss of wild species and allied species, and it is possible that it will eventually bring about a tragic situation in which potentially useful genetic resources would have already been lost by the time any sophisticated technology improvement may be made by the employment of biotechnological and other advanced methods.

With plant genetic resources undergoing serious damages today as described above, the conservation of genetic resources looms as an urgent task, and the establishment of a base to tackle with it on a nationwide scale is urgently desired.

2. Dispatching of a preliminary study team

In response to the request of the Government of Sri Lanka, the Government of Japan decided to conduct a preliminary study on grant aid cooperation for "The Research Infrastructure Development Project for Preservation and Utilization of Plant Genetic Resources" and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to the Democratic Socialist Republic of Sri Lanka, the team headed by Dr. Shinji Watanabe, Chief, Germplasm Seed Storage Centre, National Institute of Agro-Biological Resources, Ministry of Agriculture, Forestry and Fisheries, Japan, from March 31 to April 13, 1986. Successively, a preliminary study team on technical cooperation headed by Dr. Watanabe was dispatched from July 5 to July 12, 1986. Both teams have conducted the field study and have discussed their respective cooperation.

The preliminary study team on grant aid cooperation has, as a result of discussion with the concerned authorities of Sri Lanka, recognized the need to establish research facilities on plant genetic resources along with the plant genetic resources storage at Gannorwa, Kandy District, the Democratic Socialist Republic of Sri Lanka, and the preliminary study team on technical cooperation has conferred with the Sri Lankan side on basic matters concerning dispatching of experts and contents of cooperation to be extended.

The basic matters agreed upon by and between the preliminary study team on grant aid cooperation and the Ministry of Agricultural Development and Research as a result of detailed review of the contents and scale of this project have been summarized as the Minutes of Discussions dated April 10, 1986. (Refer to Appendix I Data 3.1)

The basic matters agreed upon concerning technical cooperation have been summarized as the Minutes of Discussions dated July 10, 1986. (Refer to Appendix I Data 3.2)

3. Dispatching of a basic design study team

On the basis of the study results of the preliminary study team, the Government of Japan has dispatched a basic design study team headed by Dr. Hiroshi Ikehashi, Genetic Resources Coordinator, National Institute of Agro-biological Resources, the Ministry of Agriculture, Forestry and Fisheries from July 26 through August 14, 1986.

The purpose of dispatching said study team was to review the propriety of this project and to conduct surveys necessary for drafting an appropriate basic design for the plant genetic resources storage and the facilities and equipment for research on genetic resources.

The team, upon investigating the background of this project and the state of various activities concerning plant genetic resources, has evaluated the role of this project and its degree of contribution to society. It has also discussed in detail the contents of research facilities and equipment based on the preliminary studies with the researchers of each respective field of the Department of Agriculture, Ministry of Agricultural Development and Research which is the prospective Sri Lankan counterpart, and also reviewed the organizational arrangements for project execution and for maintenance and operation of facilities, including the works to be undertaken by the Sri Lankan side, with the Director of the Department of Agriculture, who is the officer responsible for project implementation on the Sri Lankan side, and other officers concerned.

Upon reviewing the foregoing survey findings and analyzing the information and data, the study team has confirmed this project to be necessary from the standpoint of Sri Lanka's agricultural development policy, and the Department of Agriculture to be the pertinent executing agency for implementing said project.

The results of discussions have been summarized as the Minutes of Discussions dated August 4, 1986 and signed and confirmed by and between

Dr. Hiroshi Ikehashi, Team Leader and Mr. N.V.K.K. Weragoda, Secretary, Ministry of Agricultural Development and Research. (Refer to Appendix I, 3.3)

As a result of analyses and study based on the findings of the field survey since then, a draft report on basic design study has been compiled, and a team led by Mr. Yoshihide Teranishi, First Basic Design Study Division, Grant Aid Planning and Survey Department of Japan International Cooperation Agency was dispatched to Sri Lanka from October 28 to November 6, 1986 to explain the said draft report and to discuss same with the concerned authorities in Sri Lanka. The basic matters confirmed by both parties have been summarized as the Minutes of Discussions dated November 4, 1986. (Refer to Appendix I, 3.4)

This report describes the basic design of facilities and equipment, business funds, performing process, evaluation of the project, recommendation, etc. which are believed to be optimum for implementing this project.

The members of this study team, the Sri Lankan personnel who have cooperated in the survey, and the minutes of the discussions held are respectively shown in Apendix I, 1.

CHAPTER 2
BACKGROUND

CHAPTER 2 BACKGROUND

2-1 General Conditions of Agriculture

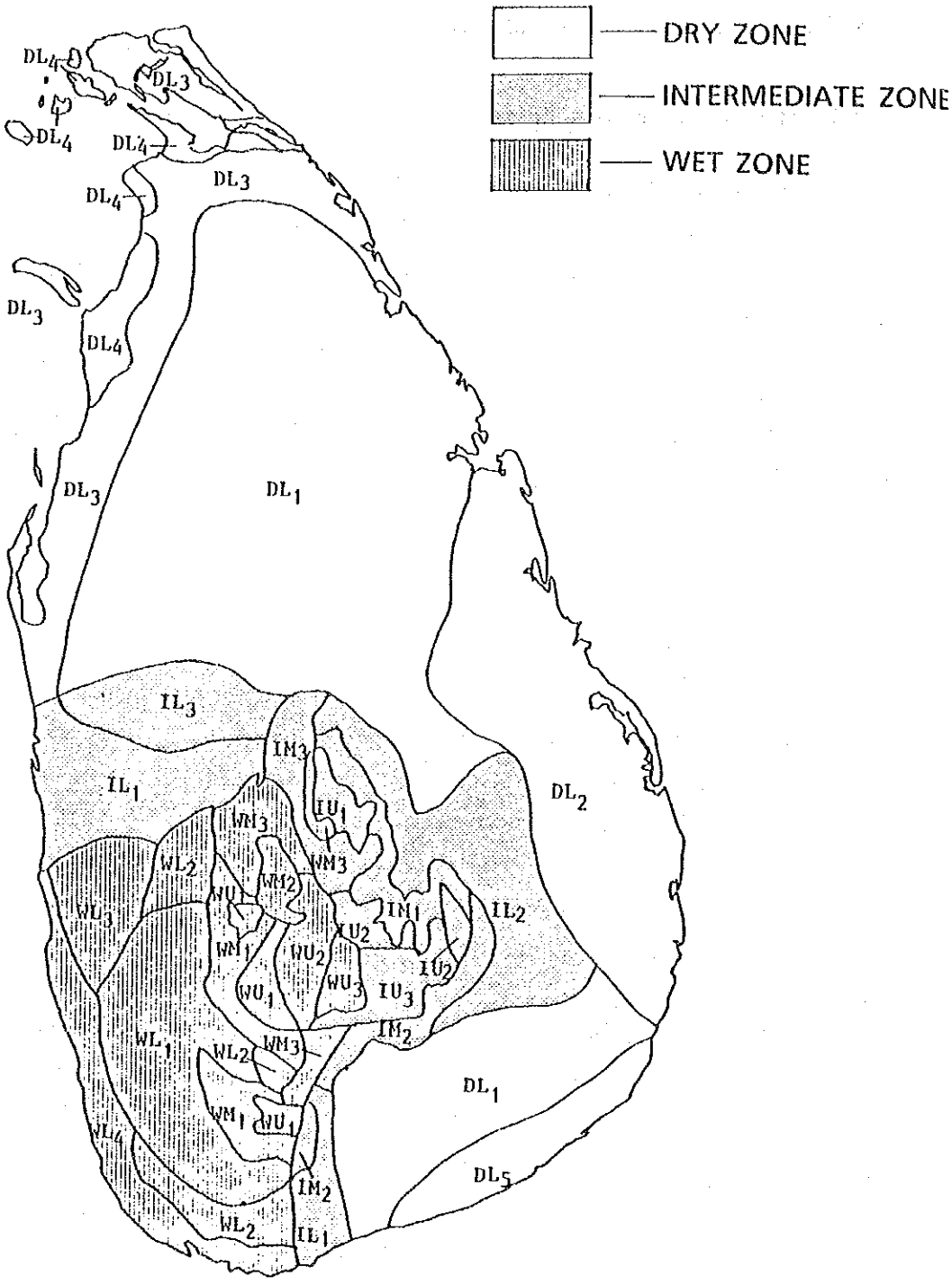
2-1-1 The Position of agriculture in the economy

Sri Lanka is a tropical island country, situated between 5°5' and 9°50' of North Latitude and between 79°42' and 81°5' of East Longitude on the Indian Ocean. Its population is about 15.6 million (in 1984), and the population density, 241 persons/km^2.

Sri Lanka belongs to the southwestern Asian monsoon zone, and has two monsoon seasons. The southwesterly monsoon prevails during April through October, and the northwesterly monsoon during November through March.

The country, when classified by the amount of rainfall, can be broadly divided into the wet zone which lies in the southwestern part of the island having one rainy season during the southwestern monsoon (annual rainfall is between 2,300mm and 5,100mm), the intermediate zone which has two rainy seasons in a year (annual rainfall is between 1.500mm and 2,300mm) and the arid zone where the only rainfall is brought about by the northeasterly monsoon (annual rainfall is between 890mm and 1,500mm). Elevation above sea level varies between 0m and 2,500m, and as the soil structure comprises a mosaic pattern (consisting of nine sections including Red-brown earth, Red-yellow latosol, Regosol in the lowland arid zone, Red-yellow Podsols in the lowland wet zone, Red-brown latosol, Brown loam and Low humic gley in the highland) an abundance of plant ecosystems exist. The country is divided into 24 agricultural production sections. (Refer to Fig. 2-1)

Fig. 2-1 Agro-Ecological Regions of Sri Lanka



The annual growth rate of the Sri Lankan economy between 1978 and 1985 was 5.8% on average, or twice as fast as the growth of the preceding eight year period (1970-1977). The prime movers of this growth were such sectors as services (tourism, banking and insurance), building construction, mining, quarrying, manufacturing and, above all, agriculture. (Refer to Appendix III Data 2)

The shares of each industry in GDP, the preliminary estimate of which for Fiscal 1985 was 144.0 billion rupees were 46.7% for services, 30.3% for agriculture, 10.7% for manufacturing, 7.8% for construction, 4.4% for tea, rubber and coconut processing and 2.3% for mining and quarrying. (Refer to Appendix III Data 1)

Now for the shares of each industry in export and import. Of the preliminary estimate of total exports amounting to 40.79 billion rupees in Fiscal 1985, the agricultural sector accounted for an overwhelming share of 53.7%), followed by industrial products (petroleum products, textile products, etc.) which accounted for 39.5% and gems for 2.5%. In imports, the agricultural sector accounted for 13.7%, consisting of agricultural products such as rice, wheat, and sugar which accounted for 10.9% and fertilizers for another 2.8%, while general consumer goods accounted for 40.8%, crude oils for 20.0% and capital goods for 19.0%, and others for the balance. (Refer to Appendix III Data 10)

A review of the employed population by occupation indicates that 45.8% of the total are engaged in agriculture, forestry and fisheries by which it can be rightly claimed that agriculture is the key industry of Sri Lanka. (Refer to Appendix Data 5)

On the other hand, the Sri Lankan economy is still predisposed to depending heavily on exports of its three major agricultural products, namely, black tea, rubber and coconut (which collectively accounted for approximately 48% of total exports in Fiscal 1985), and its structural improvement is strongly sought in the light of the recent stagnation of the international market for agricultural products.

2-1-2 Agriculture production

Sri Lanka has a total land area of 65.61 thousand km^2, of which farmland accounts for 44.7% (2,944 thousand ha). (Refer to Appendix III Data 19)

Sri Lanka's major agricultural products are rice, and black tea, rubber and coconut which are also its three big export crops. Cultivated land area and production of major agricultural crops are shown in Table 2-1, and their general situations are described in the following. (Refer to Table 2-1)

Table 2-1 Crop Cultivated Area and Production in Sri Lanka (1982 – 1983)

Crop	Cultivated Area (Ha)	Production (M/T)
Paddy	856,665	2,580,346
Tea	242,130	179,287
Rubber	205,640	39,997
Coconut	451,472	22,362 Mn.nut
Chili	26,582	28,179
Red onion	11,416	132,260
Sorghum	18,640	12,865
Maize	470,40	51,268
Cow Pea	45,606	40,290
Blackgram	17,476	12,897
Greengram	26,759	20,484
Peanut	15,177	20,099
Sesame	35,770	27,863
Soyabean	12,889	8,657
Manioc	44,853	717,846
Sweet potato	9,630	86,366
Potato	5,712	71,637

Remarks: *Tea, rubber and coconut are indicated the produced figures in 1983.
*Cultivated area of coconut is estimated from the figure of sensus in 1973.

Sources: Stastical Pocket Book of the Democratic Socialist Republic of Sri Lanka.

1) Rice

As shown in Data 12, the cultivated area for rice, assuming that it was 100 in 1970, increased by about 8.5% to 108.5 in 1983 while the yield per unit area during the same period also exhibited a jump of 36.9%, resulting in a 53% increase in rice production. This growth is attributable to the expansion of irrigated land area and improvement in rice varieties. (Refer to Appendix III Data 12)

The domestic demand and supply of rice is reported to have approximately balanced as of 1983, but when assuming a population growth rate of 2.6% a year, an eventual shortage of rice supply seems inevitable. (Refer to Appendix III Data 22)

2) Major agricultural products for export (black tea, rubber, and coconut)

As shown in Data 23, planted areas of black tea and coconut remain almost stable, whereas the planted area of rubber indicates a slightly decreasing tendency. (Refer to Appendix III Data 23)

3) Sugar

As can be seen from Data 15, the planted area of sugar cane which in 1980 reached a peak of 6,000 ha declined to 4,500 ha by 1985, lowering the production volume also from 23 thousand tons in 1980 to 19 thousand tons. Unit yield however exhibited a slightly rising trend during the period. (Refer to Appendix III Data 15)

4) Other export crops

Although data on planted area are unavailable, export volumes of pepper, cinnamon and coffee are on an increasing trend whereas clove and betel nut are on a declining trend. (See Appendix III Data 16)

5) Other crops

As shown on Appendix III Data 25, production quantities of pulse crops (cow pea, green gram, peanut, etc.) and maize exhibit a rising trend. (Refer to Appendix III Data 25)

According to Data 26, the planted areas of red onion and potato are on the rise whereas the planted areas of red pepper, cassava and sweet potato are on a declining trend. (Refer to Appendix III Data 26)

2-1-3 Agriculture policy and direction of agricultural research efforts

2-1-3-1 Agricultural policy

According to "Public Investment, 1986-1990" issued by the Ministry of Finance and Planning, the agricultural sector earns about 28% of GNP and 60% of export revenues and accounts for 45% of total employment; and the Ministry has drawn up a budgeting plan of spending 42.3% of the total national budget on the agricultural sector for Fiscal 1985. The Government of Sri Lanka considers the agricultural sector to be the key industrial sector even during the 1986-1990 period and anticipates its growth at 3.5% per annum. The following are the Government's national targets for the agricultural sector.

