REPORT OF THE TASK FORCE ON GREENING INDIA FOR LIVELIHOOD SECURITY AND SUSTAINABLE DEVELOPMENT

PLANNING COMMISSION
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PREFACE

Forest and trees are natural assets that provide a variety of benefits to the mankind. Rural people migrate to citites in the hope of finding jobs and for improving their economy but most of them are forced to live in slums consequently, triggering negative environment affecting health and livelihood of the urban population. The rural migration can be reduced by providing employment and income through greening of degraded areas, diversification in agriculture and ensuring food accessibility under "Food for work"scheme.

The cost of environmental degradation is mostly borne by the poor. Air and water pollution, soil degradation, flood and drought, desertification, degradation of fragile ecoysystems are some of the important environmental problems that need to be addressed for poverty alleviation and sustainable economic development.

Greening India Programme is faced with the problem of lack of awareness about multiple roles/benefits of trees, especially their role in drought proofing, prevention of soil and water run-off, bio-remediation of agricultural land, supply of food, fodder, fuelwood, fibre and fertilizer. The greening programme suffers from low level of technology, low level of investment, inadequate research and extension, weak planning capability, wastage in harvesting and processing, market imperfections, excessive government control, low level of people's participation and NGOs involvement, lack of private sector participation, unwanted restrictions on felling, transport and marketing of forest produce grown by the people, lack of inter-sectoral coordination.

Greening programme has to address environmental challenges, livelihood security and sustainable development. Without greening environmental deterioration and economic decline will be feeding on each other leading to pollution, poverty, poor health, political upheaval and unrest. Poverty and environmental crisis are closely linked calling for holistic approach and lasting solutions through greening of all degraded areas with people's participation.

The present report is based on the contribution made by Members of the Task Force and many other experts on natural resource management. The report is a comprehensive strategy and action plan of 10 years for greening the country by bringing one-third of the total geographical area under forest/tree cover. It will ensure conservation of all natural resources besides improving ecology, economy and generation of productive employment and ensuring food accessibility to 100 million people by providing them food under "food for work" scheme.

We would like to extend our deep appreciation to Shri K.C. Pant, Deputy Chairman, Planning Commission for his continuous guidance and support. His deep insight on aspects of integration of environmental conservation and economic development has been the guiding principle in formulation of the report.

We also place on record our appreciation for the role and contribution made by S/ Shri R.C. Jhamtani, Joint Adviser and N.K.Singh, Deputy Adviser, Planning Commssion for their sincere and diligent efforts. We thankfully acknowledge the services of Shri Naveen Bindra for typing the manuscript of the report.

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ON GREENING INDIA FOR LIVELIHOOD
SECURITY AND SUSTAINABLE DEVELOPMENT

Place: New Delhi
Date: 02.07.2001

Without trees the world would languish,

Man would faint and die in anguish,

Ignorance will fight and vanquish,

Heal the earth with trees,

Trees for beauty, inspiration,

Trees for future generation,

Trees for health and sure foundation,

Heaven bless our trees.

T.A. Drapper

"One touch of nature makes the whole world kin"

William Shakespeare

Task Force Report at a glance

Sustainability is not an option but imperative. Future development must be ecologically sound, self-sustaining and equitable in its distribution of resources and opportunities.

National Agriculture Policy, 2000 underlines the need for diversification in agriculture with the promotion of integrated and holistic development of rainfed areas on watershed basis and augmentation of biomass production through agro and farm forestry with community involvement.

National Forest Policy, 1988 envisages greening of 33% land area with appropriate research intervention, adequate investment, suitable extension strategies, harvest and processing technology, development of new products and marketing infrastructure. Circumstances warrant legal, policy and socio-economic support to render maximum benefits to forest dwellers and farmers besides curtailing the import of forest products of Rs. 8000 crore annually.

Greening programme proposes to cover 43 million ha degraded land (regeneration of 15 m ha degraded forests under JFM, agroforestry in 10 m ha irrigated and 18 m ha rainfed areas) under watershed approach. It is aimed at augmentation and stabilisation of production and productivity, meeting basic needs of forest produce, minimising ecological degradation and sustainable management of land, water and biodiversity.

We have surplus foodgrain reserve in our country and the challenge is to ensure food accessibility through "Food for Work" scheme to about 25 per cent of our population below poverty line suffering from malnutrition, ill health and environmental crises. Greening programme will help ensuring food accessibility to 10 crore people and providing them greater opportunities for employment and sustainable means of livelihood.

In order to carry out the gigantic task of Greening India in 10 years timeframe, it is proposed to set up **Green India Authority** and **Green India Fund** for effective implementation, monitoring and evaluation of the programme. Annual investment of Rs.4800 crores (inclusive of Rs 1125 crores in terms of foodgrain under 'Food for Work' scheme) has been envisaged over a period of 10 years for implementation of the programme.

Greening will ensure environmental, food and livelihood securities, alleviate poverty and mitigate the adverse impacts of pollution and health hazards. It will reduce regional disparity, bring desirable peace, prosperity and happiness and ensure an optimistic future for generations to come.

CONTENTS

List of Abbreviations/Acronym

ADB	Asian Development Bank
CFC	Common Facility Centre
CSO	Clonal Seed Orchard
DBT	Department of Biotechnology
DDP	Desert Development Programme
DFID	Department for International Development
DPAP	Drought Prone Area Programme
DRDA	District Rural Development Agency
HAS	Employment Assurance Scheme
EEC	European Economic Community
FAO	Food and Agriculture Organisation
EDA	Forest Development Agency
ESI	Forest Survey of India
CIS	Geographic Information System
HRD	Human Resource Development
HYV	High Yielding Variety
ICAR	Indian Council of Agricultural Research
ICERE	Indian Council of Forestry Research and Education
IEAD	International Fund for Agricultural Development
INM	Integrated Nutrient Management
IPIRTI	Indian Plywood Industries Research & Training Institute
IPM	Integrated Pest Management
IWDP	Integrated Wasteland Development Programme
JEM	Joint Forest Management
JRY	Jawahar Rajgar Yojana
MIS	Management Information System
MoU	Memorandum of Understanding
MPTS	Multi Purpose Tree Species
NABARD	National Bank for Agricultural and Rural Development
NAEB	National Afforestation and Eco-development Board
NCA	National Commission on Agriculture

NFAP	National Forestry Action Programme
NFP	National Forest Policy
NGO	Non Governmental Organization
NTFP	Non Timber Forest Produce
NWDB	National Wasteland Development Board
OBC	Other Backward Class
OECF	Overseas Economic Cooperation Fund
OGL	Open General License
PLP	Potential Linked Plan
PRA	Participatory Rural Appraisal
R&D	Research and Development
RIDF	Rural Infrastructure Development Fund
RRB	Regional Rural Bank
SIDA	Swedish International Development Authority
SPA	Seed Production Area
SSO	Seedling Seed Ore haul
UNDP	United Nations Development Programme
VSS	Vana Samrakshana Samithi (Forest Protection Committee)
WFP	World Food Programme

EXECUTIVE SUMMARY

GREENING INDIA FOR LIVELIHOOD SECURITY AND SUSTAINABLE DEVELOPMENT

Introduction

Sustainability is not an option but imperative. With a better world to live in (not just to survive) we need good air, pure water, nutritious food, healthy environment and greenery around us. Without sustainability environmental deterioration and economic decline will be feeding on each other leading to poverty, pollution, poor health, political upheaval and unrest.

