1990-91
First Annual Report

M. S. SWAMINATHAN RESEARCH FOUNDATION

Centre for Research on Sustainable Agricultural and Rural Development, Madras.

Cover (Front)

(Above) Threats to Mangrove forests through human-induced stresses include sea erosion, pollution, extension of urban settlements, conversion for aquaculture, mining, waste disposal and deforestation. Local communities also depend on them to meet essential needs such as fuel wood. Meeting the needs of the rural poor for fuelwood and fodder should be an integral part of any strategy designed to conserve mangrove ecosystems.

(Below) Eco-restoration of mangroves in Pichavaram, Tamil Nadu State, India. Scientists of the Centre for Research on Sustainable Agricultural and Rural Development (CRSARD) are planting *Rhizophora mucronata* propagules collected from the West Coast of India in the degraded area.

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Centre for Research on Sustainable Agricultural and Rural Development

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Introduction

The M.S. Swaminathan Research Foundation was established as a non-profit Trust in July 1988 with funds derived from the first World Food Prize awarded to Dr. M.S. Swaminathan in October, 1987. The Research Foundation's major aims are: first, to integrate the principles of ecological sustainability with those of economic efficiency and social equity in the development and dissemination of farm technologies; second, to undertake the blending of traditional and frontier technologies in a manner that opportunities for skilled jobs in the farm and non-farm sectors improve in rural areas; and third, to develop and introduce technology, knowledge and input delivery and management systems which will enable disadvantaged sections of rural communities, particularly women, to derive full benefit from technological progress. In terms of sustainable human welfare, these scientific goals should lead to a concurrent strengthening of the ecological security of rural areas and the livelihood security of rural families.

In industrialised nations, the goal of sustainable development is to preserve the life styles and high agricultural and industrial productivity levels already achieved. In our country the goal should be the eradication of excruciating poverty, unemployment, illiteracy and low productivity. In other words, while preserving the *status quo* in yield may be the goal of the sustainable agriculture movement of industrialised nations, our goal has to be the enhancement of the productivity, profitability and stability of our major farming systems based on ecological ground rules. Thus our concept of sustainability has to be a dynamic one, leading to a continuous improvement in biological productivity on an ecologically and socially sustainable basis. It is to this pathway of agricultural and rural development that the M.S.S. Research Foundation is dedicated.

Achieving these scientific and social goals will be possible only through a *participatory research* mode involving scientists and rural families. Also, social scientists and biological technologists will have to interact in a proactive manner, designing input delivery and extension systems which can ensure that new technologies reach the unreached. The training and educational methods will also have to achieve a proper match between rural needs and realities and scientific and technological approaches and objectives.

In addition to participatory research and training designed to address the major food security challenges of today, namely, protecting the ecological foundations for sustainable advances in biological productivity and generating the educational and employment opportunities needed for economic access to balanced diets, attention also needs to be devoted to the emerging problems associated with potential changes in climate and sea levels as well as changes in consumer preferences and industrial technologies. Such

anticipatory research programmes are essential, if agricultural progress is to remain relevant to changing needs and climate.

It would be clear that the above goals constitute a scientific and educational agenda far beyond the capability of a small non-governmental research centre. Hence from the beginning, the Foundation started functioning on the principle of a "centre without walls," so as to derive maximum benefit from partnership with institutions and individuals working for similar goals.

The Foundation established in March 1990 a Centre for Research on Sustainable Agricultural and Rural Development as a registered society under the Tamil Nadu Societies' Registration Act of 1975. The Centre is presently functioning in a rented building in Madras city. The Government of Tamil Nadu kindly made available to the Foundation on 30 years' lease 0.6 hectares of land in the Taramani Institutional Area in Madras for the construction of this Centre. The Tamil Nadu Government through the State Department of Forestry, has also made available 50 hectares of land in the Pichavaram mangrove area for establishing a Genetic Resources Centre for adaptation to sea level rise. Thanks to the recogition accorded by the Ministry of Science and Technology of the Government of India and by the Income Tax authorities under Section 35 (i) (ii) of the Income Tax Act, the Foundation has received generous support from many individuals and organisations, which has made it possible to begin the construction of the Research and Training Centre.

Since this is the first printed annual report of the centre, covering the period January 1990 to June 1991, an explanatory statement on the goals, methodologies and components of the following five major programmes introduces each section, for a better appreciation of the short-term and long-term objectives of the different research programmes.

Programme Area 100	:	Coastal Systems Research
Programme Area 200	:	Biological Diversity
Programme Area 300	:	Biovillages
Programme Area 400	:	Reaching the Unreached
Programme Area 500	:	Education, Training and Communication

The above five major programme areas are designed to converge on a common goal, namely the promotion of a pattern of agricultural and rural development rooted in the principles of ecological sustainability, economic efficiency and social equity. Every major programme has several sub-programmes, each spearheaded by a Project Leader. To derive maximum benefit from the available expertise and know-how the centre has constituted Project Advisory Committees for each programme area, in addition to a broad-based

Research Council. The location of the Centre in what has sometimes been referred to as the "Science Nagar" of Madras, has been a great advantage. The Vice Chancellors and professors of the Anna and Madras Universities and the Directors and Scientists of the Indian Institute of Technology and the Central Leather Research Institute have been most helpful and supportive. Similarly the Vice-Chancellors, Deans of Agriculture and several Faculty members of Tamil Nadu G.D. Naidu Agricultural University, Tamil Nadu Veterinary and Animal Sciences University and the Annamalai University have been most helpful. Above all, the various Departments of the Government of Tamil Nadu, the Indian Council of Agricultural Research (ICAR), the Department of Biotechnology and the Ministry of Environment and Forests of the Government of India, have extended full support. The State Forest Department of Tamil Nadu and the Central Institute of Brackish Water Aquaculture of ICAR have also given significant support.

As a part of its efforts to promote convergence and synergy in thought and action, the Foundation has sponsored from its inception, several wide-ranging Dialogues on important topics, as follows:

* Keystone International Dialogue on Plant Genetic Resources – January, 1990
* Dialogue on the Genesis and Spread of the Wheat Revolution in India – March 1990
* Organisation of a Global Network of Genetic Resources Centres in Mangroves– January, 1991
* New Technologies : Reaching the Unreached. I. Biotechnology – January 1991.

In January 1992, the second Dialogue under the Series "New Technologies : Reaching the Unreached" will be held at Madras on the topic "Information Sciences and Technology"

We look forward to continued cooperation, help and advice from rural families, peers, colleagues, co-workers, friends and well-wishers. The Staff of the Foundation and its Research Centre owe a deep debt of gratitude to the State and Central Governments and to the donors listed in this Report, for their support and encouragement. We are especially grateful to Mr. B.R. Barwale and Mr. Ramkrishna Bajaj, who demonstrated their confidence in us by their substantial initial contributions. We will do our utmost to be worthy of this trust. We thank *The Hindu* for the design and color separations for both the cover and central pages.

During the period covered by this report much time and thought were devoted to designing projects and to defining the initial thrusts of the technical programmes. Hence, in the following pages the programme details have been set out at some length, although work on several of them is in the preliminary stage.

Programme Area 100

Coastal Systems Research

Introduction to the Programme

India has a coastline of over 7500 km and Tamil Nadu's coastline extends across 1000 km. Coastal communities depend for their livelihood largely on fisheries, forestry, animal husbandry and tourism. Because of population pressure and unsustainable development, coastal areas are getting bereft of natural biological wealth such as mangroves, sea grasses and coral reefs. Coastal ecosystems are characterised by high genetic diversity and can be regarded in terms of their biological richness as the marine equivalent of tropical rain forests. Most people inhabiting the coastal areas of Tamil Nadu are poor. Women generally perform unskilled and underpaid jobs and child labour persists.

As much carbon is fixed in the oceans as on land. Yet, the contribution of oceans to the food resources of the world is less than 10 percent of the amount harvested from the land. Unfortunately, a detailed ocean capability classification, analogous to land capability studies, is yet to be undertaken.

Research on coastal ecosystems has so far mostly been on specific components of the system and not on the system as a whole. Thus, marine biologists and fisheries scientists have studied different aspects of the ocean surface from the point of view of yield of aquatic products. Botanists, foresters and agricultural scientists have studied several aspects of coastal vegetation and farming practices. Integrated studies of sea and land surfaces and of capture and culture fisheries and coastal forestry and agro-forestry by inter-disciplinary teams are yet to be undertaken on any significant scale.

Tamil Nadu is a rain shadow region. Water is a major constraint not only for agriculture but also for human habitation. The vast coastal region could provide a reasonable quality of life to large numbers of people provided economic development is based on the foundation of ecological security. CRSARD has hence chosen the integrated and sustainable management of coastal ecosystems for priority attention. For this purpose, CRSARD has developed a Coastal Systems Research (CSR) Methodology. The CSR methodology is an adaptation of the Farming Systems Research (FSR) methodology already widely used by agricultural scientists world-wide.

The steps involved in CSR are given in the box, based on the principles that follow.

CSR Methodology

Step I	Survey and analysis of current patterns of economic development and natural resources management and the development of a Resource Management Balance Sheet.
Step II	Analysis of the linkages between the livelihood security of local communities and the ecological security of the coastal zone.
Step III	Based on a clear understanding of sustainability and unsustainability indicators, develop a plan for the integration of appropriate new technologies with current technologies in such a manner that both the economic well-being of the coastal community and the ecological foundations of coastal aquaculture and agriculture can be concurrently strengthened. Finalise the plan in consultation with the local community.
Step IV	Articulate clearly the technological intervention points in the areas of capture and culture fisheries, coastal forestry and agro-forestry and coastal crop and animal husbandry. Identify the new material and management procedures required and the changes needed in the marketing procedure for making it producer-oriented. Discuss these with the local community.
Step V	Based on the views of the local families, introduce technologies which can help to elevate and stabilise the productivity and profitability of coastal farming systems and support such introduction with appropriate training/re-training programmes and with the basic essential infrastructure for storage, processing and marketing.
Step VI	Help to mobilise the needed credit, insurance, marketing and public policy support needed for the successful refinement and dissemination of ecologically sound methods of natural resources utilisation.
Step VII	Organise the necessary demonstration, on-farm research, fish seed and feed production and all other steps needed for the Sustainable Coastal Ecosystem Management (SCEM) package for widespread adoption and impact. The SCEM package should spell out for each area the precise technologies, services and public policies needed for the package to find favour among the concerned people and thereby trigger a self-replicating pattern of coastal eco-development.
Step VIII	Develop and introduce suitable monitoring tools and promote organisational structures for group endeavour in areas like prevention of sea erosion and conservation of coastal vegetation as well as in processing and marketing.

— The research programme must be *participatory* in nature, involving the active participation of coastal families in all phases of both planning and implementation.

— The area taken up for integrated studies can be about 10 km of sea surface and 10 km of land surface in terms of width. The length can be adjusted to suit an administrative unit such as a Community Development Block (or Panchayat Union as termed in Tamil Nadu).

— The first step is to understand the current pattern of human resources development, natural resources management and economic development in the area. The human impact on the coastal ecosystem will have to be studied from both the positive and negative angles.

— Based on the nature of anthropogenic pressures and pattern of economic development, a set of indicators to measure sustainability and unsustainability in the use of environmental capital stocks will have to standardised.

— The sources of livelihood on the existing patterns of resource use and technology adoption will be assessed. The linkages between the current patterns of employment and income generation with the ecological security of the coastal area will be studied (see Sub-Programme Area 405 for methods of calculating Livelihood Security Index)

— The opportunities available for improving employment and income through the introduction of new technologies and through improved training and trade will be studied. Opportunities for blending the new technologies with traditional wisdom and do-how will be studied. The available options will be presented to the rural families.

— Based on the decisions of the local farm and fisher families, a programme of demonstrations, training and development will be initiated.

— A monitoring system operated by local youth will be developed for ensuring that a higher rate of growth in economic well-being is not accompanied by long-term damage to the environment.

It will be clear from the foregoing that the major areas of concern for the CSR Project are :

* The ecological infrastructure of the area and its management
* The prevailing socio-economic conditions
* Current efforts in human resource development
* Opportunities available for the improvement of the quality of life and environmental protection and

* Methods of organisation and empowerment which will lead to local communities having a stake in the safeguarding of their environmental assets.

The wider human implications of the CSR Programme being developed by CRSARD will be clear from the fact that, according to UNESCO, 6 out of every 10 people in the world live within 60 km of the seashore.

Sub Programme Area 101

Surveys and Natural Resources Management Balance Sheet

A Spearhead team of social and biological scientists was constituted in March 1990 to prepare an inventory of the existing patterns of land and water use and of skilled and unskilled employment in the coastal areas of Thanjavur District of Tamil Nadu (Figure 1). Employment opportunities for landless labour families in Thanjavur District are becoming less due to conversion of double crop rice fields into single crop ones and due to the introduction of direct seeding technology in place of transplanting, resulting from the increasing uncertainty of water availability from the river Cauvery and a gradual drop in ground water levels.

Members of the Spearhead team included senior officials from various Government departments such as Agriculture, Fisheries, Forests, representatives from credit technological and training institutions and scientists from CRSARD. The members had detailed discussions with the Panchayat Union leaders, Block Development Officers, Agricultural Officers and the local agricultural and fisher families.

It was observed that the major ecological problems in coastal areas are the growing damage to land (sea erosion) and water (unsustainable utilisation of ground water) and the loss of biological diversity. Such damage in turn affects the livelihood security of the poor and reduces opportunities for gainful employment. The main focus therefore in the first phase of the CSR programme was the selection of suitable sites where, with the active involvement of the local communities, an integrated programme of management on land and sea surface (10 kms in either - direction from the shore line) can be promoted.

Criteria for site selection

* Location on coastal area
* The state of the eco-system
* Economic conditions and marketing opportunities

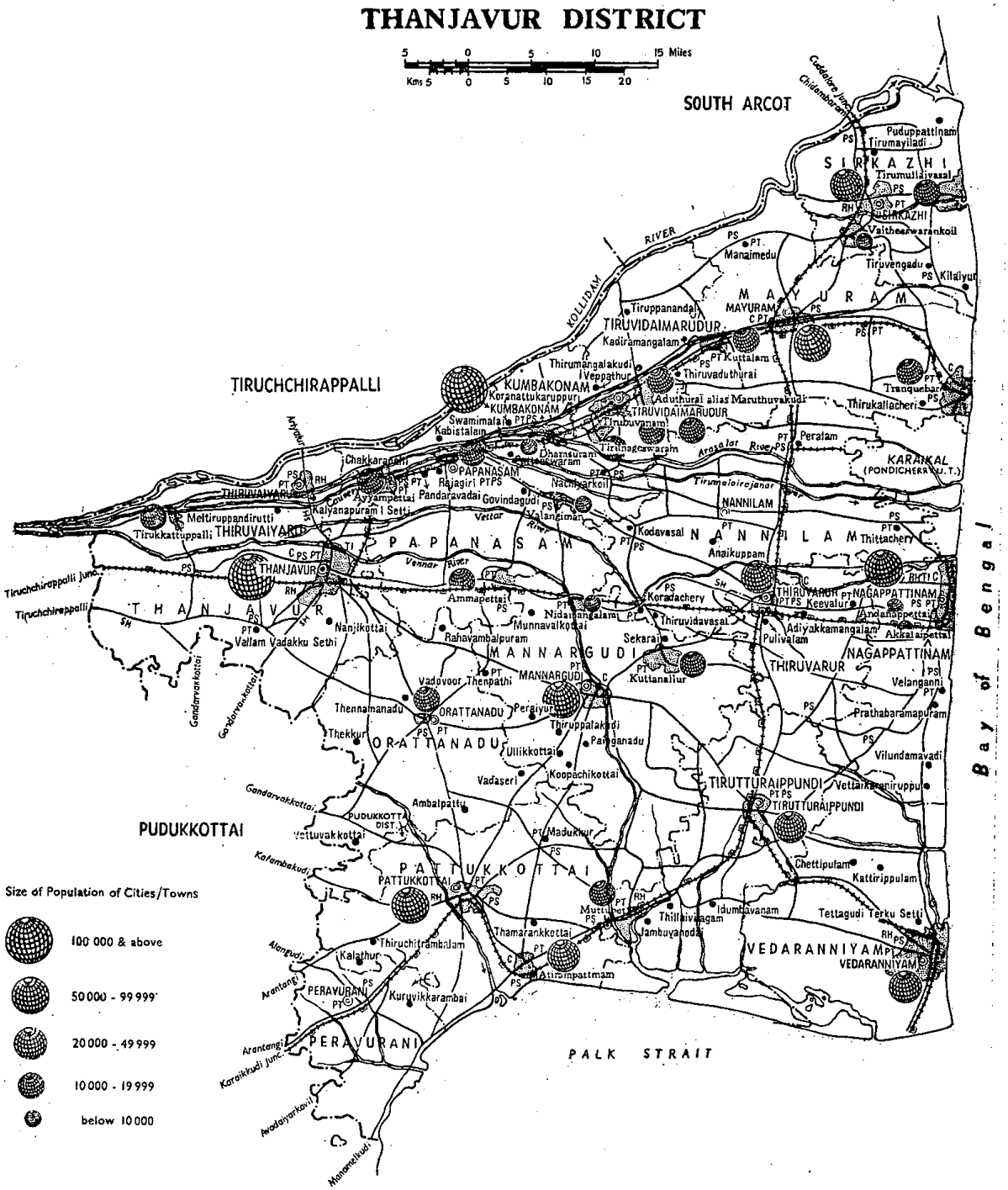


Figure 1
Map of Thanjavur District (population values are based on the 1981 Census)

* Need for diversification of employment opportunities
* Untapped opportunities for infra-technological renewal of traditional rural occupations
* Basic requisites like the availability of electricity and communication facilities,
* Literacy and receptivity to new ideas
* Scope for optimisation of natural resource use and human resource development
* Availability of technologies already on the shelf or in advanced stages of development for optimal utilisation of the natural resources base.

The team carried out a survey in those sites which satisfied the criteria listed for the implementation of the technological goals coupled with the social objectives.

As a prelude to making a Natural Resources Management Balance Sheet, an appraisal was made to understand the 'assets' and 'liabilities' available both at the village and individual family level. The study also aimed at understanding the current employment situation and available employable skills.

Survey Methodology

1. An overall assessment of each village by studying village records and through discussions with the Panchayat officials.

2. A complete listing of *all* families in one village to get a proper fix on the total human resources and the individual family situations.

3. The following surveys were carried out:

   a. Survey of Natural Resource Endowments

   b. Survey of Human Resource Endowments

   c. Survey of Infrastructure Endowments
   Education, health care, input supply, marketing, training, adaptive research, communication (rural roads) and electrification.

   d. Survey of Technological Status
   Technologies used in relation to the major farming systems in the area

   e. Survey of Livelihood Status

      i. Primary sector
      Crop husbandry, animal husbandry, forestry and fisheries

ii. Secondary sector
Agro-processing, small industries and facilities for the preparation of value-added products.

iii. Tertiary sector
Traders, artisans, Government staff, etc.

During the site selection visits, members of the Spearhead team studied the Panchayat Union areas with a population of about one lakh in the coastal taluks of Peravurani, Thiruthuraipundi, Vedaranyam and Nagapattinam.

A household survey of the villages considered to be potential sites for CSR programme in Nagapattinam taluk was carried out. This was done in three villages namely Vettaikaran Iruppu, Prathaparamapuram and Naluvethapathy, with the kind help of the Departments of Planning and Development and Rural Development of the Government of Tamil Nadu. A census survey on the socio-economic status of the population (carried out in March 1991) and a mapping of its natural resource base revealed the features listed in Table 1 for the village Vettaikaran Iruppu.

Table 1
Basic data relating to Vettaikaran Iruppu

Total population	5983
Total no. of households	1526
Total area	1168 ha
Forests	Nil
Net cultivated area	812 ha
Sown more than once	Nil
Food crop (paddy)	262 ha.
Pasture	Nil
Total no. of operational holdings	2137
No. of farmers owning below 1 ha.	1661 (75% of all farmers)
No. of families living below poverty line	1394

The immense human resource potential is illustrated by the data regarding educated unemployed in one village alone (Vettaikkaran Iruppu) gathered from interviews with a random sample of village youth (Table 2). A census of educated youth in the area is being taken up.

Table 2
Educated Unemployed in Vettaikkaran Iruppu

Category	Number	Total
Secondary/Post-Secondary		111
SSLC	76	
PUC	4	
HSC	31	
Technical		12
	5	
Dip. Mech. Eng.	3	
Dip. Tech. Ed.	4	
Industrial Training Institute		
Graduates		21
	11	
Science	5	
Arts	4	
Commerce	1	
Engineering		
Post-graduates		5
Arts	2	
Commerce	2	
Law	1	

The land use mapping was done by the village people themselves (Figure 2). Mention needs to be made here of Mr. Rajasekar, Mr. Murugan and Mr. Annadurai, who motivated the people to participate in the research.

Similar surveys have been taken up in Naluvethapathy and Prathaparamapuram. The data collection from both primary and secondary sources for other sites is still going on.

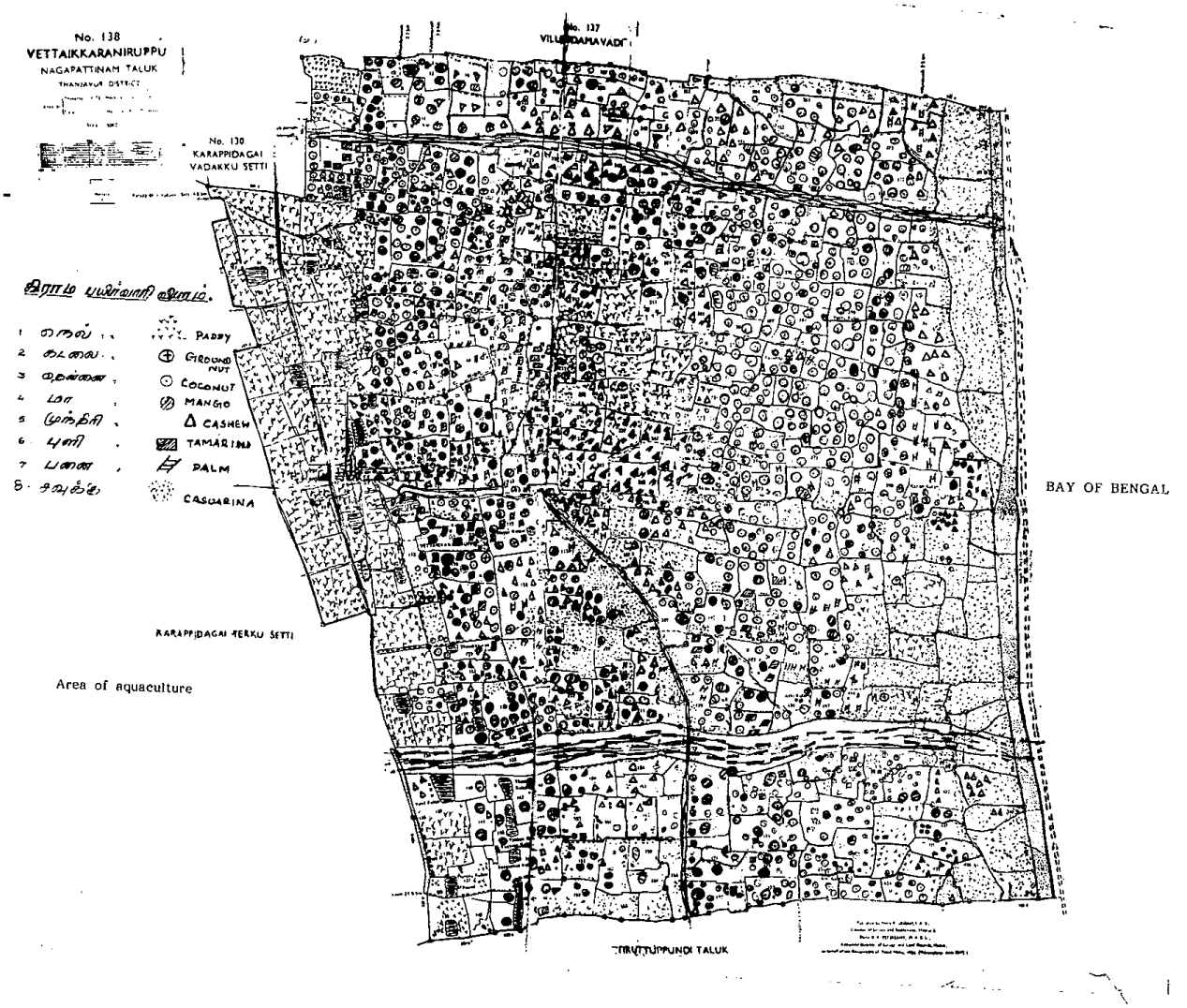


Figure 2
Resource mapping of Vettaikaran Iruppu done by the villagers themselves

The survey revealed that the crops cultivated are predominantly horticultural and agro-forestry crops such as mango, coconut, cashew and casuarina. Paddy and groundnut occupy about 30% of the land under cultivation (Figure 3). Among those engaged in agriculture, the proportion of agricultural labourers is 27%, while the proportion of marginal farmers is over half the farming population (56%) (Figure 4). The fraction of farm land held by marginal farmers is about 40% (Figure 5). A census of livestock population showed the presence of mostly local breeds among cattle; only three animals (bulls) belong to an exotic breed. Goat rearing is common and there were a few farmers interested in poultry farming which is yet to be introduced on a commercial scale.

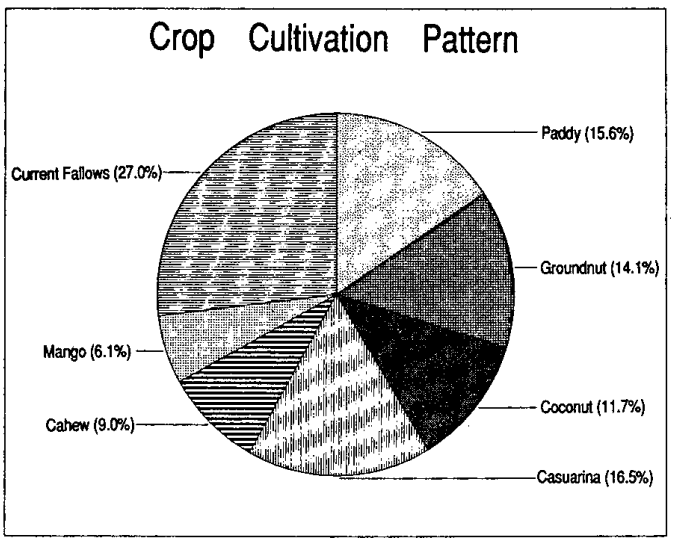


Figure 3
V. Iruppu: Net Cultivated area : 812 ha

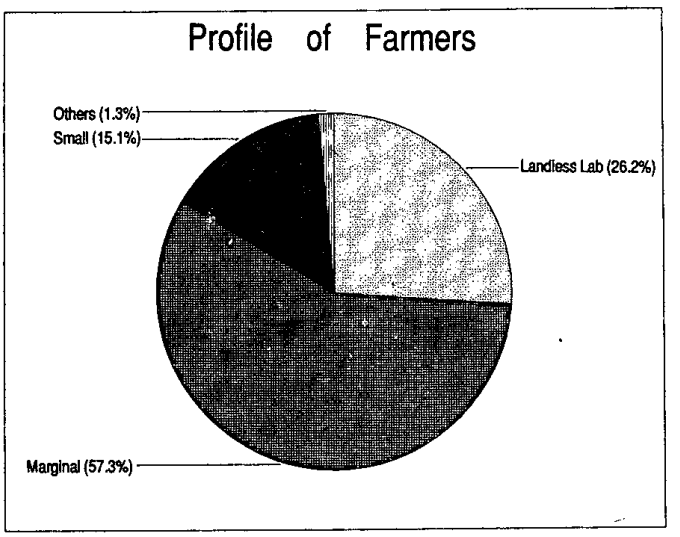


Figure 4
V. Iruppu: Total no. of farmers : 2137

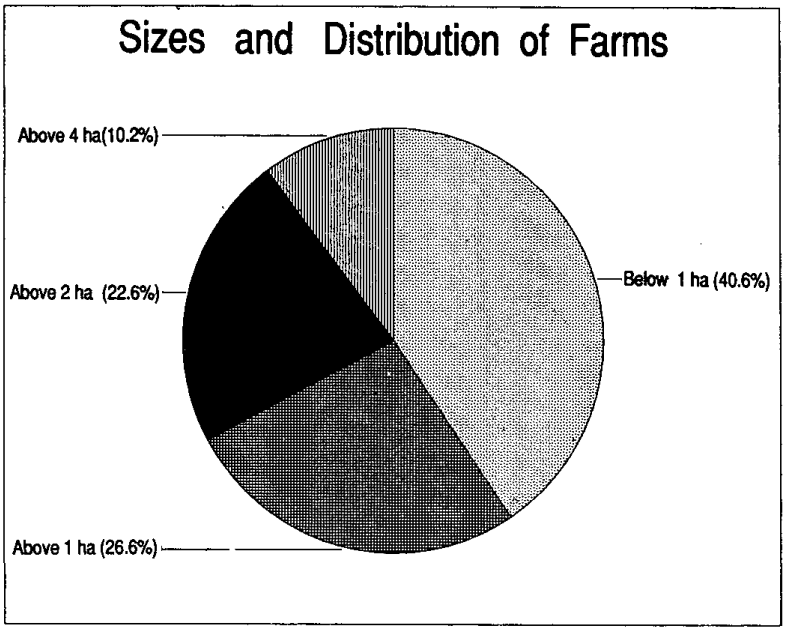


Figure 5
V. Iruppu: Total no. of operational holdings : 1661

Sub Programme Area 102

Technology Options and New Material and Management Methods

The coastal village of Vettaikaran Iruppu affords opportunities for improved capture fisheries (particularly at the marketing end), brackish water aquaculture, coastal forestry and coastal agro-forestry. The agro-forestry programme could include fuel wood and fruit tree species and horticulture and poultry farming. The existing practices and new technological options, based on discussions with the local community, are indicated in the box.

Vocation	Existing practices	Technological options
Capture fisheries	Artisanal fisheries from natural resources. Indigenous fishing crafts and gears are used. Bulk trawling deprives the share of the non-mechanised catamaran fishermen. Exploitation of juvenile and broodstock prawn and fish.	Introduction of sustainable fish harvesting practices, improved landing, harvesting drying, storage and processing facilities and producer-oriented marketing methods.
Culture fisheries	A few private farmers holding 0.5 ha – 1 ha practise prawn farming. Non availability of seed and feed are the main constraints in the existing practices.	Integrated brackish water aquaculture, seed production through hatcheries (localised) and nutritionally balanced feed preparation. Organisation of training programmes.
Coastal forestry/Agro forestry	Casuarina plantation for fuelwood tamarind, cashew, mango, coconut are cultivated with low yield. Processing and marketing facilities are not adequate. Least priority is given for vegetable and medicinal plants. Indiscriminate use of pesticides.	Improved methods in seed, nursery and plantation technique in mangroves, palm, casuarina, cashewnut, coconut, mango, vegetable and medicinal plants. Integrated pest management and improved marketing.
Crop/Animal Husbandry	Paddy is cultivated as a dry crop during the monsoon. Groundnut occupies 10-15% of the total cultivated area. Bullocks for ploughing and haulage are reared in a no. of houses. Milch animals are reared in 25% of the families. Goat rearing is a common practice, Poultry farming is not common.	Alley and organic farming technique to integrate livestock (ruminant) and crop farming. Introduction of poultry on a commercial scale.
Biomass Utilisation	Coir production is practised cashew, apple, cashew shell, tamarind shell and other plant products are not used for preparation of value-added products.	New opportunities in bio-processing leading to better utilisation of parts of the plant/animal/fish biomass.