(I) Optimum production of basic food items: rice, milk, sugar, fish and pulses, in order to achieve a high degree of self-reliance in food supply, thereby providing greater food security and improving the nutritional status of the population;
(II) Expansion and diversification of agricultural export earnings;
(III) Increasing income levels and employment opportunities in rural areas.

The following may be enumerated as concrete policy goals.

(1) Establishment of a stable supply and demand system for rice

Sri Lanka is said to have at last balanced the supply and demand situation on rice which is due to its having expanded the cultivated area of rice and having increased the yield per unit area. (Refer to Appendix III Data 21)

In order to cope with the anticipated population expansion and anomalies in the weather, it is necessary that improvements be made in rice varieties through breeding and also in cultivating techniques.

(2) Establishment of a self-sustaining system for sugar

The volume of sugar imported during Fiscal 1985 was 363 thousand tons, and domestic sugar consumption is increasing yearly. The domestic production of sugar, on the other hand, after peaking at 237 thousand tons in 1981, has slowly declined ever since, and in Fiscal 1985 it supplied only 33% of total demand. Establishment of self-support system for sugar, through varietal improvement of sugar cane, etc, is urgently required. (Refer to Appendix III Data 15)

(3) Envigoration of major agricultural products for export (black tea, rubber, and coconut)

The export volume of coconut is increasing, but exports of black tea and rubber are declining yearly due to the emergence of competing countries and the sluggish international market prices.

Inasmuch as the export revenues of these major agricultural products have accounted for 48% of Sri Lanka's total amount of exports in Fiscal 1985, the envigoration of this sector is considered to be indispensable for the Sri Lankan economy. (Refer to Appendix III Data 16)

(4) Growing of other agricultural products for export

Sri Lanka's other agricultural products for export which accounted for a mere 6% of total export value in Fiscal 1985 should be expanded as it is the sector that is likely lead to the stabilization of the Sri Lankan

economy. Some of those promising agricultural products are cinnamon, spices and cashew nuts. (Refer to Appendix III Data 14)

(5) Reduction of imported agricultural products

The three items of rice, wheat and sugar which collectively account for 81% of imported agricultural products in terms of monetary value are the cause of the outflow of the nation's precious foreign currency. Onion, red pepper and pulses also respectively account for much smaller shares of 10.0%, 3.3% and 1.7% of imported agricultural products. It is necessary to curtail the outflow of precious foreign currency through improving the self-support ratio of those importing agricultural commodities. (Refer to Appendix III Data 17)

(6) Increased production of milk

Very little milk is consumed in Sri Lanka, but in order to improve the physique and nutritive condition of its people, the production of milk must be increased.

As above, the Government of Sri Lanka is orienting the agricultural sector to emerge from the so-called monoculture system (black tea, rubber, coconut) following conquered the item (1) to (6) mentioned above and is aiming to establish self-supporting systems for rice, sugar and pulse crops and also to develop other minor crops as a means to earn foreign currency all in the hope of stabilizing its foreign currency earning position through diversification of crops and envigorating the rural regions due to increase income and opportunity of employment.

2-1-3-2 Direction of agricultural research efforts

In promoting the above described agricultural policy, the Government of Sri Lanka has announced the policy to emphasize the strengthening of agricultural research coupled with the inducement of an agricultural credit system and an emphasis on agricultural guidance. The following describes the directions of specific researches that are desirable for

each crop, pointing out in the National Agriculture, Food and Nutrition Strategy published by the Ministry of Finance and Planning in 1984.

a) Rice: Breeding of pest and disease resisting varieties, research on varieties adapted to diverse eco-edaphic and other environmental conditions

b) Sugar cane: Expansion of sugar cane varieties, establishment of self-sufficiency in sugar by determining areas suitable for cultivation

c) Other export crops: Varietal improvement, improvement in cultivation and post-harvest techniques, etc.

d) Other dry field crops: Research on cultivation management, etc.

e) Fruit trees: Quality improvement, cultivation management techniques, varietal improvement

f) Vegetables: Development of insect resisting varieties, research on local adaptability, etc.

g) Coconut: Research on fertilizer responsiveness, excellent seeds, etc.; development of new processed products.

h) Rubber: Research on plant body suitable for cultivation by small farmers

i) Animal husbandry: Development of animal feed resources, etc.

Under Sri Lanka's research system , the agriculture related research institutes belong to a number of ministries which prevents communication between relevant researchers and administrators. The need to establish an agricultural research policy council and the like to coordinate common problems has been pointed out, the realization of which is greatly desired.

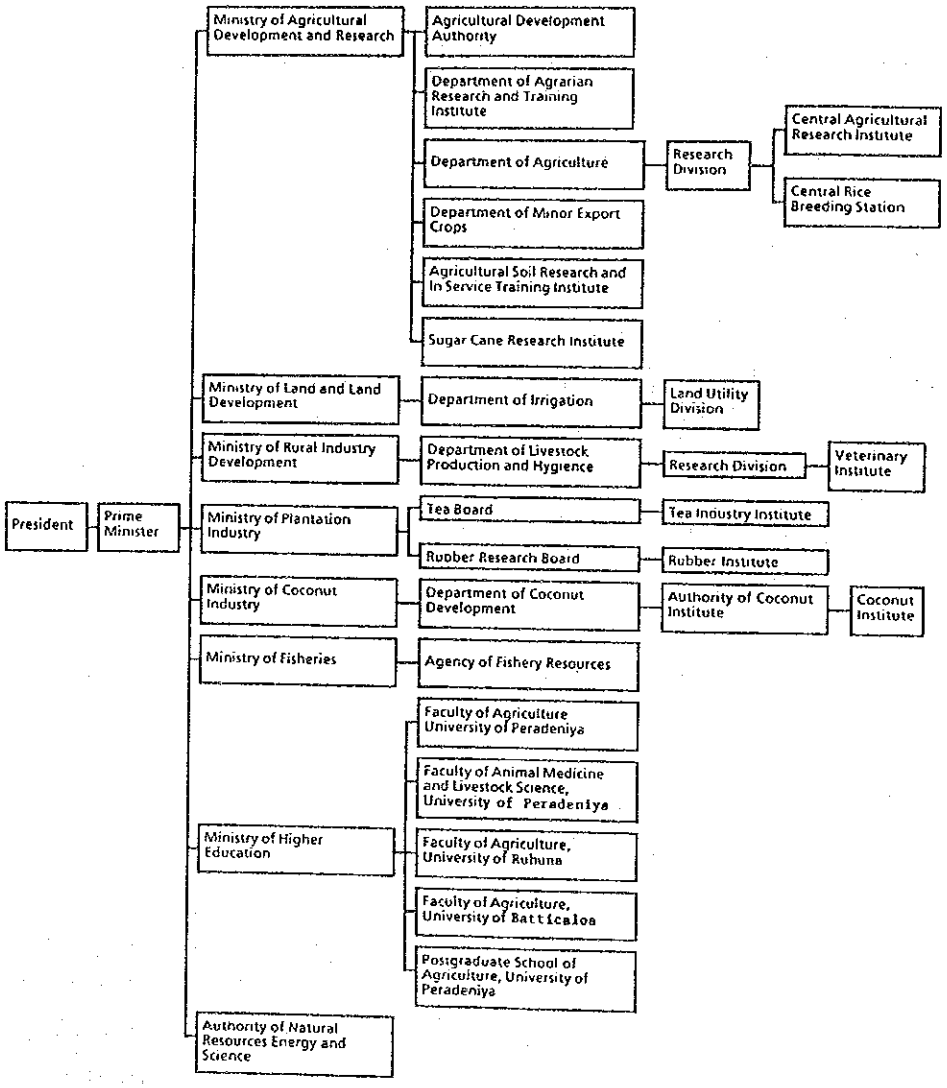
2-2 Agricultural Research Activities in Sri Lanka

2-2-1 Organizational setup for conducting agricultural research

2-2-1-1 Outline of the research organization

Research in agricultural fields is conducted by eight different ministries (including one authority) under which are 20 institutes . Those institutes are summarized in the figure below.

Fig. 2-2 Agricultural Related Ministries and Institutes in Sri Lanka



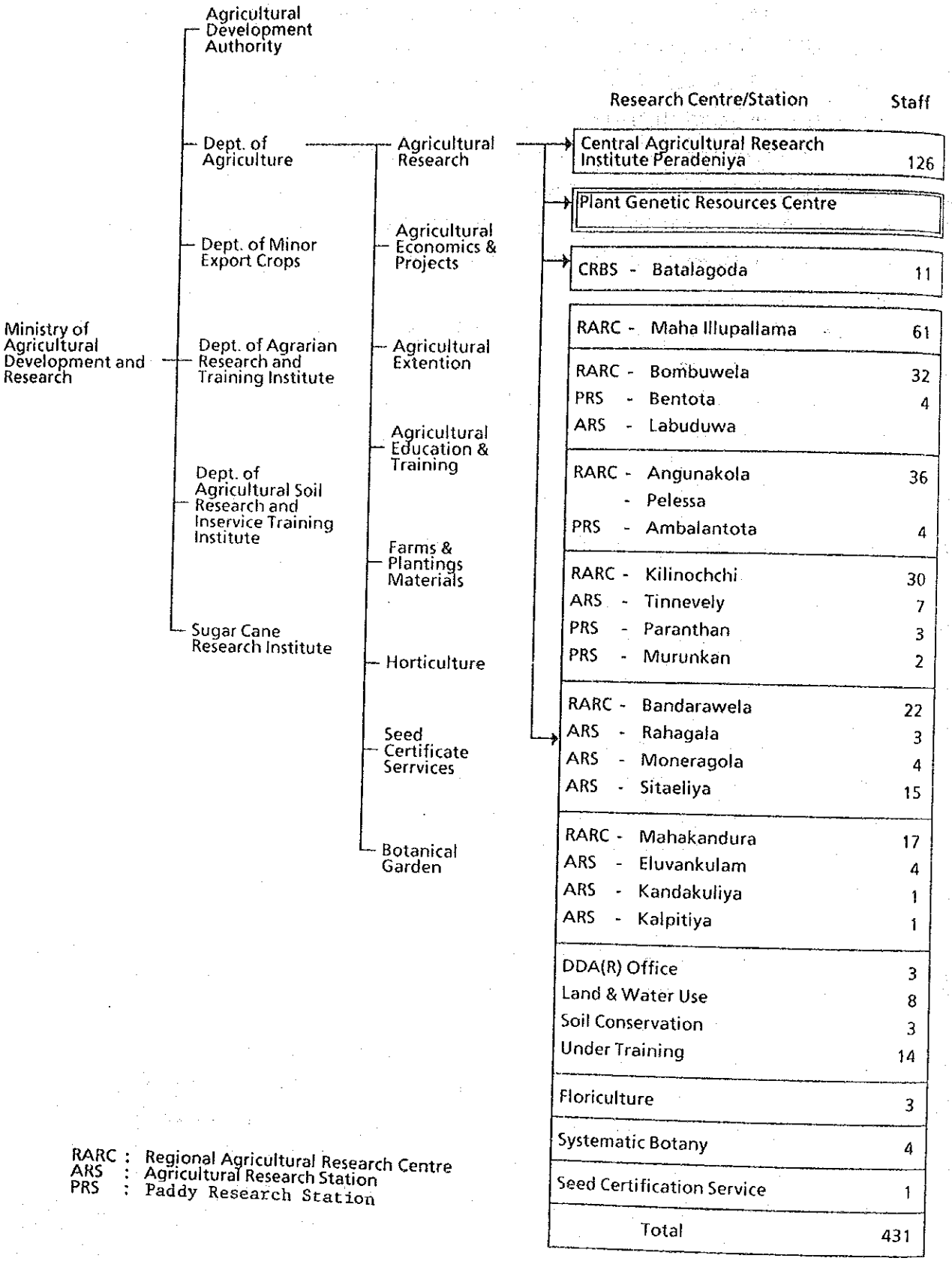
Of these, the Ministry of Agricultural Development and Research is responsible for research, technological development and extension services to farmers on food crops other than tea, rubber and coconut, and plays the leading role in agricultural research in Sri Lanka. The research activities of the Ministry are carried out at the Central Agricultural Research Institute, the Central Rice Breeding Station and eight Regional Agricultural Research Centres, all of which belong to the Agricultural Research Division of the Department of Agriculture. Research activities in their respective specialized fields are also carried out by the Sugar Cane Research Institute, the Department of Minor Export Crops, and the Agricultural Soil Research and In Service-Training Institute, each under the direct control of the Ministry. (Refer to Fig. 2-3)

2-2-1-2 Status of researchers

The number of researchers related to agriculture, including those related to forestry and fisheries, has increased notably in the last ten years from 109 in 1970 to 506 in 1983.

The breakdown of these 506 researchers of agriculture-related research institutes as of 1983 by academic background is 78 PhDs, 153 Masters and 275 university graduates (Refer to Appendix III Data 27). Of these, those who were in the Research Division of Department of Agriculture were 29 PhDs, 74 Masters and 155 university graduates, totalling 258. That post-graduates account of 39.9% of the total speaks for the fact that high level personnel and researchers have been assigned to this Division. At present, the Research Division of the Department of Agriculture alone has a staff of 420 persons including 305 researchers and 115 research assistants, which it plans to increase to 577 researchers and 160 research assistants by 1990 (Refer to Appendix III Data 28). As the required manpower for PGRC is also incorporated in this plan, the incremental personnel would be sought either by relocating the personnel from other research institutes of the Department of Agriculture or by recruiting new personnel.

Fig. 2-3 Organization Chart of Ministry of Agricultural Development & Research



RARC : Regional Agricultural Research Centre
ARS : Agricultural Research Station
PRS : Paddy Research Station

The researchers of the Research Divison of the Department of Agriculture are now classified into senior researchers (Research Officers - RO), researchers (Experimental Officers - EO) and research assistants (RA), but according to the policy of the Government announced this year, no one will be hired as an EO from now on, and even the personnel presently ranked as EO will be ranked as RO two years from now.

2-2-1-3 Status of securing budgetary appropriations

A review of the budge plan for fiscal 1985 indicates that of the 22,810 million rupees of Sri Lanka's national budget, 35.85% (7,880 million rupees) was invested in the agriculture-related sectors including fisheries, live-stock farming and forestry. Also, of the 10,292 million rupees of foreign aid during the same year, 66.7% (6,886 million rupees) was invested in the agricultural sector. (Refer to Appendix III Data 7) Accordingly, the gross investment in the agricultural sector in fiscal 1985 reached 14,746 million rupees.

Of these, a total of 1,049 million rupees including foreign aid was appropriated as the budget related to the Ministry of Agricultural Development and Research. This was equivalent to 7.1% of the agriculture-related budget.

A review of the research expenses related to agriculture including forestry and fisheries indicates that in fiscal 1983, the budget of 128.9 million rupees was spent. This was equivalent to 0.55% of GDP. Expenditures per researcher have been decreasing every year lately due to the fact that the growth of budget allocation has continued to underrun that of the number of researchers. In fiscal 1983, the research expenditures per researcher was 245 thousand rupees compared to 351 thousand rupees in fiscal 1980. (Refer to Data 29.)