The rapid increase in greenhouse gases in the atmosphere, land degradation, increasing floods and droughts, marching deserts and deteriorating conditions of fragile ecosystems, deforestation, loss of biodiversity and environmental pollution have become subjects of serious global concern. The overall impact of these phenomena is likely to result in depletion of ozone layer, change of climate, rise in sea-level, loss of natural resources, reduction in their productivity ultimately leading to an ecological crisis affecting livelihood options for development and overall deterioration in quality of life. Poverty and environmental crisis are closely linked calling for holistic approach and lasting solutions through greening programme.

The phenomenon of rural poverty is complex and varies considerably within states and over time. Among the major causes are inadequate and inequitable access to productive resources such as land, water, forest, credit and infrastructure, besides non-availability of food, employment and health facilities.

Greening programme is both people centred and environmentally sound, and meets the challenges of food accessibility (through food for work scheme), fodder for livestock, conserving soil, water and biodiversity, increasing agricultural production, enhancing off-farm employment, livelihood and environmental security by strengthening local resource management systems with the active involvement of people.

Greening programme has to address food security, poverty alleviation and environmental challenges. It should aim generation of productive employment, empowerment of forest-dwellers, artisans, tribals and other under-privileged people. Local community voices and choices should be crucial in implementation of greening programme.

Urgency for Increasing Forest/ Tree Cover

The situation of forestry has reached a critical stage and the world's concern and sense of urgency have been repeatedly expressed in declarations, conventions, protocols and principles (more loudly and clearly than even before at the 1992 Earth Summit); but still without much perceivable effect. However, while deciding Public Interest Litigations, Supreme Court and High Courts have delivered various landmark judgements and directed Governments to adopt sustainable forest management measures. In the approach paper of the Tenth Five Year Plan a monitorable target has been fixed to increase forest/tree cover to the extent of 25% by 2007 and 33% by 2012.

Natural resources particularly land, water and forests (including biodiversity) occupy centre-stage for the welfare and development of people. National Forest Policy (1988) also envisages 33% of land area under forest/ tree cover.

Efforts Made So Far

India is a leading country to recognise the contribution of forestry and tree resources to ecological stability and people centred development through qualitative and quantitative improvements. The various efforts made included:-

- Amendment of the Indian Constitution to include forestry under concurrent list. Article 48-A stated, "The State shall endeavour to protect and improve environment and safeguard the forests and wildlife of the country." Article 51-A (G) enshrined as fundamental duty of each citizen "to protect and improve the natural environment including forest, lakes, rivers and wildlife, and to have compassion for living creatures". Similarly 73rd and 74th amendments of the Constitution authorized Panchayats and Urban local bodies to promote social forestry and urban forestry and tree plantations on vacant lands.

- Adoption of National Forest Policy 1988 with the following objectives:

    i) Having regard to the symbiotic relationship between the tribal and forest, the primary task of all agencies responsible for forest management should be to associate the forest dwellers in protection, regeneration and development of forests as well as sharing of benefits (JFM).
    ii) Promoting/popularising non-wood forest products and development of medicinal plants and bamboos.
    iii) Increasing productivity through adoption of clonal forestry, application of biofertilizers, adoption of IPM system and efficient forest product development, processing, utilisation and marketing.
    iv) Carrying out detailed investment studies, harmonisation of demand and supply of forest products, and environmental impact analysis to rationalize and improve utilisation.

- Adoption of National Agriculture Policy 2000 with the following objectives:

    i) Areas of shifting cultivation will receive special attention for their sustainable management.
    ii) Integrated and holistic development of rainfed areas will be promoted by conservation of rainwater through vegetative measures on watershed basis and augmentation of biomass production through agro and farm forestry with the involvement of the watershed committee.
    iii) Agroforestry and social forestry are prime requisites for maintenance of ecological balance and augmentation of biomass production in the agricultural systems. Agroforestry will receive a major thrust for efficient nutrient cycling, nitrogen fixation, organic matter addition and for improving drainage. Farmers will be encouraged to take up farm/ agroforestry for higher income generation by evolving technology, extension and credit support and removing constraints to development of agro and farm forestry.

- Creation of National Wasteland Development Board to afforest 5 million hectares of wasteland every year. Later on National Afforestation and Ecodevelopment Board was also established in the Ministry of Environment and Forests to regenerate degraded forest land.

- Formulation of a number of externally aided social forestry projects and their implmentation in States.

- Joint Forest Management (JFM) was started for regenerating, protecting and equity sharing of forest resource. So far, 44,943 JFM Committees have been formed covering an area of about 11.629 m ha of degraded forest land. Concrete efforts are to be made to cover 15 m ha of degraded forests under JFM.

- Wood based industries started R & D efforts and various programmes for promoting agroforestry on farmlands for meeting their raw-material requirements.

- Private forestry development has to be encouraged by providing various inputs and legal & policy supports for increasing production and improving ecology and economy of the region.

As a result of all these efforts there has been improvement in controlling deforestation and as per Forest Survey of India Report 1999 the forest cover has increased by 3,896 Sq. km since the previous assessment of 1997.

Demand and Supply of Forest Products

Due to inexorable human and cattle pressure the existing forest /tree cover is under intense pressure to meet the various demands of forest products in a sustainable manner. There is acute shortage of timber, fuelwood and fodder. The total import of forest produce has exceeded Rs 8000 crore per annum, which must be reversed by greening programme for ecological and socio-economic development.