Figure 6 Technology Options

The Government of Tamil Nadu has decided to provide on lease 60% of the brackish water area to fisher families and small and marginal farmers for extensive and semi-intensive farming. The remaining 40% of area will be allotted to medium and large scale aquaculturists (20% for medium sized operations and 20% for large enterpreneurs, who have higher investment capacity and the necessary know-how). Under this policy 60% of the 1662 ha area in Thanjavur District (996 ha) will be allotted to the poorest families. This target group would need capital, technology, inputs, training and services if the programme is to succeed.

The constraints identified by the fisher and farm families in Thanjavur District are:

* Non-availability of quality prawn seeds
* Non-availability of suitable fish feed and
* Poor water management.

After a detailed discussion with experts from technical institutions such as CIBA (Central Institute for Brackish Water Aquaculture), MPEDA (Marine Products Export Development Authority) and Government representatives from the State Fisheries Department, it was concluded that the brackish water area located at Karapidigai South Sethi village of Vedaranyam taluk is suited for prawn farming and shrimp hatcheries. The area available for brackish water farming is 532.07 ha. The allotment of 50 ha brackish water area, identified for culture fisheries was negotiated with the State Fisheries Department for setting up the integrated brackish water farming programme.

At present, shrimp seed production through hatcheries and wild collection can meet only about 10% of the actual seed requirements. A substantial increase in seed production is essential for popularising prawn farming. Selection of conventional and non-conventional ingredients, their proximate composition and the preparation of feed for different species of prawns are critical in prawn feed production.

On the land surface, the CSR project is aimed at enabling small / marginal farmers to benefit from the untapped potential in horticulture and poultry farming.

A number of superior genotypes and varieties of cashew from the Konkan Agricultural University (Vengurla) *Casuarina junghuhniana* from Indonesia, *Paulownia* trees from China, bamboo varieties local as well as from other regions, and mango were collected. These genetic materials will be assessed for further progeny testing by periodic observations on growth, flowering, fruiting, pest resistance and salt tolerance. Nurseries with mist propagation chamber will enable the large-scale multiplication of elite varieties of fruit trees. Multiplication of mango by hypocotyl grafting method can help to meet the demand for quality mango grafts.

An integrated pest management procedure is essential in Thanjavur district as broad-spectrum pesticides are being sprayed indiscriminately. Post-harvest

technology needs intensification to strengthen the secondary sector in the village. The primary-sector-dominated villagers sell their perishable commodities at rock-bottom prices due to the non-availability of infra-structural facilities for cold storage, processing and marketing.

Mixed farming involving crops and livestock is both a way of life and a means to livelihood security in the rural families of Thanjavur. Most farmers own livestock such as cattle, buffalo, sheep, goat and poultry. Due to pressure on land they are kept on zero grazing during crop growing season, requiring farmers to cut and carry

To integrate livestock/crop farming the best management method was considered to be the introduction of sylvi-fodder systems of agro-forestry and the enrichment of straw. *Leucena*, *Gliricidia* and *Sesbania* are suitable for this purpose. As a supplement to the normal diet of either free- roaming on confined animals, legume tree forage reduces pre-weaning mortality, improves growth rates and shortens parturition interval. A 0.2 ha integrated farm can provide forage for 25% of the daily requirements of four ruminants during one cropping year.

The villagers of Vettaikaran Iruppu are rearing at least 10 to 20 goats in each house. It was observed that the maintenance of cattle by small landholders is very difficult due to the high cost of concentrate and paddy straw. The transport cost, non-availability of grazing land and non-availability wallowing of facilities for buffaloes add to the problems of cattle-rearing in the village. The goats reared here are small and under-nourished. They are fed with casuarina needles and groundnut hay. The introduction of Jamanapari bucks will improve goat-rearing in this village. Backyard poultry of 5-10 birds is the only poultry practice in villages in Thanjavur. The introduction of large-scale poultry should be economically feasible in these areas. The technical help of Tamil Nadu Veterinary and Animal Sciences University, National Dairy Development Board and Shri. Venkateshwara Hatcheries, Pune is being sought in the technological intervention in animal husbandry practices.

Sub Programme Area 103

Marketing and Organisation

In the ultimate analysis, only opportunities for assured and remunerative marketing can help to stimulate and sustain the interest of rural families in new technologies. The cost, risk and return structure of the technologies recommended will influence

decisions on their adoption. This is why the CSR methodology places equal emphasis on marketing, management and material.

The new opportunities identified in the villages studied by the CSR Spearhead team are in the following areas.

* Brackish water aquaculture – fish seed and feed production
* Horticulture/Agro-forestry new strains of casurina, mango, and cashewnut
* Poultry farming
* Biomass utilisation with particular reference to the marketing of enriched biomass in fodder banks.

In order to ensure that during the implementation phase of this project, farm and fisher families do not face any difficulty in marketing, discussions were started with the following agencies about marketing arrangements.

* MPEDA for prawns and aquaculture products
* NDDB for the sale of horticultural products
* Venkateswara Hatcheries with regard to poultry products.

In order to insulate farmers from risks due to factors beyond their control, the United India Insurance Co. Ltd. has been involved from the very inception of this project, to provide insurance cover to the credit made available to farmers and fisher families for taking to new technologies. Representatives of the State Bank of India and of the United India Insurance Co. Ltd. have been involved in the design of the programme.

Programme Area 200

Biological Diversity

Introduction to the Programme

The provisional figures of the Census 1991 place our current population at 844 million. The human population at the time of the independence of the country in 1947 was 342 million. At the current growth rate, the annual addition to the population will be over 16 million, the largest in the world. In addition to the vast human population, India is also rich in animal population, particularly in farm animals like cattle, buffalo, sheep, goat and poultry. Although the country has over 16% of the global human and over 20% of the farm animal population, it has only 2.4% of global land area. Forests of adequate density constitute only about 11% of the land area, while less than 4% of land is available for pastures and grazing.

It is to the credit of the country that inspite of the addition of over 500 million people to the population since 1947, no major famine has been allowed to occur since Independence. Endemic hunger however persists due to inadequate purchasing power among millions of people. Food production has been kept above population growth rates, thanks to the introduction of science - based technologies, small - farmer oriented services and public policies designed to stimulate production and consumption by the economically handicapped producers and consumers.

New crop genetic material has played a pivotal role in the transformation of our agriculture. Examples are: the Norin dwarfing genes in wheat, the Dee-gee-woo-gen dwarfing gene in rice, cytoplasmic and genetic mechanisms for male sterility in maize, pearl millet, sorghum and other crops and genetic factors for photo-insensitivity in wheat and rice.

The pressure of population as well as some of the pathways of development chosen are causing damage to major ecosystems like hill, wetland and coastal ecosystems and thereby to the loss of habitats rich in fauna and flora. Because of the diversity of soil, climate and growing conditions, India is rich in its endowments of plant species. Habitat destruction and the extension of agriculture to forest areas promote species extinction.

Sustainable advances in biological productivity are essential for meeting the food, fuel, fodder and other needs of our growing population. Biological diversity is essential for achieving sustainable gains in productivity per units of land, water, energy and time. We can neither sustain a national food security system nor face the challenge of climate change if we fail to conserve and utilise in a sustainable manner our genetic wealth in flora, fauna

and microorganisms. Fortunately, the Ministry of Environment and Forests, the Indian Council of Agricultural Research and its National Bureaus of Plant, Animal and Fish Genetic Resources, the Department of Biotechnology and the Council of Scientific and Industrial Research have taken several steps to prevent genetic erosion at the ecosystem, species and intra-specific levels. These steps have helped to conserve for current and future use a wide range of valuable genetic material. The Department of Biotechnology has also supported the establishment of special tissue culture facilities for the conservation of crop genetic resources at NBGPR. New Delhi, blue–green algae at IARI, New Delhi and micro-organisms at Chandigarh. In addition, the DBT has assisted CRSARD in establishing a Genetic Resources Centre for adaptation to potential changes in sea levels in the Pichavaram mangrove area of Tamil Nadu (see Sub- Programme Area 202). There is, however, as yet, no special programme solely designed for saving the species under threat of extinction.

The conservation and sustainable utilisation of biological diversity and the prevention of intra-specific genetic erosion are essential for access to the genetic variability needed to achieve sustainable advances in biological productivity. Such work will not succeed if it remains only a Government programme. Community awareness and participation are vital for achieving the desired goals. For this purpose a Research and Training Centre named after the Russian geneticist N.I. Vavilov, who pioneered efforts in *ex-situ* conservation in cultivated plants in the 1920's is being established by the Foundation at Madras.

Biodiversity is the total variability within all living organisms and the ecological complexes in which they exist. In the public debate on loss of diversity, most attention has been drawn to the loss of species, where a single well-known species, such as the panda or penguin, is threatened with extinction or where a species-rich ecosystem such as tropical rainforest is under threat of destruction. However, the loss occurs at every level of biological organization. The survival of a species receives more public attention than the protection of diversity within a species, but it is diversity within species that is the key to their survival in nature in the long term. Again, genetic erosion as a whole receives less attention among the public since, unlike soil erosion, it is not visible to the naked eye.

About 1.5 million species have been described by taxonomists so far. Some experts estimate that over 50 million species may exist on our planet, if we take into account the prevailing genetic variability in invertebrates and microorganisms. Unfortunately, interest in the science of biosystematics is waning among young scholars and hence we may not even know what we are losing as a result of deforestation and habitat destruction.

Hardly 3% of the terrestrial ecosystems and 1% of the marine ecosystems have been designated so far globally as "protected areas". But according to IUCN, already 91 of such sites in 57 countries (both developing and industrialised) are threatened both due to unsustainable development and anthropogenic pressures. The number of "protected areas" which are listed in the IUCN register as "threatened" is growing. In developing countries, the threat to National Parks, Biosphere Reserves and Reserve Forests sometimes comes

from human communities who perceive the protection as being in conflict with their economic survival. This is a sad reflection on the quality of our management of biological wealth. Conservation strategies should help to strengthen and not erode the livelihood security of the people of the concerned area.

The loss of genes, species and ecosystems is occurring at a time when new genetic combinations may be essential both for raising the ceiling to yield and for adaptation to potential changes in climate, sea levels and ultraviolet-B radiation, and when genetic engineering is making the transfer of genes across sexual barriers possible. The loss of every gene, species, and ecosystem will obviously limit our options for the future.

Without an intelligent use of genetic variability it will be difficult to achieve sustainable advances in crop productivity. This is why the conservation and sustainable utilisation of biological diversity are urgent tasks. This programme area is designed to achieve convergence in perception and action at the professional, political and public levels.

Sub Programme Area 201

N.I. Vavilov Research and Training Centre for the Sustainable Management of Biological Diversity

N.I. Vavilov was a visionary in the conservation and utilisation of genetic diversity in crop plants. He became a victim of politics and died in a Siberian prison. However, history was set right when the USSR Academy of Sciences and the Lenin All – Union Academy of Agricultural Sciences celebrated in Moscow on November 24, 1987, the centenary of Vavilov's birth. In a lecture delivered at the Vavilov Centenary Symposium, Dr. M.S. Swaminathan pleaded for the establishment of a network of Vavilov Centres for Research and Training in Biological Diversity.

This suggestion was welcomed by conservation scientists in India, China, Indonesia, USSR, USA, UK, Italy, Sweden, Norway, the Netherlands, Japan and several other countries. In addition, the proposal received warm support from the National Academy of Agricultural Sciences of India, Third World Academy of Sciences, the Italian National Science Academy, and the International Biosciences Network of the International Council of Scientific Unions and UNESCO. The Keystone International Dialogue on Plant Genetic Resources at its third Plenary Meeting held in Oslo in June 1991 welcomed the idea of a N.I. Vavilov Biodiversity network to arrest genetic erosion. The participants at the Oslo Dialogue concluded, "*If the loss of plant genetic resources continues unabated at the present rate, the opportunities for genetic*

alterations for needed changes in agricultural production in the future will be lost for ever." No time should therefore be lost in the establishment of such centres conceived as bridges among local communities, conservation scientists and official conservation organisations. This will be an appropriate tribute to the life and work of N.I. Vavilov, thanks to whose efforts in awareness generation the citizens of Leningrad chose to die rather than raid the gene bank containing seeds of wheat, barley and other crops and tubers of potatoes during the long seige of Leningrad by the German army during World War II. *The citizens of Leningrad thus showed that while human beings are mortal, genes can be immortal, if we wish them to be so.* It is this kind of understanding that we have to generate among the people and political decision–makers in developing countries.

It is proposed to establish the first Vavilov Centre at Madras, India on November 24, 1991, on the occasion of the 104th birth anniversary of N.I. Vavilov. The Centre is conceived as a multi-level training, research and awareness–generation organisation. Special attention is to be given to strengthening community efforts in the conservation of biological diversity through farm women and men, community leaders, NGOs and young students and research scholars. Special training programmes will also be organised for administrators and policy–makers whose action or inaction will influence the rate of genetic erosion.

Programmes

The Vavilov Research and Training Centre at Madras will undertake the following programmes during 1991-92.

1. *Promoting community involvement in the conservation and sustainable utilisation of biological diversity*

   For this purpose training will be imparted to the Community Conservation workers participating in the Community Biodiversity Movement of the World Wide Fund for Nature – India as well as of other non-governmental and grass-root level organisations.

2. *Conservation Monitoring through Bio-indicators*

   Bio-indicators are organisms which can be used to monitor the state of ecosystems. There is extensive literature on the use of bio-indicators to study changes in terrestrial and aquatic ecosystems caused by pollution and environmental modifications. To begin with the development of bio-indicators to monitor coastal ecosystems will be developed.

   There is extensive literature on the use of living organisms as bio-indicators of changes due to pollutants and environmental modifications in terrestrial and aquatic ecosystems. Bio-indication technology is a low-cost method of monitoring the ecological health of protected areas, biosphere reserves and

other important conservation sites. CAB–International is planning to prepare manuals suitable for local use in the measurement of threats to ecosystems such as the following.

— Forest disturbance (moths, beetles, spiders, lichens)
— Water pollution, (marine and freshwater algae, bacteria, corals, cyanobacteria, fish parasites)
— Air pollution (foliicolous fungi, mycorrhizas, lichens)
— Land quality (earthworms, microflora)

The centre will initiate studies in the field at a few "hotspot" locations selected in consultation with the Ministry of Environment and Forests, Government of India and the State Forest Department of the Government of Tamil Nadu.

3. *Organising training programmes on different aspects of conservation, evaluation, classification and utilisation of genetic resources for professionals, policy makers and community leaders*

Training programmes will be organised at the following levels:

a. Training programmes for community leaders and rural women and men in order to strengthen and where necessary revive the contribution to *in situ* conservation and genetic enhancement by rural families.

b. Awareness through action at the field level for school children.

c. Special workshops for political leaders, administrators and representatives of financial institutions, whose actions have a bearing on the conservation of biological diversity; It is important to influence policy makers and representatives of financial institutions whose decisions and programmes will have either a positive or negative impact on biological diversity. Policy makers, often in pursuit of short-term economic goals, tend to ignore the long-term harm that will result from genetic erosion. Two examples can be cited: (i) popularisation of aquaculture in areas rich in mangrove forests leads to the destruction of such unique forests and undermines the scope for sustainable coastal fisheries, (ii) loans which lead to promoting genetic homogeneity in crops lead to the loss of numerous land races and to increased losses from biotic and abiotic stresses.

d. Training programmes for Gene Bank Managers.
The training programmes will place emphasis on practical methods of checking genetic erosion. Gene Bank Managers will be trained in *ex-situ* conservation and on linkages between *in situ* and *ex situ* conservation.

In the training programmes, the significance and methods of conserving biological diversity at the intra-specific, species and ecosystem levels will be explained. The first such training programme will be organised for Managers of Mangrove Genetics Resources Centres during 1991-92 in collaboration with the Ministry of Environment and Forests of the Government of India.

4. *Information Centre and Computerised Data Bank on grassroot level conservation activities and on genetic resources for sustainable agriculture and for adaptation to climate change*

   A computerised information system will be developed for use by plant breeding institutions and community conservation workers. The Information Centre will concentrate on arousing public awareness and in providing training and audio-visual material to non-governmental organisations and village schools.

5. *Linking conservation with sustainable utilisation*

   In the area of sustainable utilisation of biological wealth, the Centre will assist plant breeding institutions by providing genetic stocks which can help in achieving the following goals:

   a. Achieving sustainable advances in the productivity, profitability and stability of major farming systems.

   b. Adaptation to potential changes in temperature, precipitation, sea levels and ultraviolet-B radiation.

   c. Decomposition of toxic and hazardous wastes.

   d. Development of bio-fertilizers and bio-pesticides.

   e. Restoration of degraded or waste lands.

   f. Resistance to abiotic stresses such as salinity, alkalinity and acidity.

Structure of the Centre

The main N.I. Vavilov Research and Training Centre will work closely with the National Bureau of Plant Genetic Resources of the Indian Council of Agricultural Research, the Botanical Survey of India and the Indian Council for Forestry Research and Education of the Ministry of Environment and Forests Tamil Nadu State Forestry Department and other appropriate National and State-level organisations, Research Institutes and Universities in India. Links will be established with non-governmental organisations like WWF-India, the Bombay Natural History Society and University Departments of Environment.

Programme of work for 1991-93 (Phase-I)

- — Establish the Madras centre in land kindly made available by the Government of Tamil Nadu.
- — Organise training programmes for Managers of Genetic Resources Centres for Mangroves and for community leaders, policy makers and bankers for sensitizing them to issues related to the effective conservation and sustainable and equitable utilisation of biological diversity.
- — Organise training programmes for rural women in genetic selection and seed technology.
- — Promote public and political awareness of the consequences of genetic erosion.

Guiding principles

Procedures relating to exchange of scientists and plant material will be in strict accordance with the policies and procedures laid down by the Government of India. The prescribed quarantine regulations will be strictly followed.

Sub Programme Area 202

Genetic Resources Centre for Adaptation to Sea Level Rise

This project is financially supported by the Department of Biotechnology, Government of India and is being implemented with the cooperation and assistance of the State Forest Department, Tamil Nadu.

Rationale of the Project

A majority of the developing countries are in the tropical zone each with a rapidly expanding population. The needs of each population should be met as demands for plant products as a source of food, fuel, fibre, medicine and construction materials continue to increase. Human activities are leading to considerable disturbances in the normal processes of climate and radiation regulation. Computer simulation as well as actual measurements indicate that alterations in mean temperatures, precipitation patterns and ocean levels and increased evidences of ultraviolet radiation are now a distinct possibility, if current patterns of fossil fuel energy consumption, deforestation and unsustainable life styles continue. Today, destruction of the habitats rich in genetic diversity is proceeding at an alarming

pace. Some experts believe that between 1990 and 2020, species extinctions caused primarily by tropical deforestation may eliminate between 5 and 15% of the world's species by flora and fauna.

For the same reason, the demand on mangrove land is a natural consequence but it is necessary that conservation efforts must be stepped up to save mangrove plants before they become extinct or the local habitat completely destroyed. Most of the mangroves are directly used by human beings like other forest tree species. In tropical Asia, the forest resources including mangroves, are generally shrinking year after year. The benefits of reforestation programmes derived so far are marginal. Long-term planning is urgently required to save mangrove species and propagate them on an extensive scale. Considering this, special attention needs to be paid to the problems of conservation and sustainable utilisation of mangrove areas for multiple uses and to the research needed as a sound basis for their management.

In addition to these factors, there is another major area of concern, ie., postulated changes in climate. At the World Climate Conference held at Geneva in 1990, an Inter-Governmental Committee on climate change provided an estimate of the magnitude and time horizons of likely changes in sea levels (Figure 7). Mangroves provide an effective defence against the adverse impact of sea level rise. The first important task is the prevention of further erosion of existing mangrove germplasm wealth. All existing mangrove forests should be brought under the protected areas

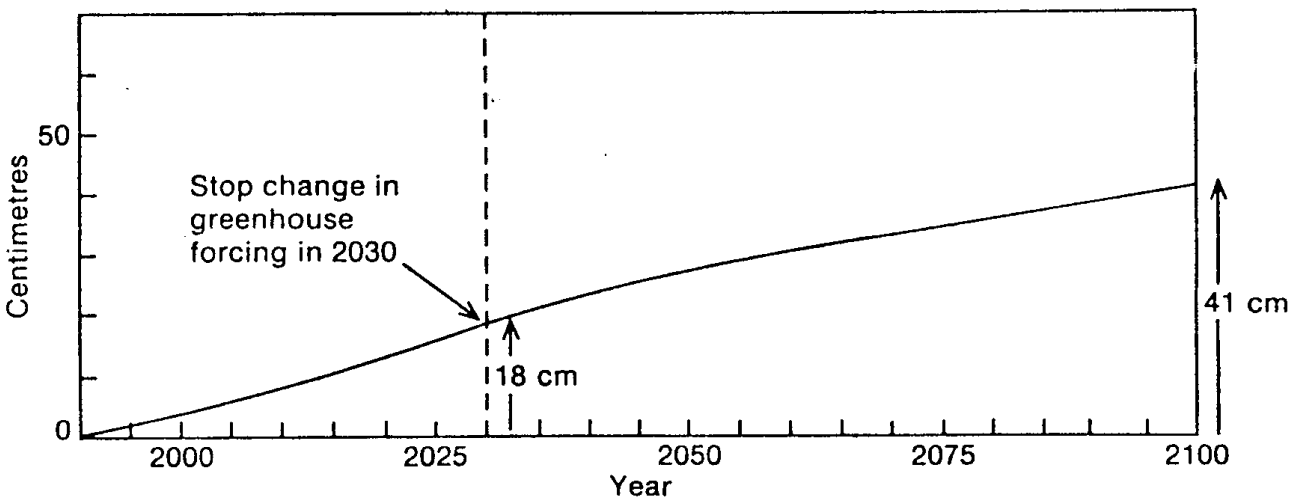


Figure 7

Commitment to sea level rise in the year 2030. The curve shows the sea level rise due to 'business as usual' emissions to 2030, with the additional rise that would occur in the remainder of the century even if climate forcing was stabilised in 2030

Source : *Climate Change: The IPCC Scientific Assessment*, Cambridge University Press, 1991. p. 278

category. Where there has been damage, restoration programmes can be undertaken through careful studies and planting of appropriate material. In addition to *in situ* conservation, there is also need for *ex situ* conservation centres where a representative sample of existing genetic diversity in mangrove species can be maintained for current and future use. Where necessary, tissue culture methods can also be adopted. Studies in the areas of restoration ecology should be fostered.

Through an integrated approach to *in situ* and *ex situ* and *in vivo* and *in vitro* conservation, it should be possible to conserve genetic diversity both as a guardian of the ecological security of coastal areas and as a source of 'candidate genes' for use in recombinant DNA experiments. Every country rich in mangrove genetic resources should therefore develop an integrated conservation strategy ensuring active public participation in the sustainable management of such resources. It is in the above context a project entitled "Genetic engineering and adaptation to climatic change: establishment of a genetic resources centre for identifying and conserving candidate genes for use in the development of transgenic plants," was initiated with financial support from the Department of Biotechnology, Government of India. An area of 50 hectares has been kindly made available for this project by the Forest Department of Tamil Nadu.

Objectives

* Conservation through saving and maintaining genetic diversity, especially of the threatened species and endemics.
* Further utilization of plant resources and ecosystems managed on sustainable basis, and
* Redevelopment of the original habitat to grow the species in suitably located habitats, easily available for study, research and exchange.

Plan of Work

1. Survey of Indian coastline for preparation of state-of-the-art of mangroves and to identify areas which need to be conserved urgently,

2. Selection of a suitable site for establishing a mangrove genetic resource centre, in the Pichavaram mangrove forest in Tamil Nadu on the basis of eco-geographical studies of the forest,

3. Establishment of a nursery at Pichavaram for collection and preservation of germplasm of different mangrove species from different regions.

4. Initiation of cytogenetical and biotechnological studies on mangroves for a better understanding of intraspecific variation, and

5. Development of data bases leading to the establishment of a Mangrove Ecosystems Information System (MEIS).

Work done in 1990-91

1. An overall survey of the Indian coastline to understand the status of mangrove genetic resources was completed,

2. A site was selected for establishing a mangrove genetic resources centre at Pichavaram mangrove forest in Tamil Nadu,

3. Taxonomic and ecological surveys of the mangrove forest of Pichavaram were undertaken to understand the zonation of existing mangrove species,

4. Standardisation of methods to study genetic variability in mangroves and their micro-propagation was initiated and

5. A generalised model was established for use in the development of databases of mangrove experts and mangrove bibliography.

Mangroves of India

The Indian mangroves comprise approximately 59 species of 41 genera belonging to 29 families. Of these, 32 species belonging to 24 genera and 20 families are present along the West coast. Similarly, there are species of mangroves like *Sonneratia caseolaris*, *Suaeda fruticosa* and *Urochondra setulosa* which have been reported only from the West Coast (Table 3). There are approximately 20 mangrove and associated species reported from Gujarat Coast, while Maharashtra has about 28 species, Goa 20, Karnataka 20, Kerala 13 and Lakshadweep 4.

Sonneratia caseolaris reported earlier by Blatter in 1905, is fast disappearing from the West coast, while *Sonneratia apetala* is found only along the Maharashtra coast.

The East Coast of India and the Andaman and Nicobar islands show a higher species diversity as well as a unique distribution of mangrove floral elements. There are 46 species of 27 genera of mangroves in this island zone (Table 4).

Table 3
Distribution of mangrove and associate species along the West Coast of India

Name of Species	Gujarat	Maharashtra	Goa	Karnataka	Kerala	Lakshadweep
Mangroves						
Acanthus ilicifolius	+	+	+	+	+	
Aegiceras corniculatum	+	+	+	+	+	
Avicennia alba		+				
Avicennia marina	+	+	+	+		+
Avicennia officinalis	+	+				
Bruguiera cylindrica	+	+				
Bruguiera gymnorhiza	+	+	+	+		+
Bruguiera parviflora			+	+	+	
Ceriops tagal	+	+				+
Cynometra ramiflora	+	+				
Excoecaria agallocha	+	+	+	+	+	
Kandelia candel		+	+	+		
Lumnitzera racemosa		+				
Rhizophora apiculata	+	+	+	+	+	
Rhizophora mucronata	+	+	+	+	+	
Sonneratia alba		+	+	+	+	
Sonneratia apetala		+				
Sonneratia caseolaris		+	+	+	+	
Mangrove associates						
Acrostichum aureum		+	+	+	+	
Aeluropus lagopoides	+	+	+	+	+	
Cenchrus sp.	+					
Cyperus rotundus	+	+	+	+	+	
Derris heterophylla	+	+	+	+	+	
Myriostachya wightiana		+	+	+		
Porteresia coarctata		+	+	+	+	
Salicornia brachiata	+	+				
Salvadora persica	+	+	+	+		
Sesuvium portulacastrum		+	+	+		+
Sporobolus sp.	+	+				
Suaeda maritima	+	+	+	+		
Urochondara setulosa	+					
Total	20	28	20	20	13	4

+ : Present

Table 4
Distribution of mangrove and associate species along the East Coast of India

Name of Species	West Bengal	Orissa	Andhra Pradesh	Tamil Nadu	Andaman & Nicobar Islands
Mangroves					
Acanthus ebracteatus					+
Acanthus volubilis					+
Acanthus ilicifolius	+	+	+	+	+
Aegialitis rotundifolia	+				+
Aegiceras corniculatum	+			+	+
Avicennia alba	+	+	+	+	+
Avicennia marina	+	+	+	+	+
Avicennia officinalis	+	+	+	+	+
Bruguiera cylindrica	+	+	+	+	+
Bruguiera gymnorhiza	+	+	+	+	+
Bruguiera parviflora	+	+			+
Bruguiera sexangula					+
Ceriops decandra	+	+	+	+	+
Ceriops tagal	+	+	+	+	+
Cynometra ramiflora		+	+	+	+
Excoecaria agallocha	+	+	+	+	+
Heritiera fomes	+				
Heritiera littoralis	+				+
Heritiera minor	+				
Kandelia candel					+
Lumnitzera racemosa	+	+	+	+	+
Lumnitzera littorea				+	+
Nypa fruticans	+				+
Rhizophora apiculata	+	+	+	+	+
Rhizophora mucronata	+	+	+	+	+
Rhizophora x lamarckii					+
Rhizophora stylosa					+
Scyphiphora hydrophyllacea			+		+
Sonneratia alba					+
Sonneratia apetala	+	+	+	+	+
Sonneratia caseolaris	+				+
Sonneratia griffithii					+
Xylocarpus granatum	+	+		+	+
Xylocarpus mekongensis				+	
Xylocarpus moluccensis	+		+		+
Mangrove associates					
Acrostichum aureum	+	+	+	+	+
Acrostichum speciosum					+
Aeluropus lagopoides	+			+	
Arthrocnemum indicum	+	+			
Carapa obovata					+
Cenchrus sp.	+				
Cerbera manghas					+
Cerbera odollam					+
Cyperus rotundus	+	+	+		+
Derris heterophylla		+	+	+	+
Myriostachya wightiana	+	+	+		+
Phoenix paludosa					+
Porteresia coarctata	+	+	+		+
Salicornia brachiata	+				+
Salvadora persica				+	
Sesuvium portulacastrum	+	+	+	+	+
Sporobolus sp.	+	+	+	+	+
Suaeda maritima	+			+	+
Suaeda monoica				+	
Total	**34**	**24**	**23**	**26**	**46**

+ : Present

Heritiera fomes, locally known as *Sundari*, after which the Sunderbans are named, is found in more freshwater areas and is limited in its distribution to the Gangetic Sunderbans and Andaman Islands. Similarly, species like *Ceriops decandra*, *Xylocarpus sp.*, *Lumnitzera littorea*, and taxa like *Nypa fruticans*, *Phoenix paludosa*, *Cerbera manghas*, are limited along the East coast. *Rhizophora mucronata*, *R. apiculata*, *Ceriops tagal*, *Bruguiera gymnorhiza*, *Lumnitzera racemosa*, *Sonneratia apetala*, *Acanthus ilicifolius*, *Avicennia marina*, *A. officinalis*, *Excoecaria agallocha* and *Achrostichum aureum* are uniformly distributed along the East and West coasts of India. *Acanthus ebracteatus* is recorded only from the Andaman and Nicobar region. Recently, Mall et. al. (1982) have reported species like *Rhizophora stylosa*, *R.* × *lamarckii* and *Bruguiera sexangula* from Andaman Islands.