2-2-1-4 Object crops of research by the Department of Agriculture and its activities

The department of Agriculture is headquartered in the City of Kandy in Kandy Province located about 110 km inland of Colombo, and is responsible for research, technological development, extension of agricultural techniques and procurement of farming materials for the production of a wide range of food crops other than tea, rubber and coconut. The object crops of research may be broadly classified as follows:

(1) Rice
(2) Coarse grains (maize, millet, sorghum, etc.)
(3) Root and tubers (Irish potato, cassava, sweet potato, yam, etc.)
(4) Pulse crops (soy bean, mugged bean, cow pea, black-eyed pea, pigeon pea, etc.)
(5) Spices (red pepper, onion, garlic, turmeric, carmine, cinnamon, etc.)
(6) Industrial crops (cotton, peanut, sesame, sunflower, castor oil, etc.)
(7) Garden crops (vegetables, fruit trees, etc.)

The Department of Agriculture is also responsible for the development of new cultivars and new cultivating techniques and for extending them among the farmers. To fulfill this responsibility, the Research Division takes charge of the development of new varieties and new cultivating techniques and extends them to the farmers by keeping close linkage with the Extension Division and the Education and Training Division.

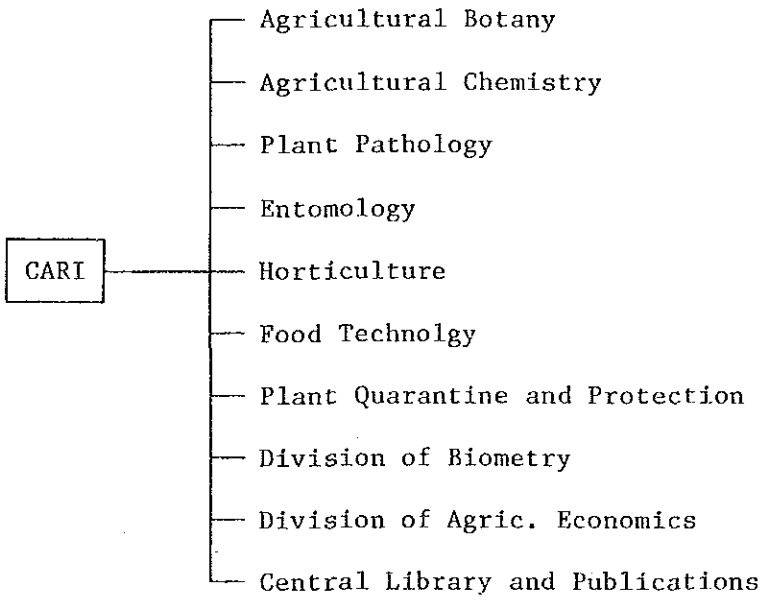
To promote the foregoing, the divisions involved have organized regional technical working groups (RTWG) who meet several times each year for discussions with a view to improve the technical level of everyone concerned. Those meetings are participated by not only the Research Division, the Extension Division and the Education and Training Division but also by the Farms and Planting Materials Division and interested persons of other organizations to strengthen the RTWGs and to promote interchange with people in other fields.

RTWGs are also involved in the planning and execution of adaptability certification tests of new varieties and demonstration tests on new techniques which are carried out in all of the 24 districts by soliciting the participation of farmers. The RARCs are responsible for planning, execution, guidance, analysis and evaluation of such tests.

2-2-1-5 Organization and research themes of CARI

CARI, as a national centre, conducts research and development of basic technologies on food crops commonly applicable throughout the entire country and develops and coordinates test programmes. Being partly responsible for the functions of RARC for Kegalle, Kandy and Metale regions, it copes with solving problems inherent to high and medium altitude wet zones. The Centre consists of the following ten divisions respectively responsible for the following fields of research.

Fig. 2-4 Organization of CARI



(1) Agricultural Botany Division

1) Preservation of crop genetic resources
2) Breeding and culturing of root and tuber crops
3) Mutation breeding
4) Coordination of rice varietal trials
5) FAO's rain fed paddy field project
6) Tissue culture, genetic engineering and biotechnology
7) Herbididal screening trials
8) Regional projects:
   a. Breeding of rice varieties resistant to cold temperature
   b. Screening of varieties resistant to low concentration phosphoric acid
   c. Ecological study of weeds
   d. Varietal adaptability test on asparagus
   e. Research on bacteria for fixation of atmospheric nitrogen
   f. Microbial studies

(2) Agricultural Chemistry Division

1) Residual pesticide analysis project
2) Chemical analysis of soil and plant body
3) Fertilizer analysis

(3) Plant Pathology Division

1) Blast screening and sampling project
2) Seed inspection

(4) Entomology Division

1) Insecticide screening and sampling project
2) Joint research on insect control

(5) Horticulture Division

1) Mass propagation of perennial crops by tissue culture
2) Vegetable screening and sampling project
3) Multiplication of fruit trees

(6) Food Technology Division

1) Chemical analysis of cereal foods

2) Quality inspection of foods

(7) Plant Quarantine and Protection Division

1) Introduction of foreign species

2) Quarantine of introduced plants

(8) Division of Biometry

1) Analysis of research data

(9) Division of Agric. Economics

(10) Central Library and Publications

Systematic arrangement and custody of books and documents

2-2-1-6 Current status of international cooperation in the field of agricultural research

The Government of Sri Lanka depends on foreign aid for much of its agricultural research expenses, and its policy is to agressively induce foreign aid and to effectively utilized it.

The research projects, other than this project and the technical cooperation associated with it, which the Department of Agriculture of the Ministry of Agricultural Development and Research is now promoting under international cooperation or which are scheduled to commence in the near future are as follows.

Table 2-2 Research Projects Financed by Foreign Aid Involving the Department of Agriculture

Project title.	Executed Agency	Period	Amount
Food Grain Improvement Project, Phase II	Canada	- 1986	CAN$ 269,900
Food Grain Improvement Project, Phase III	Canada	1987 - 1989	CAN$ 136,000
Studies on the Factors Controlling Yields Stability of Eary Maturing Rice Varieties in Sri Lanka	TARC, Japan	1985 - 1987	¥ 18,400,000
*Root and Tuber Crops Project, Phase II	IDRC, Canada	1984 - 1989	CAN$ 261,300
Bacterial Wilt Project	CIP, Peru	- 1986	US$ 9,500
Sri Lanka Rice Insect Investigation Project	CARDIFF Univ.	1986 - (1.5 years)	£ 75,000
Systematic Investigation of the Plant Family Dioscoreaceae in Sri Lanka	IFS, Sweden	1986 - (1.5 - 3 years)	SEK 36,800
*Rainfed Rice Research and Development Project	UNDP	1986 -	US$ 914,525
Diversified Agricultural	US AID	1986 - 1991	US$18,000,000
World Bank Research	World Bank and US AID	1986 - 1992	US$30,500,000
*Germplasm Collection of Minor Millets	IBPGR/FAO	1985 - 1988	US$ 15,000
*Mutation Breeding on Rice	FAO/UNDP	1986 - 1991	US$ 60,000

Most of the funds for these projects cover research expenses, manpower costs and training expenses, etc. as a package. The fact that a huge amount of foreign funds are input into agricultural research can be inferred from the above table.

The projects indicated with asterisks in the table are being conducted chiefly by CARI's Agricultural Botany Division, and are likely to be taken over by the new Plant Genetic Resources Centre upon its establishment.

2-2-2 Breeding research activities on crops

2-2-2-1 Rice

As rice has been the staple food of the Sri Lankan people from the ancient past, differentiation of rice varieties adapted to diverse environmental conditions is well progressed. Around 300 local breeds are reported to have already existed in or around 1902.

Rice varieties then cultivated were those called long age varieties that require a culturing period of five to six months and cultivated during the October-February period when the Maha rainy season sets in, and those called short age varieties that require a culturing period of three to four-and-a-half mouths and cultivated or irrigation districts and also for double cropping during the Yala season (the rainly season from May to September). Every one of the varieties had tall plant height and low yield, ranging between 1 to 1.3 t/ha.

Since the turn of the 1920s, mass selection of local breeds or so-called pure line selection was started, and by around 1945, many pure bred lines had been identified and varieties of varying culturing period that matches the prevalent cultural practice of each locality became popular. These selected pure-bred varieties exhibited an increase of about 15% in yield, but reportedly failed to show any improvement in their resistance against blast or in culturing techniques.

Since 1945, rice varieties from India and Indonesia came to be actively induced (more than 700 varieties), and varieties highly responsive to fertilizer and adaptable to Sri Lanka such as Ptb 16 (five to six month variety, India) and Mas (four to four-and-a-half month variety, Indonesia) were selected.

In the 1950s, crossing of Japonica type x Indica type was started with the cooperation of Japanese researchers which resulted in breeding of varieties with excellent disease resistance and adaptability to heavey manuring, or the so-called H series such as H-10 (3 month variety), H-7 (3.5 month variety), H-9 (5 to 6 month variety) and H-4, which contributed greatly to Sri Lanka's attainment of self-sufficiency in food.

Since the latter half of the 1960s, growing of dwarf varieties with short plant height became a worldwide trend, and Sri Lanka began to grow improved varieties of so-called Bg series and Bw series which came to be referred to as the "green revolution" of Sri Lanka. The planting of these new varieties account for almost 95% of the total today. While this shows that the extension of improved varieties is in smooth progress, it also means that the survival of native breeds is restricted to a very limited area. (Refer to Appendix III Data 11, 30, 38)

2-2-2-2 Dry field crops

At present, hardly any efforts are being made in systematic breeding of dry field crops such as coarse grains, legumes, root and tubers, etc. The prevalent condition is that a modicum of efforts is being made in selecting varieties with good yield or adaptability from among native breeds through selective extraction, or depending on varieties introduced from abroad.

As can be seen from Data 13, production volumes of dry field crops other than rice are fairly substantial; and the importance of dry field crops in Sri Lanka is also easily understood from the import statistics (Appendix III Data 17) which show that Sri Lanka depends on import for fairly substantial volumes of sugar, red pepper, onion, maize, legumes, ginger, garlic, etc.

Some 1,200 dry field crop lines are said to be stored in Sri Lanka at present (refer to Appendix III Data 31), including local and foreign varieties of pulse crops, peanut, soy bean, maize, sorghum, African millet, etc. Breeding in this field has advanced only to the stage of comparative yielding tests among varieties, as can be seen from the

Data. A review of vegetables on the local market indicates that hardly any effort is being made in varietal improvement. In the light of Sri Lanka's national policy of diversifying export crops and conserving precious foreign currency, breeding in this field and rearing of export crops are urgently desired.

2-2-3 Organization for breeding of crops

2-2-3-1 Rice

Preservation of genetic resources is carried out by CARI and CRBS; breeding is carried out by these two institutions as well as each RARC.

CRBS is engaged in breeding on a national scale. CARI, which also assumes the role of RARC, not only carries out research activities on a national scale, but also breeds cold resistant varieties for rice cropping in the cold highland areas. At other RARCs (at eight locations), too, efforts are being made to raise rice varieties adaptable to the local eco-edaphic characteristics (varieties resistant to salinity, iron, aluminium, or to drought) of each region.

2-2-3-2 Other crops

With respect to crops other than rice, the following research institutions are taking the leadership in research.

Root and tubers	- CARI's Agricultural Botany Division at Peradeniya
Potato & vegetables	- Agricultural Research Station (ARS) at Sita Eliya
"	- Vegetable Seed Research Institute at Peradeniya
Tea	- Tea Research Institute (TRI), at Tarawakere
Coconut	- Coconut Research Institute, at Warupita
Rubber	- Rubber Research Institute (RRI) at Anvillipicha
Sugar cane	- Sugar Cane Research Institute (SRI)

Besides the above, there are organizations like state run extension farms called "farms", which carry out rearing of varieties and adaptability tests. Some of these farms have orchard of mangoes and papayas attached to them where they engage in research on these fruit trees which are not studied at any of the central research facilities.

2-3 Current Status of Research on Genetic Resources

2-3-1 Rice

2-3-1-1 Exploration and collection

Systematic collection was started in 1967, and with the cooperation of IRRI since 1977, about 2,700 lines of native breeds have been collected by 1981.

At the "meeting on research for rice genetic resources preservation" held at IRRI (co-sponsored by IBPGR/IRRI), native breeds inherent to Sri Lanka were reported to be still remaining in the unexplored areas, and the recommendation was made that collection activities should be completed by the end of Fiscal 1985 with the cooperation of researchers of IRRI/IBPGR.

In 1984, a plan for collecting the varieties cultivated in the Maha season (rainy season between May and September) was established, and native breeds including wild species were collected at that time. (Refer to Appendix III Data 52, 53)

Exploration activities were carried out once again in 1985, and a plan for collection of upland rice varieties and wild species in the unexplored zones in the dry season was drafted.

The following is a brief description of the exploration and collection efforts made with the cooperation of overseas research institutes.

a) The Government of Sri Lanka planned "a study on rice" and "a study on cropping systems" between May 1977 and January 1982, and with the cooperation of IRRI, concluded a contract with it. These projects were financed by the U.S. AID fund, and were mainly concerned with development of plans for organizing genetic evaluation and utilization or rice genetic resources. They also afforded advice and counsel on rice breeding projects and on the manpower programme and training programs.

b) CARI planned a project to collect rice genetic resources in 1979, under which researchers who belonged to the genetic resources project of IRRI visited Sri Lanka from January to February, 1979. The collection targets at that time were the native breeds in salty soil areas, in areas where iron damage had occurred, and in paludal soil areas. The number of varieties collected was 267, including 251 native breeds and 16 wild species. These included drought resistant and salinity resistant varieties. The varieties with special traits were as follows.

Medicinal	7
Floating rice	2
Good eating quality	9
Resistant to brown leafhopper	2
High node tillering property	8
Resistant to toxic soil	12
Resistant to alkali ne soil	1
Strong initial growth	1
Resistant to saline soil	41
Resistant to paludal soil	9
Tolerant to flood	30
Resistant to cold temperature	11
Resistant to drought	23
Imported varieties from India	2
Kena (replotting cultivation)	3

c) During February and March, 1984, the IRRI/IBPGR joint rice exploration and collection party collected 108 native breeds and 14 wild species from 8 provinces. Wild species collected were 6 strains of Oryza rufipogon, 2 strains of O. nivera, 2 strains of O. officinalis, 3 strains of O. sativa and hybrid, and one strain of granulata. The varieties with special traits were as follows.