Strategy for Successful Implementation of JFM

Earlier forest management was not sensitive towards needs and aspirations of local people. New paradigm of forest management built on the foundation of people's participation (JFM) is expected to regenerate the degraded forest area besides improving the economy of forest dependent people. For successful implementation of JFM following conditions have to be ensured.

i) Suitable forest patches are entrusted to well-defined user groups with transparent Memorandum of Understanding (MoU) on the roles and responsibilities of JFM Committee and Foest Department.
ii) Security of tenures as well as access to benefits from the resource is assured to them.
iii) Silvicultural prescriptions followed for management of JFM forests are sustainable. Stakeholders have a voice in decision-making.
iv) Legal back-up to JFM Committees
v) Appropriate institutional and financial mechanism
vi) Tie-up of Village Protection Committees wi industries for sale of JFM produce.
vii) Detailed projects to be prepared for assistance under Rural Infrastructure Development Fund (RIDF) of NABARD.
viii) `Food for work' schemes should be launched to ensure food security and employment generation for JFM members.
ix) Setting up of Forest Development Agencies as federations of JFM committees for timely flow of funds, decentralisation and integrated rural development. This has already started in 20 states and the progress needs to be expedited.

Strategy for Agroforestry Development

Agroforestry will include promotion of sustainable agriculture, planting of multi-purpose species for meeting household requirements and for sale of forest produce. For promoting agroforestry it is recommended that:

i) Commercial agroforestry should be practiced in areas where irrigation is available. Suitable species include *Acacia nilotica*, *Bamboo species*,

Casurina equisetifolia, *Eucalyptus species*, *Populus deltoides* and *Prosopis cineraria* for different agro-climatic and edaphic conditions.

ii) High-tech modern nurseries should be established on catchment area basis.

iii) Agroforestry should be tried in rainfed areas by adopting various agroforestry models that would provide additional income as well as complementing agriculture.

iv) Elite clones (higher yielding and disease resistant) of important agroforestry species should be developed for different edaphic and climatic conditions. Corporate/ Private sector should also be encouraged to take up R & D activities and promote new agroforestry products.

v) Agroforestry product research, new product development, new designs and quality standards should be evolved for downstream processing.

vi) Market information system should be developed to inform farmers about the major buyers, market trends, etc.

vii) All restrictions on felling of trees, logging, transport and marketing of forest produce should be removed.

viii) Establishment of agroforestry boards and marketing federations should be encouraged to improve the bargaining power of farmers in domestic and export market.

Target for Greening Programme

Around 300 m ha is the available productive land out of 328.27 m ha total geographical area of the country. Actual forest cover is 63.73 m ha of which only 37.73 m ha are good forests. About 20 m ha is covered under tree plantations (agroforestry, farm forestry, social forestry and other plantations). Thus, in order to achieve one-third area under forest/ tree cover, (100-37.73-20= 42.27, say 43) 43 m ha of area is proposed to be covered under Greening programme in 10-year period. The details are as under.

i) 15 m ha of degraded forest land to be covered under JFM.
ii) 10 m ha of irrigated area to be brought under commercial agroforestry.
iii) 18 m ha of rainfed area to be brought under subsistence agroforestry.

Greening India Programme aims at achieving increased productivity, employment and income generation and food security to poverty stricken people

living in and around forests and other fragile ecosystems. “Food for work” scheme will ensure food accessibility in these areas and fruitful utilisation of surplus food grain reserve of the country. It is envisaged that implementation of greening programme will help in poverty alleviation of 105 million people (75 million by JFM and 30 million by agroforestry in rainfed areas). The programme will help in empowerment of scheduled tribes, scheduled castes, women and other weaker sections and thus addresing the problem of social disparity.

Institutional Mechanism

JFM/ agroforestry, social forestry and other plantation schemes are being implemented by several departments of the Government of India and State Governments often with different and conflicting objectives. The need for a coordinating agency has been felt for sometime.

In order to carry out the gigantic task of Greening India in 10 year timeframe i.e by 2011, a **Green India Authority** is to be set up in Planning Commission. The Authority will carry out effective coordination, monitoring and evaluation of the programme. The Authority will also operate the **Green India fund** to be created.

It is recommended that two separate departments, ie. Department of Forest and Department of Environment should be created in the Ministry of Environment and Forests. The bifurcation will not involve any additional post or financial liability and would focus the programme in an effective manner.

Department of Land Resources was created in the Ministry of Rural Development for implementing various land development programmes including wasteland development, in place of National Wasteland Development Board. On the same lines, National Afforestration and Ecodevelopmentand Board should be abolished and all schemes should be transferred to the proposed Department of Forest.

It is recommended that National Research Centre for Agroforestry, Jhansi should be upgraded to a national institute. It will provide research and technological support to agroforestry in rainfed areas.

For promoting commercial forestry in irrigated areas it is recommended that Centre for Social Forestry and Eco-rehabilitation, Allahabad should be upgraded to a national institute.

Forest Research Institute, Dehradun and Institute of Wood Science and Technology, Bangalore should carry out forest product research on priority basis and promote quality standards and designs of new products.

Indian Plywood Research and Training Institute (IPRTI), Bangalore should concentrate on development of next generation products of Bamboo composites and laminates for domestic and export market.

Indian Institute of Forest Management, Bhopal and Indian Council of Forestry Research and Education, Dehradun should carry out socio-economic and marketing research.

Department of Biotechnology should identify elite clones of important agroforestry species and standardise their micro and macro propagation techniques. It should also identify bio-fertiliser association and IPM technique for these species.

A separate cell of agroforestry/ JFM should be created in National Bank for Agriculture and Rural Development (NABARD) for providing adequate thrust to this sector.

Hundred NGOs possessing land and other infrastructure facilities should be identified for mass propagation of seedlings and extension activities.

Financial Requirement

The financial requirement for greening programme would be of the order of Rs.48,000 crores in 10 years. The annual requirement would be Rs. 4,800 crores against the current availability of Rs.1601 crores. “Food for work” scheme would add Rs.1125 crores in form of foodgrains to be supplied for 50% of the wages earned by the working people in food scarcity areas. Additional funds requirement will have to be met from the plan budget of Central and State Governments under various schemes of afforestation/tree planting, desert development, drought prone area development, watershed development, command area development, settlement of shifting cultivation, wasteland development and other schemes of rural development. Externally aided projects should also be formulated for availing assistance from various sources. Institutional finance should be mobilised through normal run schemes of NABARD. Industries should also be enthused to participate in the Greening Programme through supply of quality planting material and a captive market for the growers.

Conclusion

Significant efforts are required for greening India to address food security and environmental challenges. Deforestation has resulted in environmental crisis, economic decline and unbalanced development of the country. For resolving these problems and achieving the national goal of covering 33% of total area under forest/ tree cover, it is proposed to cover 43 m ha land in 10 year period through community and individual participation (allowing their voices and choices on care and share basis). The country is facing the problem of surplus food production on one hand and unemployment, poverty and food deficiency on the other. The implementation of Greening Programme through “food for work” scheme will ensure meeting the basic needs of people, environmental protection, food accessibility and productive employment generation to 10 crore people (mainly tribals, dalits, backwards, OBCs, landless and women).