In studying mangroves of India, it must be borne in mind that these probably have undergone a long period of intensive and continuous exploitation and what we now have are only left-overs. *Nypa fruiticans*, a very useful mangrove palm, grew all around peninsular India in the past, while at present it is restricted to a few pockets, mainly in Orissa and West Bengal; and is abundant in the Andaman and Nicobar Islands. The areas occupied by the mangrove ecosystems change rapidly because of their dependence on soil topography, hydrography, sediment deposition and climate variations – all factors that change quickly in such highly dynamic environments as the tropical coastal zones. Whatever the cause, the mangroves that border the Northern part of the Indian Ocean, except for the Eastern part of the Bay of Bengal, are at present far from being pristine ecosystems; what we now have is certainly different from what would be the natural ecological climax, a climax that is never stable for a long time in mangrove ecosystems.

Mangrove ecosystems support a large variety of wildlife, both flora and fauna. However, intermediates are found between well-developed mangroves and the stunted overexploited trees of the semi-arid coasts of Gujarat, bathed by the above-normal salinity of the surface waters of the Arabian Sea.

Along the West coast, although the Rann of Kutch and Cochin backwaters were considered to include vast areas influenced by the sea water, practically no mangroves are available in these areas because of natural as well as human-induced changes. The North-West part of Kutch, however, shows mangrove species in a degraded condition along the Southern side. Near Kandle and Mundhra particularly, scrubby growth of *Avicennia* is seen. In the Gulf of Khambhat, a similar type of vegetation has been recorded. The deltas formed by rivers like Tapti, Narmada, Dhandhar and Sabarmati favour the mangrove vegetation.

The Bombay coast earlier had a luxuriant mangrove vegetation till 1940; but since then, large-scale reclamation has constantly destroyed the mangrove vegetation. However, other creeks and estuaries along the Maharashtra coast have extensive

mangroves. Rich mangrove areas are also observed along the estuaries. Although the fringing mangroves are seen along all the major estuaries of the Karnataka coast, the best formations are observed near Coondapur, Karwar and Malpe.

The Kerala coast, which harboured mangrove vegetation in the past, has no mangroves worth mentioning at present. However, the species of *Rhizophora*, *Sonneratia*, *Bruguiera*, etc., are still seen along the Cochin backwaters and other estuaries in the State.

The delta systems of Ganga, Godavari, Mahanadi, Krishna, Cauvery and the islands like Andaman and Nicobar are responsible for the occurrence of major mangrove forests along the East coast. Along the Tamil Nadu coast, two major formations of mangroves are present – the Pichavaram mangrove formations and the mangroves of the Cauvery delta.

Varying degrees and types of exploitation of mangrove ecosystems are found in different parts of India from untouched groves – probably sacred groves, which were in existence and were respected in some parts of coastal tidal forests – to the present day biosphere reserves. Because of the different species composition of plants and animals and because of varying degrees of species diversity and the uses made of mangrove products, the ecosystem as a whole varies from place to place. Tropical, high diversity ecosystems are compatible with a variety of uses; for instance, the Sunderbans are indeed a multiple use system while marginal ecosystems allow for only one or a few uses. The mangroves of Gujarat are exploited mainly for fodder, fuelwood and tanbark and are particularly valuable because of their locally irreplaceable uses.

Considering the diversity of the mangroves as well as the population of the coastal zone, many mangrove ecosystems of India have either not been managed at all or poorly managed or even totally converted for different uses. For instance, small-scale fisheries did not receive much attention in Gujarat because of the predominantly vegetarian population. Elsewhere, rice-eating people developed varieties of salt-tolerant paddy and managed their mangroves for aquaculture as well, so as to ensure a supply of fish for their own consumption (e.g. West Bengal, Orissa, and Kerala). In the densely inhabited areas, where species diversity of the mangrove ecosystem is high, people learnt to make use of many different products. For example, in the Sunderbans, forest products, many species of edible fish, meat (mainly deer) and animal products (hides, honey, wax), several chemicals and medicinal derivatives are important sources of livelihood for thousands of families. In still other areas where human population density was not very high, the human impact was not severe enough to cause degradation of the ecosystem and the mangroves remained in their pristine stage, with only those changes brought about by time and natural evolution of the coastal zone as in the Andaman and Nicobar Islands and a few isolated places of the deltas, estuaries, backwaters and lagoons and on the mainland.

Selection of site for the Genetic Resources Centre

The Forest Department of the Government of Tamil Nadu extended their kind help by providing an area of about 50 ha in the mangrove forest of Pichavaram for establishing a mangrove genetic resources centre, the selection of which was done by the method described below.

With the help of aerial photographs (Scale 1:50,000) of the Pichavaram mangrove forest and maps obtained from the French Institute, Pondicherry, the ground-truth data collection was done. Based on the following observations, the site for establishing a mangrove genetic resources centre was selected.

Distinctive features of the project site

Pichavaram is located 200 km South of Madras city (Figure 8) in Tamil Nadu State on the South-East coast of India. The mangrove forest of Pichavaram (Lat. 11° 27' N; Long. 79° 47' E) covering an area of about 1,400 hectares, is traversed by a large number of channels and creeks which connect the Coleroon estuary in the South to the Vellar estuary in the North (12 km away from each other).

The site selected for the purpose of developing a nursery of a variety of different mangrove species and eventually a genetic resources centre of mangroves, is situated in between a group of islands covered by mangroves growing luxuriantly in the peripheral areas. It is unique in the following respects.

1. It is in the shallow water zone and contains a magnificent diversity of mangrove species existing in that region,

2. Though being sheltered by mangrove thickets, this area is easily accessible,

3. The tidal water, through a network of channels, regularly inundates this area,

4. A nursery, if developed in this region, could support the growth of propagules of a variety of mangrove species,

5. This area is influenced by fresh water run-off from landward side which flows through the Uppanar estuary-which is an ecological requirement for an ideal mangrove nursery and also a physiological necessity for young propagules in the initial stages of the germination, and

6. Human activity in this area can be checked if effective measures are taken.

Based on these favourable features, the area 'Peria Guda' was chosen for the establishment of the Genetic Resources Centre.

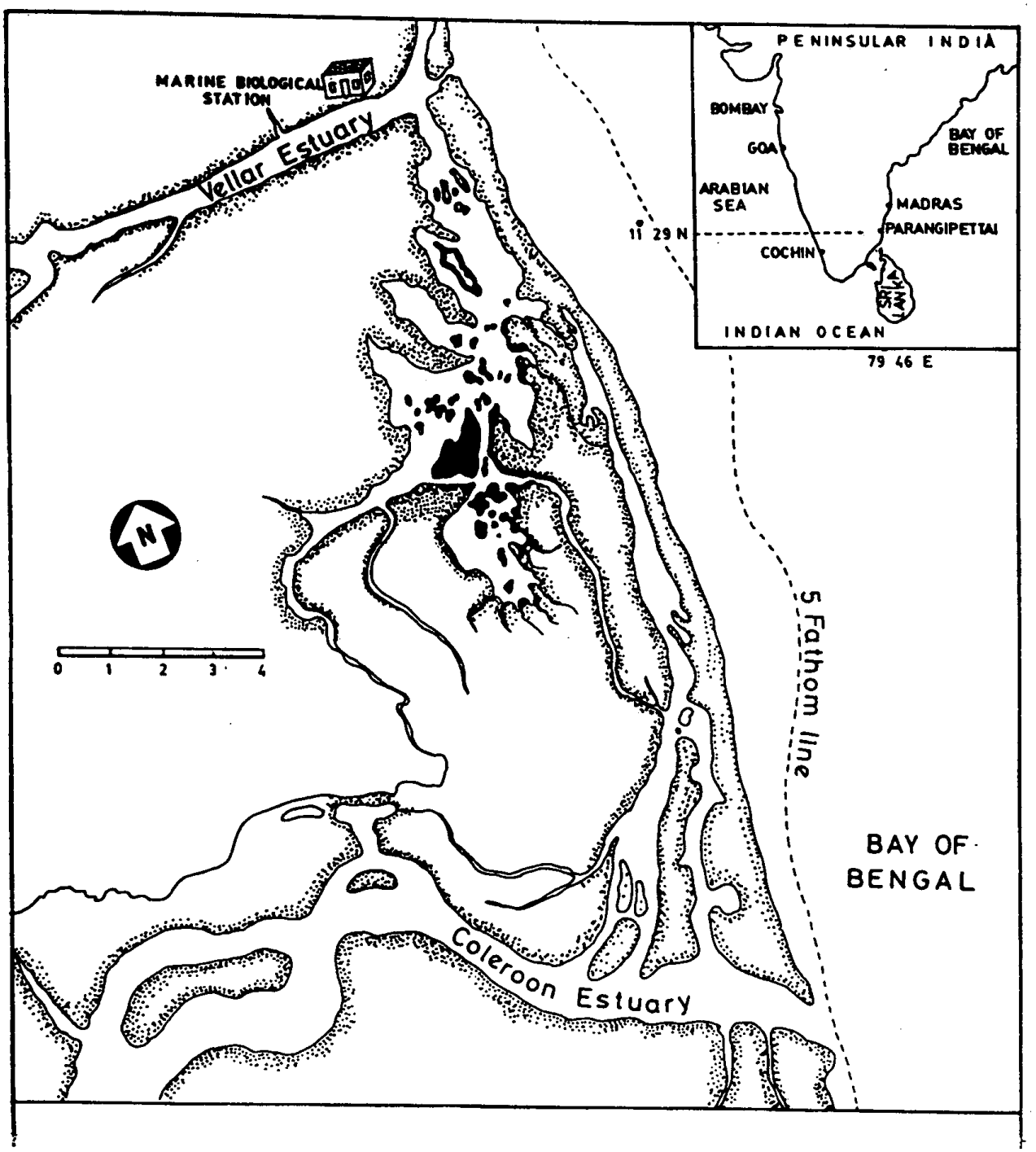


Figure 8
Distribution of Mangrove Area in Pichavaram

Table 5
List of mangrove and associate species of Pichavaram forest

Name of the Species	Family
Acanthus ilicifolius L.	Acanthaceae
Aegiceras corniculatum (L.) Bl.	Myrsinaceae
Aeluropus lagopoides (L.) Trin*	Poaceae
Arthrocnemum indicum Moq.*	Chenopodiaceae
Avicennia marina	Avicenniaceae
Avicennia officinalis L.	Avicenniaceae
Bruguiera cylindrica L.	Rhizophoraceae
Ceriops decandra (Griff.) Ding Hou	Rhizophoraceae
Ceriops tagal (Perottet) C.B. Robinson	Rhizophoraceae
Clerodendrum inerme (L.) Gaertin*	Verbenaceae
Cyperus sp.*	Cyperaceae
Derris heterophylla (Willd.) Back.*	Fabaceae
Excoecaria agallocha L.	Euphorbiaceae
Lumnitzera racemosa (Willd.)	Combretaceae
Lumnitzera littorea (Jack) Vo. gt	Combretaceae
Rhizophora apiculata Bl.	Rhizophoraceae
Rhizophora mucronata Lamk.	Rhizophoraceae
*Rhizophra x lamarckii** Montr.*	Rhizophoraceae
Salicornia brachiata Roxb.	Chenopodiaceae
Salvadora persica	Salvadoraceae
Sesuvium portulacastrum L.*	Aizoaceae
Sonneratia apetala B. Ham	Sonneratiaceae
Suaeda maritima (L.) Dum*	Chenopodiaceae
Suaeda monoica Forsk.*	Chenopodiaceae
Xylocarpus mekongensis Pierre	Meliaceae
Total 25 Species	

* mangrove associates.
** the identity of this species is yet to be confirmed.

Source : Table 3 & 4 – Mangroves of India : Status report, pp. 15-25. In: Sanjay V. Deshmukh and Rajeshwari Mahalingam, (editors). *Proceedings of the Project Formulation workshop for establishing a global network of mangrove genetic resource centres for adaptation to sea level rise*, January 15-19, 1991. Proceedings No. 2, CRSARD, Madras, India.

Table 5 – Description of the site selected for mangrove genetic resource centre, pp. 99-106. *ibid.*

Zonation of vegetation

The mangroves of Pichavaram do not show a distinct zonational pattern as seen in Andaman and Nicobar Islands, however, they are observed in different patterns of vegetation as described below.

Zone I

Avicennia marina is dominant and shrubby in this region, where the soil is principally sandy mud. The sandy area of this region is dominated by the halophyte *Salicornia brachiata. Suaeda maritima, Sesuvium portulacastrum, Arthrocnemum indicum* and *Excoecaria agallocha* are some other plants, which are sporadically distributed here. Sand heaps in this region are noteworthy which do not get flooded by regular tidal water. Such heaps are colonised by many terrestrial plants such as *Boerhaavia diffusa, Clerodendrum inerme, Spinifex littoreus, Thespesia populnea* and *Vernonia cinerea.* All the plants represented in this zone do not exceed 0.5 m in height.

Zone II

This includes the banks of three creeks lying parallel to the seashore. The banks of these creeks show gradation of floristic components from shoreline inwards. The Eastern bank of the first creek shows three belts. The fringe of the shoreward belt is almost barren, the middle is dominated by *Salicornia brachiata* and the inward belt is occupied by *Avicennia marina.* The Eastern bank of the second creek also presents three belts. The shoreward belt is colonized by *Salicornia brachiata* and shrubby *Avicennia marina.* The middle one is occupied by pure stands of *Salicornia brachiata* and the inward belt possess *Rhizophora apiculata* and *R. mucronata,* and the middle belt shows *Avicennia marina* (shrubs and trees) whereas the inner belt is found to have a mixed community of *Excoecaria agallocha* and *Salicornia brachiata.* The Western bank of the third creek presents a barren sandy area leading to terrestrial vegetation. *Arthrocnemum indicum* occurs in patches in this zone which might probably colonise the 'Blanks'.

Zone III

Luxuriant mangrove vegetation exists in this zone with a maximum number of species of mangrove plants. The fringes of the channels are bordered by *Rhizophora apiculata* while *R. apiculata* and *R. mucronata* are co-dominant along the fringes of the other water-ways. Immediately behind the *Rhizophora* communities, *Bruguiera cylindrica* and *Ceriops decandra* are among the common shrubs and *Excoecaria agallocha* also occurs.

Just behind the fringe communities of *Rhizophora* and other plants, three types of populations were observed as follows:

a) *Suaeda maritima*,

b) Mixed population of *Suaeda maritima* and *Avicennia marina* (shrubs), and

c) That of *Avicennia marina* (trees).

Aegiceras corinículatum, *Bruguiera cylindrica*, *Ceriops decandra* and *Lumnitzera racemosa* seen in this zone are distinct on the edges immediately behind the *Rhizophora* plants. *Aegiceras corniculatum* peeps through *Rhizophora* plants. Along certain banks which appear to be eroded, the fringes are bordered by *Avicennia marina*, *Bruguiera cylindrica*, *Ceriops decandra*, *Excoecaria agallocha*, *Suaeda maritima*, *Sesuvium portulacastrum* and *Xylocarpus mekongensis*. In the places where *Avicennia marina* is found, the soil is clayey and hard with occasional flooding during spring tides. *Dendrophthoe falcata* is the only angiosperm observed on the branches of *Rhizophora*. Crustose and fruticose lichens upon *Excoecaria agallocha*, *Rhizophora mucronata*, and *R. apiculata* in certain areas are noteworthy.

Zone IV

This includes areas which are influenced by freshwater and show a considerable variation in vegetation pattern. This zone, influenced by fresh water, is generally dominated by *Acanthus ilicifolius* and a climber, *Derris heterophylla*, is observed on the shrubs of *Excoecaria agallocha*. A few representatives of *Dalbergia spinosa* are also seen. There is also a sporadic occurence of *Arthrocnemum indicum*, *Excoecaria agallocha*, *Lumnitzera racemosa*, *Salicornia brachiata* and *Suaeda maritima*. This type of vegetation is observed near Thiruvasalodai fresh water channel.

Zone V

On the Western bank of the Thiruvasalodai channel, a continuous stretch of *Suaeda maritima* is observed which gives a salt-marsh appearance. Towards the seaward side the areas are brought under large-scale plantations of *Casuarina equisetifolia*.

Zone VI

This zone exists near the Coleroon estuary. Landward side of the channel of this estuary is rich with *Salicornia brachiata* where the seaward side is occupied by small, shrubby *Avicennia marina*. Sand heaps are also noticed with *Pandanus* species. The intermediate region where the channels merge near Coleroon, is occupied by *Avicennia marina*, *Suaeda maritima* and *Salicornia brachiata*.

Considering the above factors such as the structure and composition of the mangrove vegetation and the factors influencing it in the mangrove forest of Pichavaram, the site 'Peria Guda' selected for the establishment of the genetic resources centre (Figure 9) offers scope both for *in situ* and *ex situ* conservation.

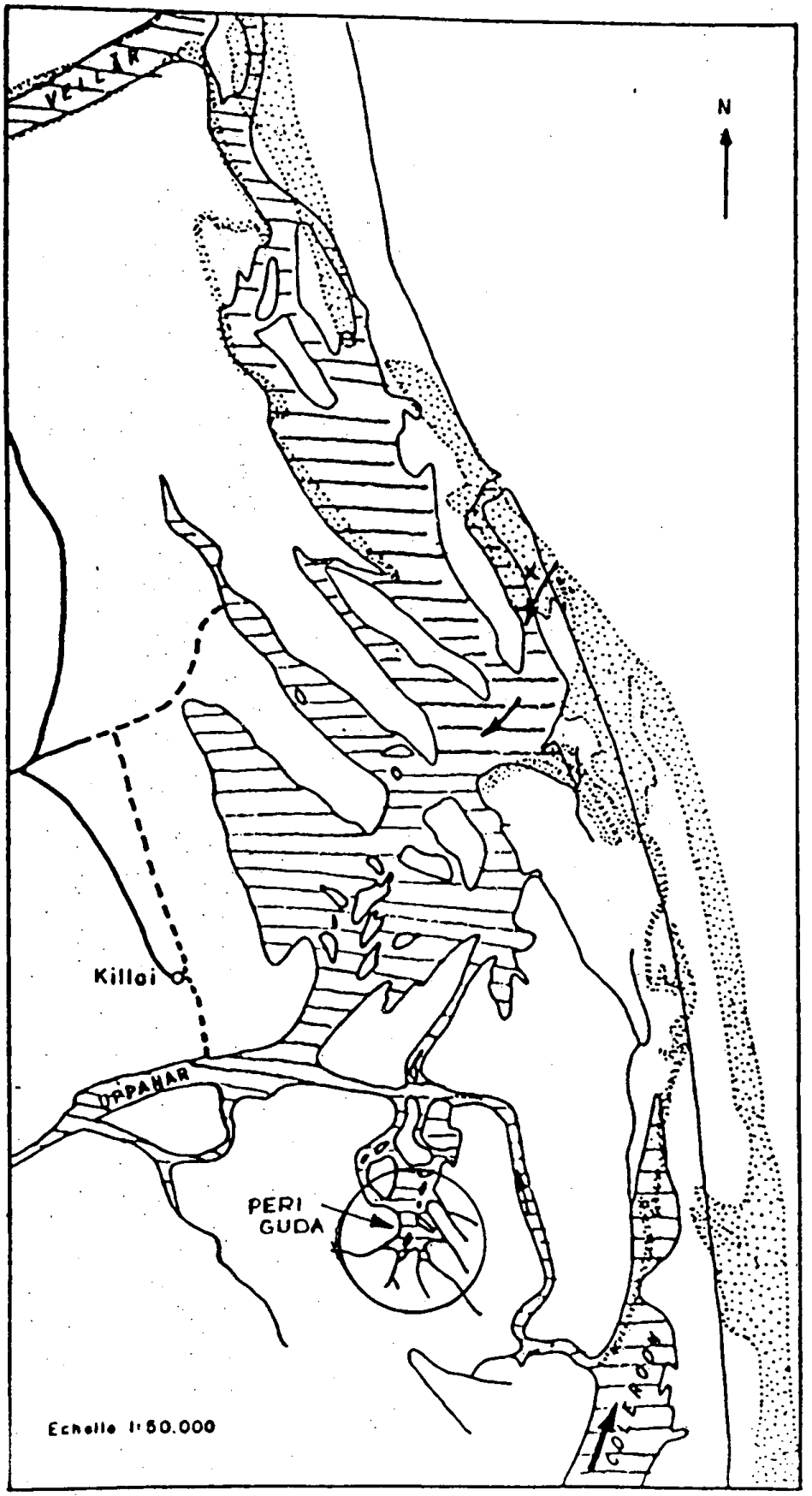


Figure 9
Pichavaram: Map showing the selected site – Peria Guda

Eco-restoration

Pichavaram is a region where mangroves are facing stresses e.g. excessive cutting and biotic interference; however, the conditions are still capable of supporting good mangrove growth. The present studies deal with developing a nursery of different mangrove species and afforestation of mangroves on a pilot scale.

The propagules collected from the Pichavaram mangrove forest as well as from the West coast of India were planted under fresh water conditions in a nursery developed in 'Killai' region. The idea is to undertake growth studies for six months and then transplant them in the main nursery which is being developed in 'Peria Guda' where the mangrove germplasm will be maintained.

A general approach for eco-restoration effort was worked out on the basis of the assessment of the local factors.

The first step was to identify areas where pilot scale mangrove planting could be tried out. In this context the initial survey of the area was very helpful. After careful assessment, four areas were identified for this purpose. These represented different locations and substratum conditions.

For the experimental plantations, the propagules were planted in rows parallel to water level, from lower shore to upper shore. Nearly 1/3rd to 1/4th (but not more) of a propagule was embedded in the soil by direct sowing.

Based on the percentage survival of the mangrove seedlings, a large-scale planting programme will be undertaken and germplasm of different species of mangroves collected from the different regions will be introduced.

Micropropagation

All the mangrove species are highly recalcitrant due to high content of phenolic compounds, tannin and salts. It has therefore been difficult to multiply them by micropropagation methods. Literature on this aspect is scarce.

Micropropagation studies were initiated in *Rhizophora*. The objective of this programme is the rapid clonal multiplication of the hybrid of *Rhizophora* which is showing heterosis for height, canopy size and girth of the trunk. The rapid multiplication of this species would be useful for afforestation programmes.

Initial attempts were made with meristem culture. Both axillary and apical meristems were tried. Different surface sterilization methods and media compositions with and without antibiotics gave little success in eliminating bacterial contamination due to endogenous bacteria.

Hence, attempts were made to regenerate plantlets through callus and somatic enbryogenesis. Leaf, petioles, floral parts as well as roots were tried for this purpose.

but they failed to callus in the media used. However, when highly meristamatic tissues were cultured, callus induction could be obtained within a week of initiation. It was found that a high auxin concentration is needed for callus induction and sub-culturing of callus. Work on the standardization of an effective medium for the speedy multiplication of callus and somatic embryogenesis is in progress.

Pollination Studies

Studies were initiated to understand the nature of pollination in *Rhizophora* species and also the occurrence of spontaneous hybrids in nature.

The work was initiated in *Rhizophora apiculata*. The dehiscence of the anther takes place much before the opening of the flower. The pollen fertility was found to be 85%. The flower buds were covered with butter paper bags to prevent wind and insect pollination. The following experiments were carried out after bagging.

1. Bagging the flower buds before opening of the flower allowing self-pollination

2. Pollinating the flowers with pollen from different trees before the opening of the flower but after dehiscence of anther

3. Pollinating the flowers with pollen from different trees just after the opening of the flower and anthers persisting and

4. Pollinating the fully opened flowers (anthers withered). Observations on fruit set will be recorded when fruits develop fully.

The stigmas from 10 flowers each from the above mentioned treatments were fixed 24 hours after pollination in 3:1 Alcohol: Acetic acid and after softening was cleared in 8 N NaOH.

It was stained in 0.2% Anilin blue in 0.1 N K_3PO_4 solution and observed under flourescent light of a Carl Zeiss microscope. Pollen grains failed to germinate on the stigma in both self and cross pollinated cases indicating non-receptivity of the stigma at the time of anthesis. Protandry seems to be occurring in *Rhizophora apiculata*. Similar results were also observed in the last two cases which meant that the stigma receptivity may be only for a short period.

Mangrove Ecosystems Information System (MEIS)

The MEIS will initially be composed of two databases, namely

1. Mangrove Experts Data base, and

2. Bibliographic Data base

The MEIS aims to maintain comprehensive information on mangrove ecosystems for the purpose of conservation and preservation of mangrove genetic resources. Other data bases like mangrove resources data base and genetic variability data base will be added in future, when reliable data become available.

The MEIS can also be linked to other data bases relating to coastal wetlands research. It is being designed in such a way that it would be easy to fit it into other information systems. e.g. the one on coral reefs used in Queensland, Australia and the other on aquatic resources developed by the International Centre for Living Aquatic Resources Management (ICLARM) in the Philippines.

Mangrove Experts Data base

This directory system will maintain a data base of persons and institutions working on mangrove ecosystems and related subjects. The data base is initially based on the information available in the "Directory of Mangrove Experts" published by UNESCO/UNDP in 1984. Survey forms as shown below have been sent to the institutions involved in mangrove ecosystems research and management

Updates will be made as soon as additional information becomes available. These will be provided to the users on a quarterly basis.

Name : Institution : Designation : Mailing address : Telephone : Telex : Fax : Educational and professional background : Field of specialisation : Major current research : Objectives : Future research plans :	Cooperative programmes with other institutions and scientists : Any other relevant information : Mangrove-related publications : — Articles and technical papers — Reports — Books Other publications : Documentaries : Permanent Address :

Bibliographic Data base

This would contain bibliographic information on mangroves and related publications. This information is being collected from bibliographic indexes, libraries, institutions and other related publications as well as existing bibliographic data bases. The format used is CDS/ISIS developed by UNESCO. This would facilitate exchange of information with other institutions as it is compatible with existing bibliographic data bases.

Sub Programme Area 203

Saving Endangered Plant Species

There is now general agreement that current rates of species loss exceed anything found in the past 65 million years. The International Union for the Conservation of Nature and Natural Resources (IUCN) has calculated that if current trends continue, we may lose upto one quarter of the world's species by 2050.

In our country, the Botanical Survey of India has so far published three Red Data Books (1987, 1988, and 1990). These three Books contain a list of 814 threatened taxa of Indian flora. The World Conservation Monitoring Centre at Cambridge, UK, has warned that unless urgent steps are taken, biological diversity of immense economic and ecological value may be lost at several locations in India. Some of these areas are:

* Agastyamalai Hills (Western Ghats)
* The Silent Valley and the New Amarambalam Reserve (Western Ghats)
* The Periyar lake area (Western Ghats)
* Eastern Himalayas
* Western Himalayas

In the lists of extinct, possibly extinct, endangered, vulnerable or rare species published by the Botanical Survey of India as many as 123 species occur in the State of Tamil Nadu alone (Box). The Botanical Survey has further indicated that the species listed separately (Box) can be grown in Madras but efforts to collect seeds or planting material of these species are not meeting with much success. It is possible that some of them might have already become extinct. The species under threat of extinction are occurring in all the major biogeographic habitats in India.

The Commission on National Parks and Protected Areas of IUCN in its report on "Threatened Protected Areas of the World" prepared in November, 1990, has listed the following protected areas in India as endangered.

* Manas Wildlife Sanctuary, (World Heritage site), Assam.
* Kaziranga National Park, Assam
* Gulf of Kutch Marine National Park, Gujarat
* Keibal Lamjao National Park, Manipur
* Gir National Park, Gujarat

Dangers to these parks arise largely from anthropogenic pressures and/or unsustainable developmental activities.

Names of 123 species listed as extinct, possibly extinct, endangered, vulnerable or rare which occur or are known to have occurred in Tamil Nadu. India.