For dry field cultivation	36
of which for Kena cultivartion	22
Drought resistant during initial growth period	12
Submersion resistant during initial growth period	12
Highland adaptable type	7
Fast growing type	5
High yielding type	3
High ripening (cropping) ability (type with few glumiflorae)	1
Lodging resistant	1
Disease resistant	1
Fragrant rice	6
High swelling after cooking	2
Retains good quality after cooking	2
For medicinal use	8

2-3-1-2 Preservation

a) Lines preserved at IRRI

According to (an excerpt from) the catalogue of IRRI issued in March 1983, lines preserved in duplication which were forwarded from Sri Lanka and stocked in the seed storages of IRRI are 2,069 strains, and with the additional 112 strains forwarded in 1984, altogether 2,191 strains are now in stock.

b) Within Sri Lanka

Sri Lanka, had prefabrication type low temperature seed storages as preservation facilities donated by Japan in 1972 which were installed in CARI and administered by CARI's Agricultural Botany Division. These storages, however broke down in 1981 and became unusable as repair work was impossible locally. Because of this, CARI has switched to field regeneration and maintenance for the most part while preserving some in a deep freezer after wrapping and sealing in aluminium foil. Rice genetic resources in the possession of CARI are said to be about 900 strains.

Besides the above, CBRS at Batalagoda has a storage of about $20m^2$ in space which is equipped with two coolers. About 600 strains of rice genetic resources are reportedly stored in this storage, but the inside temperature of this storage is 20°C and humidity is not controlled, so that preservation is imperfect. Here again, maintenance by field regeneration is resorted to, but loss due to perishing and varietal commingling seems unavoidable.

As above, rice genetic resources stocked in Sri Lanka now are 900 strains at CARI and 600 strains at CBRS, adding up to a mere total of 1,500 strains. If seeds of available varieties of all breeding institutions were to be collected from now on, it would come to about 4,000 strains, and if exploration and collection of native breeds were to be carried out more aggressively, the preserved lines would probably reach about 15,000 strains in the next ten years.

2-3-1-3 Evaluation

As the breeding targets become increasingly sophisticated and diversified and the problems of insect resistance, disease resistance and resistance to environmental stresses multiply, selective screening and extraction of preserved genetic resources begin to be practiced more intensively. In Sri Lanka, too, evaluation as indicated on Appendix III Data 39 has been rendered, by which useful raw material lines such as shown on Appendix III Data 36 have been extracted. When the future direction of breeding is taken into consideration, however, a great deal more of evaluation will become necessary, for which the provision of facilities and equipment will be required urgently.

2-3-1-4 Problems in connection with management of rice genetic resources

a) At present about 1,500 strains are in stock, but because the evaluation of their traits and the development of the raw materials are inadequate, their functions remain undemonstrated, which in turn is hampering the breeding programmes.

b) Maintenance and preservation of seeds are difficult due to want of long term storage facilities, as a result of which valuable plant genetic resources are being lost.

Their maintenance by regeneration is feared to cause hybridization with other species or varietal mixing through erroneous handling.

c) As approximately 95% of the cultivars are accounted for by the so-called high yielding varieties, collection activities of native breeds and wild species must be carried out as soon as possible.

d) With the advances made in breeding, the breeding targets will become increasingly complex and diverse. To cope with this, the development of breeding raw materials must be specialized. With the current system, it is not only difficult to maintain the level of HYV but it is possible that it will lead to varietal degeneration.

e) Bg series which are currently diffused are descended from the varietal line called CINA, and are inviting genetic uniformity. In terms of disease resistance and insect resistance, securing of genetic variation is quite vital.

f) Due to environmental changes accompanying population increase and cultivated area expansion, etc., changes and destructions of the eco-system are in progress. Spontaneous allied species and wild species are perishing with it. These species must be preserved and managed as soon as possible.

2-3-2 Dry field crops (coarse grains, pulses, root and tubers, etc.)

Major crops in Sri Lanka are edible pulse crops (green gram, cowpea, peanut, soy bean, etc.), coarse grains (maize, millet, African millet, etc.), root and tubers (cassava, Irish potato, sweet potato, yam, etc.), vegetables (onion, red pepper, etc.), besides perennial crops such as coconut, tea, papaya, etc. If the exploration and collection of these genetic resources were to be carried out, their number would be approximately 10,000 strains. Accordingly, a collection of all genetic resources including rice in Sri Lanka in the next 10 years would presumably reach about 25,000 strains.

Of the dry field crops collected, the number of pulse crops and coarse grains collected are shown on Appendix III Data 31, and of root and tubers and other specialty crops on Appendix III Data 35, 39. Although the number of items collected is small on the whole, Sri Lanka is interested in these dry field crops, and the research institutions that belong to the Research Division of the Department of Agriculture are enthusiastically engaged in their collection. It is presumed from these tables that CARI is taking the lead in undertaking preservation and development of root and tubers, and also evident that collaboration and linkage with international research institutes are in progress.

The following is a summary of the descriptions on genetic resources research taken up from the country report on each crop delivered at international conferences and similar events by the Sri Lankan researchers.

(1) Coarse grains

Millets, sorghum, and maize are included in this category. Some of the papers also report on adlay, wheat and rye.

a) Millets

African millet, foxtail millet, millet and barnyard grass for sparrows are included in this category. These are widely distributed throughout the country except in the highland. Although the yield is relatively small save for African millet, they are important as hardy plants as they can be cultivated even in an unfavorable environment.

As a custom in Sri Lanka, they are cultivated together with maize, rice, or pulse crops. They are rich in variation, which appear particularly in the head type and head color. Varieties introduced from India and Africa are also observed.

b) Sorghum

Cultivated in limited areas. The color of head is observed to be red or white, and the form of head also varies, some being pointed and some spreading out.

Though it is necessary to study the native breeds the improving target in breeding should be placed in research of their genetic heterosis, yield and stableness.

c) Maize

Mainly cultivated in arid areas. There are varieties for the table and for feedstock.

d) Other grains

There are spontaneous habitats of adley, dog millet, etc. Which must also be collected.

(2) Pulse crops

They are an important source of protein in Sri Lanka and a large volume of them is imported. They are the dry field crops in which Sri Lanka hopes to become self-sufficient.

a) Pigeon pea

Improved varieties were introduced in the 1960s which replaced the cowpea. Wild allied species are available domestically, and rearing of disease resistant variety is said to be possible with osmotic hybridization.

Among the wild species are Atylasia, Rhynchosia, Viscasa, Dunbaria, etc. A. Scaraboeoides is widely distributed in Sri Lanka.

b) Peanut

Mainly cultivated in the arid land, and varietal improvement by selection of introduced varieties and mutation breeding is under way.

c) Cow peas

Includes green gram (Vigna radiata), black gram (V. mungo), cow pea (V. unguiculata), etc. and quite many of their individuals have been collected. Aggressive evaluation of their characteristics and their utilization are looking forward to.

d) Soy bean

Introduced in the 1970s and is now being comprehensibly studied mainly at the Soy Bean Research Institute.

e) Chick pea

Introduced after the turn of the 1980s. Also bush bean and Broad bean introduced in same time.

f) Winged bean

CARI started its collection in 1975 and has collected 21 local varieties so far. As it abundantly contains protein, its future utilization is looked forward to. Elite lines have emerged as a result of introducing foreign varieties from Papua-New Guinea, Nigeria, and other places, and through selection and extraction.

(3) Root and tubers

As a result of having carried out systematic collection activities in accordance with the Joint Research Project (1978 - 82) with IDRC in Canada, 110 strains of Cassava, 71 strains of sweet potato, 29 strains of yam, 15 strains of taro, 19 strains of baulis, besides, arrowroot, konjak, artichoke, etc. have been collected. These lines are preserved at CARI now and are undergoing systematic evaluation.

Collection of root and tubers was also carried out in the 1984/1985 Maha season, and these are also undergoing evaluation currently. The number of strains collected then was as follows.

a) Arroids (taroes)

Colocasia	9
Xanthosoma	7
Alocasia	5
Of which 2 are ornamental.	
Lasias	2
Armophophallus	1

b) Caulis 20

c) Dioscorea (Yams)

D. alata	19
D. esculenta	7
D. bulbifera	3
D. rotumbara	2
D. spp. (wild)	7

d) Other root and tubers

Ginger and its wild species	2
Turmeric and its wild species	3
Artichoke	1
Arrowroot	1
Canna	1

(4) Species

Cinnamon, pepper, cardamon, nutmeg, etc. are included in this category. They are attracting attentions as agricultural products for export, and their positive utilization is desired.

(5) Garden crops

a) Fruits

Diversity of the fruits plant, like banana, lime, orange, tree apple, mango, jackfruit, avocado, mangosteen, durian, lumpootan, guava, pomegranate, etc.

On banana, some are preserved in CARI's experimental field. On citrus fruits, numerous species had existed in the 1950s but were mostly lost since then due to drought and disease injury. They must be collected urgently; and the method for storing them must also be established as soon as possible as their seeds are quite susceptible to dryness.

b) Vegetables

The environmental conditions being diverse, diverse types of vegetables ranging from the temperate to the tropical are grown, but it is difficult to specifically point out which of the genetic resources are prospering or decaying. But what is apparent is that genetic resources of melons, tomato, egg plant, amaranthus, etc. are decreasing little by little. It is therefore necessary to carry out a basic survey on native breeds of vegetables as soon as possible. The target species are carrot, cabbage, beet, cauliflower, reek, kidney bean, pea, lettuce, radish, etc., but the immediate problem is how to proceed with the production of good seeds.

(6) Others

a) Oil crops - sesame, sunflower, castor oil plant, citronella
b) Fibrous plants - cotton, kenaf
c) For eating perfume - cashew

2-4 Current Condition of Laboratory Equipment Now Under the Possession of the Central Agricultural Research Institute

The building of the Central Agricultural Research Institute, built in 1967 by the aid of the Government of Australia, is considerably worn out through aging. The ten divisions mentioned in Paragraph 2-2-1-5 are housed in this building where they are engaging in research activities of their respective fields.

The equipment necessary for chemical analysis including colorimeter, chemical balance, oven, kjeldahl method analytical device, pH meter, centrigufal separator and gas chromatography are installed in the Agricultural Chemistry Division. The Division conducts soil analysis using the Kjeldahl method analytical device and the colorimeter, and also conducts analysis of residual pesticides using gas chromatography. Particularly noteworthy is the fact that vigorous research activities are being pursued in tissue culture of root and tubers by the Agricultural Botany Division, and also in tissue culture of pineapple by the

Horticulture Division financed by FAO with the use of chemical balance, centrifugal separator, pH meter, laminar flow, autoclave and autostill.

Although chemical balance, oven, colorimeter, etc. are also installed in the laboratories of other fields, many of them are out of order and unusable.

As above, most of the researchers of said Institute pursue research activities mainly on the test field due to the lack of adequate laboratory equipment. Research themes that require chemical analysis are not undertaken except only by a few of the laboratories.

2-5 Circumstances which Led to the Present Request and the Contents Requested

2-5-1 Circumstances which led to the present request

The Government of Sri Lanka has planned to establish a plant genetic resources centre for such purposes as storage and evaluation of plant genetic resources of food crops (rice, coarse grains, pulse crops, root and tubers, vegetables, fruit trees) and technological development including biotechnology as the means for breeding, and has requested the Government of Japan to provide the necessary research facilities and equipment and other related facilities.

As the background for this request, the following may be enumerated.

(1) There is no long range storage facility for plant genetic resources in Sri Lanka.

(2) As the share of high yielding varieties is high, a rapid loss of native breeds and wild species is anticipated with the progress of inland development.

(3) Evaluation and utilization of food crop genetic resources are quite important for Sri Lanka's strategy.

For these reasons, the Ministry of Agricultural Development and Research attaches high priority to improvement of plant genetic resources research technologies including collection and preservation of plant genetic resources and biotechnology.

Following its request for provision of research facilities, the Government of Sri Lanka has also requested the Government of Japan for technical cooperation in conducting research on plant genetic resources.

2-5-2 The contents requested

2-5-2-1 Project objective

The work plan of the Government of Sri Lanka consists of two parts, namely, the development of research facilities and laboratory equipment under the grant-in-aid cooperation of the Government of Japan in Phase I, and the technical cooperation with respect to preservation, genetic evaluation and utilization of germplasms in Phase II.

According to the request, the project intends to construct storage facilities for plant genetic resources and related research facilities on a corner of the site of the Central Agricultural Research Institute (CARI) at Peradeniya in order to promote research and development of plant genetic resources, improve the technical level and prompt more efficient crop breeding and thereby contribute to its development.

The project objectives are as follows.

(1) In order to amplify the research activities, plan for expansion and improvement of research facilities and equipments and preparation of research environment shall be established and implemented.basic, applied, and commercialization research activities, the agricultural research functions shall be strengthened by expansion and improvement of research facilities, manpower resources development and improvement of research environment.

(2) In order to promote collection, storage, evaluation and utilization of native breeds and improved varieties of food crops, the genetic resources preservation facilities shall be fully equipped to serve future breeding efforts in joint research with Japanese researchers.

(3) The technical cooperation (collaboration) programme between Japan and Sri Lanka shall be continued on an expanded scale in order that experience and knowledge may be exchanged to train the Sri Lankan researchers.

2-5-2-2 Brief description of the request

Contents of facilities and equipment requested by the Government of Sri Lanka are as follows.

(1) Facilities

1) Two-story headquarters building	4,800m^2
Plant genetic resources laboratory	140m2
Tissue culture and genetic engineering laboratory	445m^2
Breeding laboratory	155m^2
Biochemistry laboratory	170m^2
Plant physiology laboratory	285m^2
Agronomy laboratory	250m^2
Visiting researchers' laboratory	160m^2
Laboratory in reserve for future expansion	200m^2
Meteorological rooms	100m^2
Herbology rooms	190m^2
Microbiology rooms	160m^2
Radio isotopic tracer room	255m^2
Information management room	80m^2
Library	50m^2
Lecture room	90m^2

Dark room	65m^2
Specimens exhibition room	140m^2
Administration office rooms	205m^2
Auditorium	700m^2
Common facilities	960m^2

2) Seed storage 400m^2

3) Green house, screen house, phytotron complex 1,055m^2

Green houses for plant physiological studies	3
Green houses for experiments for joint use	4
Green houses for isolated cultivation	2
Dome-shaped green house	1
Phytotron complex	1

4) Field management building 475m^2

5) Workshop building 325m^2

6) Apartment type staff dormitory 5 x 165m^2
Independent lodging 1 x 185m^2

7) Irrigation facilities for the experimental field

8) Improvement of waterworks, electricity and telephone systems

9) Improvement of drainage facilities

10) Development of onsite roads and garden

11) Recreation facilities for the staff

(2) Equipment and apparatus

1) Equipment and apparatus related to collection, storage and evaluation of genetic resources

2) Equipment and apparatus related to tissue culture and genetic engineering

3) Equipment and apparatus related to plant breeding

4) Equipment and apparatus related to plant physiology

5) Equipment and apparatus related to biochemistry

6) Equipment and apparatus related to agronomy

7) Equipment and apparatus related to radio isotope

8) Equipment and apparatus related to meteorology

9) Equipment and apparatus related to photographing

10) Equipment and apparatus related to the specimens exhibition room

11) Equipment and apparatus related to information and data management

12) Office supplies

13) Vehicles

14) Tools

15) Agricultural equipment and implements

16) Equipment and apparatus for lecture room and for conferences

As above, the request contains many items. For details, please refer to Appendix III Data 24.