The successful implementation of the programme will help the country achieving ecological security, environmental and economical balance, and hold the country in pride position amongst developed nations of the world. Greening will ensure sustainable management of land, water, forest and biodiversity. Integrated development of these natural resources will bring desirable peace, prosperity, happiness, livelihood security and sustainable development.

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CHAPTER – I

INTRODUCTION

General

Natural resources, which are vital for food, livelihood and environmental security, are under intense pressure. The challenges of their conservation and sustainable use remain enormous. Circumstances warrant integration of environmental issues with strategies of poverty alleviation.

It is now widely accepted that future of food, livelihood & environmental security depends upon the attention paid to management of natural resources viz land, water, forest and biodiversity. The term 'management' in the context of natural resources involves concurrent attention to conservation, sustainable use and equitable sharing of benefits. In fact development activities must not be allowed to result in severe depletion of natural resources and degradation of our environment. We must adjust our needs within the productive limits of natural resources. Policies and programmes aimed at sustainable development call for coordination given the multiplicity of organisations, both private and government that are involved in the development process.

Protection of environment has been the cornerstone of Indian ethos and culture. We are signatory to the following conventions and principles in the interest of protection of our global environment: -

- Agenda 21 to address the pressing problems of present and preparations for the emerging environmental challenges of the 21st century.
- Convention on conservation and sustainable use of biodiversity.
- Convention to combat desertification.
- Convention on mountain development.
- Global policy on sustainable forest management called as "Forest Principles"
- UN framework convention on climate change and the Kyoto Protocol of 1997.

Land, water and forest can no longer be used in the same way as they have been used in the past. Conservation, development and sustainable and equitable use of these resources for the benefit of the present and future generation, is one of the most urgent tasks before the humanity.

Recognising that land degradation, deforestation and pollution are major environmental concerns that are adversely affecting productivity and socio-economic conditions, suitable measures have to be taken for addressing these problems. Expansion of greenery through increase in forest/ tree cover over one-third geographic area of the country has been envisaged in the National Forest Policy, 1988. It is possible to achieve this objective by adoption of Joint Forest Management

(JFM) & agroforestry. Some priority actions needed for greening the country include the following: -

- The concept of people managed forests in India gained popularity about a decade ago when government realised that forests cannot be managed without the cooperation of communities living in and around. This led to widespread adoption of Joint Forest Management which needs further strengthening.
- Agroforestry, an age old practice must be encouraged for sustainable agriculture, enriching the soil by nitrogen fixation, improving drainage, efficient nutrient cycle, opportunity for vertical expansion to optimise land productivity and diversity in output to meet domestic and export market needs and improving economy of farmers.
- Technology and institutions must be adapted to each other and are in harmony with ecology.
- Entry of the market into natural resource sector has to be carefully orchestrated to protect the interests of poor people. Trade of bamboo and medicinal plants have to be promoted on priority basis.
- There need be no ideological preference for either nationalisation or privatisation since both have limitations. Marketing institutions if state sponsored must be supported by an appropriate legal and policy environment.
- Research on all aspects of forestry (scientific, technological, economic, social, environmental and institutional) is essential to maintain the dynamism of the sector.
- The Government should support relevant research, extension, technological packages, input delivery, market information, credit and insurance facilities.
- All restrictions on felling, transport, logging, processing, marketing and export of forest produce should be removed. The JFM, agroforestry and farmforestry should be encouraged as envisaged in National Forest Policy. The import of forest produce should be suitably regulated. The impact of policy should be continuously monitored and evaluated for necessary modification.
- There is a need to step up allocations to forestry sector for enhancing forest/tree cover. This calls for intensive efforts for project formulation and fund mobilisation from all potential sources public and private, domestic and external.
- “Food for work” programme should be dovetailed with Greening programme to generate employment and to ensure accessibility of food to tribals and other poor people who are victims of hunger and malnuitrition.

Land

Land is normally defined as a physical entity in terms of its topography and spatial nature. A broader integrative view also includes natural resources like soil, mineral, water and biota that the land comprises. The components are organised in ecosystems, which provide a variety of services essential to the maintenance of

integrity of life support systems and productive capacity of the environment. Land resource is used in many ways that take advantage of all these characteristics.

Land is a finite resource, while the natural resources it supports can vary with time and according to management practices and uses. Expanding human requirements and economic activities are putting ever-increasing pressures on land resource, creating competition and conflicts and resulting in sub-optimal use of both land and its natural resources. If, in the future, human requirements are to be met in a sustainable manner, it is essential to resolve these conflicts and move towards effective and efficient use of land and its natural resources. Integrated land use planning and management is an eminently practical way to achieve this. By examining all uses of land in an integrated manner, it makes possible to minimise conflicts, to make the most efficient trade-off and to link social and economic development with environmental protection and enhancement, thus helping to achieve objectives of sustainable development. The sense of integrated approach finds expression in the coordination of the sectoral planning and management activities concern with the various aspects of land use and land resources.

Sustainable use of Agricultural Land

The studies have shown that not withstanding the highly visible increase in production and yields of a few crops in a few areas, both agricultural production and productivity in aggregate terms showed a lower rate of growth after the introduction of 'Green Revolution' in 1966-67. The fallouts of the 'green revolution' are summarised as under: -

Environmental:

- Soil degradation (nitrification, loss of soil flora/fauna, depletion of soil fertility)
- Mining of fossil fuels to sustain fertilizer production (high cost of ecological capital)
- Loss of productive land from canal irrigation associated with High Yielding Varieties (HYV), salinisation and water logging.
- Incalculable loss of genetic diversity from increasing adoption of the new technology.
- Replacement of traditional wheat varieties by HYV in Madhya Pradesh, for example, has resulted in loss of production due to the shallow roots of the latter being unable to absorb soil moisture.
- Leaching of nitrates into surface and groundwater (under certain conditions, intestinal bacteria convert nitrates into toxic nitrites). Decline in protein and increase in carbohydrates affecting tissue building. Imbalance of amino acids in protein molecule.

Social:

- Gradual transfer of surplus from the farming to the industrial urban community. From a self-sufficient people practicing agriculture as a way of life, cultivators were reduced to the Status of labour-component in the new 'industrial agriculture'.