S.No.	Name of Species	Status in India	Distribution within Tamil Nadu
1.	*Acranthera grandiflora**	Endangered	Tirunelveli
2.	*Actinodaphne bourneae**	Endangered	Palani hill
3.	*Actinodaphne lanata**	Endangered	Nilgiris
4.	*Actinodaphne lawsonii*	Rare	Nilgiris
5.	*Amomum microstephanum*	Rare	Anamalais
6.	*Anoectochilus rotundifolius**	Endangered or possibly extinct	High Wavies (Madurai District)
7.	*Antistrophe serratifolia*	Rare	Anamalais
8.	*Aponogeton appendiculatus*	Indeterminate	Madras
9.	*Atuna travancorice*	Indeterminate	Courtallam
10.	*Belosynapsis kewensis**	Endangered	Tirunelveli Kanyakumari
11.	*Bentinckia condapanna*	Rare	Tirunelveli
12.	*Bulbophyllum albidum*	Rare	Nilgiris & Tirunelveli
13.	*Bulbophyllum acutiflorum**	Rare	Nilgiris
14.	*Bulbophyllum elegantulum*	Vulnerable	Nilgiris
15.	*Bulbophyllum kaitiense**	Vulnerable	Nilgiris
16.	*Bunium nothum**	Possibly extinct	Nilgiris
17.	*Campanula alphonsii*	Rare	Nilgiris & Palani hills
18.	*Capparis diversifolia**	Vulnerable	Tirunelveli
19.	*Capparis fusifera*	Rare	Tirunelveli
20.	*Capparis rheedii*	Rare	Tirunelveli
21.	*Capparis shevaroyensis**	Vulnerable	Ramanathapuram
22.	*Carex christii**	(Indeterminate) Possibly extinct	Nilgiris
23.	*Carex pseudoaperta**	(Indeterminate)	Nilgiris
24.	*Carex vicinalis**	(Indeterminate)	Nilgiris
25.	*Cayratia pedata**	Rare	Nilgiris
26.	*Cayratia roxburghii*	Vulnerable	Tirunelveli
27.	*Ceropegia barnesii*	Endangered	Nilgiris
28.	*Ceropegia decaisneana*	Rare	Anamalais and Nilgiris
29.	*Ceropegia fimbriifera*	Vulnerable	
30.	*Ceropegia maculata*	Endangered or possibly extinct	Anamalais
31.	*Ceropegia metziana*	Rare	Western Ghats
32.	*Ceropegia thwaitesii*	Vulnerable	Kodaikanal
33.	*Ceropegia omissa**	Endangered	Courtallam
34.	*Ceropegtia spiralis*	Vulnerable	(Specific area not furnished)*

S.No.	Name of Species	Status in India	Distribution within Tamil Nadu
35.	*Ceropegia pusilla*	Rare	Nilgiris
36.	*Chrysoglossum hallbergii**	(Indeterminate & insufficiently known)	High Wavies (Madurai district)
37.	*Cleo x me burmanni*	(Indeterminate)	Ramanathapuram
38.	*Coelogyne mossiae*	Vulnerable	Nilgiris and Palani hills
39.	*Commelina hirsuta**	Rare	Nilgiris and Palani hills
40.	*Commelina tricolor**	Vulnerable	Karadimalais
41.	*Commelina wightii**	Vulnerable	Nilgiris & Palani hills
42.	*Corymborkis veratifolia**	Rare	Nilgiris
43.	*Cotoneaster buxifolius**	Vulnerable	Nilgiris & Palani hills
44.	*Crotalaria clavata**	Endangered	Coimbatore, Madurai and Salem
45.	*Crotalaria digitata*	Rare	Kolli & Palani hills
46.	*Crotalaria fysonii**	Endangered	Palani hills.
47.	*Crotalaria globosa*	Rare	Nilgiris, Courtallam, Dindugul
48.	*Crotalaria kodaiensis**	Endangered	Palani hills
49.	*Crotalaria longipes**	Endangered	Kolli hills & Nilgiris
50.	*Crotalaria priestleyoides*	Rare	Anamalais & Nilgiris.
51.	*Crotalaria peduncularis*	Rare	Anamalais & Palani hills
52.	*Crotalaria rigida*	Rare	Nagapattinam, Coimbatore and Tirunelveli
53.	*Crotalaria scabra**	Rare	Coimbatore, Kanyakumari, Salem and Tirunelveli
54.	*Cyanotis cerifolia**	(Indeterminate)	Anamalais
55.	*Cyathea nilgirensis**	Endangered	Nilgiris
56.	*Cynometra travancorica*	Rare	Tirunelveli hills
57.	*Decaschistia rufa*	Endangered	Chengalpattu
58.	*Desmos viridiflorus*	Endangered	Anamalais, Coimbatore
59.	*Dictyospermum ovalifolium*	Rare	Western Ghats
60.	*Elaeocarpus venustus*	Vulnerable	Kanyakumari
61.	*Elaphoglossum beddomei**	Rare	Nilgiris & Anamalais.
62.	*Elaphoglossum nilgiricum*	Endangered	Nilgiris hills.
63.	*Elaphoglossum stigmatolepis**	Vulnerable	Nilgiris & Palani hills
64.	*Eragrostis rottleri*	Presumed extinct	Tranquebar
65.	*Eria albiflora*	Rare	Nilgiris
66.	*Eriochysis rangacharii**	Presumed extinct	Nilgiris

S.No.	Name of Species	Status in India	Distribution within Tamil Nadu
67.	*Eugenia discifera**	Endangered	Sethur hills (Kamarajar district)
68.	*Eugenia singampattiana**	Endangered or possibly extinct.	Tirunelveli
69.	*Euonymus angulatus*	Endangered	Nilgiris
70.	*Euonymus serratifolius**	Endangered or possibly extinct	Anamalais & Nilgiris hills.
71.	*Goniothalamus rhynchantherus*	Rare	Tirunelveli
72.	*Habenaria barnesii*	Rare	Nilgiris
73.	*Hedyotis albonervia**	Endangered	Tirunelveli
74.	*Hedyotis barberi**	Vulnerable	(Specific area not furnished)
75.	*Hedyotis buxifolia*	Rare	--
76.	*Hedyotis cyanantha*	Rare	--
77.	*Hedyotis eualata*	Rare	--
78.	*Hedyotis ramarowii*	Vulnerable	--
79.	*Hedyotis swersioides*	Rare	--
80.	*Hedyotis hirsutissima**	Possibly extinct.	Nilgiris
81.	*Humboldtia decurrens*	Rare	Tirunelveli
82.	*Helichrysum perlanigerum**	Rare	Coimbatore
83.	*Humboldtia bourdilloni*	Endangered	Courtallam
84.	*Humboldtia unijuga*	Endangered	Tirunelveli
85.	*Hydrocotyle conferta**	Rare	Nilgiris & Palani hills
86.	*Impatiens neo-barnesii**	Endangered	Nilgiris
87.	*Impatiens nilagirica**	Endangered	Nilgiris
88.	*Indigofera barberi*	Rare	South Arcot, Shevroy hills
89.	*Indotristicha tirunelveliana**	Rare & Vulnerable	Tirunelveli
90.	*Miliusa nilagirica*	Vulnerable	Nilgiris & Anamalais
91.	*Murdannia juncoides**	Rare	Courtallam
92.	*Neuracanthus neesianus*	Endangered or possibly extinct	North Arcot
93.	*Nothopegia aurea-fulva**	Endangered	Tirunelveli
94.	*Ophiorrhiza brunonis*	Presumed extinct	Nilgiris & Palani hills
95.	*Ophiorrhiza pykarensis**	Possibly extinct	Nilgiris
96.	*Liparis biloba**	Vulnerable	Nilgiris
97.	*Murdanmia lanceolata*	Vulenerable	Red hills (Madras) Singampatti Valley (Tirunelveli dist.)
98.	*Orophea uniflora*	Rare	Tirunelveli
99.	*Palaquium bourdillonii*	Extinct (Indeterminate)	Tirunelveli hills
100.	*Paphiopedilum druryi*	Endangered or Possibly extinct	

S.No.	Name of Species	Status in India	Distribution within Tamil Nadu
101.	*Peucedanum anamallayense*	(Indeterminate)	Anamalais
102.	*Pimpinella pulneyensis**	Possibly extinct	Palani hills
103.	*Piper barberi**	Rare	Kanyakumari
104.	*Popowia beddomeana*	Rare	Tirunelveli
105.	*Psychotria globicephala**	Endangered	Courtallam
106.	*Rhynchosia velutina**	Vulnerable	Thanjavur, Tirunelveli, Kanyakumari
107.	*Salacia beddomei*	Rare	Anamalais
108.	*Santapaua madurensis**	Endangered	Madurai, Pudukottai, Thanjavur
109.	*Senecio kundaicus**	Endangered	Nilgiris
110.	*Smilax wightii**	Rare	Nilgiris
111.	*Sphaeropteris crinita*	Endangered	Nilgiris
112.	*Syzygium gambleanum**	Endangered	Kanyakumari
113.	*Syzygium courtallense**	Endangered	Courtallam
114.	*Teucrium plectranthoides**	Vulnerable	Tirunelveli
115.	*Thottea barberi**	Vulnerable	Tirunelveli
116.	*Vanasushava pedata*	Rare	Palani hills, Anamalais
117.	*Vanda wigtii**	Possibly extinct	Nilgiris
118.	*Vanilla wightiana*	Rare	Tirunelveli, Kanyakumari
119.	*Vernonia pulneyensis**	Endangered	Palani hills
120.	*Vernonia recurva**	Endangered or possibliy extinct	Anamalais
121.	*Wendlandia angustifolia**	Presumed extinct	Tirunelveli
122.	*Willisia selaginoides*	Rare	Anamalais
123.	*Youngia nilgiriensis**	Endangered	Nilgiris

* Species which are endemic to Tamil Nadu or where specimens have been found only within Tamil Nadu are marked with an asterisk

Source: *Botanical Survey of India*

List of some threatened species for collection and cultivation in Research and Training Centre of the Foundation.

1.	*Cynometra bourdilloni* Gamble (Fabaceae). Dist.: S. Kanara, Hasan in Karnataka.
2.	*Humboldtia decurrens* Bedd. ex Oilver (Fabaceae) Dist.: Western Ghats: Travancore, Tirunelveli Hills.
3.	*H. Unijuga* Bedd. var. *unijuga* (Fabaceae) Dist.: Travancore & Tirunelveli Hills.
4.	*Decaschistia rufa* Craib. (Malvaceae) Dist. : Tiruvallur, Kambakkam Hill in Chengleput, Tamil Nadu; Ballipalle, Cuddapah Andhra Pradesh.
5.	*Kingiodendron pinnatum* (Roxb. ex DC.) Harms (Fabaceae) Dist.: Western Ghats: Karnataka (Coorg & Hasan dists.) Tamil Nadu (Kanniyakumari & Tirunelveli dists.)
6.	*Calliandra cynometroides* Bedd. (Fabaceae) *(Inga cynometroides* (Bedd.)) Bedd. ex Baker Dist.: South Travancore Hills (Rosemalai estate). Kerla.
7.	*Dialium travancoricum* Board. (Fabaceae) Dist.: S.W. Ghats (Ponmudi, Quilon dists.)
8.	*Pterospermum reticulatum* Wt. & Arn. (Sterculiaceae) Dist.: Western Ghats: Karnataka, Kerala & Tamil Nadu.
9.	*Hildegardia populifolia* (Roxb.) Sch. & Endl. (Sterculiaceae) Dist: Southern Eastern Ghats Nagari Hills, Cuddapah district, Andhra Pradesh & Dharmapuri and Kallukurichi, Kalrayans of S. Arcot dist., Tamil Nadu.
10.	*Eriolaena lushingtonii* Dunn (Sterculiaceae) Dist.: Nallamalai Hills, Andhra Pradesh & Sriviliputhur Reserve Forest, Kamarajar district, Tamil Nadu.
11.	*Isonanadra villosa* Wt. (Sapotaceae) Dist.: Eastern Ghats: Velligonda hills, nellore dist., Andhra Pradesh; Kambakkam hills, Chengalpattu district, Tamil Nadu; Coastal areas of Quilon dist., Kerala.
12.	*Bentinckia codapanna* Berny ex Roxb. (Asteraceae) Dist.: Southern Western Ghats, Travancore & Tinnevelli Hills.
13.	*Bentinckia nicobarica* (Kurz) Becc. (Arecaceae) Dist.: Nicobar Islands.
14.	*Mangifera andamanica* King (Anacardiaceae) Dist.: South Andaman Island.
15.	*Calamus dilaceratus* Becc. (Arecaceae) Dist.: Andaman Islands.
16.	*Korthalsia rogersii* Becc. (Arecaceae) Dist.: Havelock Island, South Andamans.
17.	*Corypha macropoda* Lindel ex Kurz (Arecaceae) Dist.: South Andaman Island.

Source : *Botanical Survey of India*

The loss of ecosystems, species and genetic strains within species is occurring at a time when the tools of molecular biology and genetic engineering are making true Charaka's immortal remark that no plant is useless. Genetic diversity makes innovative and novel genetic combinations possible through recombinant-DNA research. No further time should therefore be lost in initiating systematic efforts for saving the species listed in Red Data Books. At the same time, efforts are also necessary for saving species of potential economic value occurring in endangered "protected" areas.

Programme of Work

The present project has been designed to undertake the following tasks.

1. Undertake in collaboration with the Botanical Survey of India, Forestry Departments, NBPGR and other appropriate research agencies / institutions / universities studies on the locations / sources from where planting / propagating material of the species listed in the Red Data Books can be obtained.

2. Develop priorities in the conservation of endangered species, giving specific attention to "hot spot" locations and species on the verge of extinction.

3. Conduct research on the most appropriate, economical and speedy method of multiplication of the species chosen for priority attention. The potential for multiplication through seeds, clonal and mist propagation and other conventional methods of propagation will be studied carefully.

4. Organise tissue culture propagation of species, where this method has either a comparative advantage or is the most effective approach. Develop protocols for *in vitro* propagation for the species chosen.

5. Distribute the seedlings raised to Forest Departments / Botanical Gardens / Research Institutions for conservation and further multiplications.

6. Promote studies in restoration ecology, so that the seedlings of endangered species can be re-introduced in their original habitats.

7. Disseminate information on methods of saving endangered species and organise training programmes at the post-graduate level in collaboration with appropriate organisations and scientists, and

8. Provide facilities to research scholars and post-doctoral fellows from all parts of the country to undertake research on saving the endangered species of interest to their area through tissue culture techniques.

To sum up, the early warning systems developed by agencies like the World Conservation Monitoring Centre (WCMC), IUCN and the Botanical Survey of India provide valuable information on species under threat of extinction. Such early warning, unless followed by timely action to prevent the warning coming true, will be a waste of effort. What we propose is an interlinked system of early warning and timely preventive action.

Sub Programme Area 204

Establishing a Genetic Garden for Sustainable Agriculture

It has been estimated that by the year 2000, the population of India may reach a level of 1 billion. Annual food production will have to go up to at least 225 million tonnes from the present level of about 175 million tonnes. Similarly, production of all other agricultural commodities and fuelwood and fodder will have to go up substantially. At the same time good farm land is either getting increasingly diverted to non-farm uses or losing some of its biological potential due to various forms of damage to soil health. Even now the *per capita* arable land availability in our country is only about 0.15 ha. There is thus no option except to produce more from less land to meet the needs of the growing population.

FAO and UNEP estimate that a major cause of deforestation is extension of the cultivated area. In addition, soil erosion, salinization, water-logging and similar factors are reducing the biological potential of soil in many previously fertile areas. Increase in productivity per unit area thus becomes an ecological necessity. The pathway of yield improvement should however, not result in any depreciation of environmental capital stocks like land, water, flora and fauna or influence adversely the factors that shape climate. Such a pathway is now referred to as ecological or sustainable agriculture. The vital need for accelerated economic development based on ecological ground rules was stressed by the World Commission on Environment and Development (WCED) chaired by Mrs. Gro Harlem Brundtland in its report submitted in 1987 and by the Committee of WCED on Food Security, Forestry and Environment chaired by Dr. M.S. Swaminathan (1987). The conservation and effective use of plant genetic resources are important for reducing the need for external or market-purchased inputs like mineral fertilizers and chemical pesticides and to overcome technology - induced biotic and abiotic stresses.

A special programme for the collection, evaluation, preservation and enhancement of plant genetic resources directly related to the promotion of sustainable advances in crop productivity will be undertaken as a priority activity of CRSARD. Collection and conservation of the followiing will be undertaken during 1991-92.

a. Germplasm of nitrogen-fixing tree species and shrubs, stem nodulating legumes like *Sesbania rostrata*, as well as of *Azolla*, blue-green algae, *Rhizobia* and other microflora. Work on this research topic was initiated in 1990 with a collection of genotypes of *Sesbania rostrata* (see Sub Programme area 303)

b. Plant species of importance in pest control including tree species, annual plants, fungi and bacteria which act as repellents of pests and those which control soil nematodes and weeds.

c. Germplasm of species which can enhance the efficiency of fertilizer use including Neem, *Azadirachta indica* and other tree species whose seed cakes have a nitrification inhibition capacity,

d. Species which can help to prevent/reduce soil erosion and protect local food security often referred to as ecological or economic key species such as vetiver grass *Vetiveria zizanoides*, *Chenopodium* species, and grain and leaf Amaranths.

e. Tree species and shrubs of value in agro-forestry and alley farming practices and in restoring the fertility of degraded and wastelands.

A Project Design workshop to articulate clearly the scope and priorities of the Genetic Garden for Sustainable Agriculture is being organised at Madras on November 22-23, 1991. A request for the allotment of 25 ha of land for this specialised Genetic Garden has been made to the Government of Tamil Nadu.

Sub Programme Area 205

Use of RFLP Analysis in the Study of Genetic Variability in Mangrove Species

Conventional genetic studies are difficult in mangroves and many forest tree species. Consequently, practically no information exists on the genetics of mangroves. Chromosome numbers have however been determined in several species. They

generally range from 2n = 16 to 2n = 38. The Temple Tree at Chidambaram, *Excoecaria agallocha* (Figure 10) has however been reported to have a chromosome number of n = 65. At present, it is not possible to partition with a reasonable degree of confidence the observed phenotypic variability into environmental and hereditary components.

In view of the difficulties and delay inherent in conventional Mendelian analysis, it is proposed to standardise molecular methods of genetic analysis, using the molecular variations in DNA known as restriction – fragment length polymorphisms (RFLPs). The DNA variation uncovered by RFLPs can be treated like any other Mendelian phenotypic trait and mapped by standard genetic crosses to give information on chromosomal location and linkages. The aim is to develop an array of reference points that span the genome, making it possible to pin-point the location of particular genes more efficiently than possible with isolated and Mendelian markers.

RFLP techniques are currently being used in plant breeding for purposes such as manipulation of quantitative traits, parent and varietal identification, pathogen identification, marker-assisted introgression of major loci, plant population biology and understanding somaclonal variation. In plants like mangroves, RFLP techniques coupled with morphological and isoenzyme studies, may help in understanding and estimating the extent of intra-specific variability existing in different species. The experience gained and expertise developed will be of use in working with other perennial tree species.

Figure 10

***Excoecaria agallocha**, which has a chromosome number of n=65.*

Mangrove forests consist of about fifty dominant species which are considered as true mangroves and almost the same number of their associates. They have wide environmental tolerances, adapting to growth in different environments. This great diversity in growing conditions is reflected in variable tree form, spatial arrangements of species and stand structural attributes.

The variability in species associations and the dominance of each in a given environment are predominantly determined by the characteristics of the landforms that can be colonised by each species in a given region. The type, size and frequency of occurrence of available landforms is a function of the particular mix of fluvial, tidal and wave energies found in that particular region. Different species colonise these sites depending on their adaptations and edaphic preferences.

Considering the genetic variability in these unique tidal forests, their structure and floristics have been poorly studied. For conserving this genetic diversity, it becomes essential to understand the basis of genetic variability at intraspecific and site-specific levels. The existing techniques, scoring from morphological variability and isozyme variability, are particularly difficult and unreliable in forest trees. Hence, there is need to develop tools / techniques for measuring genetic diversity.

Recent advances in the RFLP technique has made it possible to use it as a valuable tool in plant genetic studies and also to understand genetic diversity and phylogeny. Such data will be helpful in understanding the evolution of new adaptations, gene flow, and introgression leading to speciation. The advantage of this method is that RFLP markers do not depend upon gene expression and are not affected by environment. These markers simply represent the presence and absence of characteristic base sequences. They are the direct reflection of the genotype; and maintain their identity in all possible genetic backgrounds.

A Senior Reseach Fellow was deputed to a RFLP training course organised by the International Centre for Genetic Engineering and Biotechnology (ICGEB) at New Delhi in February, 1991. Work on RFLP analysis in mangrove species was initiated in March, 1991, with the facilities kindly provided by the Anna and Madras Universities (Department of Biotechnology and the Centre for Advanced Studies in Botany respectively) and the Southern Petrochemical Industries Corporation (SPIC) Science Foundation. Work on the development of the necessary probes is ongoing.

Programme Area 300

Biovillages

Introduction to the Programme

Creation of opportunities for skilled jobs particularly for women and educated youth is a challenging and urgent task in villages. CRSARD has hence undertaken research on promoting skilled employment through the integration of traditional and frontier technologies. The first kind of technology chosen for this purpose is biotechnology. The term "biovillage" is used to denote the integration of recent advances in biological technology with the best in traditional techniques, in a manner that the livelihood security of rural people can be upgraded ecologically and economically. The aims of this project are to promote the efficient and sustainable use of natural resources, and to achieve a continuous and steady growth of agricultural production while protecting and improving the environmental capital stocks of the village. Unless the ecological security of the farm and the economic well-being of the farm family are linked in a symbiotic manner, sustained advances in agricultural productivity and family welfare cannot be achieved.

Thus, the basic paradigm of the biovillage projects will involve considerations of a) ecological sustainability b) participatory research and development c) economic efficiency coupled with equity d) women's employment and income generation and e) attraction and retention of educated youth in rural professions. Such a project should help to foster a new social contract between the rural poor and the professionals working in the forward edge of Science and Technology.

For designing the biovillage projects, a Dialogue on "New Technologies: Reaching the Unreached. 1. Biotechnology" was organised at Madras in January 1991. The participants included biotechnologists, social scientists, industrialists and policy–makers from India and abroad. The Dialogue helped both to impart conceptual clarity and to delineate an operational strategy for the biovillage project. Based on the suggestions made at the Dialogue the following protocol was developed.

Strategies

1. Identify villages where there is a high probability of success in achieving the social and technological goals of the project. At the same time, keep in view the need for selecting sites with a large extrapolation domain.

2. Identify technologies which could help to increase the productivity and profitability of the farming systems of the village on an ecologically sustainable basis. Examine jointly with rural families, how the new technologies can be integrated in a desirable manner with existing technologies and farm practices.

3. Present the technological options before the village community and develop a blue-print for action jointly with rural women and men. The principle here is "before you teach the farmers, listen to them."

4. The blueprint for action should include the following five components.

   a) Marketing opportunities (home trade and exports)

   b) Management procedures for technology integration and dissemination.

   c) Material derived from biotechnological research such as tissue culture propagated plants, sero-diagnostics and vaccines, bio-fertilizers and bio-pesticides.

   d) Training and demonstrations based on the principles of "learning by doing" and "seeing is believing" and

   e) Resource mobilization, especially in relation to technical and financial resources.

5. Establish the following pilot project implementation and management procedures.

   a) A Science and Technology Consortium consisting of appropriate Government agencies, University Departments and private sector industry. The Science and Technology consortium will help to identify technology options, technology integration mechanisms and marketing opportunities. It will arrange for the necessary training and monitoring services.

   b) A Financial and Management Back-up Consortium consisting of financing institutions, donor agencies, insurance companies and private and public sector industries which are willing to help in the provision of credit and in the organisation of marketing and management.

6. Establish a Bio-centre preferably operated by educated youth belonging to landless labour families, to provide the necessary services as well as facilities for preparing value-added products from the available biomass.

7. Establish a Biovillage Society consisting of representatives of participating rural families, in order to promote group efforts in management and monitoring.

A conceptual diagram of the Biovillage Project is given in Figure 11

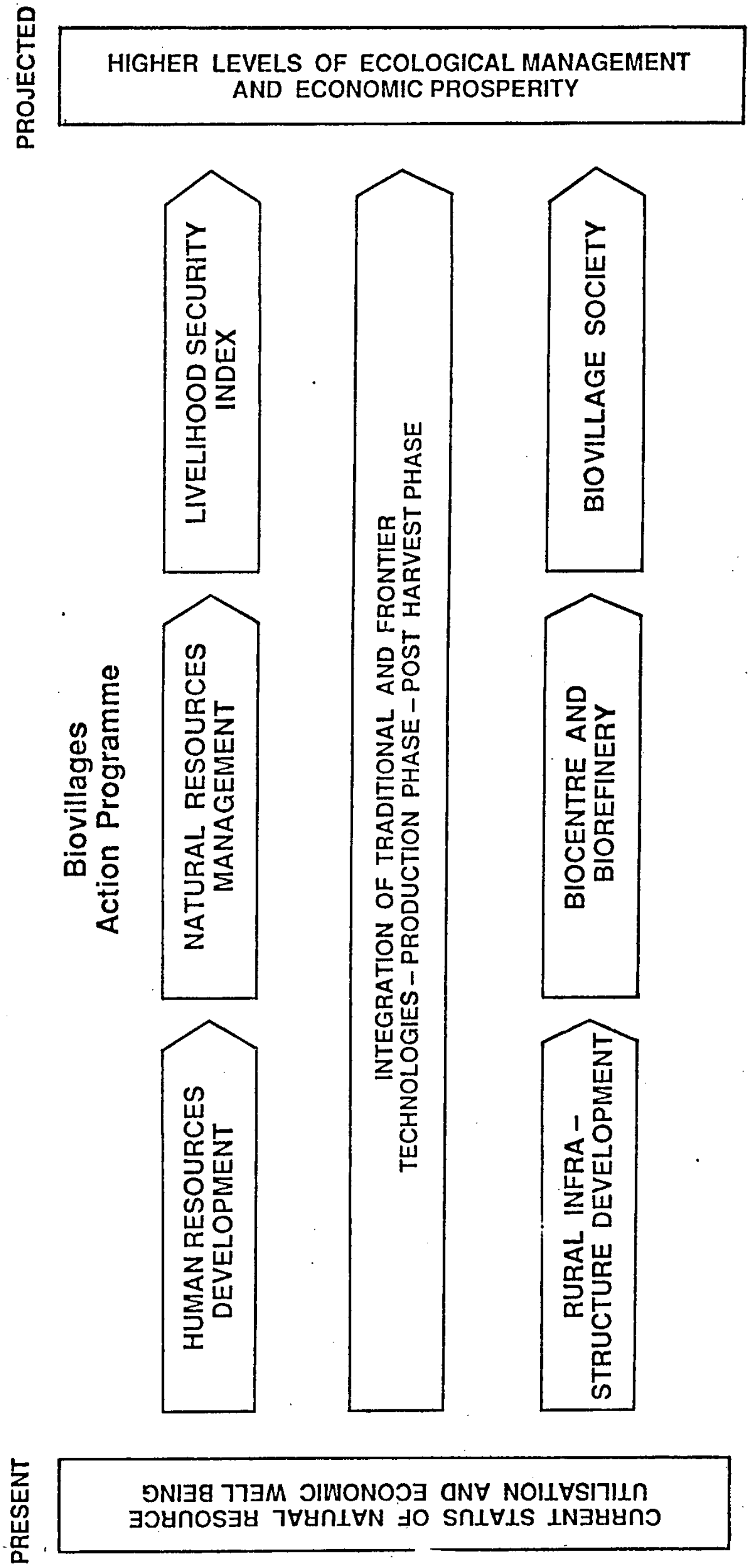


Figure 11.
Conceptual diagram of the biovillage Project

Sub Programme Area 301

Establishment of Biovillages in the Union Territory of Pondicherry – Surveys

The project was initiated in January 1991 with financial support from the Asian Development Bank. This report summarises the work completed in the period January – June 1991.

Selection of the area of study

The Union Territory of Pondicherry has been selected by the Project Design team for setting up the Biovillage Pilot Project. A preliminary visit to Pondicherry was made in February 1991. With the approval of the Lt. Governor of the Union Territory of Pondicherry, a meeting was held with all the Secretaries of the relevant Government Departments to review the status of agriculture and rural development programmes active in the Union Territory and to see if there was scope for setting up a pilot programme for biovillages in Pondicherry. The Government of Pondicherry nominated Mr. P.P. Zacharia, Director, Department of Agriculture, as the liaison officer for the project.

A week later the project team visited four villages suggested by the Development Commissioner. On the basis of this field visit the following villages were selected for micro-level surveys for the biovillage programme:

1. Revenue village Kizhur and its hamlet Sivaranthakam.
2. Pillayarkuppam

Rationale for selection

These. villages are representative of different types of social structure, land ownership patterns and other socio-economic characteristics found in Pondicherry. Inferences drawn on. the basis of the detailed survey should therefore lend themselves to extrapolation for the entire district. Urbanisation rate is slow; agriculture will continue to be the mainstay of the economies of these three villages in this decade. All three villages are located in the Villianur Commune, and they lie at a distance of approximately 20 km from Pondicherry.

— Kizhur has a dominant Yadava Pillai community. Dairy farming is an important traditional occupation in this village.

About the Building

The construction of the Research and Training Centre of the M.S. Swaminathan Research Foundation was started on April 14, 1991, with the staff of the Centre and well-wishers participating in the laying of the first bricks. The design of the building, developed by Nataraj and Venkat, Architects, (see centre pages) envisages a ground floor plus two additional floors.

The land for the building, measuring 0.6 hectares and located at S.No.2, No.6 Block, in the Taramani Institutional Area, Madras, has kindly been made available by the Tamil Nadu Government on a 30 years' lease. The construction work has been entrusted to M/s. New Metro Construction Co. Pvt. Ltd. Madras. The pile foundation for the building is being laid by Messrs. Simplex Concrete Piles (India) Ltd. Madras and this work will be completed on August 15, 1991.

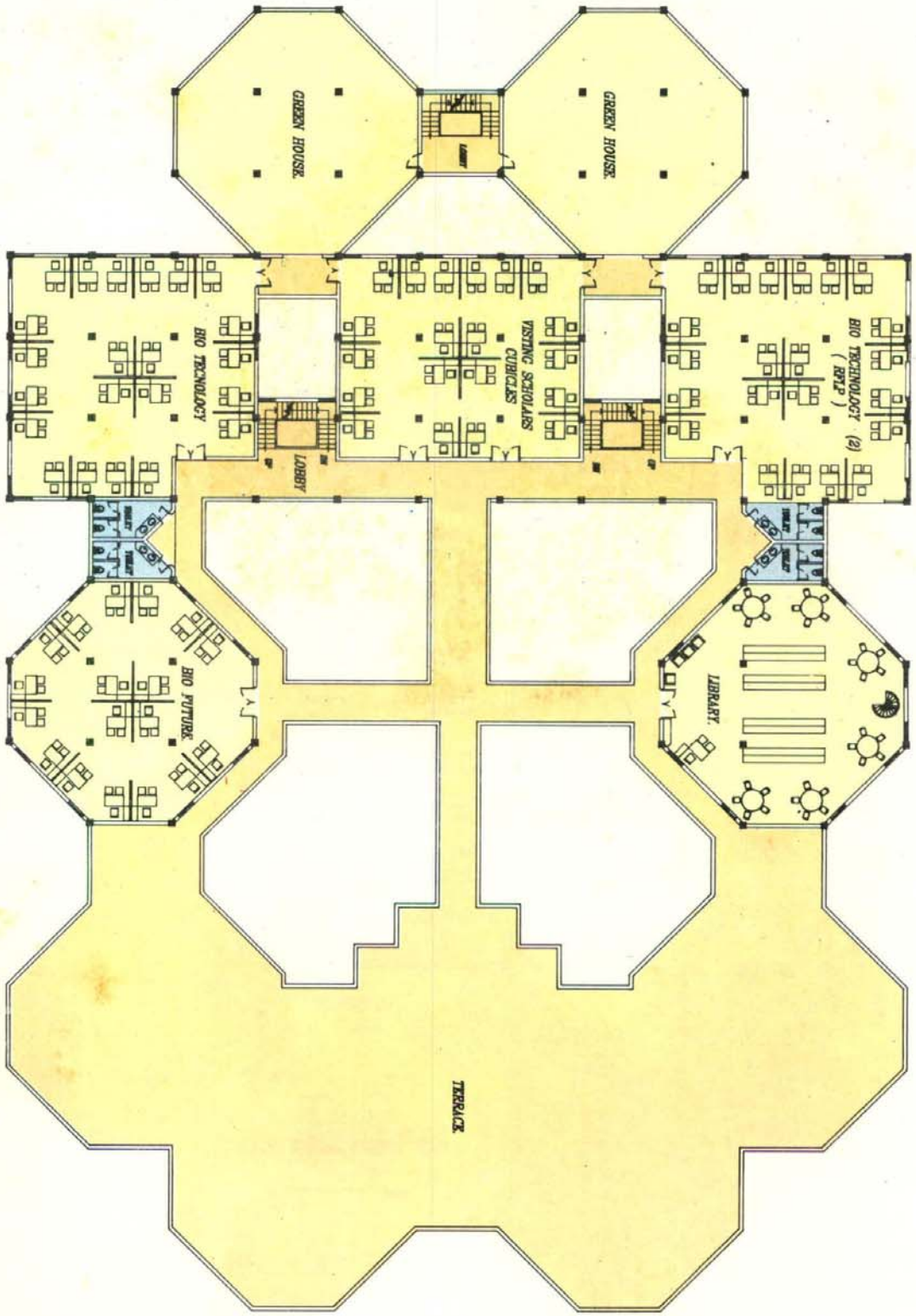
In keeping with the aim of the centre to work for ecologically sustainable development, the following features have been incorporated:

* *Low-cost maintenance*
* *Use of natural light and solar systems for lighting and heating water*
* *Collection of rain water and its use for Laboratory work*
* *Use of the poor quality ground water (high sodium content) for irrigation after treatment with gypsum in a drip irrigation system*
* *Growing of representative samples of species under threat of extinction in the courtyard*
* *Minimising the use of timber by choosing alternative material for doors and windows and*
* *Providing adequate opportunities for future growth.*