CHAPTER 3
CONTENTS OF THE PROJECTS

CHAPTER 3 CONTENTS OF THE PROJECTS

3-1 Objective

This project aims to establish a Plant Genetic Resources Centre (abbreviated as PGRC) for the exploration, collection, preservation, multiplication for distribution, evaluation and data management of plant genetic resources of rice, coarse grains, legumes, root and tubers, vegetables, fruit trees and others, to secure and preserve these plant genetic resources in Sri Lanka and to utilize them for the promotion of crop improvement. In order to attain this objective, the Government of Japan shall provide the necessary facilities and equipment under the grant-in-aid cooperation.

3-2 Review of the Contents Requested

Preceding the dispatching of this basic design study team, two preliminary study teams were dispatched to Sri Lanka to review the propriety of the contents of the request from the Government of Sri Lanka as described in Paragraph 2-5-2.

Although the contents of the request from the Government of Sri Lanka aim for the upgrading of the level of the Agricultural Botany Division by renewing and modernizing its entire research facilities, while establishing the development of the facilities for the conservation and management of plant genetic resources as the central theme, it was agreed, as a result of discussions, between the two preliminary study teams and the Sri Lankan side that the contents of facilities and equipment shall be those which are indispensable for smoothly carrying out the activities necessary for the collection, preservation, evaluation and utilization of genetic resources and also indispensable for the research works which are to become the basic foundation of these activities.

This study team has worked out the basic design on the basis of the foregoing results of review made by the preliminary study teams.

3-2-1 PGRC's role

In view of the socio-economic importance of agriculture in Sri Lanka, the Government of Sri Lanka has indicated in its agricultural policy its intention to promote the collection, preservation and utilization of plant genetic resources. PGRC was conceived as the nucleus of its efforts to proceed with the preservation of seeds of rice, legumes, coarse grains and vegetables, etc., and to initiate the collection and preservation of genetic resources of vegetatively propagated crops, too.

In order to proceed with the acquisition, preservation and utilization of plant genetic resources, PGRC, which is placed under the Department of Agriculture, shall establish close linkages with CARI, CRBS, the eight RARCs, the Department of Forestry, the Coconut Research Institute, TRI, RRI, the Department of Minor Export Crops, and also with agricultural and botanical research institutes of universities and, under a system in which all parties shall cooperate, shall assume the central role in conducting research on plant genectic resources in Sri Lanka.

PGRC shall also establish close collaborative relationships with international agricultural research institutes. Particularly its ship with IBPGR, it shall, as a part of the international network among genetic resources centres, actively cooperate in the collection, preservation, evaluation and exchange of information on plant genetic resources. As a link of international networks in the field of plant genetic resources centre, the PGRC may carry out to exchange information on collection evaluation and preservation which should be established a closed corporational relationship with organizations of international agricultural research institute, especially an aggressive exchange with IBPGR shall be expected.

3-2-2 Scope of preservation

The number of plant genetic resources to be preserved in Sri Lanka was projected to reach 15,000 items of rice varieties and 10,000 items of other dry field crops, totalling 25,000 items 10 years from now, on

which basis the functional performance of utilities and mechanical systems under this project was determined.

The number of rice varieties currently preserved is only about 1,500 items combining those held by the Central Agricultural Research Institute and those held by the Central Rice Breeding Station, but about 4,000 additional items including the native breeds and wild species held by other domestic institutions will be collected after the opening of the Plant Genetic Resources Center, and this number, 10 years from now, is expected to reach 15,000 items including the lines introduced from foreign countries. According to the IBPGR's survey conducted in 1980, as many as 69,555 items of rice genetic resources are preserved in the Philippines, and 48,738 items in India. Considering the number of items being preserved now in these neighboring countries, the figure of 15,000 for Sri Lanka 10 years from now seems reasonable.

Table 3-1 Germplasm Collection in Food Legumes and Rool Crops in Asian Countries

	India	Philippine	Taiwan	Indonesia
Food Legumes				
Spya Bean	–	–	10.000	–
Cowpea	3.400	3.200	5.440	–
Winged Bean	1.000	200	–	–
Pigeon Pea	8.775	300	–	–
Ground Nuts	8.000	850	–	–
Chick Pea	12.000	–	–	–
Total	33.175	4.550	15.440	–
Root Crops				
Aroids	–	569	–	482
Yam	–	404	–	143
Sweet Potatoes	–	769	–	1.200
Cassava	1.800	883	–	700
Total	1.800	2.625	–	2.471

Source : IBPGR, 1980

Regarding other dry field crops, the number of items preserved in countries adjacent to Sri Lanka, even when taking only food legumes and root crops on which main emphasis is being placed, is as shown on Table 3-1, and considering the advances that will be made in research by Sri Lanka during the coming decade, the collection of 10,000 items to be preserved 10 years from now seem reasonable enough.

3-2-3 Research activities

Prior to establishing the contents of PGRC's research activities, this study team has discussed them with the Sri Lankan side from the following four viewpoints.: a) the agreements reached by the preliminary study teams, b) PGRC shall function as a research institute of plant genetic resources, c) it shall conform with other existing research institutes, and d) its future plans.

Although mutual agreements were readily reached with respect to the establishment of the laboratory for exploration and collection, laboratory for seed storage, laboratory for vegitatively propagated plants, and the laboratory for data management which constitute the basic functions of this centre, some gap of opinion has been observed in both parties with respect to the positioning of the laboratory for evaluation (biochemical studies, plant physiological studies), plant breeding studies, agronomic studies, meteorological studies, utilization of isotopes, herbological studies, and microbiological studies, each as a research field of the Plant Genetic Resources Centre.

Finally, both parties has reached to agree after Sri Lanka's request as follows;

1) Utilization of isotopes

Although it is an important research field in the area of mutation breeding techniques, it shall be excluded from the scope of this project because breeding at this centre will not be carried out on a full scale. The local technical level and safety are also among the reasons.

2) Herbology and microbiology

As these are outside the scope of the breeding function, these shall be excluded from the scope of this project. Instead, CARI shall establish new laboratories for these fields.

3) Plant breeding studies

Full scale breeding studies relevant to the utilization of plant genetic resources shall be carried out by the existing research institutes of various crops.

4) Biochemical studies, plant physiological studies, and agronomic studies

Fundamental research pertinent to the evaluation of genetic resources shall be carried out mainly by the laboratory for evaluation. Research of more advanced level shall be carried out in cooperation with CARI and other existing research institutes for each crop.

A series of biotechnology-related studies were deemed necessary for tissue culture and cytogenetics-related studies to be conducted at this centre based on the reasoning that they would be instrumental in developing the fields which are closely related to the conservation of genetic resources.

5) Meteorological studies

This centre shall only observe the weather, which shall be assigned to the laboratory for data management.

Based on the foregoing, research activities of PGRC shall be shared among the following five laboratories. The contents of activities of each of these five laboratories and their relationships are as shown on Fig.

(1) Laboratory for Exploration and Collection

Native breeds of mostly the major crops of Sri Lanka shall be actively explored and collected.

In order to establish the major crop and cash crop segments in Sri Lanka, useful genetic resources shall be introduced from various other countries to diversify the variations in genetic resources. Passport data (classification, collected site, collector, collected date etc.) of these explored and collected lines shall be controlled by this laboratory. The work plan for exploration and collection shall be established by analyzing domestic and foreign information.

(2) Laboratory for Seed Storage

Genetic resources of seed collected shall be stored as seeds in duplication in each of the long term (at 1°C, for 30 years), medium term (at 10°C, 10 to 15 years) and short term (at 20°C, five years) storage facilities to preserve said genetic resources. The long term stock shall be for ever-lasting preservation, the medium term for distribution and multiplication, and the short term stock for evaluation and for use as breeding material.

Seeds to be preserved shall be adequately dried to water content of 6 or 7%, and shall be subjected to periodical germination tests.

(3) Laboratory for Vegitatively Propagated Plants

Genetic resources of vegitatively propagated plants and perennial crops collected shall be preserved by tissue culture. For this purpose, appropriate technology shall be developed for each crop.

(4) Laboratory for Evaluation

One of the objectives of preserving genetic resources is to develop new varieties by utilizing them for breeding. Accordingly, evaluation criteria with respect to their usable characteristics shall be developed. The evaluation items shall be established according to the

priority of their use for breeding of each crop species, and studies on evaluation shall be carried out under close linkage and collaboration with CARI and each experimental station.

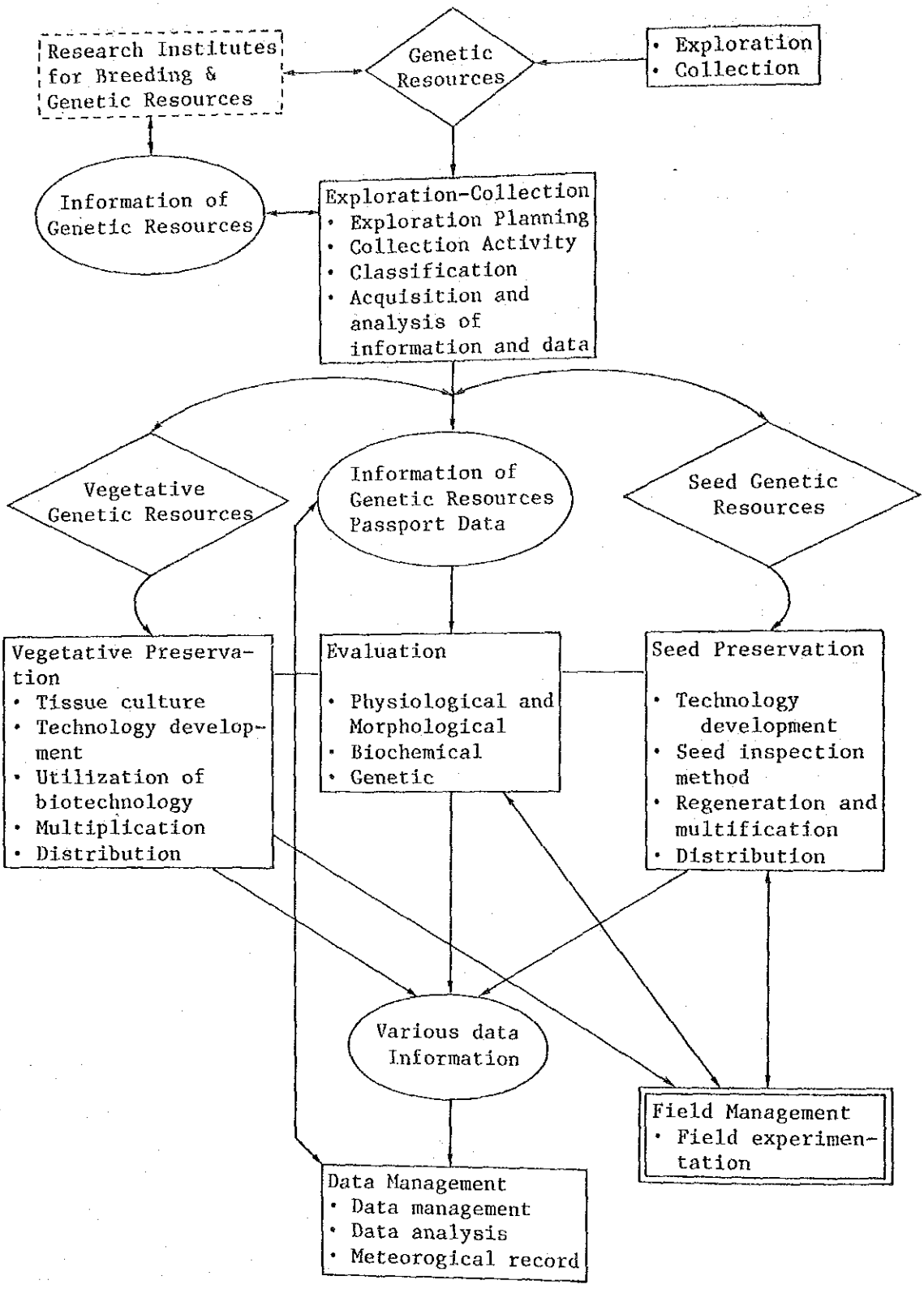
(5) Laboratory for Data Management

All of the data including passport data, evaluation results, etc. on genetic resources preserved shall be input into a computer so that they may be utilized for analysis and extraction of evaluations. This laboratory shall also issue the "Catalogue of Plant Genetic Resources in PGRC, Sri Lanka".

Indispensable as one of the activities of PGRC is the research and development of new technologies to be carried out under international cooperation. It was therefore assumed that PGRC will involve itself in international interchange of not only information and data but researchers as well, and for this purpose, it was decided that an independent laboratory for visiting scientists shall be provided in addition to the foregoing five laboratories.

A field management function shall also be attached to this Centre for management of each laboratory's test cultivation on the experimental field carried out according to its respective experimental design. Activities of PGRC is shown on Fig 3-1.

Fig. 3-1 Activities of Plant Genetic Resources Centre



3-2-4 Facilities and equipment

The contents of the request from Sri Lanka initially contained 8,065m2 of building including a laboratory building, a seed storage building, green houses, screen houses and lodging facilities and a huge volume of laboratory equipment including isotopes and electron microscopes. On the basis of the contents of research activities as defined in the preceding paragraph, however, the contents of facilities and equipment have been readjusted.

(1) Seed storage facilities and conditions

In order to reduce the maintenance costs as much as possible, the temperature shall be set at 1°C for long term the storage, 10°C for medium term storage and 20°C for short term storage, and refrigerator shall be the walk-in type prefabricated refrigerator. Seed Storage methods are as follows.

	samples	sample	method
Long term (30 years)	25,000	30g x 3 = 90g	Canned 6 - 7% in moist content and stored in refrigerator at 1°C
Medium term (10-15 years)	25,000	100g x 3 = 300g	Sealed Dried Seed (moisture content 6 - 7%) in aluminium bag, placed in container with silica gel and stored in refrigerator at 10°C
Short term (5 years)	10,000	250g x 2 = 500g	Sealed Dried Seed (moisture content 6 - 7%) in aluminium bag, placed in container with silica gel and stored in refrigerator at 20°C

The prefabricated refrigerator is drawing much attention as an energy saving type of storage means having the following advantages.

a. Inexpensive to maintain (power consumption can be reduced by about 30% compared to the conventional type).
b. Easy to operate and seldom breaks down.
c. Can be repaired easily with the technique and skill needed to repair an ordinary refrigerator.
d. The temperature which is an established environmental condition, seldom varies as the storage space is limited to inside the refrigerator.
e. A sudden rise in temperature can be prevented by the double wall structure even in the event of power failure.
f. If the refrigerator goes wrong, the contents can be moved to another refrigerator quickly, thereby containing damages to a minimum.

(2) The germination test room and the seed inspection room shall be placed in one and the same room. It is concluded that there is no obstacle of research activity even jointed in one room.

(3) The seed drying room and packing room shall be placed in one and the same room. It is concluded that there is no obstacle of research activity even jointed in one room.