Equity:

- Claimed to be scale-neutral but not resource-neutral, the new technology has resulted in widening disparities between larger and smaller cultivators. The rural landless have been increasingly marginalised, especially with the severing of the traditional links between agriculture and animal husbandry.

By any standards these environmental social and economic impacts of 'green revolution' must be considered high. For practising sustainable agriculture and to encourage sustainable land use and management of land resources it is necessary to introduce agroforestry in such areas. The appropriate priority should be given to:

- Assessment of land capability and ecosystem functions.
- Developing indicators of sustainability for land resources, taking into account environmental, economic, social, demographic, global and political factors.

Land Utilisation

The total geographical area of the country is about 329 m ha. The data available for land use classification is only for 305 m ha. Nearly 22 m ha area is under urban and non-agricultural uses. This includes land under roads and railways as well as land under water bodies, i.e. rivers and canals, lakes, etc. About 19 m ha land is barren and unculturable because of intrinsic reasons such as the land being perpetually snow-bound or rocky in nature. Thus, out of the 305 m ha, 41 m ha is out of bounds for agricultural purposes.

Of the remaining 264 m ha, about 107.4 m ha are degraded land. Out of this about 67.6 m ha are subjected to wind and water erosion. Waterlogged area is estimated to be about 3.20 m ha and 2.38 m ha are affected due to shifting cultivation. Out of 142.82 m ha of net sown area, 89.82 m ha (63%) is rainfed, where crop production suffers from low yields. The total forest cover as per FSI 1999 report has been estimated to be 63.73 m ha, out of which 25.51 m ha is degraded forest and another 5.19 m ha is scrub. Thus, total degraded forest is about 30.70 m ha.

Land Degradation is Unacceptable

We are aware that where land remains neglected people remain poor. We also recognise that while the land cannot expand, population is rising and exerting pressure on the land beyond its carrying capacity. The biotic pressure results in

land degradation of various types – erosion by water and wind, salinity, alkalinity, acidity, water logging, gullying, landslides, and finally, desertification. Accurate assessments for land degradation have not yet been completed, though a beginning has been made. Protective cover of the natural forest is declining leading to the loss of valuable biodiversity. Common property resources on which the rural poor survive are highly degraded and encroached upon. The land base per person is shrinking, posing the challenge of maintaining the soil health while obtaining more and more from less and less area and quality of land. Soil erosion accelerates greenhouse effect (on a global scale, it causes emission of 1.14 billion tons of carbon to the atmosphere every year). The task is to reverse land degradation under the present patterns of land use, biotic pressure, state of technology and investment.

Land use decisions are also water use decisions

Land degradation equally affects the quantity and quality of water. Forest denudation affects hydrological cycle. Unscientific land use also leads to the unsustainable exploitation of the aquifer. Recurring droughts, floods, falling ground water table, and shortages of drinking water in rural and urban areas forcefully reminded us that we will face graver crises in future unless we begin prudent management of our watersheds and water resources. The Government has to launch a national campaign for integrated watershed management through vegetative means and water conservation techniques with the active participation of various user groups. Hence, land, water and vegetation care leading to **more crop per drop** is vital for safeguarding both food and livelihood security.

Land, water and vegetation care: Essential Components of Ever-green Revolution

The 'green revolution' led to increase in production through enhanced productivity. A vertical growth in productivity, rather than a horizontal growth in area, has helped many countries to strike a balance between population growth and food supply. Such a growth in productivity per units of land, water, time and labour has also helped to save vast areas of forests, which otherwise would have been cleared to grow food crops. Most developing countries have no option except to produce more from less per capita arable land and irrigation water in this century. Thus, continuous improvements in productivity are essential but these must be capable of being maintained in perpetuity. In other words, **an ever-green revolution rooted in the principles of ecology, economics, social and gender equity, energy conservation, employment generation and social auditing,** is essential in the major farming systems of the world. Land, water and vegetation care constitutes the foundation for building up such an **evergreen revolution movement.**

Both problems and solutions are known but wanting in action

The adoption of the UN Convention on Desertification by many members of the United Nations is evidence of the growing political commitment to the cause of safeguarding the biological potential of the soil. Now, Government has to provide the required technological and financial support for both halting further desertification and for rehabilitating the drought prone areas. The influx of environmental refugees from rural to urban areas and across nations will increase in intensity, unless the loss of rural livelihoods due to land degradation, deforestration and drying of water sources is prevented. Therefore, conservation and sustainable and equitable management of land, water and forest resources are local, national and global imperatives.

Uncommon opportunities

Modern science with spectacular advances in the field of biotechnology, information and communication, space, nuclear and renewable energy technologies have opened up uncommon opportunities for making the vision of sustainable food, livelihood and environmental security realistic. National and international agencies should strive to bridge the fast expanding technological, economic and demographic divides in the world. This will call for concerted efforts in bringing the best of modern technology to those who have so far been bypassed by such technological advances.

Fusion of people, political and professional power can accelerate progress in the sustainable management of all natural resources. Experiences have shown that whenever there is a synergy among public, political and professional power, impossible tasks can be achieved. Such fusion of political will and action, people's cooperation and professional skill usually takes place during emergencies. In our view, there is such an emergency in the case of land, vegetation and water crisis. Prime farmland is going out of agriculture at a fast pace. In order to halt this process and to conserve and improve land resources through the application of science and technology, a time has come to launch a **Community-centred Land, Vegetation and Water Care Movement.** Such a movement will be successful only if it is based on partnership among all stakeholders and social and gender equity in sharing benefits. The Government on their part should update and modernise all land records, and technology and make the information available in a transparent manner. **Wherever women do not have rights in land or forest, they should be provided immediately.** Women suffer more from the degradation and abuse of common property resources, since this limits their access to fodder, fuelwood and water.

Role of Forests/ Tree Cover

Forests play an important role in environmental stability and provide a variety of benefits to the economy. As our dependence upon healthy ecosystem became

visible throughout the world, forestry has moved from the shadows of social indifference to the dazzling glare of international media. To maintain and enhance the ecological, biological, climatic, socio-cultural and economic contributions of forests, their conservation and management are urgently required.

Forests help in biological rejuvenation of soils. Trees through their sturdy root structures open the soil improve it by adding organic litter or humus rendering it hospitable to useful micro and macro flora and fauna. Researches support facilitated establishment of critical limits of species towards salt tolerance, identification of species tolerant to stress, standardisation of soil amelioration methods and application of micorrhiza with leguminous tree rhizobium. Besides having ecological and scientific values, forests have socio-economic, religious and ethnic importance too.