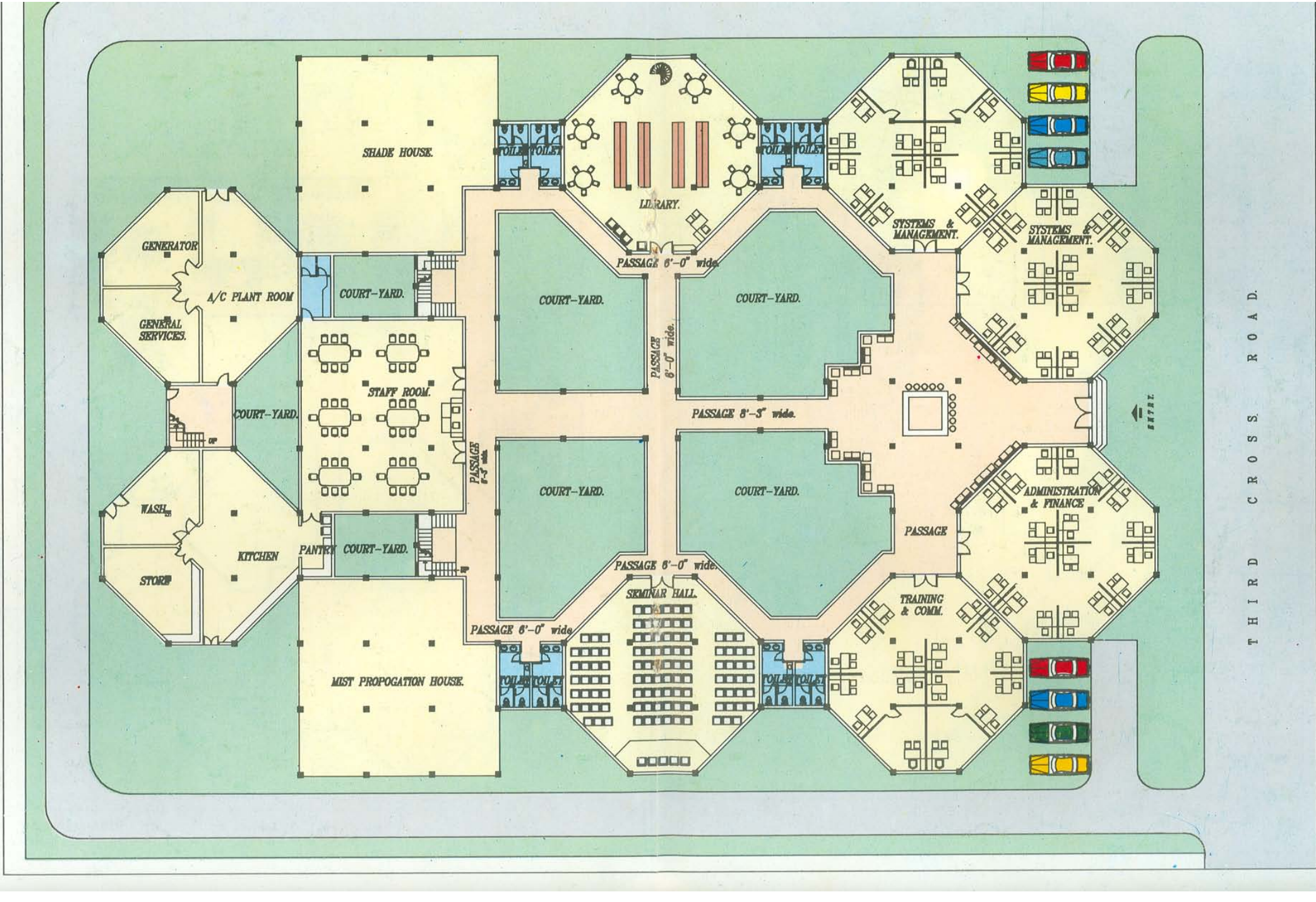
Users

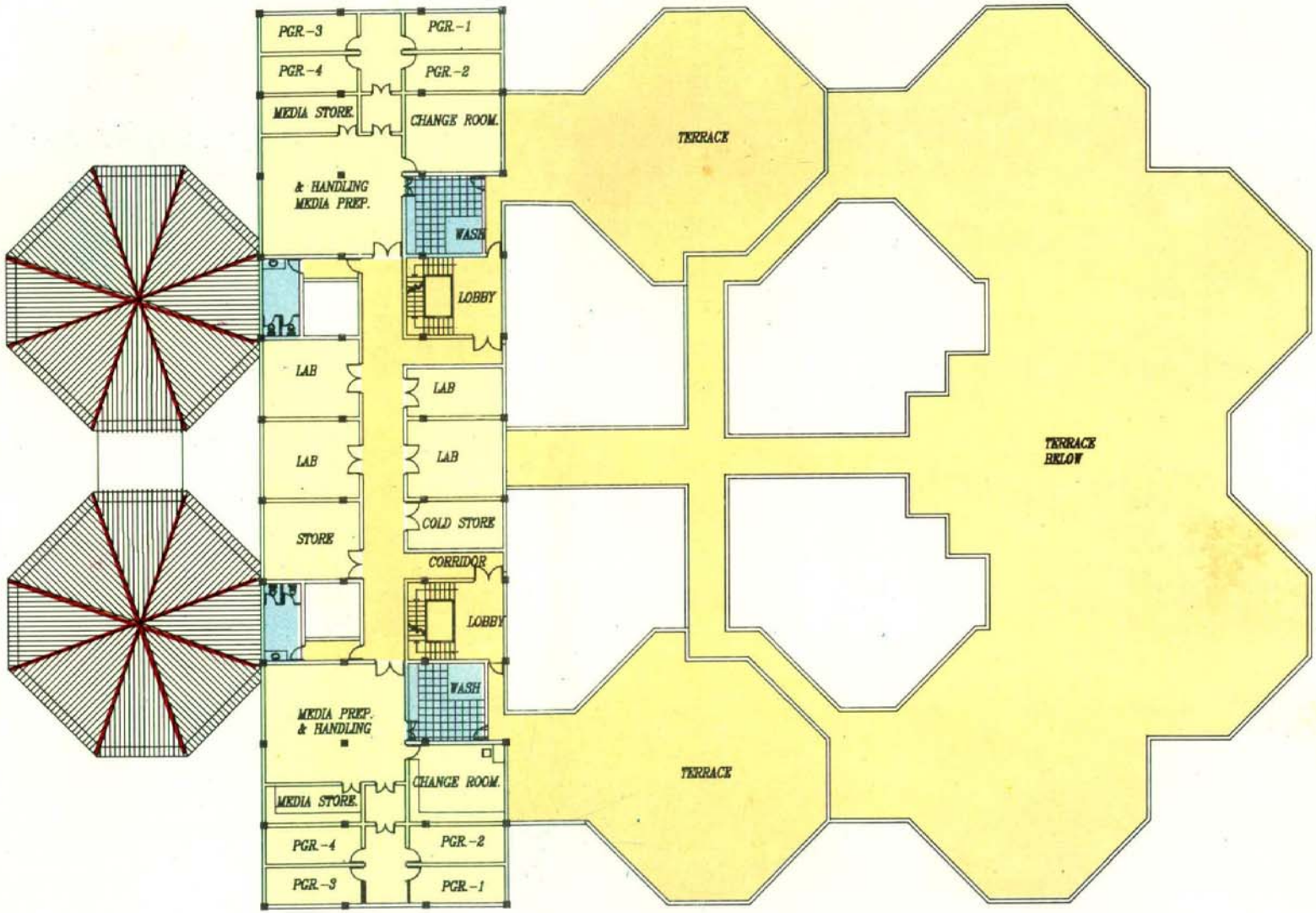
The space is being designed for the following activities and laboratories:

* *A Coastal Systems Research Group, including social scientists and technologists, which will work on problems relating to new materials, management methods and marketing principles in agro-forestry, horticulture and coastal aquaculture.*
* *A Computer-aided Extension System Group, which will work on integrating meteorological, management and marketing information to promote ecologically and economically sound land and water use patterns.*
* *A Biodiversity Group, which will work on all aspects of conserving endangered plant species and organise and operate Genetic Resources Centres for sustainable agriculture and for adaptation to climatic and sea level changes.*



THIRD CROSS ROAD.


SHADE HOUSE.
TOILET
TOILET
LIBRARY.
TOILET
TOILET
SYSTEMS & MANAGEMENT.
SYSTEMS & MANAGEMENT.
GENERATOR
A/C PLANT ROOM
GENERAL SERVICES.
COURT-YARD.
PASSAGE 6'-0" wide.
COURT-YARD.
COURT-YARD.
PASSAGE 6'-0" wide.
STAFF ROOM.
COURT-YARD.
PASSAGE 8'-3" wide.
ENTRY
PASSAGE 6'-3" wide.
COURT-YARD.
COURT-YARD.
WASH
KITCHEN
PANTRY
COURT-YARD.
STORE
ADMINISTRATION & FINANCE
PASSAGE
PASSAGE 6'-0" wide.
SEMINAR HALL.
TRAINING & COMM.
PASSAGE 6'-0" wide.
TOILET
TOILET
TOILET
TOILET
MIST PROPOGATION HOUSE.
THIRD CROSS ROAD.


PGR.-3
PGR.-1
PGR.-4
PGR.-2
MEDIA STORE.
CHANGE ROOM.
& HANDLING
MEDIA PREP.
WASH
LOBBY
LAB
LAB
LAB
LAB
STORE
COLD STORE
CORRIDOR
LOBBY
WASH
MEDIA PREP.
& HANDLING
CHANGE ROOM.
MEDIA STORE.
PGR.-4
PGR.-2
PGR.-3
PGR.-1
TERRACE
TERRACE
BELOW
TERRACE
THIRD CROSS ROAD.

- *A Biotechnology Group, which will work on saving endangered plant species through tissue culture and undertake studies on molecular linkage maps (RFLP analysis) and genetic enhancement.*
- *A Biofuture group, which will work on promoting the growth of biovillages through the integration of traditional wisdom with frontier technologies.*
- *An Education and Training Group, which will work with traditional and emerging information technologies and pedagogic methods for reaching the unreached, particularly rural women.*
- *A Human Resources Development Group, which will work for better child care and educational services for the poor by developing methods for inducing convergence and synergy among programmes relating to children and women.*
- *Central Services like Library, Computer Centre and Seminar Rooms.*

The core groups in these areas at the Centre will implement projects in collaboration with other scientists and institutions working for the same or similar goals. In addition, provision is also being made for guest research workers and scholars who may come to work for varying periods.

Architectural Features

At a glance the overall plan looks like one large honeycomb. The key element of the whole concept is flexibility in planning. A repetitive module is being used which can facilitate an interchange of activity zones. The basic plan form constitutes a cluster of interlinked octagons. The central octagon opens out to form courtyards, in which endangered species of trees are to be grown.

The entrance foyer is on a central axis. On either side of it are the higher access zones - the training and communication centre, systems and management areas and the administration block.

The foyer also leads to a central courtyard which is the hub of all activity. This has walkways which lead to the lower as well as upper levels. The library and seminar rooms are on either side of the courtyard.

Beyond the courtyard are the biofuture, biotech and computer technology areas. These are low access areas; the physical difference in level separates them from the rest of the Centre. The rear block houses the kitchen and general services.

The main structure will be of brick and concrete with the use of stone terracota and Indian patent stone. The walkways have stone pillars with timber rafters and mangalore tiles on top.

The total built up area of the Research and Training Centre will be about 6500 square metres.

— Sivaranthakam is a relatively prosperous village with progressive farmers. Large, medium and small holdings are found here. There is also a large landless agricultural labour population.

— Pillayarkuppam is a very poor village consisting of only small and marginal farmers and landless labour families.

Within the general objective of developing a quantitative understanding of the agro-ecology of farming systems and an in-depth understanding of constraints to greater sustained productivity, surveys were conducted to understand local agro-ecosystems, farmers' practices, farmers' knowledge, the reasons underlying the practices, and then to identify ways to apply such findings to technology development. Farmer-participatory research is essential to achieve sustainable productivity, given the dynamic complexity of the agro-ecosystem and the resource-poor nature of most of its farmers.

This project has the following specific objectives:

1. Analyse and quantify production constraints at the farm and system level (physical, biological and socio-economic) and determine priority research directions to overcome them.

2. Quantify yield and production stability and understand the socio-economic factors and farmers' strategies that contribute to increasing stability, and

3. Prepare maps to show topography, soil, drainage, current and projected patterns of land use.

Data Collection

Secondary Data

Working in close collaboration with the Agriculture Department in the Union Territory of Pondicherry, detailed studies on soil and hydrology have recently been completed. Information regarding meteorology, irrigation, animal husbandry, geology, entomology, health studies and Government schemes being implemented for Rural Development was collected from the various departments in Pondicherry.

Primary data collection

Primary data were collected with the help of the following field methods: a) Participant observation and b) Interviews and questionnaire survey. The survey team made seven three-day visits to each of the three villages selected for the Biovillage Pilot Project during March to May. In these visits the following work was completed:

a) Household level survey to collect information on family details such as size of family, levels of education, occupation, income and expenditure patterns.

b) Household energy consumption and quality of life (sanitation, electricity, housing, water supply, medical, entertainment).

c) Annual and seasonal patterns of time use.

d) Interviews with an appropriate sample of the target population on a) defining development b) what they feel development goals should be, c) aspirations for their children and d) perceived maladies affecting the village.

e) Agricultural practices (cropping pattern, crops grown, irrigation facilities, energy used in agriculture, fertilizers, pesticides, electric power, mechanical power, tractors, tillers; animal power, human labour, quantity of seeds used/ha, yield/ha).

f) Post-harvest handling and marketing.

Table 6
Basic statistics for the three villages

	Sivaranthakam	Kizhur	Pillayarkuppam
Land area	*311. ha		238 ha
Land/capita	0.15 ha (0.37 acre)	0.15 ha (0.37 acre)	0.13 ha (0.33 acre)
Total population	1204	857	1787
No. of households	233	163	357
Average family size	5.16	5.25	5.00
Males	612	451	937
Females	592	406	892

* includes land area for Kizhur

Survey results : Socio-economic characteristics of the villages

A. *Demography*

1. The population pyramid

Figures 12a, 12b, and 12c depict the demographic profile for the three villages. All three villages have a very young and growing population. This has very strong implications for development since the pressure of population on land is on the increase.

Sex Ratio : The 1991 Census reveals that in the country as a whole the sex ratio (number of females per 1000 males) has declined to 929 from 934 reported in Census 1981. Except for the West Coastal Zone, the South, and parts of the Uttarkhand region in Uttar Pradesh, this ratio is below 950 for the rest of the country. The decline in sex ratio, observed since the 1901 census, has been continuous till 1991, except for a reversal noticed in 1981.

In the Union Territory (UT) of Pondicherry, there is a marginal decline in sex ratio from 985 in 1981 to 982 in the year 1991. While the UT average is above the national average, the sex ratios in the biovillages are : Sivaranthakam – 967; Kizhur – 910; Pillaiyarkuppam – 952, well below the ratio for the UT. Such low sex ratios, particularly the very low figure for Kizhur, cause concern and indicate the need for special attention to the female child and women in these villages.

2. Levels of Education in the three villages

Figure 13a, 13b, and 13c show that the majority of the population has never been to school. (However, these figures include children below 5). Women in particular do not go beyond primary school education. The drop-out rate for girls after puberty is high and few girls go in for secondary education. A very small proportion of the population has studied beyond high school in all the three villages.

3. Non-working population

Figures 14a, 14b and 14c show that almost 50% of the population of every village belongs to the non-working category. These figures include children below the age of 5, students, housewives, disabled and elderly people, and dropouts. The last category, youth in the age group of 18-20 who have attended primary school and dropped out are a burden to society and do not contribute to the economic well-being of the household. Youth with higher education form a negligible part of the society – the unfortunate part is that once these people graduate they are unable to find work.