(4) The laboratory for evaluation shall be accommodated in one room.

The scope within which the evaluation of plant genetic resources should be contained was discussed, and since it was determined that most of the research works of the genetic evaluation laboratory, the physiology and morphology laboratory and the biochemistry laboratory for which the Sri Lankan side has requested individual laboratories can be carried out at each of the existing laboratories, and the basic primary evaluation can be rendered by utilizing the green house, it was decided that the laboratory for evaluation shall be contained in one room.

(5) The scope of the biotechnological equipment

A huge number of equipment ranging from those for plant biochemistry to the ones for food chemistry, etc. have been requested under the pretext of "carrying out evaluation of genetic resources from all angles". Since the Sri Lankan side has consistently requested for biotechnology-related infrastructural development, it was decided that its equipment needs should be considered to accommodate its future advanced research capabilities. As a result, it was decided that equipment necessary for sendering evaluation from the viewpoint of nutritive science based on analysis of isozyme and amino-acid composition as well as equipment for tissue culture shall be provided.

(6) Laboratory in reserve to provide for future growth

It was excluded as it is outside the scope of eligible objects for grant-in-aid assistance.

However, since the policy of the Sri Lankan side, upon completion of the collection of plant genetic resources in the future, is to emphasize the research on the use of these resources, the space for the laboratory for visiting scientists may be used for this purpose.

(7) Electron microscope

Electron microscope strongly requested by the Sri Lankan side was excluded from the equipment list for this project as it was judged too early to introduce it for the following reasons.

a. The running costs run up high as around-the-clock air-conditioning is necessary to prevent dew condensation on the lens.
b. No repair service is available in the event of its break-down.
c. The electron microscope introduced by the Peradeniya University is not operating satisfactorily.

(8) Seminar room

Following table is showing the expected seminar plan.

As a facility for the various meetings described in the table below, two seminar rooms, one large and the other small, shall be provided.

The partition between the two rooms shall be made movable so that the size of the rooms can be flexibly changed according to the number of users.

Seminar Title	Number of Attendant	(person)	Frequency
Weekly Work Programme and Research Report Meeting	Researchers of PGRC and CARI	50	1 time /week
Group Discussion	Every Research Group	10	1 time /week
Research Leader Meeting	Research Leader of PGRC and CARI	20	1 time / month
Seasonal Research Programme Presentation	Research Leader of PGRC and Regional Technical Working Group Leader	25	4 times/year
Programme Implementation Meeting	Regional Technical Working Group	15	4 times/year
Individual Research Paper Discussion	Researchers of PGRC and CARI	15 - 20	1 time / month
Special Lecture by Visiting Scientists in Sri Lanka and Abroad	Researchers of PGRC and CARI	50 - 80	1 time / month

(9) Conference hall

The conference hall of this Center shall not be only for the use of the Center's staff but shall function as the national centre for organizing and administering plant genetic resources management.

During the initial stage, the conference hall will be used mainly for training to disseminate knowledge necessary for managing plant genetic resources, and later on, for preparation of national research goals in this field, determination of the order of priority of the research works to be promoted, and for strengthening of mutual linkages and for coordination of programmes.

Besides the foregoing, the conference hall is slated to be used for conferences by the Department of Agriculture alone or inclusive of other departments, meetings for presentation of research papers or for academic conventions to be attended by all research institutes of universities as well as for activities related to research in this field.

The hall therefore is positioned as a facility which will supplement the research activities of the Center itself and which will augment its effect further by positively contributing to joint and collaborative undertakings by serving as a facility of the Plant Genetic Resources Centre for joint use.

The activities of the Department of Agriculture had been hampered because it did not have any appropriate facility for gatherings. If it uses the conference hall of this Centre for these meetings, it is sure to be beneficial to all agricultural research activities.

Although the floor area of the conference hall was to be 700m^2 according to the request from the Sri Lankan side, 300m^2 or so is considered to be sufficient in view of the above described purpose of use and its functions.

Following table is showing the expected conference plan.

Conference Title	Number of Attendance	(person)	Frequency
Annual Agricultural Research Conference (Each Crop Bases)	Officers and Researchers of Departments and Regional Agricultural Research Centres	350	4 times/year
Annual Agricultural Research, Extension Workers Planning Conference	Officers and Researchers of Agricultural Extention of Agricultural Research Education and Training	400	2 times/year
National Genetic Resources Strategy Conference	Researchers of Regional Agricultural Research Centres	150	2 times/year
National Coordinated Varietal Release Meeting	Researchers of Regional Agricultural Research Centres	200	1 time /year
Research Programme and Evaluation Meeting	Researchers of Regional Agricultural Research Centres	150 - 200	2 times/year
Genetic Resource Management Seminar			
1) Long Term Programme	Researcher & Research Assistant	150 - 200	30 days 3 times/year
2) Short Term Programme	Researcher & Research Assistant	400	2 days 15 times/year
Research Equipment Operation Seminar Programme	Research Assistant	100	2 days 4 times/year

(10) Exhibition

The room wherein dried specimen of genetic resources collected will be exhibited is indispensable for the function of this Centre as these specimen are helpful as references for identification of varieties.

(11) Library

A library and reading room where the data on plant genetic resources management and studies on them reported from various parts of the world may be kept in custody shall be set up. It shall accommodate about 2.000 magazines and documents and about 10 seats for reading.

(12) Lounge

Besides the above, a lounge where researchers can relax and chat and where refreshments might be served shall be provided.

(13) Screen house

As the temperature of both the green house and growth chamber is difficult to control under tropical conditions and their maintenance costs would run high, the simplified green house (screen house) shall be installed.

(14) Irrigation facilities for the field

A well for irrigation has been drilled for which a pump is now being installed by the CARI, and very soon water from this well will be led to the water tank on a corner of the field. The irrigation canal on the field is already in use, which extends up to the proposed experimental field for exclusive use of this centre. As Kandy region has a lot of rainfall with very little month-to-month variation, the period of serious water shortage is said to be brief. In view of this, any large scale irrigation facility will not be planned. Instead, a simple irrigation device, for example, a movable sprinkler shall be equipped to irrigate the field to where the irrigation canal extending from the water tank has not yet reached.

(15) Housing accommodation for personnel

Although staff houses for three officers' families two units for visiting researchers and circuit bungalows for patrolmen have been requested, our judgement is that these ought to be provided by the Sri Lankan side in the light of the policy of the grant-in-aid cooperation system of Japan.

(16) The requested space

When the space composition of the requested facilities as a whole is reviewed, the ratio of the common area to the various necessary rooms is quite small. This is presumably because the middle corridor type arrangement of rooms was in the minds of the Sri Lankan side. In such a case, provision of a mechanical air conditioning and an artificial illumination system will become inevitable, which will bring about an increase in maintenance costs. Hence, it is necessary to reorganize the composition of rooms and allocation of space.

3-2-5 Operating budget for PGRC

Since the salaries and wages of CARI's current researchers and regular personnel are being directly paid by its superior office, the Department of Agriculture, the same shall apply to PGRC when it is newly inaugurated. As will be stated later, PGRC plans to increase its staff drastically by 1991, and as this plan has already been approved by the concerned superior office, personnel reshuffling within the Department of Agriculture and recruiting of new staff will be implemented in accordance with this plan. We are informed, therefore, that there will be no budgetary problems regarding PGRC's staff assignment. Accordingly, one problem will be arised how to ensure the operational budget in Sri Lanka.

Accordingly, one problem will remain, how to ensure the budget for operation and maintenance, other than the personnels expenditure of PGRC. Annual budget in 1986 estimated of the Department of Agriculture

which is an executing agency of this project was Rs 356 million. About Rs 45 million was allocated for the expenditures of agricultural research institutes such as the Central Agricultural Research Institute, the Central Rice Breeding Station Institute and the Regional Agricultural Research Center in 1985. The expenditure exclude salaries and allowances for the research workers.

The annual expenditure for operation and maintenance, other than the personnel costs, of PGRC are expected to be about Rs 2 million which is 4.4% of the above mentioned budget for the agricultural research institutes. The Department of Agriculture has already decided to secure the budget for PGRC on priority basis.

It is considered possible, therefore, that although no definite budgetary measure have been caused for PGRC yet, the necessary budget for its operation and maintenance can be sufficiently secured by the Department of Agriculture.

3-3 Project Outline

3-3-1 Executing agency and administration system

The executing agency of this project shall be the Department of Agriculture since a consensus was reached among the concerned authorities to place the new Plant Genetic Resources Center, which is now being favorably considered for the position as a national level institute, under the Department of Agriculture of the Ministry of Agricultural Development and Research.

If it becomes and institute of a national level, this Center would be positioned as a research institute of equal status with the Central Agricultural Research Institute, the Central Rice Breeding Stations and the Regional Agricultural Research Stations at eight locations.

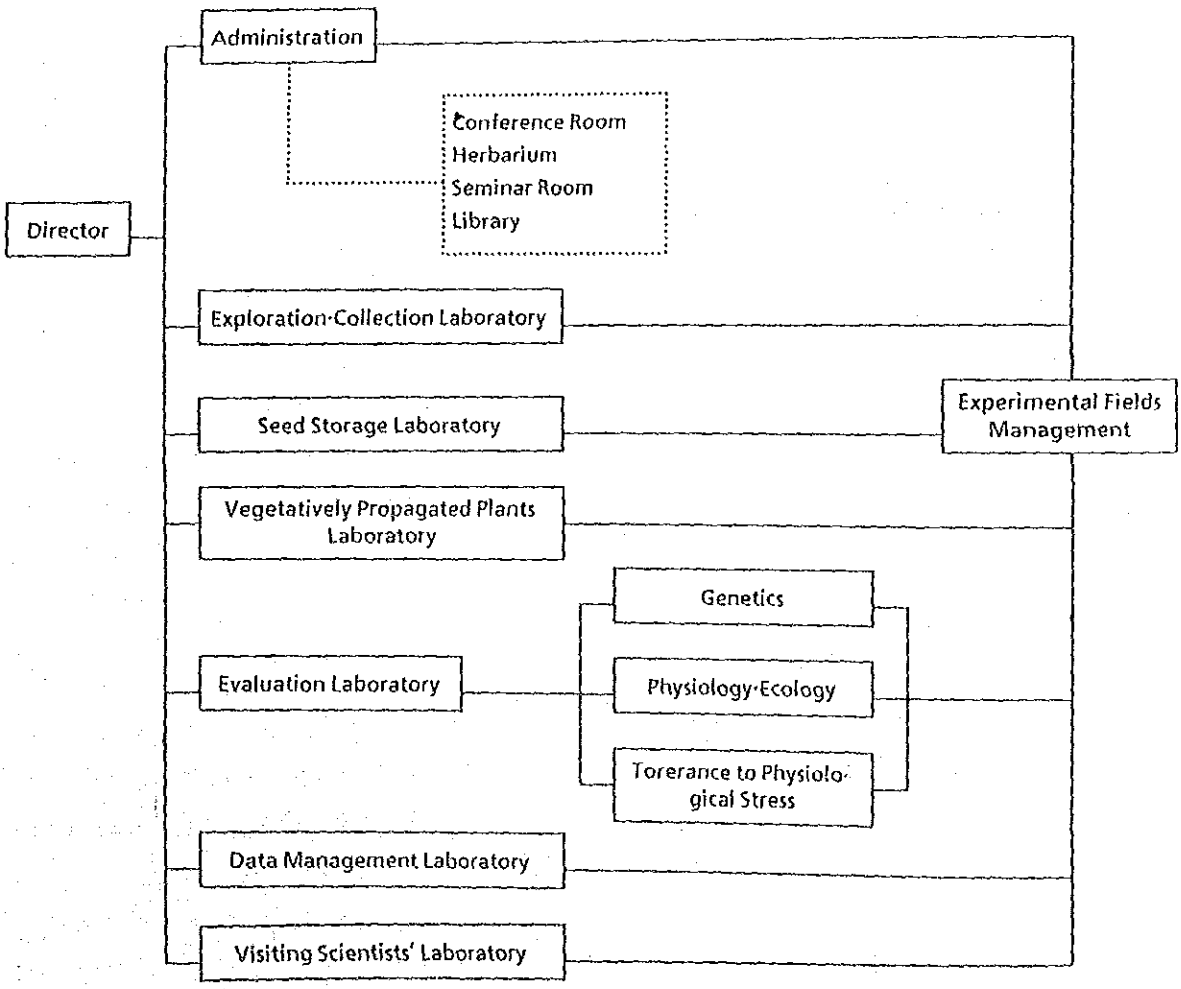
Their organizational relations are shown in the Fig. 2-3.

3-3-1-1 PGRC's organization

The organization chart of the Plant Genetic Resources Center (PGRC) is shown in the Fig. 3-2.

The six laboratories are placed under the Director with the Field Management Office, and the Administration Division which oversees the entire Centre. This way, the laboratories are systematically linked with each other and enables each to demonstrate effective research results.

Fig. 3-2 Organization Chart of Plant Genetic Resources Centre



3-3-1-2 Manpower plan

34 persons out of the 37 strong research staff of CARI's Agricultural Botany Division, excluding the three in herbology and microbiology, are slated to be assigned to PGRC as researchers and assistants. Allocation of these staff to each laboratory within PGRD is shown in Table 3-2.

Table 3-2 Plan for Transferring Research Staff from CARI's Agricultural Botany Division to PGRC

(Units in persons)

Laboratory	Researchers	Assistants	Total
Exploration & Collection	6	3	9
Seed storage	3	1	4
Evaluation	10	3	13
Vegetatively propagated plants	4	2	6
Data management	1	1	2
Total	24	10	34

As above, CARI's Agricultural Botany division would be absorbed by the new PGRC. This seems to be quite reasonable as much as many of the present research fields of CARI's Agricultural Botany Division are concerned with the preservation, evaluation and tissue culture of plant genetic resources.

At CARI, on the other hand, two new research divisions of herbology and microbiology would be established with the abolition of the Agricultural Botany Division to further strengthen the research fields other than those related to plant genetic resources which had been carried out by the Agricultural Botany division so far.