Management must be regarded as a key variable in the productive use of renewable natural resources because if the rate of use is not within the limits of renewal or replenishment, it cannot be sustained over time. Unsustainable use can mean a rate of use falling anywhere on the spectrum between the two extremes; one at which the harvest species renews and the other, it is used to the point of extinction.

In spite of several constraints the forestry sector is facing, it has many strengths, which motivate us to adopt new policies, practices for sustainable management of this natural resource for our survival. The strengths are: the long tradition and history of forestry in the country, the network of "Protected Areas" for conservation of biodiversity, existence of excellent institutions for research, education, training and extension, wealth of traditional knowledge on the conservation and sustainable use of forest products including medicinal plants and presence of many NGOs. Due to concerted efforts, the degradation of forests has stopped and forest cover has shown a rising trend since an increase of 3896 sq.km has been reported by FSI in 1999. For continuing this trend and also to further improve the forest productivity the following inter-related issues are to be addressed:-

- Protection of existing forest resources through conservation, development and appropriate use.
- Improving forest productivity through biotechnology, tree improvement, regeneration, rehabilitation and rejuvenation of degraded forests and wasteland through people participation.
- Reducing total demand of forest product through substitution of timber by bamboo products.
- Strengthening policy and institutional framework for harvesting, processing, new product development for domestic and export market.
- Ending the long neglect of forest dwellers by involving them in forest management on care and share basis (JFM) and promotion of agroforestry in rainfed and irrigated areas.

National Forest Policy

The National Forest Policy (NFP) of 1988 took note of the importance of protecting the livelihood security of people, who live in and around forest, along with the ecological and environmental objectives of forest management. Some important policy statements enunciated in the NFP are tabulated in the following box:-

People – Centred Policy

The holders of customary rights and concessions in forest areas should be motivated to identify themselves with the protection and development of forests from which they derive benefits. The rights and concessions from forests should primarily be for the bonafide use of the communities living within and around forest areas, specially the tribals.

The life of tribals and other poor living within and near forests revolves around forests. Rights and concessions enjoyed by them should be fully protected. Their domestic requirement of fuelwood, fodder, minor forest produce and construction timber should be the first charge on forest produce. These and substitute materials should be made available through conveniently located depots at reasonable prices.

Having regard for the symbiotic relationship between the tribal people and forests, the primary task of all agencies responsible for forest management, including the Forest Development Corporation, should be to associate the tribal people closely in the protection, regeneration and development of forests as well as to provide gainful employment to the people living in and around the forest, while paying special attention to the following: -

- Protection, regeneration and optimum collection of minor forest produce along with institutional arrangements for the marketing of such produce;
- Development of forest villages on par with revenue villages;
- Family-oriented schemes for improving the status of tribal beneficiaries;
- Undertaking integrated area development programmes to meet the needs of the tribals' economy in and around the forest areas, including the provisions of alternative sources of domestic energy on a subsidised basis, to reduce pressure on existing forest areas.

The NFP envisages a new dimension of people care. People living in and around forests have to be stakeholders in forest management. It was a major departure from the practice followed for nearly 125 years, which was to use forests to produce wood for industries. The new policy lays emphasis on natural

regeneration, preserving biodiversity and adopting management practices that helped the local people.

Forest Productivity

The forest of India have a growing stock of 4,740 million m^3 with annual increment of 87.62 million $m.^3$ Since 78% of the forest area is subjected to grazing as well as heavy removal of forest products and 51% is subjected to occasional fire (the net annual loss being about 74,000 hectares), the productivity of forest is only 0.7 m^3 per hectare per year against potential productivity of at least 2 m^3 per hectare per year. The yields obtained from plantations are also less than the potential.

Demand & Supply of Forest Products

Fuelwood

According to a study of Forest Survey of India (FSI), the total requirement of fuelwood in the country was around 201 million tones in 1996. Out of this roughly 103 million tonnes was brought from the forest areas (including plantations), which constitutes nearly 51 percent of the total requirement, and the balance 98 million tonnes from farm forestry sector including plantation on common land. As per estimates (FSI, 1995), the annual increment of India's forests in terms of fuel wood is around 26.3 million cu.m (21 million tones). Of this around 17 million tonnes is available on sustained basis. In this way, nearly 86 million tonnes of fuelwood is being removed from the forests and plantations of India every year in excess of what they are capable of producing on sustained basis. The projected demands of fuelwood for 2001 and 2006 are 223 and 247 million tonnes respectively. We have to bridge the gap to prevent the problem of environmental degradation.

Timber

Total demand of timber has been estimate at 64 million cu.m in 1996, which will rise to 73 and 82 million cu.m in 2001 and 2006 respectively. Out of 64 million cu.m, nearly 31 million cu.m comes from farm forestry and other woodlands and 12 million cu.m from forests. The balance 21 million cu.m is removed from plantations and from natural forests, largely (70%) as small timber to meet the domestic need. Gregarious bamboo flowering is expected from 2003 onward. Concerted efforts have to be made for preparation of emergency plan in order to advance harvesting of bamboo and converting them into various utility products.

Fodder

Out of 445 million cattle in the country, nearly 270 million graze in forests. FSI has estimated (1996) that the requirements of green and dry fodder were 593 and 482 million tonnes respectively. The requirement of green and dry fodder will

increase to 699 and 552 millions tonnes and 817 and 615 millions tonnes respectively in 2001 & 2006.

It is generally agreed that nearly 30% of the fodder requirement of the country comes from the forest areas. Therefore, there is removal to the extent of 145 million tonnes of dry fodder and 178 million tonnes of green fodder annually from the forest areas. In certain cases lopping of trees during crunch period is a common practice and this has been causing considerable depletion of the forest resources.

Joint Forest Management

Government realised that forest cannot be managed without the cooperation of the communities living in and around them. Consequent to the new NFP, the Ministry of Environment & Forests, GOI issued guidelines to State Governments on June 1, 1990 to involve village communities living close to the forest, in the protection and development of degraded forestland. It also prescribed sharing of usufruct benefits to participatory village communities to meet their demand of forest produce.

To check the loss of forest cover the World Commission on Forest and Sustainable Development concluded that **"forest can no longer be used in the same way as they have been in the past… forest products and services must be shared through new political choices and policy decisions that ensures the survival of forest".** About 147 million people living in 1,70,000 villages of the country (inside as well as on the fringe of forest blocks) are completely or substantially dependent on nearby forests for their livelihood requirements. Their attitude towards forest could determine the success of forest conservation efforts. A large number of programmes in watershed development, drinking water, agriculture, irrigation and dairy development will have a sustained benefit only when forest areas remain green and covered with trees.