PILLAYARKUPPAM : Age Structure

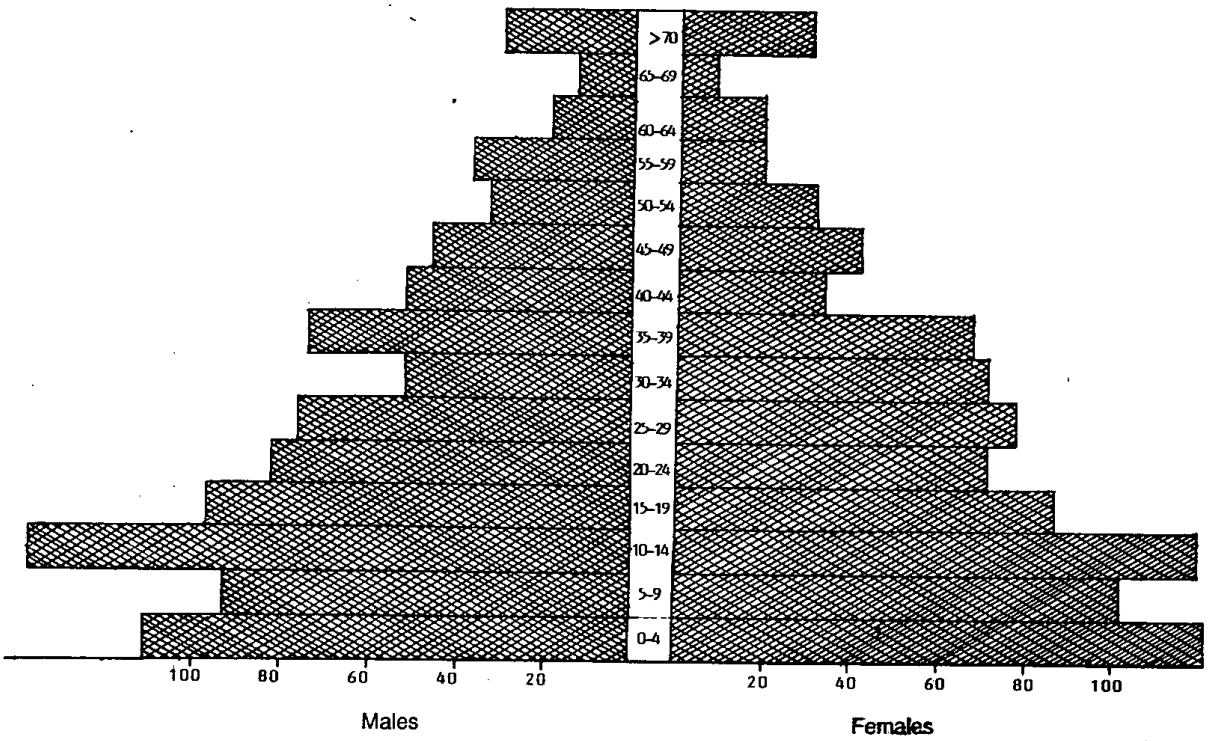


Figure 12a

KIZHUR : Age Structure

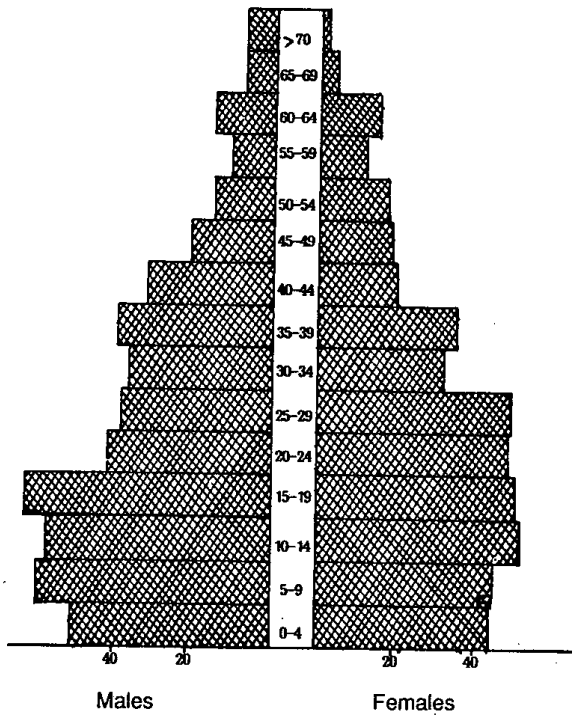


Figure 12b

SIVARANTHAKAM : Age Structure

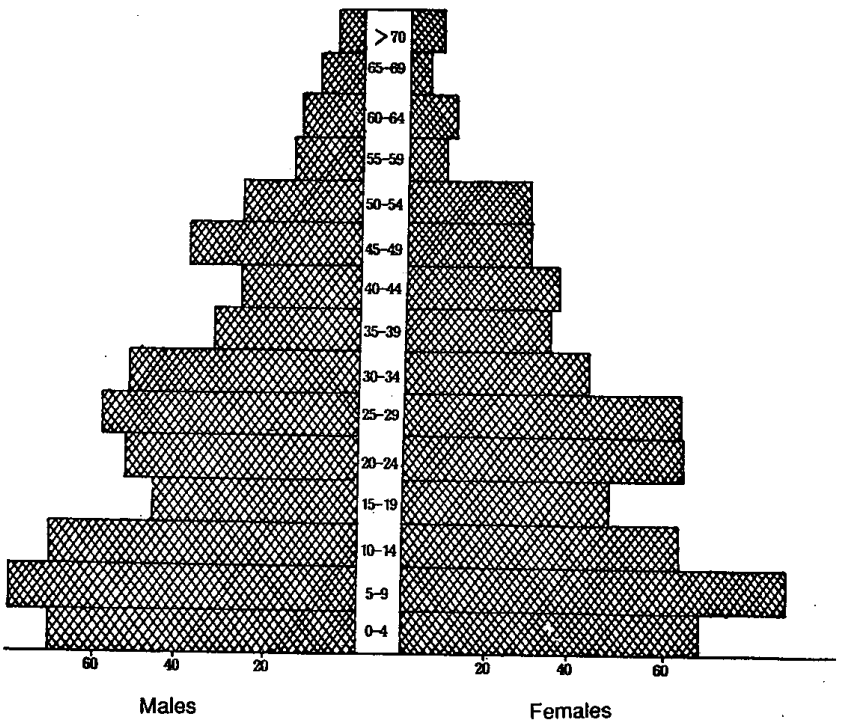


Figure 12c

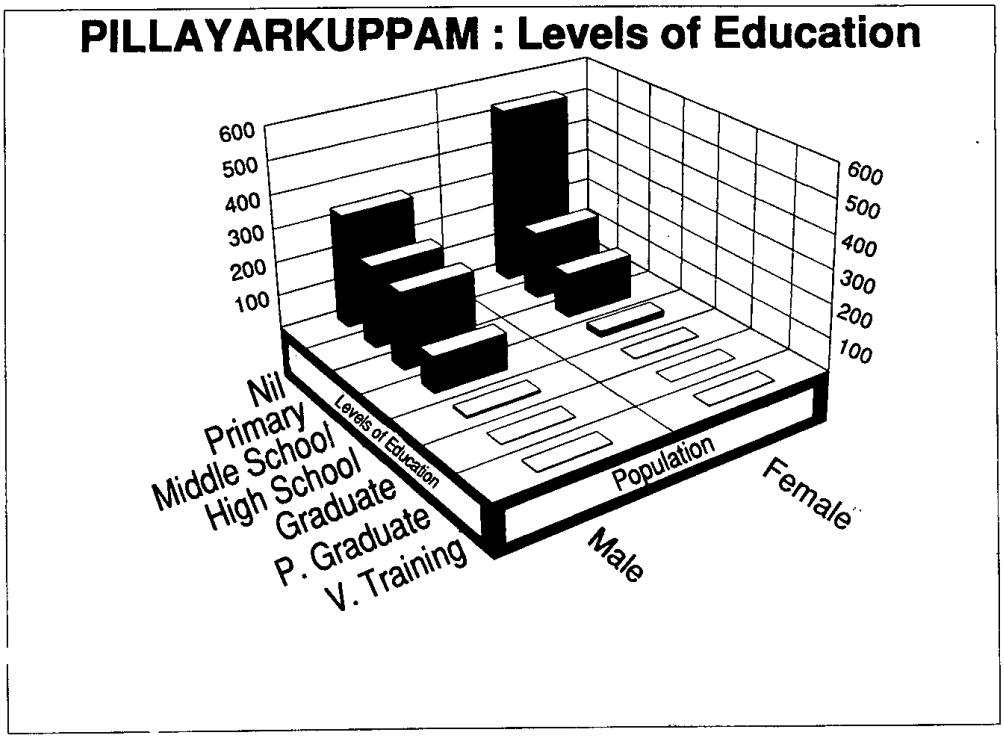


Figure 13a

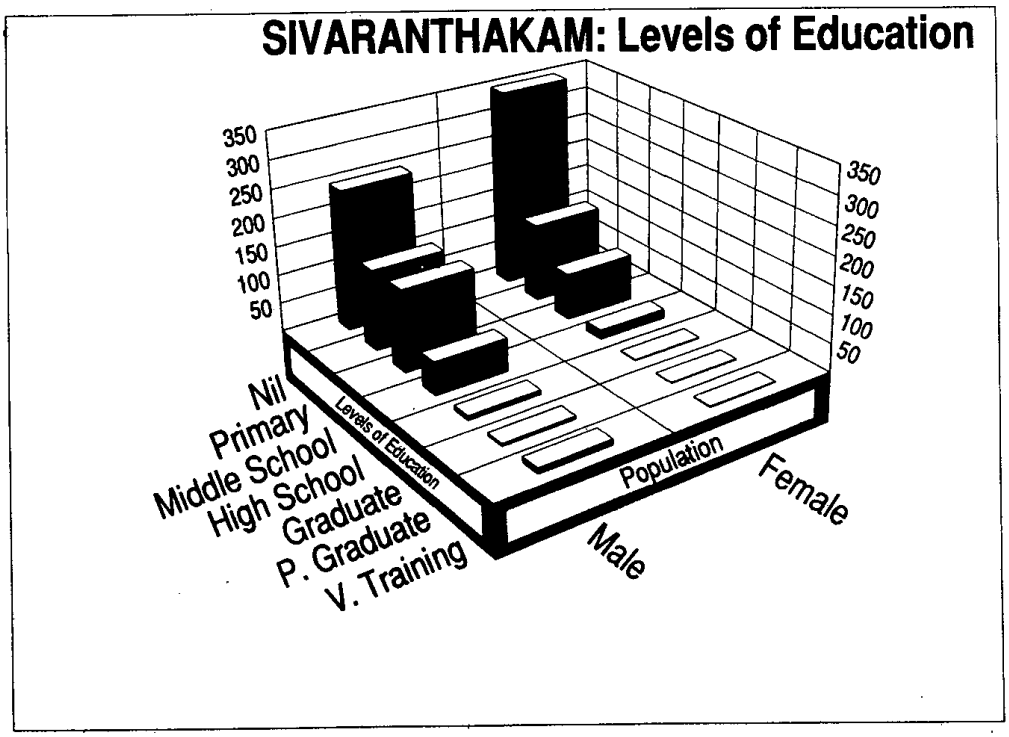


Figure 13b

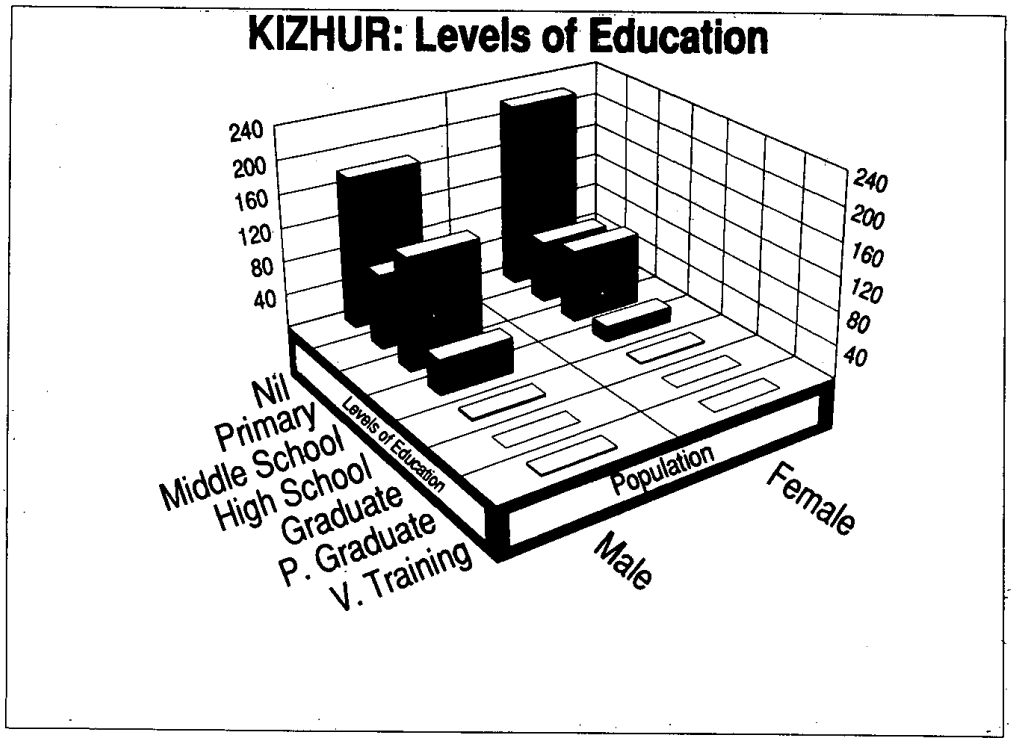


Figure 13c

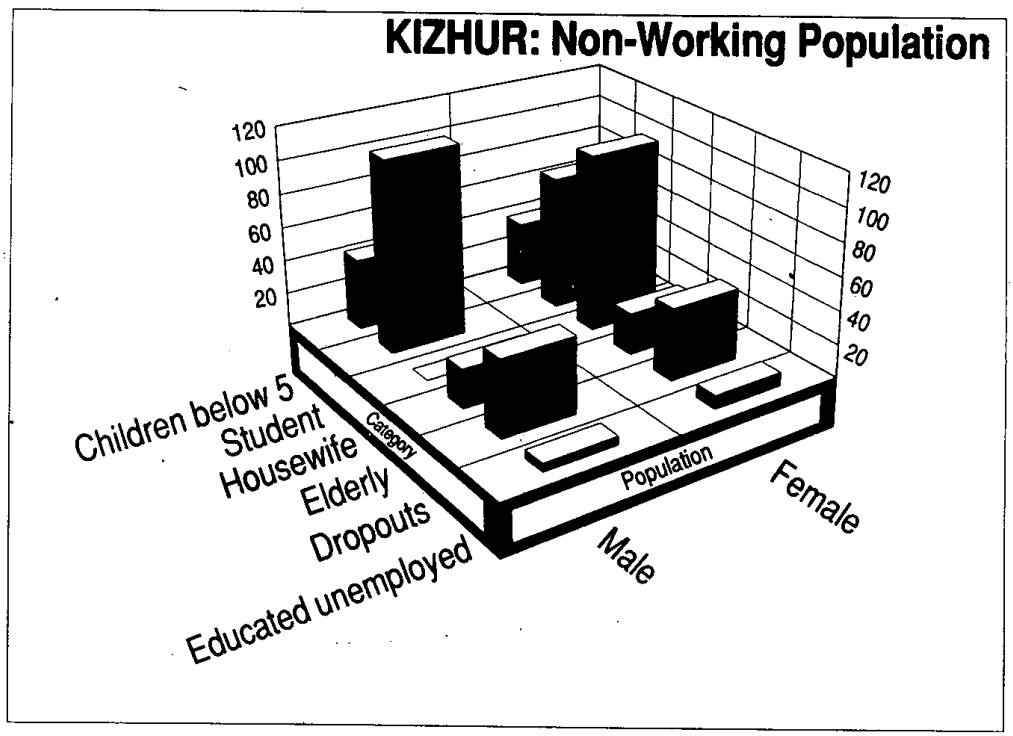


Figure 14a

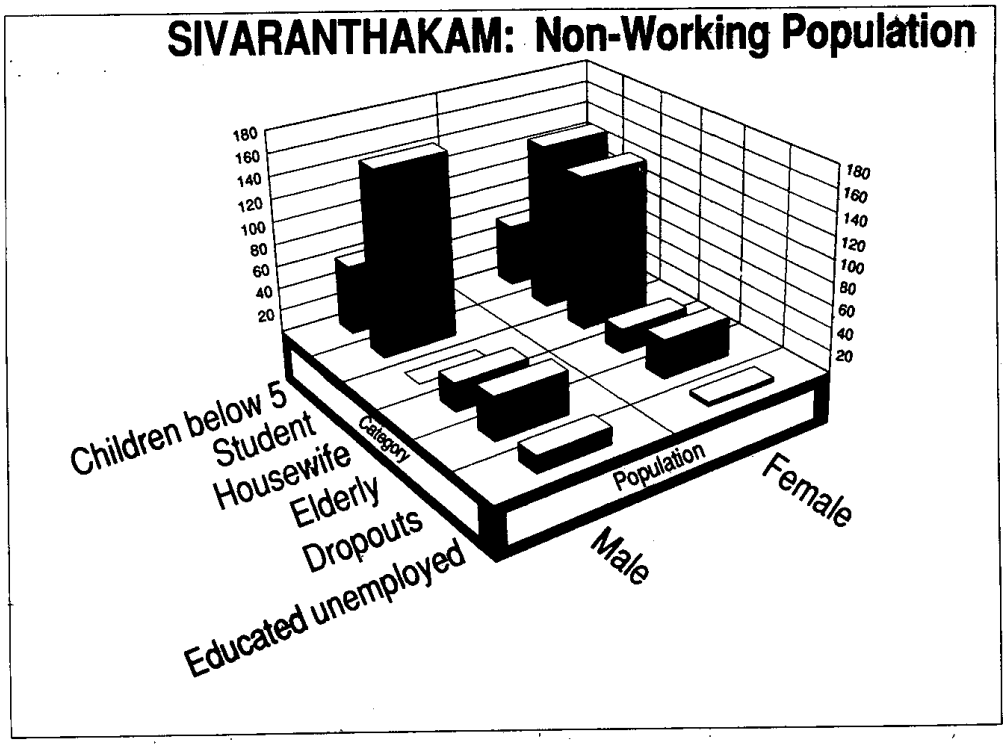


Figure 14b

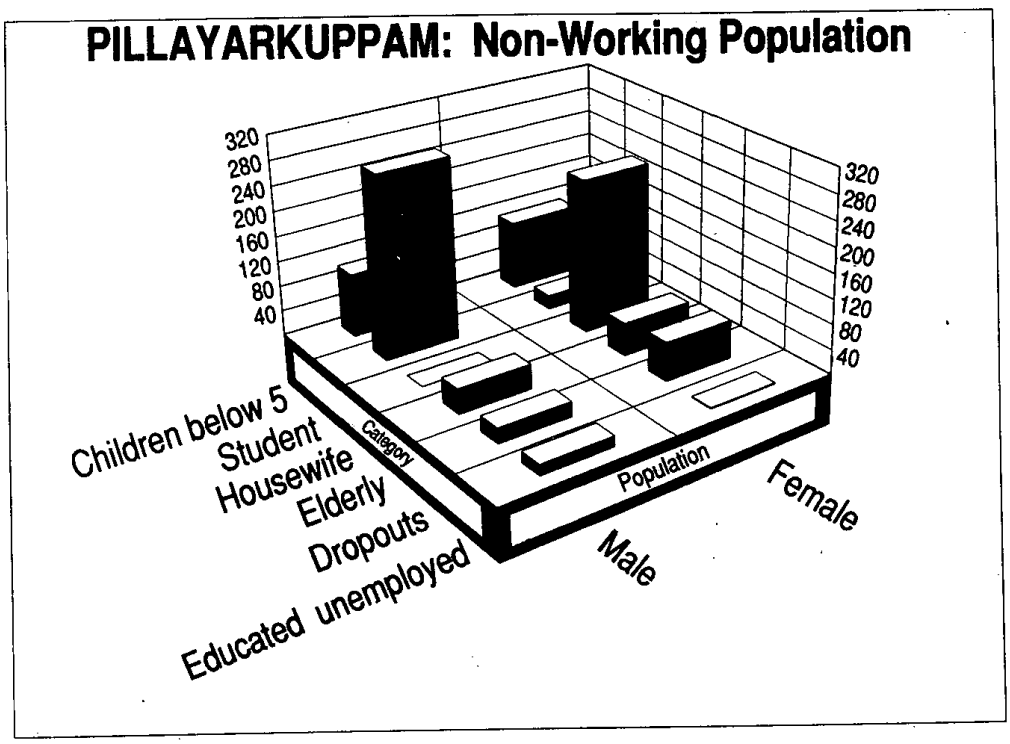


Figure 14c

4. Working Population

The following categories of workers were observed in all three villages:

1. Agricultural labourers constitute the major fraction of workers in all three villages. The wages for males is Rs. 25 for a 8-hour day and for females is Rs. 15 for a 8-hour day. All the uneducated adults in the families that do not own land work as agricultural labourers.

2. Farmers: Very few women are reported as being farmers. This is probably because land deeds are almost always made out in the name of a male member in the family. They earn approximatey Rs. 15000/ha of land owned.

3. Private Enterprise: Private enterprise provides work for a very negligible portion of the working population. They include toddy tappers, carpenters, potters, dhobis, tailors and petty shopowners in each village. They earn approximately Rs. 4500 / year.

4. Government Service: The educated portion of the population have opted to seek Government jobs outside the village. They commute nearly 15 km / day and earn approximately Rs. 12000 / year.

   Interestingly enough in all three villages people are occupied in either primary or tertiary sector activities. Absolutely no secondary activity was reported.

5. Contribution to income by occupation: The contribution to total income from Government jobs far exceeds the contribution of primary activity in Pillayarkuppam and in Sivaranthakam. This is despite the fact that more people work in agriculture than in the services sector. The per capita annual income of Kizhur, Sivaranthakam and Pillayarkuppam is Rs. 2087, Rs. 2258, and Rs. 2393 respectively, while the income per household is Rs. 11000, 11300, 12400 respectively in the three villages.

B. *Quality of life indicators*

1. Type of House in the three villages

Figure 15 shows that more than 52%, (70% and 49% respectively of the population in each village) live in mud-walled, thatch roofed, one-or-two-room houses. These houses do not have any attached toilets and the people therefore are forced to use open fields or grounds demarcated for this purpose. The women in particular suffer from the lack of toilet facilities. As the population of the village increases, the number of people using the same area for their toilet is also increasing. No measure is taken to dispose of the fecal matter and this tends to create a health hazard.

2. Electricity facility in the three villages

Figure 16 depicts the status of electricity facility in the three villages. Despite the fact that an electricity grid exists in the villages and the Government has implemented a free one-bulb service scheme for every house, more than 50% of the households have no electricity, while 40%, 29% and 14% of the households in Kizhur, Pillayarkuppam and Sivaranthakam respectively reported actual meter service. These houses had more than one bulb and some appliances in their house. Only 4 of the families in Sivaranthakam vilage owned a refrigerator, colour TV and a VCR.

C. *Health and nutrition status*

A random sample in Pillayarkuppam of ten percent of the total number of households were selected to do a nutrition survey of the village. The questions asked related to the food habits of the various income-groups of the village; time spent in doing daily chores of cooking, fetching fuel and firewood was also noted.

The tri-color tape developed for malnutrition assessment was used on all the *anganwadi* children in Sivaranthakam and Pillayarkuppam. On the whole 50 children were examined.

Pillayarkuppam

1. According to the headmaster the children come hungry to school; their main meal is the noon meal provided by the school. They eat dinner at home.

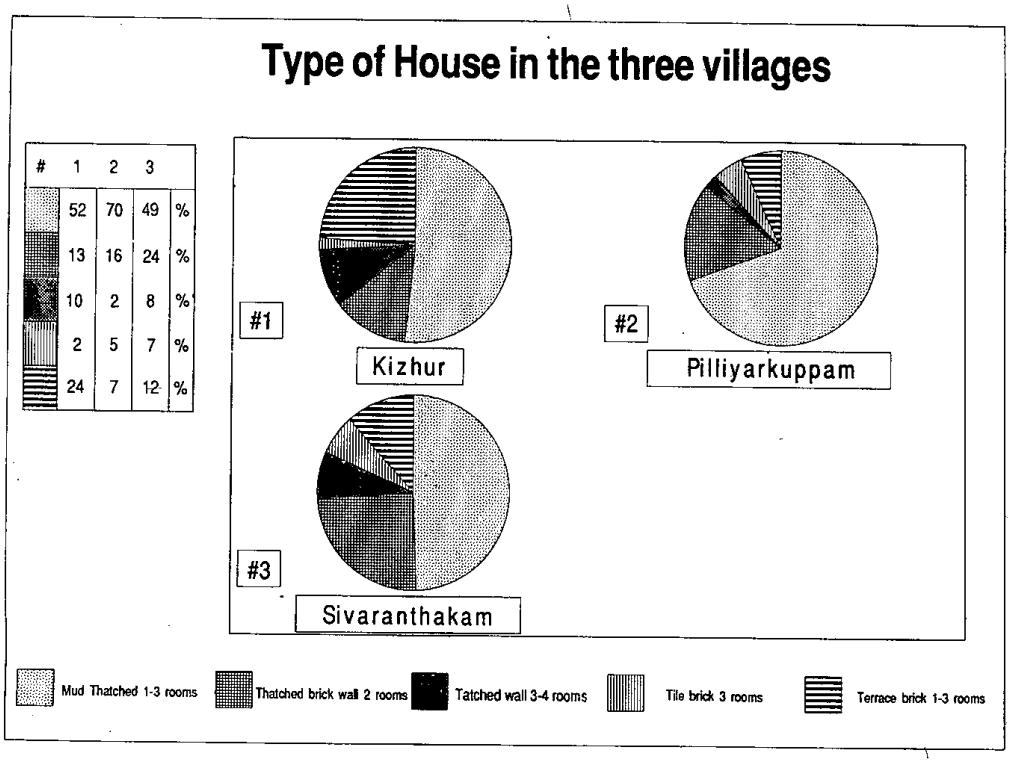


Figure 15

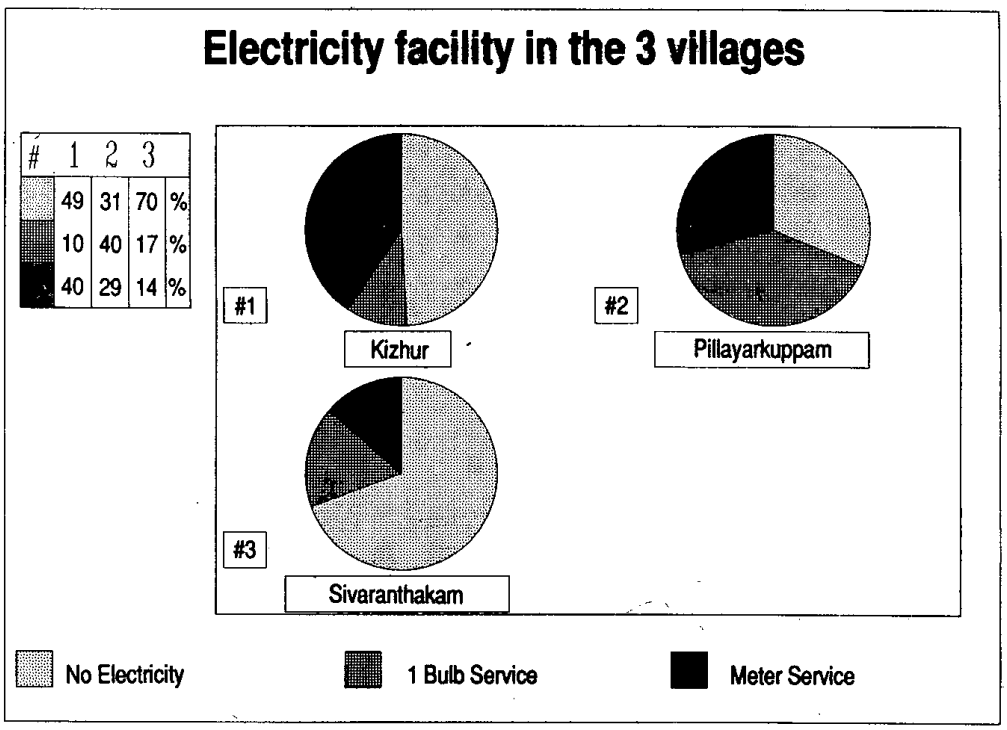


Figure 16

2. Vitamin A and Vitamin B deficiencies are very common. From the school medical records it was found that almost 90% of the children suffered from either worms or angular stomatitis – an indication of vitamin B deficiency.

3. Out of the 29 *anganwadi* children (ages 3-5) observed with the tri-color tape, 18 children were normal and healthy, 10 were moderately malnourished and 1 child (boy) was severely malnourished.

4. A few cases of children below five with blond hair were also noted, implying a possible deficiency of proteins in the diet.

Table 7
Sivaranthakam: Common diseases (January – April 1991)

Diseases	Incidence (No. of cases)	Diseases	Incidence (No. of cases)
Dysentery/diarrhoea	117	Conjunctivitis	15
Gastro-enteritis	46	Ear infection	20
Worms	40	Common cold	190
Parasitic skin infections	96	Tonsillitis	57
Asthma	05	Influenza	83
Allergy	02	Bronchitis	35
Vitamin A deficiency	100	Teeth problems	30
Anaemia	88	Skin diseases	38

Most of the common diseases are related to unhealthy living habits, lack of sanitation, going to the toilet in an open place, water pollution and lack of personal hygiene, especially observed among the poorest section of the society in the village.

D. *Resource Accounting / Land use mapping*

Figures 17, 18, and 19 show the current pattern of land use in the three biovillages. The maps were prepared jointly with the farmers, based on an outline of the village map obtained from the Department of Agriculture. This map was laid out before a group of farmers and we explained to them that we wanted to carry out a mapping exercise of the current pattern of land use in the villages. Once they understood what was to be done they helped in identifying the crops growing on all the fields in the village.

SIVARANTHAKAM VILLAGE

Land Use 1991

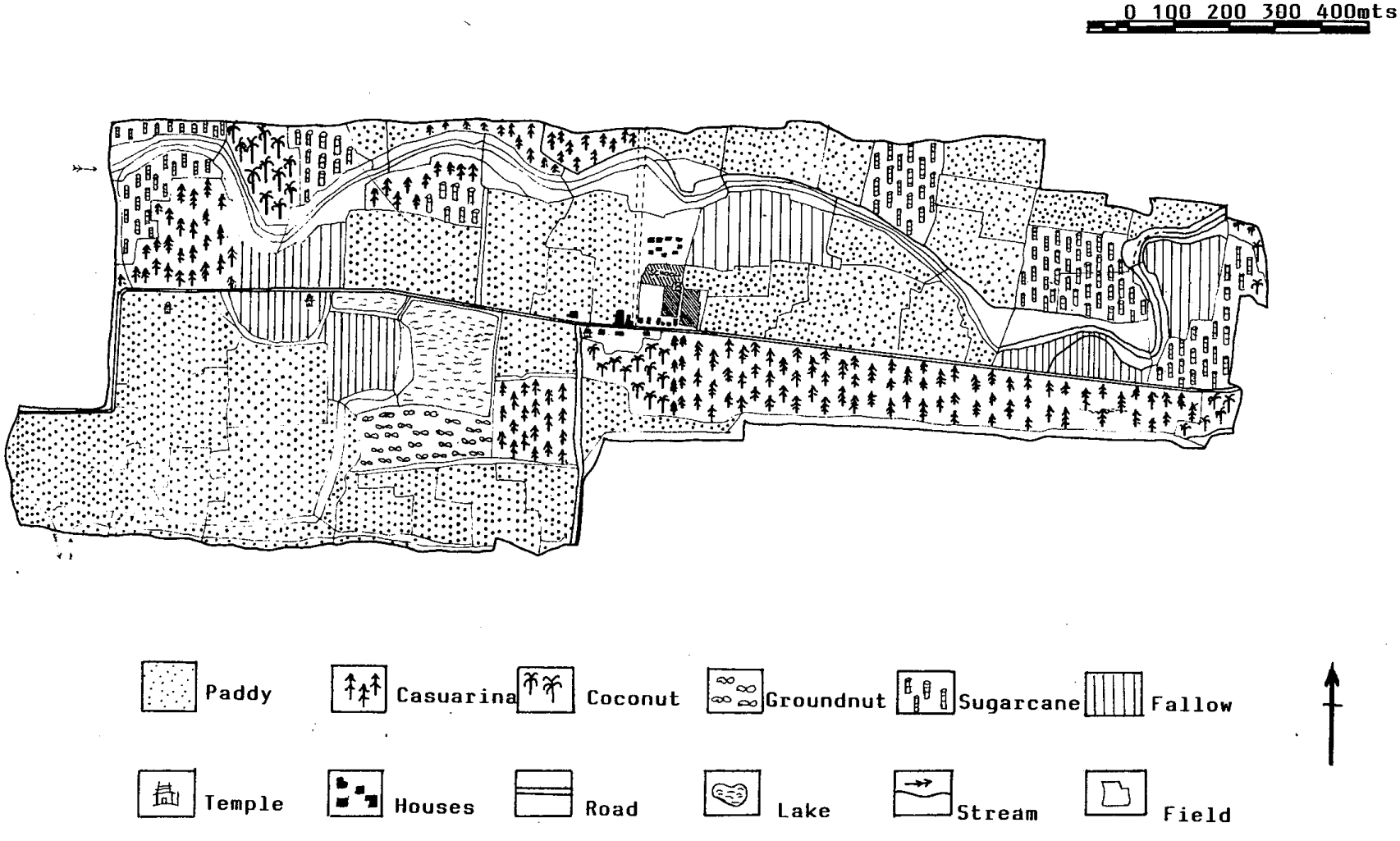


Figure 17

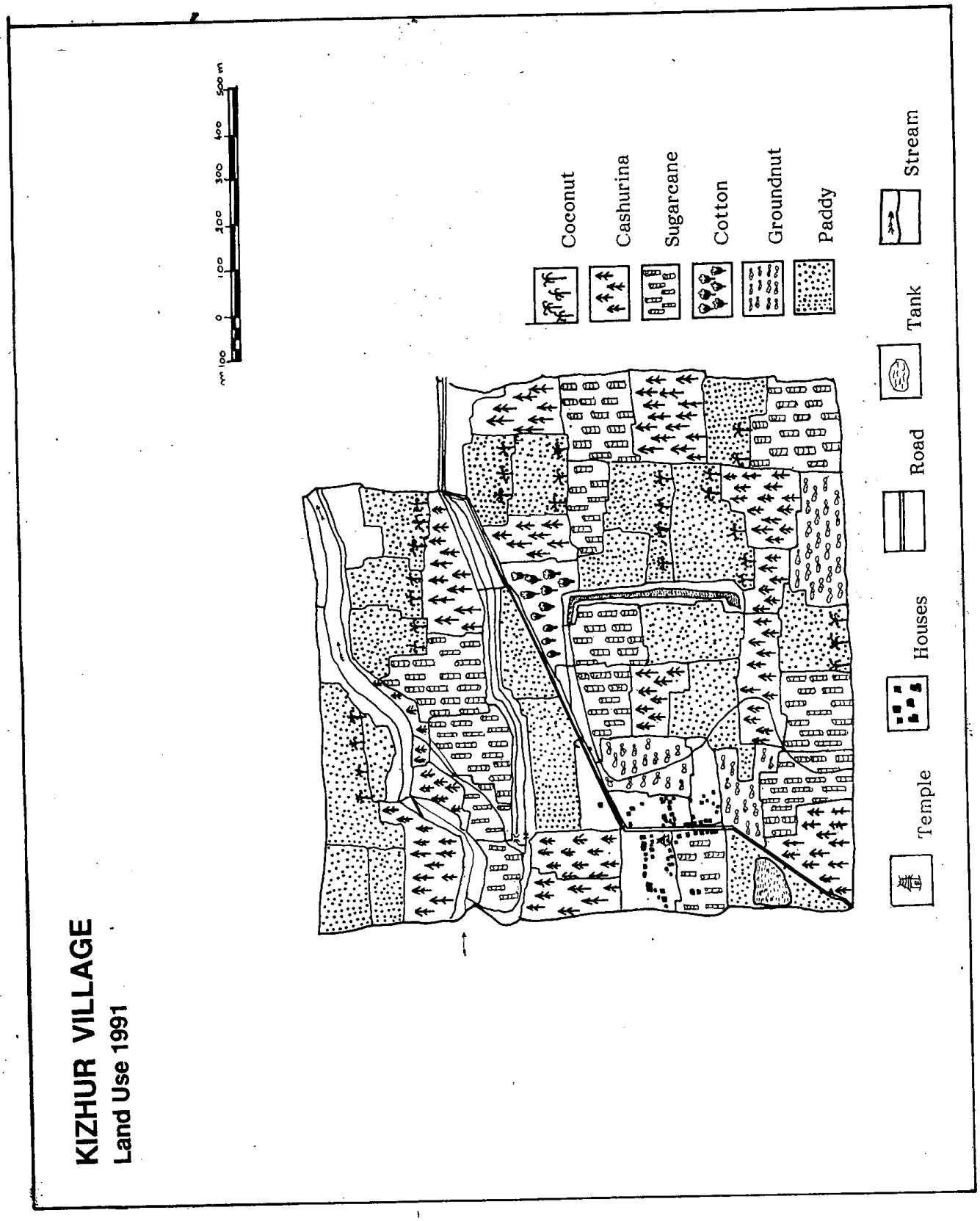

KIZHUR VILLAGE
Land Use 1991
0 100 200 300 400 500 m
Coconut
Cashurina
Sugarcane
Cotton
Groundnut
Paddy
Stream
Tank
Road
Houses
Temple

Figure 18

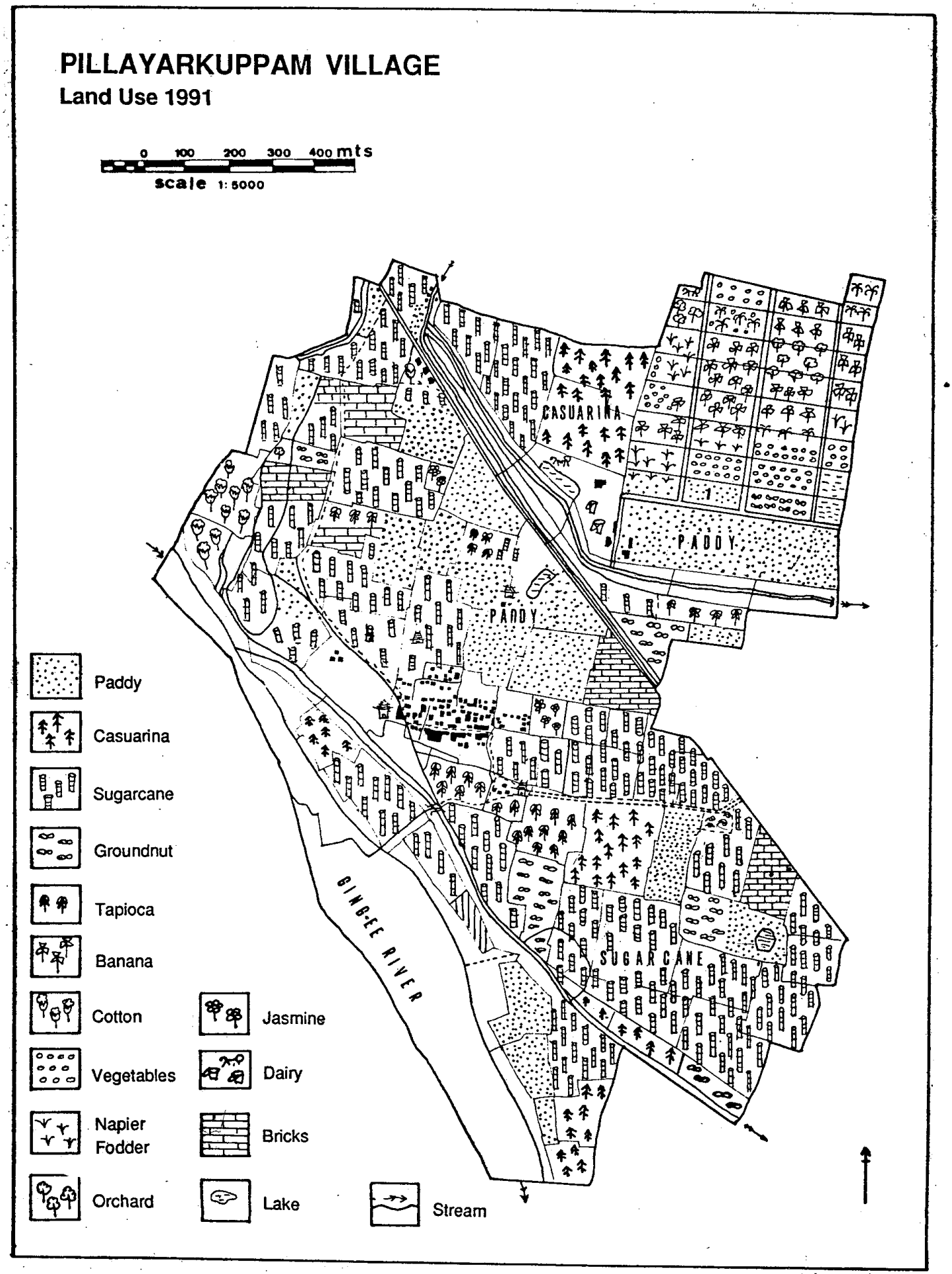

PILLAYARKUPPAM VILLAGE
Land Use 1991
0 100 200 300 400 mts
scale 1:5000
CASUARINA
PADDY
PADDY
PADDY
SUGARCANE
GINGEE RIVER
Paddy
Casuarina
Sugarcane
Groundnut
Tapioca
Banana
Cotton
Vegetables
Napier Fodder
Orchard
Jasmine
Dairy
Bricks
Lake
Stream

Figure 19

Sivaranthakam and Kizhur

Sivaranthakam and Kizhur are located on the banks of the Kodavayur river in the western partof the Villianur Commune. The area covered is 311 ha of land. The combined population of the two villages is 2061.

The main crops grown are paddy (3 crops/year), casuarina (intensive farming), sugar cane and groundnut. The minor crops grown are cotton, gingelly and millets. Some coconut trees were planted on the bunds. Horticultural crops are not very popular. Only a few mango, banana and papaya trees were planted for home consumption. Fear of theft was given as the main reason why the people did not go in for horticulture.

Pillayarkuppam

The main crops grown are sugarcane, paddy (2-3 crops), casuarina (dry farming), tapioca and groundnut. The minor crops grown are cotton, jasmine, chillies, gingelly, pulses and millets.

In all three villages, groundnut and gingelly were often intercropped with casuarina. Pulses, millets and groundnut are also grown as the *sornawari* crop.

Sub Programme Area 302

Farming Systems Research

Methodology

Thirty percent of the farmers in every village were interviewed on a random sampling basis to identify the current farming practices. A questionnaire was used to collect data on energy use in agriculture.

The methodology followed for a basic input-output analysis is as follows:

1. The analysis corresponds to system boundary at level 2 as contained in the conventions of energy analysis developed by the International Federation of the Institutes of Advanced Study (IFIAS, Stockholm 1976)

2. The norms used for energy equivalent of purchased inputs are listed in Table 8.

3. Energy in the output grain (paddy) is calculated as the heat of combustion of the *dry* grain. The average value of heat of combustion is taken to be 14.7 MJ/kg grain in dry condition. The moisture content is assumed to be 11% (Source: Mitchell, R. (1979) *Analysis of Indian Agro-Ecosystems*, Delhi: Interprint Publishers).

Table 8
Gross energy requirement values for inputs

Input	MJ/Kg
Ammonium sulphate (N)	14.5
Phosphoric acid	5.7
P (Phosphate)	14.0
K	9.7
Diesel	44.5
Urea	36.0
Fungicides/herbicides/ pesticides	120.0 (approx.)
*Man hours (kJ/hour)	2050
*Animal hours (kJ/hour)	9660

Slesser, M & Lewis, C. (1979), *Biological Energy Sources*, London: E & F.N. Spon.

* NCAER (National Council of Applied Economic Research) (1981), *Report on Rural Energy Consumption in Northern India*, New Delhi : Department of Science & Technology, Govt. of India.

In the case of animal and human labour the energy estimates are reckoned in terms of the gross and not the net output of energy. It is well known that the output of energy in the case of men and animals would be much less (about 40%) than the energy content in their food intake. For a required output, the man or the animal has to be fed a larger quantum of energy in the form of food. The energy equivalent of this intake by the man or the animal is what has been adopted in this report.

Input and Output Analysis

The cropping pattern and energy used in cultivation were studied in great detail and data have been gathered for cultivation of all the major crops, viz paddy, sugarcane, groundnut, casuarina and tapioca. Detailed results of energy inputs in paddy cultivation in Village Kizhur have been presented in Tables 9 to 11, while Table 12 lists the tools traditionally used in the rice production.

Table 9
Animal and human labour in rice production / ha

	Animal (h)	Man (h)	Woman (h)
Nursery Ploughing	15	15	0
Transporting Manure	15	0	0
Field Ploughing	175	175	0
Seedling Collection & Distribution	0	95	0
Transplanting	0	0	225
Weeding	0	0	375
Spraying	0	28	0
Harvesting	0	85	148
Post Harvest	0	88	133

From Table 9 it can be noted that there is a clear demarcation between the roles of males and females in agriculture. Women contribute most of the labour energy for growing paddy.

Table 10
Fertilizer inputs / ha

Name	kg	Cost(Rs.)
NPK 17:17:17	380	435
Urea	245	600
Potash	135	160
Ammonia	88	175
Total Chemical Fertilizer	800	2090
Neem Cake	40	80
Farm Manure	5000	200

Table 11
Pesticide inputs / ha

Name	ml
Malathion	1145
Monocrotophos	555
Dithane	520
Dimecron	120
Endosulphon	105

Table 12
Tools used in rice production

Name	Total	Wt/unit (kg)	Price (Rs)	Life (Years)
Sickle (sm)	20	0.5	3.50	3
Spade	3	1.5	40.00	2
Crowbar	1	15	150.00	10
Uprooter	5	0.5	20.00	2
Sickle (L)	20	1.0	15.00	3
Plough	1	10	150.00	3
Trambler	1	15	180.00	3

Table 13 contains the energy input – output analysis for paddy cultivation. The data used here are based on the input data presented in Tables 8–11 and have been converted to energy equivalents per tonne–output basis.

Table 13
Energy input–output analysis : paddy cultivation

Purchased and Labour inputs (MJ/tonne of output)			
	Sivaranthakam	Pillayarkuppam	Kizhur
Labour	*1586 (8.4%)*	*2135 (12.5%)*	*1890 (13%)*
Fertilizer	10620 (56.6%)	8773 (51.2%)	7953 (54%)
Pesticide	155 (0.8%)	150 (0.8%)	150 (1%)
Irrigation (electricity)	6393 (34.1%)	6210 (36.3%)	4595 (32%)
Total	18755	17268	14585
Yield(kg/ha)	4825	4725	5300
Output/ Input ratio	3.77	4.02	5.33

.We notice the following:

1. Fertilizer followed by irrigation represents the largest fraction of inputs in paddy cultivation. These two inputs account for almost 90% of the total input energy.