At present, the Department of Agriculture employs 305 researchers and 115 research assistants, altogether a staff of 420 strong but plans to increase its researchers to 557 persons and research assistants to 160 persons by 1990. (Refer to Appendix III Data 28) PGRC's manpower requisition plan is also incorporated in this plan, according to which PGRC's manpower would be further strengthened either by transfer from other research institutes within the Department of Agriculture or with newly recruited staff. In this connection, the manpower of PGRC is expected to the 48 researchers, 36 research assistants and 11 other officers, adding up to a total of 95 by 1991. (Table 3-3)

Table 3-3 Staff Assignment Plan for the Proposed Centre

Laboratory	Categories of Staff	CARI Botany Div.	Annual Plan					Total
			1987	1988	1989	1990	1991	
Exploration & Collection Laboratory	R.O.	6	2	–	–	1	–	9
	R.A.	3	2	2	–	1	–	8
Seed Storage Laboratory	R.O.	3	1	1	2	1	1	9
	R.A.	1	2	1	1	1	–	6
Evaluation Laboratory	R.O.	10	–	6	–	1	2	19
	R.A.	3	–	6	–	1	2	12
Vegetatively Propagated Crops Laboratory	R.O.	4	–	2	–	–	1	7
	R.A.	2	–	2	–	–	1	5
Data Management Laboratory	R.O.	1	–	2	–	–	1	4
	R.A.	1	–	3	–	–	1	5
Sectional Total	R.O.	24	3	11	2	3	5	48
	R.A.	10	4	14	1	3	4	36
Field Management Services	F.M.	–	–	1	–	–	–	1
	A.F.M	–	–	1	–	–	–	1
	Supervisors	–	–	1	–	–	–	1
Administration	A.D.O.	–	–	1	–	–	–	1
	Clerical	–	–	3	–	–	–	3
	Typist	–	–	2	–	–	–	2
	Maintenance Technician	–	–	2	–	–	–	2
Total		34	7	36	3	6	9	95

R.O. : Research Officers
R.A. : Research Assistants

3-3-2 Activity programmes

3-3-2-1 Research programmes

As stated before, the collection of food crop genetic resources is estimated to reach about 25,000 items in the next 10 years, and as of now, research programmes have been established for each of the PGRC's laboratories for six years following the completion of this centre, to be carried out in three phases (two years for each phase). The exploration and collection activity programme presented by the Sri Lankan side is shown on Appendix III Data 44, the preservation programme on Appendix III Data 45, the evaluation programme on Appendix III Data 46, the evaluation criteria for each on Appendix III Data 47, the clonal preservation programme on Appendix III Data 48, and the data management programme on Appendix III Data 49.

Each of these programmes is summarized below.

1) Laboratory for exploration and collection

Its objects of exploration and collection in Phase 1 shall be rice, coarse grains, legumes, root and tubers, cayenne peppers and vegetables of (1) all recommended varieties and varieties maintained by local breeders, and (2) wild species and native breeds of varying ecological areas. It has collected most of the native breeds of rice, root and tubers already, however.

In Phase II, its collection of the crops in Phase I shall be continued, and it shall also introduce the genetic resources of the same crops from foreign countries. Also, native breeds and present cultivars of fiber crops, medicinal plants, fruit trees and oil crops shall be newly collected.

In Phase III, collection of the crops newly taken up in Phase II shall be continued, while also cultivars and wild species of green manure crops, spice crops, plantation crops and other useful crops shall be collected.

2) Laboratory for seed storage

It shall preserve the seeds in the three stages of long term, medium term and short term in duplication throughout the whole period. The laboratory shall also carry out tissue culture of vegetatively propagated plants,

3) Laboratory for evaluation

In Phase I, the laboratory shall organize a working group for evaluation of genetic resources, who, as basic evaluation, shall record the morphological characteristics of the crops collected in Phase I, in accordance with the evaluation method of IBPGR.

In Phase II and III, it shall evaluate all the lines collected on the basis of morphological characteristics, taxonomic studies according to the constituents, resistance to pest and diseases, tolerance to physiological stresses such as drought, cold, salinity, photosynthetic efficiency, efficiency in nitrogen fixation of pulse crops, quality, nutritive values, etc. These evaluations shall be carried out under close linkages and collaboration with each of CARI's research divisions and other research institutes.

4) Laboratory for Vegetatively propagated plants (clonal preservation)

In Phase I of the programme for tissue culture (culturing of cell, tissue and organ) of vegetatively propagated plants, (1) culturing technology of cell, tissue and organ for multiplication of each crop by variety, and (2) method for preservation (for short-, medium-, and long term) by tissue culture and growing point culture, shall be completed. In Phase II, (1) virus-free germplasms shall be prepared by the growing point culturing technology and (2) culturing technology under non-poison (septic) condition for international exchange of genetic resources shall be developed and utilized.

In Phase III, the tissue culture technology shall be applied for crop improvement.

5) Laboratory for data management

All data on genetic resources shall be input into computer throughout the entire period. The data shall be recorded and preserved on file card. Information on principal traits of genetic resources preserved shall be printed and published for utilization by breeders and other researchers.

3-3-2-2 Technical interchange with relevant institutes

In order to promote activities for the preservation of plant genetic resources aggressively, vigorous research activities of PGRC's researchers are necessary, but since the objects of research are so far-flung, the fields of research pursued at this Centre would naturally have to be limited. Fortunately, the Department of Agriculture periodically holds training sessions in the utilization aspects by calling upon the personnel concerned of CARI, the Regional Agricultural Research Centers (RARC) at various locations and the Central Rice Breeding Station (CRBS). There are also meetings of the Regional Technical Working Group (RTWG) consisting mostly of agricultural researchers of various localities and which are participated by other concerned parties. In order to carry out efficient research activities, it is necessary that these reciprocal technical training programs be utilized and actively promoted by the cooperation of every person involved.

(1) Training session

It is held every month by inviting everyone concerned from various parts of the country for the purpose of technology transfer and improvement of their technical level. It is desirable that basic knowledge of taxonomy, ecology and genetic evaluation methods be imparted to the persons concerned through these training sessions and that each area

organize its respective system around these people who have been trained.

(2) Regional technical working group (RTWG)

It is a study meeting held from time to time and attended by concerned persons of the Agricultural Research Division, the Agricultural Extension Division which extends agricultural techniques, the Agricultural Education and Training Division which trains extension workers and the Farms and Planting Materials Division, all of which belong to the Department of Agriculture, as well as outside organizations including universities (attended by about 300 persons). The purposes of the meeting are to improve agricultural techniques and knowledge and to strengthen linkage with other disciplines. If the cooperation of these people who have the fundamental knowledge can be obtained, more efficient exploration, collection and evaluation activities would become possible.

3-3-3 Brief description of facilities and equipment plan

3-3-3-1 Facilities (Buildings and structures)

The following compares the outline of facilities (buildings and structures) to be provided for this Plant Genetic Resources Centre with those (buildings and structures) requested by the Government of Sri Lanka.

( ) ..... Laboratories excluded from the project

* ..... Facilities newly provided by consolidating the research programmes requested.

Requested Facilities	Planned Facilities
1) Two story main building 4,800m^2	1) Two story laboratory building 3,553m^2
Plant genetic resources laboratory Tissue culture and genetic engineering laboratory (Breeding laboratory) (Biochemical laboratory) (Plant physiology laboratory) (Agronomics laboratory) Laboratory for visiting scientists (Laboratory space for future expansion) (Meteorology Unit) (Weed Science Unit) (Micro Biology Unit) (Radio Isotope Unit) Computer Data Bank Library Lecture rooms	Laboratory for seed storage (including seed storages) Laboratory for vegetatively propagated plants Laboratory for exploration and collection..... * Laboratory for evaluation.. * Laboratory for visiting scientists Laboratory for data management Common facilities Balance room Microscope room Specimen preparation room Incubator room Dark room Library Seminar rooms
Administration office Room for the Botanist Room for the Assistants Store room Visitors room	2) Administration Building 2 story 1,741 m^2 Director's room Administration office Reception room Visiting scientist's rooms Conference hall Lounge Herbarium
Museum and Demonstration room	
Auditorium	

Requested Facilities	Planned Facilities
2) Seed storage 400m^2	(included in Laboratory Bldg).
3) Green house, screen house, phytotron complex 1,055m^2	3) Screen house 450m^2
Green house for plant physiological study 3 Green houses for experiments for joint use 4 Green houses for isolated cultivation 2 Dome-shaped green house 1 Phytotron complex 1	Simplified green house for: Entomological studies 1 Pathological studies 1 Physiological studies 1 Tissue culture studies 1 Germplasm studies 1
4) Work management building 475m^2	4) Field management building, one story 135m^2
5) Workshop building 325m^2	5) Workshop building, one story 441m^2
6) Apartment type staff lodging 5 x 165m^2 Independent staff house 1 x 185m^2	To be constructed by the Sri Lankan side
7) Irrigation facilities for the experimental field	Portable sprinkler to be provided

Requested Facilities	Planned Facilities
8) Provision/improvement of water works, electricity and telephone systems	6) Pump house, one story $90m^2$ well, water receiving tank and water supply tower to be constructed
	7) Power substation building, $90m^2$ Telephone exchange facility to be provided in the Administration Building.
9) Provision/improvement of drainage facilities	Onsite drainage facilities and septic tanks to be constructed
10) Development of onsite roads and garden	Development of onsite roads
11) Staff recreation facility	A tea lounge to be provided in the Administration Building.
Total floor are of requested facilities: $8,065m^2$	Total floor are of planned facilities: $6,523m^2$

3-3-3-2 Equipment

Brief description of equipment to be provided for this Plant Genetic Resources Centre is as follows.

(1) Facilities and equipment for storing plan genetic resources
(2) Facilities and equipment necessary for research and experiment of the research divisions of exploration and collection, seed storage, clonal preservation, evaluation, data management, laboratory for visiting scientists, and field management room.
(3) Common facilities and equipment that require special environmental conditions, such as for weighing, microscope, dark room, thermostatic chamber, etc.
(4) Facilities and equipment for test cultivation and regeneration of plant genetic resources collected.
(5) General administrative facilities and equipment such as office rooms, lecture rooms, conference room, library, and exhibition room.

The following table compares the equipment requested and the equipment to be provided.

Requested equipment	Planned equipment
Equipment and apparatus related to germplasm collection, storage and evaluation of genetic resources	- Long, medium-, and short term seed storage equipment and apparatus - Equipment and apparatus for seed inspection and germination tests room - Equipment and apparatus for seed drying and packing room - Equipment and apparatus for the laboratory for exploration and collection. - Equipment and apparatus for the laboratory for evaluation. Seed inspection equipment and rice milling equipment shall be added to those.
Equipment and apparatus related to tissue culture and genetic engineering development.	- Equipment and apparatus for the laboratory for vegetativily propagated plants - Equipment and apparatus for the laboratory for new technology development - Equipment and apparatus for the room for microscopes - Equipment and appratus for the room for preparing microscopic specimens. - Equipment and apparatus for the room for incubators

Requested equipment	Planned equipment
	* Spectrophotometer, atomic absorption spectrophotometer and electron microscope shall be deleted.
Equipment and apparatus related to plant breeding	- Equipment and apparatus for the laboratory for evaluation.
Equipment and apparatus related to plant physiology	- Shall be deleted.
Equipment and apparatus related to biochemistry	Salinity meter, pH meter, etc. to be provided for the laboratory for evaluation; Electrophoresis device and amino acid analyzer to be provided for the laboratory for new technology development
Equipment and apparatus related to agronomy	- Equipment and apparatus of the laboratory for exploration and collection. - Equipment and apparatus of the laboratory for evaluation. * Truck scale, muffle furnace and autoanalyzer shall be deleted

Requested equipment	Planned equipment
Equipment and apparatus related isotope studies	- Shall be deleted.
Equipment and apparatus related to meteorology	- Fully automatic ones shall be changed to semi-automatic ones.
Equipment and apparatus related to photography	- Black and white film developing
Equipment and apparatus related to museum	- Fixtures and fittings for the herbarium exhibition corner
Equipment and apparatus related to computer system	- Equipment and apparatus for the laboratory for data management. * Shelves and cabinets for storing data files shall be added.
Office equipment	- Office equipment. * Drawing instruments, wall clock, cleaner, microfilm filing system, and bookbinding machine shall be deleted.

Requested equipment	Planned equipment
Vehicles & Farm Machinery	- Four-wheel drive vehicle for exploration and collection and tractors and tillers for field management shall be provided.
Workshop tools	- Tool set for maintenance of tractors and wood working tool set.
Field equipment	- Equipment for threshing, cleaning and drying of seeds, equipment for fumigation, and equipment for screen house culturing management shall be added.
Irrigation facility	- Simple sprinkler set
Equipment and apparatus related to audio-visual	- Equipment and apparatus for seminar rooms and conference hall.
Various balances	- Equipment and apparatus for the room for balances.

For details of equipment, please refer to the list in Paragraph 4-3-4-1.

3-3-4 General condition of the project site

3-3-4-1 Project site

The proposed project site is located at Peradeniya, Gannorwa which is adjacent to Kandy, the country's old capital in the centre of the country. It is situated in the central highland zone about 500m in elevation and is about 120km from Colombo, or about three hours' drive from there.

The site owned by the Department of Agriculture of the Ministry of Agricultural Development and Research, is located within the premises of the Central Agricultural Research Institute (CARI) of the Department's Agricultural Research Division, and is currently used as a test cultivation field by CARI.

CARI is the national centre of the Regional Agricultural Research Centres (RARC) which are located at eight places throughout the country and which belong to the Agricultural Research Division of said Ministry, and it carries out research and development on fundamental technology commonly applicable to food crops throughout the country and also undertakes planning and coordination services for common tests, etc.

In the same area and next to CARI are the Soybean Research Institute (SRI), seed certification and plant quarantine facilities and the In Service Training Institute of the ministry of Agricultural Development and Research. Also concentrated in Peradeniya are most of the agriculture-related organizations including the headquarters of the Department of Agriculture, Peradeniya University (with Faculty of Agriculture and Post Graduate Institute of Agriculture) and the National Botanical Gardens.

Hence, the proposed site is quite desirable as the construction site for the facilities of this project to carry out their role as a antional centre for research on plant genetic resources. The location also seems satisfactory in terms of research environment as it affords easy access to research data and conveniences for interchange among researchers.

3-3-4-2 Condition of the site and its surroundings

The site faces the Central Agricultural Research Institute (CARI) across the arterial road that runs lengthwise through the premises of CARI. It is a flat, rectangular piece of land about 25,000m^2 in area and deviating by about 45° from the north-south axis. It faces roads on two sides, one is the aforesaid arterial road which connects Peradeniya and Kasugasutota, and the other is the onsite road which leads to the In Service Training Institute of the Ministry of Agricultural Development and Research.

As site, however, is lower than the roads by two to three feet, so that banking is necessary for constructing the access road to the buildings to be constructed. Because the site is also lower than the side ditches of the existing road, the new rainwater drainage ditches cannot be connected to them. Special consideration is therefore necessary with respect to drainage method.

A high tension power transmission line runs 10m above ground along the arterial road on the site which prohibits the construction of any structure immediately beneath it for the width of 18m. Along the other road is a telephone line for I.S.T.I. wired about 6m above ground. As this telephone line and the stringing poles are obstacles to gaining access to the facilities to be constructed under this project, they must be relocated to the opposite side of the road.

The site is enclosed by mountains of rich verdure and contacts the Mahaweli River on one side. All buildings of the research institutes in the neighborhood are two stories high, built not close together but wide apart on a vast site. The environment therefore is perfect for research facilities.