Now all the states have started JFM covering an area of about 11.629 million ha managed by 44,943 JFM committees. The concept of bottom up planning is finding a true expression in the form of site-specific microplans prepared by villagers. Not only these plans are more realistic but also people oriented as greater emphasis is being laid on planting of those species of trees, which meet the requirements of the rural population.

JFM has tremendous possibilities for changing the face of rural areas by poverty removal. Besides providing better opportunities for wage employment the returns to the villagers from regeneration of forests can be substantial and many. With emphasis on suitable species for production of non-timber forest produce (NTFP) the income in the form of grass, fuelwood, etc. is rising. Regeneration of forests is bringing about other benefits in the form of greater water availability to villagers and environmental benefits. Once the planted trees gain maturity, large incomes will accrue to the villagers in the form of timber, bamboos and medicinal

plants, and their sales. The drudgery of women in the collection of fuelwood and fodder is getting reduced since supplies become available nearer to home.

The “food for work” programme can be linked with JFM programme for regeneration and development of degraded forest area. It will, in addition, help in improving the food security to poverty stricken people living around forests and other resource poor areas. The country has surplus food grain reserve but due to lack of adequate infrastructure and poor economic condition of people , access to food is restricted. The programme will help in employment generation and food accessibility livelihood support to about 105 million people living in and around forests and rainfed areas.

JFM may contribute in real sense to the political, social and economic empowerment of the downtrodden and the weaker section as they take decisions and enforce various regulatory measures. However, JFM has to be implemented in a meaningful way to derive the expected results. The new institutional arrangement will be effective if the following conditions are ensured: -

- Keeping the distributive effects in view, the less well-off sections of society are cushioned from the impact of exposure to the market;
- Common resources are left to the community, while simultaneously strengthening the institution of local self-government;
- Suitable forest areas are entrusted to well defined user groups;
- Stakeholders have a voice in decision making;
- The technology, the institution and the environment are mutually harmonised.

Agroforestry

Agroforestry is a land management system that optimizes land productivity by harnessing positive interactions between tree-crop-livestock system on a land area. It is a holistic concept that involves various organisms sharing habitat and its abiotic and biotic components. Its components should have ecological and economic interactions in their spatial and temporal dimensions. Conservation of natural resources and optimization of productivity could be considered as vital to its functioning. While at the small land holdings it is a livelihood strategy, at larger holdings it may take a commercial dimension.

Though forestry activities are mainly with government, rural people have been practising tree planting in their farms and homestead, to meet household requirements for fuel, fodder, poles, timber, fruits and non-timber forest produce. The objective of agroforestry is to take advantage of the complimentary relationships between trees, crops and livestock in such a way that the productivity, stability and sustainability of the total system exceed most of the single cases. Currently the area under agroforestry (including farm forestry) is over six million hectares. Nearly 10 million hectares are covered with rubber, cashew, coconut, mango and other species.

There is a need for diversification in agriculture for improving economy and sustainability. Agroforestry may promote sustainable agriculture, enrich the soil by fixing nitrogen, improve drainage, efficient nutrient cycling, opportunity for vertical expansion to optimise land productivity and diversity in output to meet domestic needs and improving economy of farmers. Agroforestry generates high income and minimises risks in cropping enterprises. It provides long term investment opportunity, diversified land use, commercial tree cropping and best option for absentee landlords. This can generate diversified on-farm employment, wood and Non Timber Forest Produce (NTFP) and ensure raw-material supply to forest based industries. Agroforestry is a viable proposition to support a large number of wood/pulp based industries when promoted on wood catchment basis. Such captive plantations may offer considerable income and employment generation in agricultural sector. Agroforestry is a potential technology for commercial farming, improving degraded and polluted sites, an opportunity for stabilizing fragile ecosystems and also a farming system for arid and semi-arid zones.

However, the following constraints have been responsible for inadequate development of agroforestry in the country: -

Cumbersome legislation in respect of tree felling, wood transportation and processing

All the States have some sorts of restrictions on felling of trees even from the private holdings. In addition, transit rules are applicable for movement of wood in many states. The tree growers while planning to fell and sell their trees, find the procedure quite harsh, lengthy, costly and frustrating. Unless legislation and procedures for felling, transportation and selling of tree are simplified, farmers do not find this activity as encouraging and profitable.

Market information and infrastructure

Marketing in its technical sense has not been developed for forest products in India. Traditionally the Government had been the only major producers of timber/wood and therefore, an infrastructure for an open and free timber market could not develop. Considering the scarcity for wood raw material and to ease the situation in processing industries the trade barriers were removed and liberalized imports allowed. This policy change has lead to increased imports of timber and has adversely affected the local market prices. This has adverse effect on agroforestry plantations.

Farmers are interested in getting remunerative prices and a stable market for agroforestry product. For this an information network of important markets of wood and other forest products should be created. Some mechanism needs to be developed for collection and dissemination of information regarding prices, import, export and domestic trade of wood products.

Dearth of appropriate agroforestry models

Various technical aspects are involved in practicing agroforestry such as selection of appropriate species for a given site, which should not interfere with agriculture, use of correct planting techniques, carrying out timely maintenance and adopting scientific management principles. Arid, semi-arid, hill areas, wastelands and fragile ecosystems need specific agroforestry models. Research back up is necessary in key areas such as development of new clones/hybrids/varieties of tree species for introduction into agroforestry systems. Agroforestry models for different site conditions have to be developed and demonstrated under different agro-ecological regions in the country.

Absence of economic security and incentives for tree growers

The tree growing business having a gestation period of minimum five years is more risky and uncertain than agriculture. The agriculture sector provides a lot of security and incentive to the farmers in the form of subsidies, support prices, soft loans, and income tax concessions. Now, the Government has introduced comprehensive crop insurance scheme for the farmers. Agroforestry is not given any support and is left to the vagaries of fluctuating markets and exploitative middlemen. It should get same concessions as provided to agriculture.

Lack of extension training and demonstration

Although people may think that tree growing is an easy proposition but there is certainly a need for training and education to optimize productivity. Presently there is no mechanism to provide training and demonstration to farmers. Extension and transfer of technology for growing, harvesting, processing, product diversification and innovation of new product designs are crucial for development and expansion of agroforesgtry in the country.

Non-availability of quality planting material

The planting material such as seeds, seedlings, clones, improved hybrid varieties, etc. available for agroforestry are generally of poor quality. There is a need for systematic and time bound action for raising planting stock with adequate R&D support.

Unfavorable Import and Export policy

The current import policy to allow duty free import of timber and pulp needs to be reviewed. In spite of tough competition from forestry sector as well as importing agencies farmers are managing 50 per cent of the wood supplies from their holdings.