2. The output/input ratios reported here are high.

Work to be completed in 1991

Data Analysis

1. Rural systems analysis: This will be done with the help of systems diagrams, tracing human economy – ecosystem linkages for rural areas, describing how each one is related to each other.

2. All the systems (energy sources, storages, production, consumption systems within the overall system) will be analysed and quantified to assess resource availability within the target area.

3. Development of current model of current resource use and livelihood security.

4. Time-use analysis to assess the availability of time resources (annual, periodic, daily time budget of people).

5. Assessment of trade-technology-training linkages.

6. Need-based analysis: Socio-economic survey will help assess quality of life vis–a–vis a viz resource use.

Preparation of Pilot Projects

Based on the above analyses and looking at technologies available on the shelf, pilot projects will be prepared for selected areas in consultation with the rural families.

Sub Programme Area 303

Bioenergy

Energy is a key input in farming. It is often the most expensive as well as effective component of the package of inputs. Hence, a study of energy use efficiency and an examination of the scope for substituting chemical sources of energy with biological ones is an important aspect of the biovillage project.

In the three villages chosen for the biovillage project, rice is the dominant crop and nitrogen is the fertilizer nutrient most commonly applied to the rice fields. It is estimated that to produce one tonne of brown rice (paddy), the nitrogen absorbed by the crop is about 19-21 kg nitrogen.

Technological Options

In Tamil Nadu, particularly in the Thanjavur district, green manure (GM) was in the past an important source of nitrogen for lowland rice. However, recently green manuring is on the decline in most countries of South and South East Asia. Discussions with a representative section of farmers in the three biovillages confirmed that the application of GM for sustained production of rice and to reduce the dependence on market-purchased mineral nitrogen fertilizers is feasible. Thus biological nitrogen fixation (BNF) by leguminous crops has potential in this area.

Green Manure Crops

Though the phenomenon of stem nodulation has been known since 1928, the recent discovery of stem nodulating *Sesbania rostrata* has helped to revive interest in green manure crops.

Sesbania rostrata is a tropical legume of West Africa that has a dual system of nodulation (on both stem and roots). It is a fast-growing and high-nitrogen-fixing legume with good potential as a source of nitrogen for rice. Vegetative propagation is possible and the plant has advantages like reduced time and labour requirement for land preparation, and ability to fix over 60 kg N per ha. The stem nodulating ability provides additional opportunities to fix nitrogen under flooded and high soil nitrogen concentrations.

Aeschynomene afraspara is another tropical legume of West Africa that has a dual system of nodulation. It is also a potential GM plant, possessing two additional advantages over *Sesbania rostrata* – first, it is less photoperiod-sensitive, and produces higher biomass and nitrogen year round and second, it branches profusely and produces less woody stems, which makes incorporation easy.

Strains of both *Sesbania rostrata* and *Aeschynomene afraspera* will be tried out in the biovillages.

The other green manure crops currently in use by farmers in India are listed in Table 14.

Table 14
Green manure crops

Southern India	1. Daincha (*Sesbania aculeata*)
	2. Sesbania (*Sesbania speciosa*)
	3. Wild indigo (*Tefrosia purpurea*)
	4. Pillipesera (*Phaseolus triloba*)
	5. Sunnhemp (*Crotalaria juncea*)
	6. Aviri (*Indigofera tinctoria*)
Eastern India	
	1. Daincha (*Sesbania aculeata*)
	2. Clusterbean (*Cyamopsis tetragonoloba*)
	3. Cowpea (*Vigna sinensis*)
	4. Horsegram (*Dolichos biflorus*)
	5. Sunnhemp (*Crotalaria juncea*)
	6. Senji (*Melilotus parcisflorus*)
Central India (Chota Nagpur)	
	1. Daincha (*Sesbania aculeata*)
	2. Berseem (*Trifolium alexandrinum*)
	3. Sunnhemp (*Crotalaria juncea*)
Northern India	
	1. Daincha (*Sesbania aculeata*)
	2. Berseem (*Trifolium alexandrinum*)
	3. Sunnhemp (*Crotalaria juncea*)

Source: Garrity, D.P. and J.C. Flinn (1988). *Green Manure in Rice Farming* Los Banos: International Rice Research Institute, pp. 111–130

A preliminary survey on the use of GM in rice cropping systems in the biovillages reveals that the farmers rarely used GMs like Daincha (*Sesbania aculeata*) and Sunn hemp (*Crotalaria juncea*). The green manures are planted mainly during the rainy season of June – December (Samba season). Sunn hemp is a 30–day crop and Daincha is a 40 – 45 day crop. The plants are grown for about 3 feet and before flowering they are ploughed *in situ*.

For initiating a programme of trials and demonstrations, samples of six strains of *Sesbania rostrata* (EC 308 403, EC 308 396, EC 308 395, EC 308 404, EC 308 400, EC 308 394) were obtained from the International Rice Research Institute, Los Banos, Philippines and were raised in Chidambaram, Tamil Nadu.

The seeds showed good germination. The growth is being monitored to select a suitable variety for introduction in the biovillage.

Blue-green Algae (BGA)

As mentioned earlier, rice is the major crop grown in the three bio villages. BGA (cyanobacteria) are prokaryotic organisms with oxygen evolving photosynthetic system and many of them are capable of fixing atmospheric nitrogen The role of these organisms in the conservation of nitrogen levels of rice ecosystems is of great economic significance. Their use as bio-fertilizer has been an area on which much attention has been focussed in recent years. A BGA bloom usually corresponds to less than 10 kg N/ ha and a dense bloom may contain 10 to 20 kg N/ ha. Data published before 1980 vary from a few kg to 80 kg nitrogen /ha/crop (mean: 27 kg) It can also be used as a supplement (30-70%) along with chemical fertilizers and is broadcasted 10 days after transplantation of the rice crop.

One of the prerequisites of a successful BGA bio-fertilizer programme is the understanding of the indigenous taxa that occur in the rice field. A preliminary survey of the rice fields in the three biovillages show that most of the fields had considerable BGA population consisting of both nitrogen-fixing and non-nitrogen fixing cyanobacteria. The nitrogen fixing cyanobacteria belong to the genera *Nostoc, Anabaena, Cylindrospermum Aulosira* etc. the non–nitrogen–fixing cyanobacteria belong to the genera *Oscillatoria, Phormidium* and *Lyngbya* etc. It is proposed to isolate native BGA, multiply it and get it tested in rice fields.

Azolla

Azolla is a free–floating water fern that fixes nitrogen in symbiotic association with *Anabaena*, a nitrogen–fixing cyanobacterium.

Azolla bio-fertilizer can contribute 30 to 40 kg nitrogen/ha. Nitrogen fixing rates range from 0.4 to 3.6 kg nitrogen/ha/day and average 2 kg nitrogen/ha/day. The multiplication of *Azolla* in wetland rice fields has been shown to suppress the aquatic weed population. The fresh *Azolla* inoculum required for per ha of transplanted rice field is about 500 kg. One of the important factors in using *Azolla* as a bio-fertilizer for rice crop is its quick decomposition in the soil and efficient availability of its nitrogen to rice plants.

During a preliminary survey of the rice fields of the three villages, it was noted that the population of *Azolla* was less due to certain constraints such as soil quality (sandy loam) and water stagnation.

The range of estimates of nitrogen fixed by various agents in wetland rice fields (kg N/ha/crop) and theoretical maximum potential (assumptions and value) are given below.

BNF associated with rice rhizosphere	1 – 7 kg N/ha/crop
BNF associated with straw	2 – 4 kg N/ton, straw applied
BNF heterotrophic (total)	1 – 31 kg N/ha/crop
BNF by BGA	0 – 80 kg N/ha/crop
BNF by *Azolla*	20 – 150 kg N/ha/crop in experimental plots
BNF by LGM	10 – 50 kg N/ha/crop in field trials

Source: Roger, P.A. and Ladha J.K.(1990) Estimation of N-fixation and its contribution to nitrogen balance in the wetland rice fields. In: *Transactions. 14th International Congress of Soil Science, Vol. III*, pp. 128–133, Kyoto, Japan.

It has been recommended by the Tamil Nadu G. D. Naidu Agricultural University that *Azolla microphylla* and another hybrid of *Azolla* may be introduced in the biovillages for on-farm testing and trials for the farmers to assess their usefulness.

Programme Area 400

Reaching the Unreached

Introduction to the Programme

An integral part of research on sustainable development is a programme to enhance the efficiency of organisational and delivery systems. The objective of efforts under this programme is to develop methodologies and strategies which may lead to organisational modifications that would enable technology packages and services to reach the unreached. The guiding principle in programme implementation is to strengthen or improve existing systems of delivery and communications, rather than develop parallel ones, so that the population normally bypassed by ongoing programmes will be helped to have access to available technology, services and information.

Activities under this programme during 1990-91 have centred around child survival, protection and development, following the World Declaration on the Survival, Protection and Development of Children (United Nations, September 1990). This declaration, issued at the World Summit for Children held at New York under the auspices of UNICEF, expresses the commitment of world leaders to give high priority to the rights of children, to their survival and to their protection and development which would ensure the well-being of all societies. The declaration outlined a 10-point programme to cover wide-ranging areas of concern such as the rights of the child, provision of clean drinking water and sanitation, eradication of malnutrition, strengthening the role and status of women, indicative of the holistic paradigm adopted to ensure the well-being of children. In the Plan of Action adopted at the summit, the following specific goals were laid down, to be achieved by the year 2000.

a Reduction of 1990 under–5 child mortality rates by one-third or to a level of 70 per 1000 live births, whichever is the lower

b Reduction of maternal mortality rates to half of 1990 levels.

c Reduction of severe and moderate malnutrition among under-5 children to one half of 1990 levels.

d Universal access to basic education and completion of primary education by at least 80 percent of primary school-age children.

e Universal access to safe drinking water and to sanitary means of excreta disposal.

f Reduction of adult illiteracy rate to at least half its 1990 level with emphasis on female literacy

g Protection of children in especially difficult circumstances, particularly in situations of armed conflict.

Meetings held in November 1990 under the auspices of the Union Planning Commission, the State Planning bodies and the Global Hunger Project in New Delhi, Madras and Bombay revealed that the adoption of a holistic approach, initiating concurrent action on all the sectors related to these goals, is a fundamental need for achieving success. These meetings also led to formation of State-level Councils in Tamil Nadu and Maharashtra, whose aim is to identify the pathways and action needed to enable the general population to achieve the threshold which enables the move forward from the survival level and results in release of the potential necessary for constructive lives. The Tamil Nadu State Council, which is itself an effort to converge and synergise governmental and non-governmental action relating to the areas broadly identified above, consists of senior officers of the State Government, academics, representatives of service organisations and the media. The Council, whose secretariat is located in the Foundation, has launched action-oriented studies and projects in the areas of (a) generating awareness on the need to work for the survival of the female child (b) increasing economic opportunities available to women through training in new skills (c) convergence and synergy of government and non-governmental welfare measures (d) development of alternative child care strategies, and (e) advocacy, promotion and support of services which address the intersecting needs of children, women and girls.

These efforts centre around the districts of Tamil Nadu where the IMR (rural) is considerably above 50.

Sub Programme Area 401

ACCESS: Action for Child Care and Education Services

This programme, commenced in May 1991 is based on the approach of PA 400, namely that of integration of available infrastructure, facilities and programme measures to develop a qualitatively improved delivery system. The objective of the ACCESS project is to advocate, promote and support services for the care, welfare and development of children which address the intersecting needs of women, children and girls. Action is planned in the following areas:

1. Undertaking action-research and other related studies.
2. Development of training programmes for child care personnel
3. Networking with institutions and delivery agencies concerned with child care services.
4. Development of communication media and materials, (including performing arts and folk media)
5. Documentation of child care activities
6. Development of materials for training.
7. Development of resource expertise

A Programme Advisory Committee at the national level has been constituted to aid the development of the programme and assist in its effective implementation.

Sub Programme Area 402

Alternative Strategies of Child Care

Work in this area is designed to lead to the building of alternative models and strategies for child care, based on the realisation that child care must meet essential needs in women's development, permitting women to engage actively in economic, political and social life while liberating girls engaged hitherto in child care to attend school or take advantage of training in new skills. The State of Tamil Nadu is unique in India in having a network of child care centres through the combined grid of Noon Meals Scheme and the Integrated Child Development Services scheme. Such a vast infrastructure is often not fully utilised and is also not always fully responsive to the needs of the women and children (particularly those below two years of age) in different localities and occupations. Thus there is scope for the development of alternative models and strategies of child care which would meet the needs of women, children and girls and make the most effective use of the existing infrastructure.

This project, initiated in February 1991, is located in the Chengai MGR (formerly Chengai Anna) district of Tamil Nadu (Figure 20). The project activity is being taken up in the following villages/localities which have been identified on the basis of field surveys.

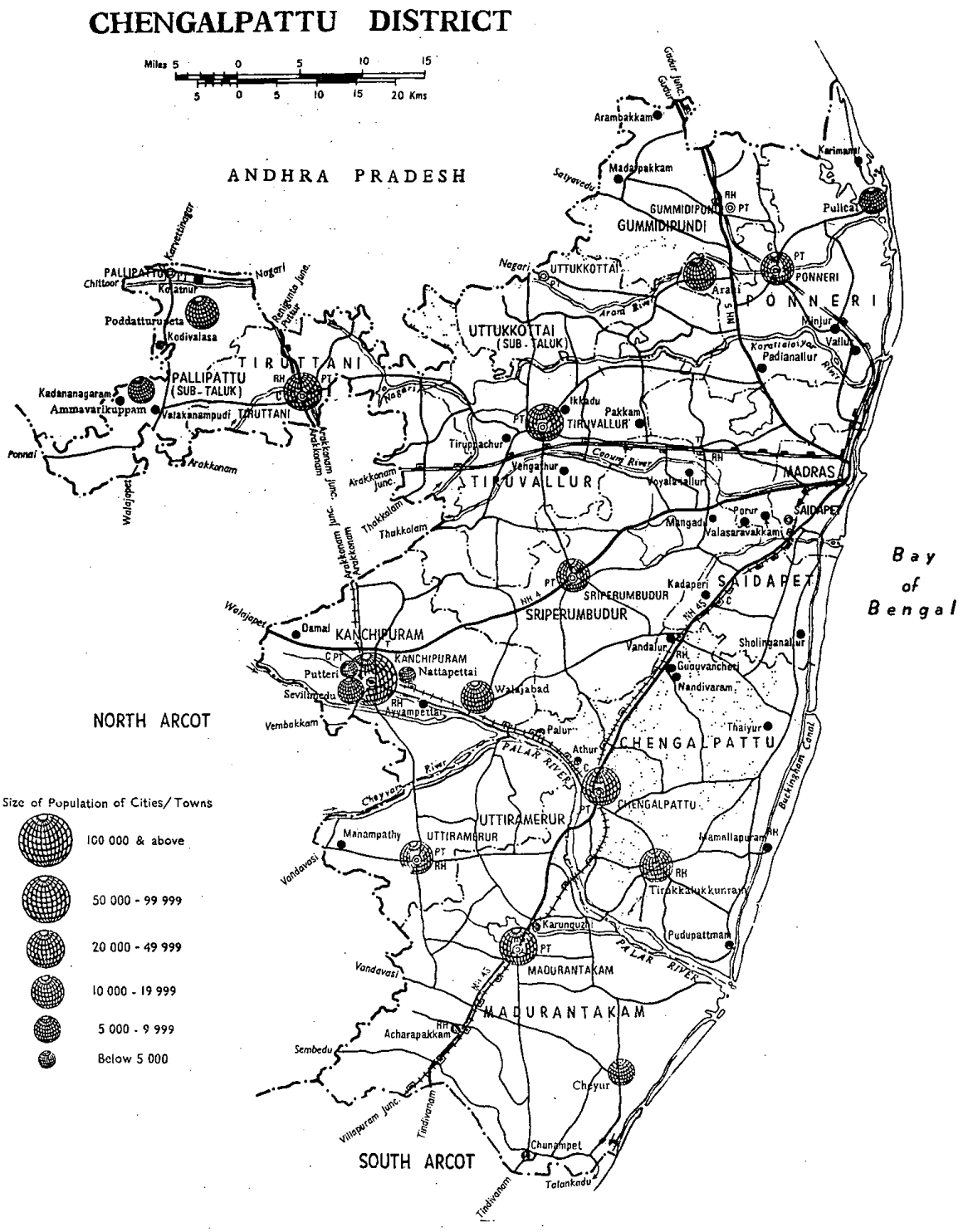


Figure 20

Map of Chengai-MGR district (population data based on the 1981 census)

Block/Union	Village/Locality
Thirukkalunkundram	1. Kokkilamedu/Vemburasham
Kattankolathur	2. Kirapakkam
	3. Ninakkarai
	4. Senneri
	5. Thirukatchur/Kolattur
Thirupporur	6. Kalipathur
	7. Thandalam
	8. Dargamedu
Ambattur Municipality	9. Ambattur Town

The work is divided into two phases. In the first phase (on-going) the following activities are taking place: (a) assessment of the needs and preferences of the community for child care services, (b) assessment of the potential and actual utilisation of the existing infrastructure for child care, (c) initiating a process of dialogue with the communities and concerned government departments to optimise the benefits from existing infrastructure and resources through alternative strategies. The second and final phase will involve the implementation, monitoring and evaluation of the adopted strategy.

Sub Programme Area 403

Convergence of Mother and Child Welfare Services

Under this programme a study was initiated in the Thiruvannamalai-Sambuvarayar District of Tamil Nadu in February, 1991. It is now widely accepted that various organisations – governmental and non-governmental – often run programmes in the field without providing an adequate level of interlinkages. Bridging such missing links is known to augment the effectiveness of the delivery system, in addition to optimising the return from the available financial and infrastructural resources.

This programme aims at developing a method for the identification and promotion of such linkages.

Thiruvannamalai-Sambuvarayar District, newly created in 1989/90, has a population of about 2,010,000 in 1991 (provisional) and has 8 taluks of varying sizes. The IMR for the district as a whole is not yet computed, but the provisional estimate is 70 (based on block-level data available at the district headquarters).

There is no urban conglomeration with sizeable commercial activity and the district is predominantly non-urban. Preliminary investigation has revealed that activities of NGOs and service organisations (except in the areas of environmental concern) are low, leaving the government the major or even the sole agency to operate welfare/development measures of any kind. Also, preliminary investigation reveals that availability of drinking water round the year is the most serious problem and the data compiled indicate the extent of this problem.

One of the most effective ways to evolve and implement remedial measures involves cooperation between the government and the non-governmental agencies working for development. Endowing such cooperation with an institutional framework can only strengthen the effort. It is proposed to initiate a development cooperative as part of the programme, which will start with channelisation of efforts to improve the water situation, later becoming a conduit for all measures to benefit children.

Table 15
Status of water supply in the rural habitations of Tamil Nadu
District : Thiruvannamalai - Sambuvarayar

Sl. No.	Name of Union	Total habitations	FC	PC	NC	No. of Villages without OHT/
1.	Arni	138	–	138	–	5
2.	West Arni	179	26	112	41	1
3.	Annakavoor	163	64	90	9	18
4.	Cheyyar	210	48	145	17	17
5.	Vembakkam	219	43	165	11	41
6	Pernamallur	174	38	131	5	63
7.	Thellar	238	102	99	37	19
8.	Vandavasi	256	45	180	30	43
9.	Chengam	220	49	128	43	25
10.	Pudupalayam	156	35	80	41	35
11.	Thandarampet	242	99	106	37	22
12.	Chetpet	165	55	98	12	42
13.	Kalasapakkam	201	116	45	40	6
14.	Polur	247	89	109	49	14
15.	Kilpennathur	246	50	151	45	20
16.	Thuranjapuram	237	105	94	38	18
17.	Tiruvannamalai	308	108	141	59	28
18.	Jammanamathur	256	82	86	88	26
	Total	3855	1155	2098	602	443

Source : Tamilnadu Water and Drainage (TWAD) Board.
* : A habitation consists of 100 households located at a minimum distance of 250 metres from another habitation.
FC : fully covered : PC : partially covered; NC : no coverage; OHT : overhead tank.

Sub Programme Area 404

Promoting Household Nutrition Security

The project initiated in the Chengai-MGR District of Tamil Nadu has been designed to provide opportunities for rural families to lead a healthy and productive life, by gaining access to education, employment assets and nutrition. Household nutrition security, for the purpose of this project, is defined as economic and physical access to balanced diets and safe drinking water at the level of individual families.

The objectives are:

1. To promote household nutrition security through attention to the health and nutrition of women and children belonging to economically and socially handicapped families.

2. To provide women with additional income-earning opportunities and to empower them to improve their status in the family and society.

3. To analyse the nutritional maladies among school children and to promote the cultivation of horticultural crops that can help combat the specific nutritional problems of the area.

4. To encourage self-employment using skills like nursery propogation techniques of fruits and vegetables and management and marketing techniques.

Several nutritional maladies have horticultural remedies. Hence Nutrition Gardens are being organised in homesteads and schools. The target groups are women, adolescent girls and children in the selected villages. Skills for raising improved varieties of horticultural crops, which are nutritionally rich, and for adopting improved nursery techniques, ecologically sound horticultural practices and micro-propogation methods will be imparted. Decentralised production supported by group marketing will be promoted to ensure that the producer gets a fair share of the price paid by consumers. At present, most small producers of vegetables are getting less than 20 percent of the price paid by consumers.

Site Description

Preliminary work was started during March 1991, in Chengai MGR District, Tamil Nadu. The district has an area of 7920 sq.km. with a cultivable area of 4.43 lakh ha. The major crop is paddy, grown over 3.10 lakh ha. Peanut, finger-millet, sugarcane are the other major crops of the district. Irrigation sources are mainly wells and tanks. The district consumes about 1230 tonnes of fertilisers, 30,000 litres of liquid

pesticides and 560 M.T. of pesticide dust formulations.

There are two co-operative sugar mills and two State seed farms with a capacity of 100 tonnes each year. Average rainfall of the district is 1200 mm. and the total population is 36,16,508 (1981 census) out of which 22,08,722 (1981 census) are rural. The district comprises of 13 taluks, 27 panchayat unions and 2,227 villages. The Chengalpattu taluk has three blocks. After discussions, visits and meetings with government officials of the State, District and village level officers and NGOs, Kattangulathur block in Chengalpattu taluk of Chengai MGR district was selected for this project.

Kattangulathur block comprises 100 villages and 10,226 farm families. 64% of farm holdings are marginal (less than 1 ha), 21% are small (1-2 ha), 14.4% are medium-sized and 0.6% are large holdings of above 5 ha. The block has a population of 85,800 males and 80,526 females. Literacy level is 45%. There are 8,714 cattle, 11,239 buffaloes and 10,708 sheep. There are 458 irrigation tanks, 822 wells with pumpsets and 5,946 wells without pumpsets. Soil is predominantly of the alfisol (red soil) type.

Based on socio-economic factors and agricultural situation, five villages, Ninnakarai, Anjur, Thirukachur, Thenmelpakkam and Kachaadimangalam, were taken up for survey and work relating to Nutrition Gardens. These five villages are situated within 45 to 60 kms south of Madras City.

Clinical survey

Clinical survey of Ninnakarai village school-children was undertaken with the help of Dr. R. Madhavan, a paediatrician and Mrs. Saroja Raghavan, a nutritionist. The sample comprised children, both boys and girls, selected at random. Out of the 345 children studying from Ist to VIIth standards, 5 boys and 5 girls from each class totalling 90 children, were selected. The data collected were fed into the computer to facilitate easy comparison of children in the same age-groups, before, during and after completion of the intervention over a three-year period. The clinical survey showed the prevalence of Vitamin A and B-complex deficiencies among 50% of the children. Symptoms were in the form of Xerophthalmia and 4 out of the 90 examined, had symptoms of Bitot spots, 6% of the children suffered from Glositis and 8% from Pellagra.

The data indicate that access to appropriate vegetables and fruits could be effective in combating nutritional deficiency diseases, as children have at present limited or no access to balanced diets. Children will be taught about the role of fruits and vegetables in human diet in 'learning through action' projects. Work relating to the laying of school gardens will be taken up during July 1991 when the school re-opens after summer holidays. Horticultural remedial measures like mass fruit-tree and vegetable planting in the village homesteads, farms, roadsides, and school gardens

will also be launched in the village. The village school will be involved to teach and demonstrate to students the basic concepts of Nutrition Gardens.

Village Household Survey

Socio-economic individual household survey was taken up to cover all the houses in Ninnakarai village. Nearly 200 houses out of the total 400 houses have been covered so far. On the basis of the survey, 12 individual households belonging to small, marginal and landless labour families have been selected on the criteria of having an open area for garden around the hut or house, families with young children and women with leadership qualities. During the course of the survey, through individual and group contacts, the villagers especially women and adolescent girls, were helped to appreciate that nature has provided nutritive vegetables and fruits to suit different agro-ecological and socio-economic conditions and that these would provide some of the solutions to the nutritional and economic problems of the household.

The lack of awareness about the nutritive value of vegetables and fruits was a major constraint. Hence, meetings were held with women and adolescent girls who generally welcomed the idea of planting Nutrition Gardens in their backyards, provided inputs like seeds, seedlings, agro-chemicals and advice on plant protection, are made available to them on a regular and continuing basis. They expressed their readiness to grow improved fruit varieties and vegetables and also to undertake cooperative activities in integrated pest management and marketing.

A group of women from 12 households of Ninnakarai village, have already started the work of levelling their backyards, clearing the wild, thorny bushes and erecting fences for laying Nutrition Gardens in their backyards. Work on spreading information on the role of horticultural crops in human nutrition and the basic concept of Nutrition Gardens, has already been initiated. Training is being given in the selection of the right crops, planning the garden and in nursery practices such as seed bed preparation, sowing and potting.

Based on surveys, the following crops were chosen out of which selection will be made on the basis of the wishes of the residents of each household. The planting will start in July 1991.

The following crops were identified for Nutrition Gardens in Chengai MGR district in consultation with local women and men.

Greens

— Greens – *Amaranthus spp.*
— Spinach – *Basella alba*
— Chekurmanis – *Sauropus androgynus*
— Ceylon spinach – *Thalinum triangular*

— Curry leaf – *Murraya koenigi*
— Coriander – *Coriandrum sativum*
— Cucumber – *Cucumis sativus*
— Fenugreek – *Trigonella foenum* (methi)
— Mint – *Mentha arvensis* (podina)
— Manarthakali – *Lycopersicum sp*

Vegetables

— Lady's finger – *Abelmoschus esculentus*
— Beans – *Dolichos lablab*
— Cow pea – *Cajanus cajan*
— Cluster beans – *Cymopsis tetragonaloba*
— Green chillies – *Capsicum spp.*
— Drumstick – *Moringa olifera*
— Tapioca – *Manihot utilisima*
— Tomato – *Lycopersicum esculentum*
— Radish – *Raphanus sativus*
— Sweet potato – *Ipomea batatas*

Fruits

— Custard apple – *Annona spp.*
— Banana – *Musa sapientum*
— Cherry – *Malphigia punicifolia*
— Mango – *Mangifera indica*
— Papaya – *Carica papaya*
— Pomegranate – *Punica granatum*

Ecological Horticulture

A holistic resource management of farms is being promoted to encourage participatory research and a feeling of involvement among the farming community. A farm with an area of 0.4 hectare has been selected to produce good quality seeds and for multiplying fruit plants that are in demand in that village and in the adjoining areas.

New skills like improved nursery techniques, micro-propogation, water management and ecological pest-proofing are being imparted. Thus the household nutrition security programme in Ninnakarai village is built on the following steps.

1. Analysis of clinical survey of the school children of the village,

2. Education, awareness generation and training, and

3. Carefully planned programmes of health intervention, nutrition education and income generation through Nutrition Gardens, ecological horticulture and producer-oriented marketing.

Future Lines of Work: (1991-1992)

1. Clinical survey of the village *Balwadi* (for children below the age of five).

2. Creating awareness among villagers, school children and farmers on Nutrition Gardens.

3. Training programmes for women and children and for male farmers in their fields.

4. Collection and rearing of important seed and planting material essential for the programme.

5. Demonstration of nursery practices

6. Promoting ecological horticulture

    i. Water harvesting and use of economical methods of water delivery

    ii. Pest-proofing using integrated pest management techniques

    iii. Right stage of harvest

    iv. Post-harvest practices

    v. Group marketing to fetch for the producer a high proportion of the price paid by consumers.

7. Monitoring of food habits and consumer preferences.

8. Organising Field Days so that the concept of Nutrition Gardens gains a self-replicating momentum in the district.

Sub Programme Area 405

Livelihood Security Indicators

The programmes of CRSARD designed to take the benefits of new technologies to the socially and economically underprivileged sections of rural society require new measurement and educational tools integrating the principles of ecology, economics and equity. In 1990, UNDP published its first Human Development Report which contained a methodology for the construction of a Human Development Index (HDI). HDI is based on three types of deprivation. These are: life expectancy, adult literacy, and income for a decent living standard. The minimum values were chosen by taking the lowest 1987 national value for each indicator. For life expectancy at birth, the minimum value was 42 years in Afghanistan, Ethiopia and Sierra Leone. For adult literacy, it was 12% in Somalia. For the purchasing power adjusted GDP per capita, the value was US$ 220 in Zaire (*Human Development Report, 1990; 1991*, Oxford University Press).

The central message of UNDP's Human Development Report of 1990, to quote Mr. William H. Draper III, Administrator of UNDP, is that "while growth in national production (GDP) is absolutely necessary to meet all essential human objectives, what is important is to study how the growth translates or fails to translate into human development in various societies. Some societies have achieved high levels of human development at modest levels of per capita income. Other societies have failed to translate their comparatively high income levels and rapid economic growth into commensurate levels of human development."

UNDP's 1991 Human Development Report shows that India has a low HDI rank, occupying the 123rd position among the 160 countries studied. The report concluded that the potential is enormous for restructuring national budgets and international aid in favour of human development. Within India, there is obviously considerable variability at the State level in HDI. Kerala, for example, is likely to have a high HDI, although the per capita income in the State is lower than in several other States.

Several analysts have suggested a further elaboration of HDI. Lester Brown for example states, "while the HDI represents a distinct improvement over income figures as a measure of changes in human well-being, it says nothing about environmental degradation. As a result, the HDI can rise through gains in literacy, life expectancy or purchasing power that are financed by the depletion of natural support systems, setting the stage for a longer term deterioration in living conditions" (*The State of the World 1991. A Worldwatch Institute Report on Progress toward a Sustainable Society*, New York and London: W.W. Norton and Company.