3-3-4-3 Natural conditions

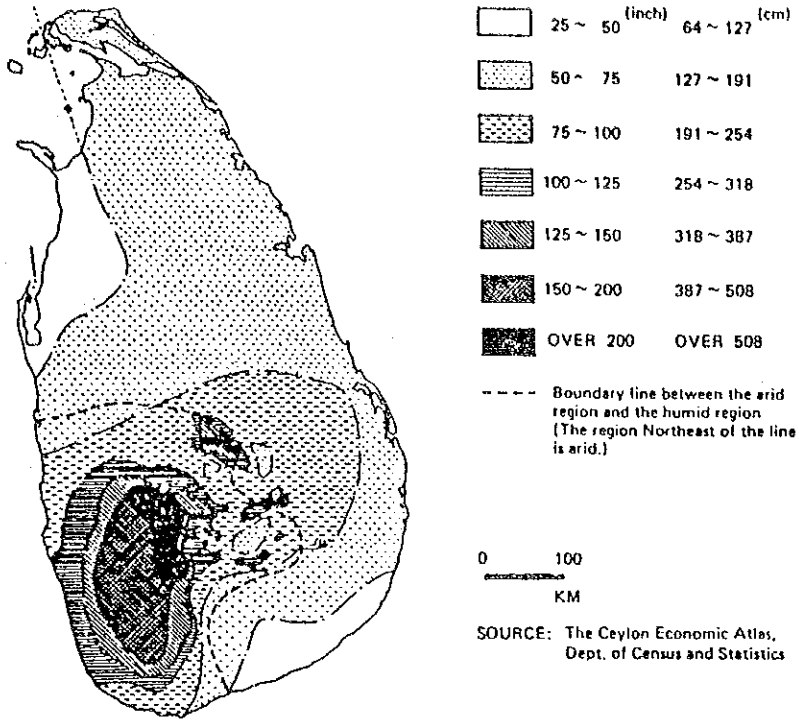
Sri Lanka is situated between 6° and 10° of north latitude, in the hot and humid tropical monsoon zone. Being an island country whose territorial land area is not very large and encircled by the sea, there is very little difference in temperature among localities throughout the year. Rainfall, however, differs greatly. The country may be broadly divided into the arid lowlands in the north and east, the wet lowlands in the south and west, and the wet highland in the centre. Kandy, where the proposed project site lies, is situated approximately in the centre of the island, about 500m above sea level and belongs to the wet highland zone.

The mean temperature in Kandy is 24°C which hardly changes throughout the year. The highest mean temperature is around 30°C during the March-May period, and the lowest mean temperature slightly below 20°C during the December-February period.

The climate here is more comfortable than in the lowland zones in the south and west, for the mean relative humidity is 74%, being 65% during the dry seasons and 78% during the rainy season. Hence, the rooms do not require any cooling facility. Annual rainfall during the last 10 years has been recorded to be in the range of 1,500mm and 2,400mm. It rains a lot during April, May, October and November and hardly in January and February. The amount of instantaneous rainfall due to squalls during the rainy season is large, however, which requires special attention to the drainage plan. The wind is always westerly between April and October and easterly between November and March. This is due to the influence of the equatorial air which either rises northward or southward. Being located in the inland and surrounded by mountains, the maximum wind velocity has never exceeded 5m/sec. on average in the last 10 years, so that it has seldom suffered any damage from cyclones.

As Sri Lanka is outside the major seismic belts of the world, it has no need to worry about earthquakes or seismic force in designing its structures.

Annual Average Rainfall (1911 – 40)



Metrological Data in KANDY

Rainfall

(mm)

Month / Year	1	2	3	4	5	6	7	8	9	10	11	12	Total
1974	0	110	76.9	225	158	37.9	240	140	271	119	144	112	1669
1975	17	67	140	422	88	239	121	233	286	254	371	133	2378
1976	61	0	54.4	165	20	32	175	123	19	270	404	158	1486
1977	2.8	6.7	124	206	450	173	76	92	48	638	311	37	1594
1978	92	51.3	144	101	229	120	107	114	86	309	291	16	1724
1979	38	151	50	236	191	263	206	46	224	362	414	185	2372
1980	1.3	0	86	209	14	146	129	105	120	221	333	76	1570
1981	49.9	9.2	110	157	57	204	190	58	37	112	287	49	1662
1982	0	0	62.5	231	295	238	166	115	33	255	382	216	1996
1983	7.6	12.0	68.1	32.2	220	148	113	187	112	141	223	317	1583
1984	218	119	210	23.6	116	170	358	92.2	325	205	302	99.3	2455

Humidity

(%)

Year \ Month	1	2	3	4	5	6	7	8	9	10	11	12
1974	45.4	64.9	62.4	73.5	73.3	76.3	-	-	-	72.5	76.4	76.2
1975	-	-	-	80.5	78.0	80.5	75.5	81.5	77.5	87.0	82.0	77.0
1976	71.0	62.5	64.0	81.0	66.5	74.0	70.5	75.5	69.0	77.0	79.5	76.0
1977	63.5	64.5	65.0	77.0	82.5	75.0	75.5	73.5	70.0	81.0	71.0	73.0
1978	71.0	67.5	71.0	71.5	82.5	81.5	74.0	80.5	77.5	77.5	73.0	75.5
1979	70.0	73.0	68.0	74.0	73.5	79.0	80.0	75.5	83.5	80.5	85.5	75.5
1980	69.0	57.0	64.0	74.5	74.5	77.0	80.0	81.0	75.0	78.0	81.0	75.0
1981	67.5	62.0	60.0	73.0	76.0	75.0	77.0	76.0	80.5	77.0	78.5	72.5
1982	60.8	55.3	66.4	73.6	76.2	82.8	78.7	76.3	68.8	79.7	78.9	77.0
1983	67.9	57.9	56.8	61.4	71.4	76.5	77.1	79.2	78.6	70.0	72.8	77.1
1984	80.1	80.0	72.1	81.2	74.7	77.3	83.0	73.1	76.3	78.9	80.4	78.2

Average Temperature

(°C)

Year \ Month	1	2	3	4	5	6	7	8	9	10	11	12
1974	23.3	23.8	24.5	25.0	24.6	23.8	-	23.8	23.5	24.5	25.9	25.2
1975	-	-	-	26.9	27.0	24.8	23.6	24.4	24.5	23.7	23.5	23.0
1976	22.5	23.7	24.9	25.0	25.9	25.6	24.9	24.7	24.1	23.6	24.6	23.6
1977	23.5	26.3	25.8	25.3	24.7	24.4	25.2	24.6	24.2	24.3	24.2	24.0
1978	23.7	25.1	24.2	26.1	27.1	24.8	24.5	22.7	24.3	24.4	23.7	23.7
1979	24.5	25.2	25.2	26.0	26.0	25.3	24.7	25.1	22.6	23.4	23.2	23.9
1980	21.0	24.9	24.4	30.2	26.8	23.9	24.3	24.0	24.4	23.5	23.5	23.1
1981	22.6	23.9	26.2	24.4	26.1	24.2	24.1	24.1	23.5	24.0	23.4	22.9
1982	23.7	24.1	25.3	25.3	24.8	24.8	24.4	24.0	24.3	23.3	23.6	24.1
1983	23.6	25.2	26.2	27.0	25.4	24.9	23.7	24.3	23.8	22.4	21.2	23.5
1984	23.5	23.9	24.9	25.2	25.5	25.1	24.0	23.6	24.4	23.9	24.2	23.2

3-3-4-4 Condition of infrastructure

The condition of infrastructure development around the site is as stated below.

(1) Power supply

A high tension three-phase, three-wire 33KV 50 Hz aerial distribution line is installed near the road on the north side of the proposed construction site. Also low tension three-phase, four-wire 400/230V 50 Hz aerial distribution lines are installed along the roads on the west and north. Power to CARI's existing buildings is being supplied from the 33 KV aerial distribution line and transformed by the three 100KV/150KVA transformers installed outdoors before being distributed to each building via the low tension distribution line network.

It is considered preferable, however, to lead in power not via the existing low tension line but via an independent line directly from the 33 KV high tension line that runs across the site in view of the fact that the characteristic of the facility lies in assuring safe and long term preservation of seeds.

The power supply situation in Sri Lanka is gradually improving in recent years. Additional power plants are being constructed with the progress of the Mahaweli River System Development Project, and accompanying this, a 132 KV extra high voltage distribution network is being developed throughout the country.

At present, the Kandy-Peradeniya area receives its power supply from two sources, one via the Matalley distribution line from Ukuwella substation (132/33AV) and the other via the Gannorwa distribution line from Eliyagama substation (66/33KV). The Gannorwa distribution line is subject to large voltage drops during the peak hours of the evening due to the fact that the substation capacity is small, and blackouts for about two hours occur two to three times a month on average.

In accordance with the new power supply improvement project of Sri Lanka, a new substation with a capacity of 66MVA is now under

construction to eventually replace the Elliyagama substation, and it is scheduled for completion by the end of 1987. When completed, this substation will be able to sufficiently supply the kandy-Peradeniya area with power transformed from 132 KV to 33 KV via its new high tension distribution network, which will result in less frequent occurrences of large voltage drops and blackouts.

However, the purpose of this Centre being to safely preserve genetic resources that will be installed, and in view of the laboratory equipment, it is considered necessary to install an emergency power generator and protective devices against voltage fluctuations.

(2) Telephone

About 30 telephone circuits are laid near the proposed construction site at Gannorwa. Three exchanges lead into CARI's 20 circuit switchboard in the operating room which connects with the 20 extension telephones installed in each of its facilities. The preliminary understanding reached with the Kandy Branch of the Telecommunication Department of Sri Lanka is that there are still about 15 extra circuits in the Gannorwa area which makes it possible to install new telephones.

It is considered necessary to relocate the aerial telephone line which is installed along the road on the west side of the proposed construction site as it obstructs the entry and exit of vehicles during construction work under this project.
There is no problem in installing temporary telephones to be used during construction work as the telephone circuits for this Centre are available.

(3) Water supply and drainage

Neither public water main nor public sewer main are laid on the proposed project site. CARI and its related facilities draw water from the shallow well drilled on the Mahaweli River bank. Waste water is not directly discharged into the river but allowed to infiltrate into the ground.

1) Water supply source

The 8 to 15 m deep shallow wells drilled on the Mahaweli River bank are the water sources from which the existing buildings receive their supply of water for domestic use and field use. Method of filtration is natural filtration by sand and gravel on the river bank, by which satisfactory water is obtained for domestic use.

Water for the existing laboratory building is pumped by a 50 x 385 l/min. x 60m storage pump into an elevated tank from where water is also supplied to the staff houses nearby.

For irrigating the fields, water is pumped from a shallow well 5.1m in diameter and 8m in depth into a concrete water receiving tank of 200m^3 in capacity. Some of this water is distributed through the sprinkler piping system and the rest through the irrigation channels to each bloc of field.

More than enough water is available even during the dry season. Until last year, not only the wells but the pump house used to become innundated every time the Mahaweli River rose, but this problem has been liquidated by the completion of the Kotomalay dam on the upstream which was constructed by foregin aid. However, in view of the location of the existing wells and the capacities of the water tanks and pumps, it is considered necessary to provide an independent water supply facility on the site for this Centre.

2) Drainage situation

Rain water discharged from the existing buildings around the sits flows into the side ditches build along the roads and is eventually discharged into the Mahaweli River. Domestic sewage is introduced into the septic tank before being allowed to infiltrate into the ground. Since the existing septic tank has no spare capacity available for this Centre and it is located at a higher place than the proposed site, waste water from this Centre cannot be disposed of by connecting pipes and

remodelling the existing septic tank. It is therefore necessary to newly construct an independent septic tank on the site.

3-3-5 Technical cooperation

The need for technical cooperation for this project and its anticipated effects have already been investigated by the "preliminary study" and "field survey on technical cooperation", the results of which have been discussed and confirmed by the Sri Lankan side.

The basic design study team, on its part, was able to acquire, through its field survey conducted this time, a better understanding of Sri Lanka's research in this field which, even judging from past achievements is considered to have attained a certain reasonably high level, and the team is now fully convinced that Sri Lanka will be able to benefit greatly from the technical cooperation that will be extended from Japan following the provision of facilities of this Centre as a grant-in-aid.

The tentative frame work of technical co-operation agreed with both sides in the preliminary study are as follows:-

1. Purpose of the Project

   The project is to be carried out in the Plant Genetic Resources Centre in Peradeniya for the purpose of promoting crop improvement in Sri Lanka through activities for collection, conservation, evaluation and utilization of Plant Genetic Resources of crops such as rice, coarse grains, pulses, root crops and so on.

2. Executing Organization

   The Central Agricultural Research Institute (Peradeniya in Kandy District) of the Department of Agriculture of the Ministry of Agricultural Development and Research will implement the Project with technical co-operation by the Government of Japan.

3. Duration of Technical Cooperation

Five (5) years form the date of signing the Record of Discussion for the Project.

4. Activities of the Project

(1) To carry out the following activities and research

(i) Exploration and collection of Plant Genetic Resources

(ii) Classification and Evaluation of Plant Genetic Resources

(iii) Conservation and Multiplication of Plant Genetic Resources

(iv) Managing Information about Plant Genetic Resources

(2) To exchange necessary information, data and research materials for the above subjects.

5. Measures to be Taken by Japanese Side

(1) Dispatch of Experts

(i) The field of Japanese Experts on the long term basis are as follows:

a. Genetic Resources Management

b. Genetic Resources Research

c. Coordination and Agronomy

(ii) In addition to the above long term experts, short term experts of following fields would be dispatched depending on necessities.

a. Exploration and Collection

b. Storage Technology of Genetic REsources

c. Cell Biology

d. Classification and Evaluation of different kinds of plant groups

e. Information Management System

f. Other field, if necessary.

(2) Acceptance of counterpart personnel

Several counterpart personnel would be accepted for training in Japan during the cooperation period.

(3) Provision of equipment

Necessary equipment and materials for implementation of the Project would be provided within budgetary limitation for the Project.

6. Measures to be Taken by Sri Lankan Side

(1) Provision of Land, building and facilities for the Project
(2) Assignment of necessary number of counterpart personnel
(3) Budgetary allocation necessary for the implementation of the Project.

7. Establishment of Joint Committee

For smooth implementation of the Project, the joint committee shall be established as follows:

(I) Members

Chairman : Secretary of the Ministry of Agricultural Development and Research

Sri Lankan side

1) The Director, Department of Agriculture of the Ministry of Agricultural Development and Research.
2) The Deputy Director (research), the Department of Agriculture of the Ministry of Agricultural Development and Research.
3) The Deputy Director, the Central Agricultural Research Institute of the Department of Agriculture.
4) Botanist, the Division of Botany, Central Agricultural Research Institute.
5) Representative of the Department of External Resources.
6) Representative of the Budget Division of the Treasury.

Japanese side

1) Team Leader
2) Experts to be dispatched from Japan
3) Coordinator
4) The Representative of JICA SRI LANKA Office
5) Other experts and personnel concerned to be dispatched by JICA Head Quarters, if necessary.

NOTE:
Official(s) of the Embassy of Japan may attend the Joint Committee as an observer.

(II) Functions:

1. To work out the annual plan of the Project
2. To discuss budgetary plan of the Project
3. To review the Project activities
4. To deal with other specific matters concerning the Project

(III) Meeting of the Joint Committee

The Joint Committee is to be held regularly, at least twice a year and whenever necessity arises.