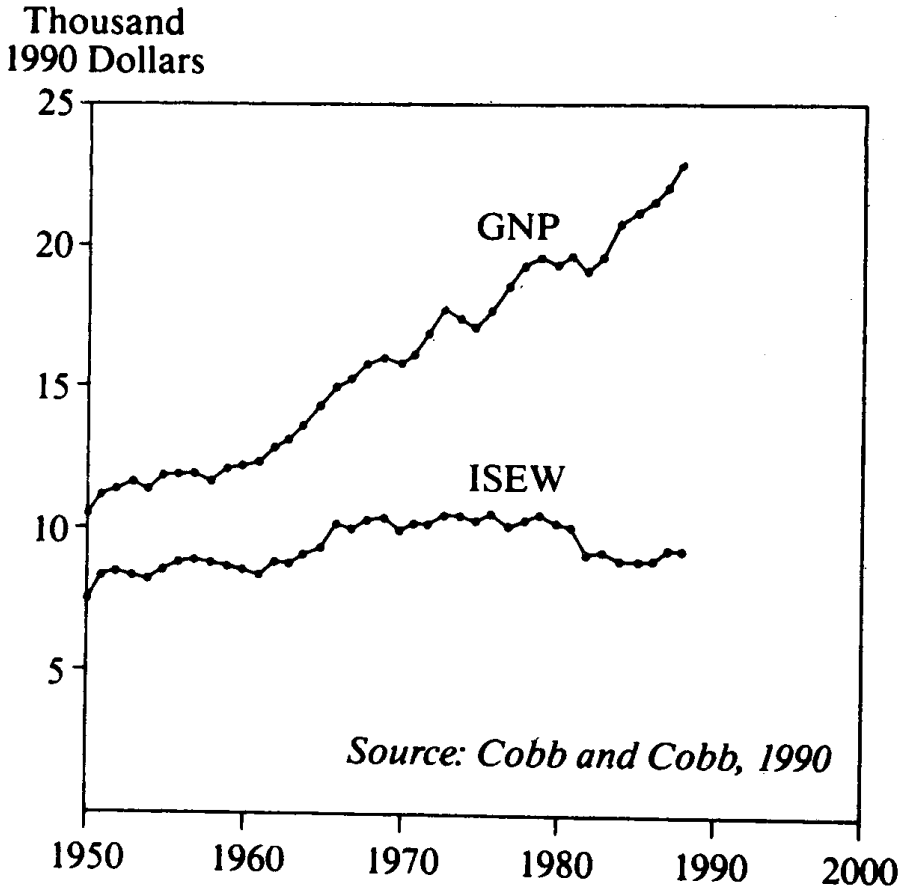


Figure 21
GNP and Index of Sustainable Economic Welfare (ISEW) per ccapita, United States, 1950 - 88 (Quoted in Lester Brown, 1991)

Herman Daly and John Cobb (1989) proposed an Index of Sustainable Economic Welfare (ISEW), which takes into account the impact of development on environmental capital stocks (*For the Common Good: Redirecting the economy toward community, the environment and a sustainable future.* Boston: Beacon Press.) They recalculated the progress of the United States based upon that index and observed that since 1976 there has actually been regress and not progress (Figure 21). Unfortunately comprehensive data on the extent of air and water pollution as well as information on year to year changes are not available for most parts of India. Lester Brown prefers per capita grain consumption as an index of human well-being. The amount of money required to purchase the minimum essential calories of food in urban and rural areas has generally been used by the Planning Commission of India to fix the poverty line.

Procedure for calculating the Livelihood Security Index (LSI)

The LSI methodology developed at CRSARD has the following three major components.

First, a careful analysis is made of the relationship between human and animal populations and the carrying capacity of land and water at current levels of

technology. The aim is to understand the extent of anthropogenic pressure on land and water and the scope available for enhancing land and water productivity through improved technologies and management.

Second, data are collected on the number of adults in the village deriving their livelihood from the primary, secondary and tertiary sectors of economic activity. These ratios helps to bring out the extent to which diversified opportunities for employment exist and to understand the growth linkages between on-farm and off-farm employment existing in the village. The greater the diversification, the greater is the insulation from acute distress in years of drought or other natural calamities leading to crop losses.

Third, data are collected on female literacy and employment, since this not only gives information on the status of women but also on household food security, particularly under conditions of male alcoholism in the poverty groups.

Thus, ecological, economic and equity factors are inter-woven in LSI, which is a good measure of sustainable food and nutrition security at the household level. The data for LSI are collected with the active participation of the villagers, so that the very process of its estimation becomes an educational tool for stressing the need for limiting population growth to the level natural resources can reasonably support.

LSI Studies

LSI studies were initiated in the following villages chosen for CSR and for the biovillages.

1. Vettaikaran Iruppu, Thanjavur District.

2. Kizhur, Sivaranthakam and Pillayarkuppam villages in the Union Territory of Pondicherry.

While the detailed data are under analysis, the following general features have been noted.

a. The villages in Pondicherry are characterised by high female literacy in contrast to Vettaikaran Iruppu. The male-female population ratio is however adverse to women in all cases.

b. In all the 4 villages, most families depend upon the primary farm sector for their livelihood security. The secondary processing and industrial sector is conspicuous by its near total absence. Employment in the tertiary sector relates largely to Government jobs. General services directed to producer-oriented marketing are yet to be developed.

c. The per capita land availability varies from 0.13 ha to 0.20 ha in these

villages. The current population of Pillayarkuppam village is nearly double what current levels of land and water productivity can sustain.

d. Educated unemployment or inappropriate employment is high in all the villages.

e. There is generally a mismatch between the skills needed for economically viable self-employment and those possessed by the educated youth. Self-employment opportunity-oriented training or re-training is urgently needed.

f. There are practically no effective organisational structures which can help to empower the poor and women and to improve the efficiency of operations both at the production and post-harvest phases of farm activities.

During 1991-92, work on the precise estimation of LSI in these villages with the active participation of the village youth will be continued. The effectiveness of this index for assessing the factors influencing the livelihood security of rural populations, both in the short and long term, will be carefully studied.

Programme Area 500

Education, Training and Communication

Introduction to the Programme

Results of scientific work which are not published remain buried with the investigator. We however live in an Information Age where there is an explosion of publications, in addition to a vast expansion of the scope and impact of electronic and visual media.

Rural communication should therefore aim at sifting the growing volume of information available on a particular topic and sharing those which may make a difference for the better in the quality of life of village women, men and children.

Communication with rural families is a two way process - one learns as much as one shares. The philosophy outlined by Gurudev Rabindranath Tagore is the underlying principle in CRSARD's educational programmes.

> A candle which is not lit
> cannot light others
> A teacher who is not learning
> cannot teach others.

CRSARD's limited studies in villages in Pondicherry and in the Thanjavur District of Tamil Nadu indicate that often there is a mismatch between employment opportunities and employable skills. Young graduates, irrespective of the field in which specialised in the University, are anxious and willing to learn new skills, whether in aquaculture or agro-forestry. CRSARD therefore proposes to establish local-level non-degree training institutions for enhancing human effectiveness by ending the divorce between opportunities and capabilities at the local level. Such institutions will be established in villages jointly with the rural people, so that successful farm men and women and rural artisans participate along with professionals in training programme. Participatory training is as important as participatory research.

The communication media to be used will include all approaches from the traditional to the frontier. Steps have been initiated to design Information villages where the impact of new information on the productivity and sustainability of the prevailing farming systems can be assessed.

Ecologically sound technologies are also knowledge-intensive. Knowledge helps to optimise the benefits from the available land, water, labour and capital. CRSARD therefore attaches great importance to PA 500, which on the one hand helps to establish links with the scientific community and on the other with rural men and women

In the ultimate analysis, education is essential for promoting a conservation society – a society where the best in agricultural, industrial and information technologies is blended with traditional technologies and leads to what may be termed "a green mind" – a mind that cares, saves and shares. The greening of the mind is essential for the greening of technologies and life styles. The following Chinese saying is relevant in this context:

> If you are thinking one year ahead – plant rice
> If you are thinking ten years ahead – plant trees
> If you are thinking hundred years ahead – educate the people.

Sub Programme Area 501

Training Programmes in Coastal Systems Research

Appropriate training programmes are vital to ensure the success of an integrated management approach. The training methods to be used in CSR are largely based on the principle of "learning by doing". Therefore the training staff are scientists and technologists from co-operating institutions, the project staff as well as the practising farmers and fisher people. The purpose is to impart skills that can synchronise with the available and potential employment opportunities. The priority target groups are educated unemployed youth, women and practising farmers and fisher people.

Training programmes are being developed as modules, each module relating to each of the technological components, namely horticulture, agro-forestry, animal husbandry and aquaculture (module for brackish water farming is in the box). For each module, the specific techniques (as identified under the particular component) will be imparted by scientists and technologists from collaborating institutions who have developed or have expertise in such techniques. Where the success of a technology has been proven in the field other than the site, the practitioners of such a technology will also be involved in imparting training and skills. The overall approach towards evolving the training programme is to make use of existing / developed technologies and expertise through encouraging and enabling the involvement and active participation of those who possess them.

Training Modules for Brackish Water Aquaculture

Technology	Duration (in weeks)	No. of persons to be trained							
		Graduates and post-graduates		Post-matriculate/ Diploma holders		Skilled workers		Total	
		M	F	M	F	M	F	M	F
1. Prawn farming technology	4	40	–	–	–	–	–	40	–
– Water management	2	–	–	40	–	–	–	40	–
– Stock management	2	–	–	40	–	–	–	40	–
– Seed collection from natural sources	1	–	–	–	–	40	40	40	40
2. Prawn hatchery technology	4	40	–	–	–	–	–	40	–
– Broodstock management and induced breeding	2			40					
– Rearing of larvae in hatcheries	2			40					
– Mass culture of uni-cellular algae	2	40						–	40
– Culture of rotifers	2			40				40	–
– Preparation of artificial diets for prawn larvae and post-larvae	1				40			–	40
– Artemia culture	2			40				40	–
– Nursery management	2			40				40	–
– Packing and transportation of seed	1				40			40	–
3. Artisanal prawn feed production	2			40				40	–
– Prawn feed preparation (cottage level)	1				20	40		20	40
– Processing of raw feed materials	1				20	40		20	40
4. Sea food processing technology	4	20						20	–
– Preservation and quality control	2		40	20				40	20
– Peeling and processing of prawn for freezing	1						100		100
5. Sea foods product development	1		40	60				40	60

Training in Integrated Coastal Farming

1. Prawn farming technology

   — water management
   — stock management
   — seed collections from natural sources.

2. Shrimp hatchery technology

   — broodstock management and induced breeding
   — rearing of larvae in hatcheries
   — mass culture of unicellular algae
   — culture of Rotifers
   — preparation of artificial diets for parwn larvae and post-larvae
   — artenia culture
   — nursery Management
   — packing and transportation of seed.

3. Artisanal prawn feed production

   — prawn feed prepation (cottage level)
   — processing of raw feed materials.

4. Training in agro-forestry / Horticulture

   — selection of high-yielding, pest-resistant coconut and fruit trees.
   — soil conservation techniques and soil health care.
   — water management techniques
   — raising community nurseries
   — raising nutrition gardens
   — improved nurseries (mist propogation, new methods in grafting).
   — pest-proofing and integrated pest management (knowledge of pest-appropriate chemicals and dosage, time of spraying, and biological control).
   — post-harvest technology.

Training Institutions

CRSARD will organise the training programme in collaboration with the following institutions.

Aquaculture

Central Institute of Brackish Water Aquaculture (CIBA), Madras.
Central Institute of Fisheries Technology and Cochin.

Fisheries College, Tuticorin.
Marine Products Export Development Authority (MPEDA), Thanjavur, Cochin.

Horticulture

Indo-American Hybrid Seeds Co., Bangalore,
National Horticulture Development Board, Madras
Tamil Nadu G.D. Naidu Agricultural University, Coimbatore.
State Department of Horticulture, Government of Tamil Nadu

Animal Husbandry

Tamil Nadu Veterinary and Animal Sciences University, Madras.
Shri Venkateswara Hatcheries, Pune,
National Dairy Development Board, New Delhi
Concerned State Departments, Government of Tamil Nadu

Sub Programme Area 502

Promotion of Traditional Communication Media

The Foundation has taken up a collaborative project with other non-governmental organisations to promote the use of folk performing arts, especially *Koothu*, for development. The objectives are :

- To promote the use of folk theatre forms to communicate developmental and educational messages to rural audiences.
- To develop the capability in folk performing artists to address contemporary issues such as environment protection and rural development.
- To promote livehood opportunities for folk performing artists as self-employed artisans through development channels.
- To develop training facilities in folk performing arts for children and youth

Work has been supported in two directions.

1. An original play in *Therukoothu* style carrying an environmental message, has been developed by Thiru. P. Rajagopal through the *Therukoothu* training school of the Perungattur Ponnuswami Therukoothu Nataka Manram and is performed by children and youth (ages 8 – 18) belonging to the repertory company of the school. Through a series of critical discussions, inputs were made into the play even while it

was being prepared. A circular was sent to a large number of NGOs interested in environmental issues, with a view to developing new rural audiences. The play was performed in 10 villages with financial assistance from the Ministry of Environment and Forests, Government of India. Feedback indicates that the play is widely appreciated and in demand, cost being the only factor discouraging more invitations to perform.

2. In February 1991, a one-night *Mahabaratham* was jointly performed in Kancheepuram by seven professional *Koothu* troupes. This unique event, intended to be the first in a series of annual *Koothu* festivals was organised by the Tamil Nadu Kattaikkoothu Valarchi Munnetra Sangam, a federation of professional *Koothu* Companies, each of which participated in the programme. Support was offered through advertisements, invitations to visitors and reviews in the press. This activity is expected to strengthen the Foundation's relationship with the Sangam, assist in developing a wider network of communication channels, and draw the artistes' attention to the possibilities of new themes relevant to sustainable development.

Financial assistance for this project has been received from the Kalaimanram Foundation of the Netherlands.

Sub Programme Area 503

Publications

Proceedings/Monographs

Reference has already been made to the different Dialogues organised by the Foundation during 1990-91. These meetings have led to the publication of the following proceedings.

Genesis and Spread of the Wheat Revolution in India (Proceedings No.1–Editor: M.S. Swaminathan)

* is the outcome of an international dialogue among scientists, political leaders, administrators, social scientists and farm leaders who played a key role in the sixties for promoting India's wheat revolution through integrated packages of high-yield technology, services and public policies. The Dialogue was attended among others by Dr. Norman E. Borlaug, Nobel Peace Prize Laureate, Shri. C. Subramaniam, during whose tenure as Union Food and Agriculture Minister the new agricultural strategy was developed and introduced and Shri. B. Sivaraman,

who served as the Union Agriculture Secretary during the critical years of the sixties when great changes took place on the Indian agricultural scene.

Organisation of a Global Network of Genetic Resources Centres in Mangroves (Proceedings No.2 – Editors : Sanjay V. Deshmukh and Rajeshwari Mahalingam)

* contains papers presented at an International Workshop organised in collaboration with the International Tropical Timber Organisation (ITTO) for designing a project leading to the establishment of a global network of Mangrove Genetic Resources Centres. These papers relate to status reports and description of work on mangrove ecosystems in over 20 countries in all the continents. Mangrove forests, in addition to conferring multiple economic benefits, serve as shelter-belts and wind-brakes against sea waves and protect coastal communities from storms and gales. They are the last frontiers in our defence against changes in sea levels. The Dialogue participants formulated a project (included in the volume) to protect mangrove ecosystems and to preserve for posterity a representative sample of the existing genetic variability in mangrove species.

New Technologies: Reaching the Unreached I. Biotechnology (Proceedings No. 3 – Editors : M.S. Swaminathan and Vineeta Hoon)

* is a collection of discussion papers presented at an International Dialogue on devising methods and strategies to ensure that the poorer sections derive economic benefit from recent developments in biotechnology. Papers cover all relevant areas, ranging from crop and animal husbandry, fisheries, forestry, pollution control to pest management and pharmaceuticals. Scientists working in the frontier areas of biotechnology as well as social scientists actively involved in fostering a social contract between science and society undertook a proactive analysis of the social, economic and ecological implications of biotechnology as related to agricultural and rural development. The participants developed a blueprint for organising biovillages supported by biocentres. The full proceedings of this Dialogue will be published later in 1991 by Macmillan India.

From Stockholm to Rio : The Road to Sustainable Agriculture (Monograph no. 1: M.S. Swaminathan)

* is a collection of articles and lectures of Dr. M.S. Swaminathan prepared during 1990-91 and presented in different fora, national and international. The purpose of this collection is to present concepts and pathways through which the adjective "sustainable", liberally added to the word "development" can be converted from a cliche to a realisable concept in the field of agriculture. The whole collection is placed in a 20-year setting, from the time of the Stockholm Conference on the Human Environment in 1972 to the Rio de Janeiro Conference on Environment and Development, due to take place in 1992.

Specific suggestions are made in the last chapter of this monograph for saving endangered species of plants and for mobilising the genetic resources essential for sustainable advances in biological productivity.

Papers/Articles

Papers published in journals or books or presented in conferences by the staff members of the Foundation are listed below.

1. Scientific Journals

Swaminathan, M.S. (1990) "Jawaharlal Nehru and Agriculture in Independent India" *Current Science* 59 : 303 - 307.

Swaminathan, M.S. (1991) "Environment and Development" *Current Science* (in press)

Deskmukh, Sanjay V. (1991) "Understanding Mangroves" *Sanctuary Asia* 11 (2) : 46-50

Swaminathan, M.S. (1991) "Green Revolution and Small Farm agriculture" *Point of View* in CIMMYT Annual Report 1990, Mexico, 12-15.

Swaminathan, M.S. (1991). "Biodiversity and sustainable agriculture: Look at it this way." *Outlook on Agriculture* 20 (1) : 3 - 4.

2. Invited Papers / Lectures

Swaminathan, M.S. (1990) "Changing nature of the food security challenge: implications for agricultural research and policy" Sir John Crawford Memorial Lecture, Consultative Group on International Agricultural Research (CGIAR), Washington, pp. 24.

Swaminathan, M.S. (1990) "Agriculture and food systems" in *Proceedings of the Second World Climate Conference*, Geneva : World Meterological Organisation.

Swaminathan, M.S. (1990) "Equity in Conservation" Presidential Address, World Conservation Union – IUCN, Perth, Australia.

Swaminathan, M.S. (1990) "State of the Environment: 1972 - 1992" Contribution to a book being compiled by the United Nations Environment Programme.

Swaminathan, M.S. (1991). "Human Influence on the Evolution of Demography in the Coastal Zone." Keynote lecture at the UNESCO Conference on Coastal Systems Studies and Sustainable Development, Paris, May, 1991.

Swaminathan, M.S. (1991) "Sustainable Management of Water Resources:

Implications for food and livelihood security." Ninth IHD Endowment Lecture, Centre for Water Resources, College of Engineering, Anna University, Madras.

Swaminathan, M.S. (1991) Valedictory Address, Indian Geosphere – Biosphere Programme (ed.) T.N. Khoshoo and Manju Sharma, New Delhi : Har Anand Publications and Vikas Publishing House, pp. 273-286.

3. Articles in Books

Swaminathan, M.S. (1990) "Sustainable management of environmental capital stocks: role of technology blending" in *Technology Blending and Agrarian Prosperity* (eds) J.P. Verma and A. Varma, New Delhi: Malhotra Publishing House, pp. 1-7.

Swaminathan, M.S. (1990) "Making agricultural progress sustainable - role of new technologies" in *Agricultural Development Policy : Adjustments and Reorientation* New Delhi: Indian Society of Agricultural Economics, pp. 108 - 132.

Swaminathan, M.S. (1990), "Indian Agriculture: accomplishments and challenges" in *Glimpses of Science in India* (ed) U.S. Srivastava, Diamond Jubilee Commemoration Volume, National Academy of Sciences, Allahabad, pp. 25-48.

4. Papers presented at Scientific Meetings / Conferences

Deshmukh, Sanjay V. and S.M. Karmarkar (1990) "Plantations of mangroves in disturbed habitats" in *Proceedings of the National Symposium on the Significance of Mangroves."* Pune, (in press).

Deshmukh, Sanjay V. and S.M. Karmarkar (1990) "On the concepts and techniques applied in the vegetation survey and gradient analysis of a mangrove swamp forest in Bombay" *Proceedings of the International Seminar on Advances in Cartography*, Bombay, (in press).

Deshmukh, Sanjay V. (1991) "Mangroves of India : status report" in *Proceedings of the Project Formulation Workshop for Establishing a Global Network of Mangrove Genetic Resources Centre for Adaptation to Sea Level Rise* (eds.) Sanjay V. Deshmukh and Rajeshwari Mahalingam, Proceedings No.2, Madras: CRSARD, pp. 15-25.

Deshmukh, Sanjay V. (1991) "Description of the site selected for the mangrove genetic resource centre" in Sanjay V. Deshmukh and Rajeshwari Mahalingam *ibid.* pp. 99-106.

Hoon, Vineeta (1990) "Towards a sustainable management of mountain resources: lessons learnt from the Bhotiyas of Kumaon" *Written submission to ECO 92 Public Forum*, New Delhi.

Rajeshwari Mahalingam, Rashmi Pachauri Rajan and M.S. Swaminathan (1990) "A sustainable approach to environmental literacy among coastal communities in Tamil

Nadu, India" *International Conference on Our Common Future: Pathways for Environmental Education* Adelaide, Australia.

Rajeshwari Mahalingam and M.S. Swaminathan (1990) "Sustainable management of coastal resources through a coastal research programme" *International Symposium on Exploitation and Management of Island Coast and Embayment Resources* Haikou City and Sanya City, People's Republic of China.

Rajeshwari Mahalingam (1991) *Writing Workshop for the IUCN Publication on Planning and Management of Tropical Coastal Lowland Wetlands*, Thailand.

Rajeshwari Mahalingam (1991) "Environmental consideration in development of coastal areas" Seminar at the International Food Policy Research Institute, Washington.

Rashmi Pachauri Rajan, Rajeshwari Mahalingam and M.S. Swaminathan (1990) "Potential options for environment education at the national level in India" *International Conference on Our Common Future : Pathways for Environmental Education* Adelaide, Australia.

Reports

Dr. M.S. Swaminathan chaired the following national / international committees, whose reports were presented during 1990-91.

1. *Report of the Core Committee set up by the Ministry of Environment and Forests, Government of India for preparing a National Strategy for Conservation and Sustainable Development.* Ministry of Environment and Forests, Government of India, April 1990.

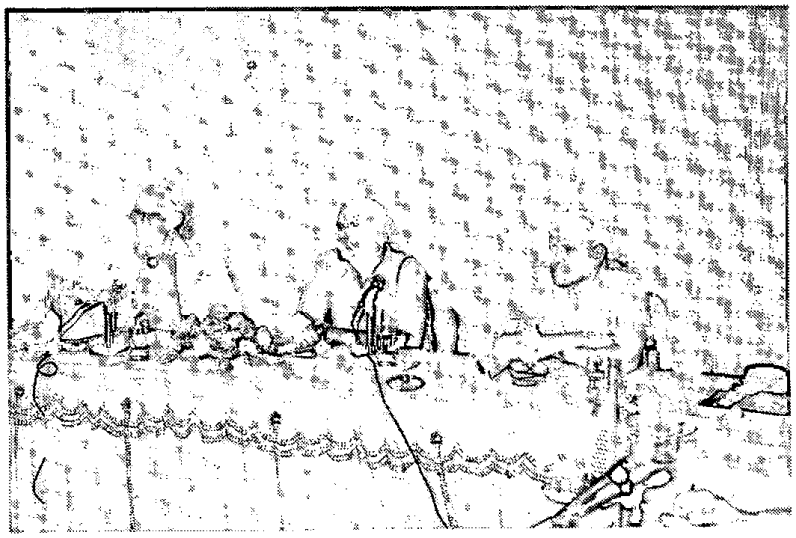
2. *Report of the Working Group on Conservation of Natural Resources and Sustainable Development – Tamil Nadu Planning Commission, 1989.*

3. *Programme for Sustainable Tropical Forestry – Report of a Commonwealth Group of Experts* – Commonwealth Secretariat, London, August 1990.

4. *Consensus Reports of the Keystone International Dialogue series on Plant Genetic Resources*
   Second Plenary Session, Madras, January 1990.
   Third Plenary Session, Oslo, Norway, May – June 1991
   The Keystone Center, Keystone, Colorado, USA.

5. Report of the High Level Multidisciplinary Committee on Central Ground Water Board, Ministry of Water Resources, Government of India. August, 1990

Dialogue on the Genesis and Spread of the Wheat Revolution in India



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B. Sivaraman and
M.S. Swaminathan

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C. Dowswell, O.P. Gautam,
Dhani Ram Vasudeva and
K.S. Gill
(Back Row)
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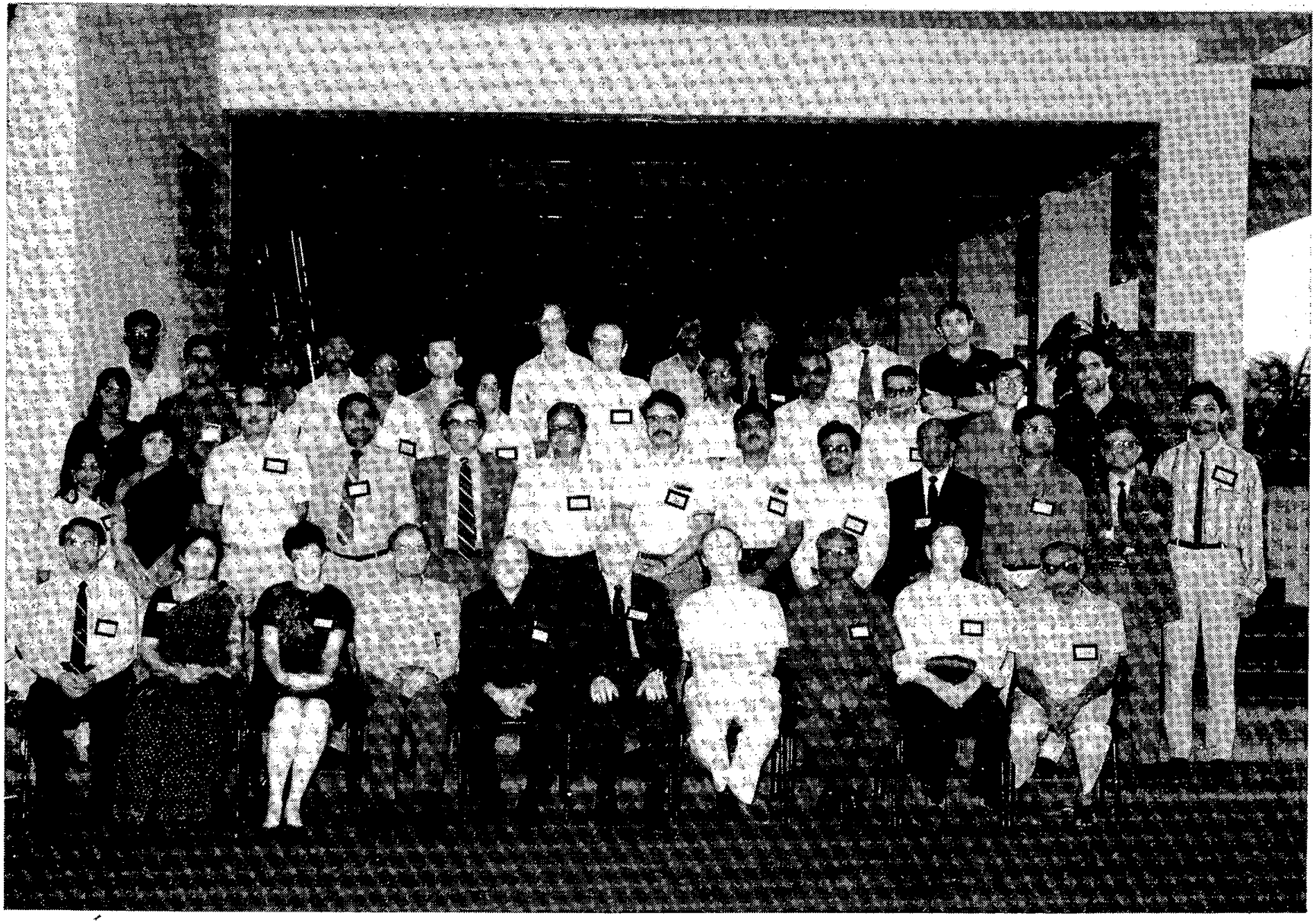

Participants at the
Diologue on New Technologies: Reaching the Unreached I. Biotechnology, Madras, January, 1991

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5. District Forest Officer, Cuddalore, Tamil Nadu.
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Ms. Shanti Subramanian & Ms. Sanjukta Sarkar, *School of Ecology, Central University, Pondicherry.*

Visitors

We have had the benefit of interaction with a large number of scientists from India and abroad. A few of them are listed below.

Mr. Adlai G. Amor. Information Department, World Wide Fund for Nature, Gland, Switzerland.

Prof. Umberto Colombo, ENEA, Rome, Italy.

Dr. S.N. Dwivedi, Additional Secretary, Department of Ocean Development, Government of India, New Delhi.

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Ms. Nona Javier, Executive Trustee, Ramon Magsaysay Foundation, Manila, Philippines.

Dr. Atm. S. Haque, Director, Centre for Integrated Rural Development for Asia and the Pacific, Dhaka, Bangladesh.

International Development Research Centre – team of scientists from the Southeast Asia Office, Singapore: *Dr. C. Devendra, Dr. N.Mateo, Dr. C.B. Sastry and Dr. Pushpamma.*

Mr. Korntheur, GTZ, Frankfurt, Germany.

Dr. Veit Koster, Director-General, Ministry of Environment, Government of Denmark.

Dr. Dan Martin, Director, Environmental Programmes, Macarthur Foundation, Chicago, U.S.A.

Prof. M.G.K. Menon, President, International Council of Scientific Unions, New Delhi.

Dr. Michael Pitman, CSIRO, Canberra, Australia.

Dr. Finn Rexen, Head, Agro-Industrial Research, Commission of the European Communities, Brusscls, Belgium.

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Mr. W.H. Smith, Editor, International Rice Research Institute, Los Banos, Phillippines.

Prof. Li. Zhensheng, Vice–President, Chinese Academy of Sciences, Beijing, China.

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The work described in the preceding pages would not have been possible but for the generous financial support extended by many organisations and individuals. We are extremely grateful to them for their support.

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Cover (Back)

(1) Top (left): Coastal Mangroves are good shoreline protectors: *Pemphis acidula* being clear felled in Musal tivu, Gulf of Mannar, South India.

(2) Top (right): *Rhizophora lamarckii*, a sterile hybrid of *R. apiculata* and *R. stylosa*, naturally occurring at Pichavaram is in urgent need of conservation.

(3) (Middle): Conceptual view of the bio-centre component of a Biovillage. The Bio-centre, operated largely by educated youth belonging to the economically disadvantaged sections of the rural community will provide services such as seeds, propagating material of fruit and fuelwood trees, fodder bank, animal health facilities, bio-refinery, mushroom spawn production laboratory and information centre. The aim is to promote decentralised production supported by a few key centralised services.

(4) (Bottom): Participatory research activity in biovillages: Scientists of CRSARD are discussing with villagers of Pillaiarkuppam, Pondicherry, the details of blending frontier and traditional technologies in order to improve concurrently the ecological foundations for sustainable agriculture and the economic foundations for a better quality of life for the rural poor.

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