We are importing timber and pulpwood mainly to reduce pressure on forests. Agroforestry has a potential to meet the total wood requirements of the country. By meeting timber and pulp needs it can eliminate import burden of about Rs. 8000 crores annually.

Similarly many forest produce put in the negative list of export (such as bamboo, medicinal plants) can easily be cultivated and exported for improving economy and generating employment through agroforestry.

Raising of short rotation crops in forest areas

The National Forest Policy (1988) stressed that forest farming should be encouraged for meeting forest based industrial raw-material requirements. Like Brazil, China, Malayasia, the Government may also avoid growing of agroforestry species in forestry plantations (Eucalyptus, Casuarina, Poplar, Babul, etc.). By avoiding duplication of species unhealthy competition may disappear between forestry and agroforestry sectors and farmers can start forest farming for their economic gains.

Poverty alleviation, tribal development and women's empowerment schemes to focus on agroforestry

Agroforestry has a potential to optimise production in the rainfed and semiarid regions as well. However, this has neither been stressed nor monitored in poverty alleviation, tribal development and women's empowerment schemes under implementation.

Integrated watershed development programme

There is a serious problem of ecological deterioration in watershed areas. An integrated approach is needed for conserving, upgrading and using the natural resource base of land, water, plant, animal and human resources. Agroforestry can play the dominant role in promoting livelihood opportunities through agroforestry.

Research and Technology Programme

For generating solutions to the innumerable field problems that have to be addressed to enable agroforestry to shape into a profitable mass movement, scientific, technological, economic, social, environmental and institutional researches are essential to keep the dynamism of the sector and to support its development.

Agenda for Action

Adoption of the following agenda to facilitate the conservation, enhancement and sustainable and equitable use of natural resources may be expedited.

- Restrict/ prevent the diversion of prime farmland for non-farm uses and promote agroforestry.
- Prevent the use of topsoil for brick making and promote the use of fly ash, rice husk and suitable alternative materials.
- Prevent flood irrigation in soils with poor external or internal drainage. Improve irrigation water efficiency through sprinkler and drip irrigation and promote precision farming methods.
- Promote the efficient use of fertilizers based on scientific recommendations and promote use of bio-fertilisers, green manure and bio-pesticides.
- Encourage conservation tillage and natural farming methods including organic farming.
- Discourage the burning of crop residues and biomass.
- Restore disturbed lands (for example mine spoils) to their original contours and undertake revegetation.
- Ensure conservation and sustainable use of biodiversity.
- Conservation and harvesting of water, regulating its systematic use and protection from pollution.
- Bio-remediation of rainfed agricultural areas through agroforestry
- For improving drainage and productivity of irrigated agricultural land, commercial agroforestry has to be promoted.
- Encourage Joint Forest Management for regenerating degraded forest areas and for improving socio-economic condition of forest dwellers.
- Undertake afforestation of steep lands, agriculturally marginal lands and other ecologically fragile areas.
- Educate people for taking care of all natural resources ie. land, water, vegetation for environmental protection.

Attention to land, forest and water care presents a 'win-win' situation for everyone. Inaction can only lead to the Malthusian apprehension of imbalance between human population and food production, coming true. Therefore, there is no time to relax. Eternal vigilance in safeguarding the basic life support systems ie land, water, forests and biodiversity is essential.

Conclusions

In the country, from time immemorial, land has been called "Dharti Mata", the mother earth, and Vedic hymns sung about harmony among living creatures and the natural resources. Land, water and forest care is thus a good index of a civilization's commitment to live in harmony with nature.

The forests are primordial component of environment. Forests provide wood and biomass being sources of cellulose, acetate, esters, ethers, other chemicals and energy. Faster socio-economic progress of forest-dwellers (largely living below the poverty line and facing starvation) depends on forestry development. Forestry schemes should focus on meeting the forest-produce needs of people, adequate employment opportunities and supply of food under "food for work" scheme and their socio-economic development.

For meeting the developmental and environmental needs, 1/3rd area of the country has to be brought under forest/ tree cover. The problems are not beyond the present state of knowledge and technology. Given the required political will, societal commitment and financial support, the nation shall be able to meet the challenge. The report proposes to achieve the objective by the following measures: -

- Regeneration of 15 m ha of degraded forests, which have natural rootstock through Joint Forest Management. It would ensure productive employment and food accessibility to 105 million people who are living in and around forest areas.

- Promoting commercial agrforestry in 10 m ha irrigated land, which is suffering from water logging, soil erosion and salinisation. Diversification of agriculture is imminent in view of poor return from crop, stagnation/ reduction in productivity due to land degradation and unemployment in rural sector.

- Encouraging agroforestry in 18 m ha rainfed area, which is suffering from low yields of crop production and soil erosion due to inadequate vegetative cover. These areas are also characterised by poverty, low income, food insecurity, unemployment and natural resource erosion. Agroforestry would help improving food accessibility, employment generation through diversification in agriculture, conservation and development of natural resource and overall economic development of the region.

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CHAPTER – II

AGROFORESTRY

Introduction

Agroforestry is an age-old practice. The process of human evolution has been from forests when man learnt the art of domesticating plant and animals after leaving the hunting and gathering habit. Agroforestry is a land use system, which is capable of yielding both wood and food while at the same time conserving and rehabilitating ecosystems. This has coevolved with agriculture and is practiced in the country in different forms. Relationship of man with trees and the land use system can be appreciated in its temporal and spatial dimensions across agroclimatic regions. Agroforestry systems have been the target of scientific enquiry and analysis and thus have been defined by many in different ways.

Agroforestry Defined

Bene et.al. (1977) defined agroforestry as “a sustainable management system for land that increases overall production, combines agricultural crops, tree crops and forest plants and or animals simultaneously or sequentially and applies management practices that are compatible with the cultural patterns of local population”. Several authors have attempted to define agroforestry during the past two decades. The recent definition by Leakey states that, “Agroforestry is a dynamic ecologically based, natural resource management system that through the integration of tree in farm and rangeland, diversifies and sustains small holder production for increased social, economic and environmental benefits.” Thus, agroforestry is an efficient land use system where trees /shrubs are grown with arable crops seeking positive interactions in enhancing the productivity on a sustainable basis.

Agroforestry concepts evolved during early 1976 have undergone change (Table 1). The perceptions of agroforestry at different levels have been well characterized by Pathak and Dagar and show the varieties of thoughts, by different users of agroforestry (Fig. 1).

It needs to be clearly understood that specifying the existence of spatial – temporal arrangements among the components does not help in defining the agroforestry, but its value lies in classifying agroforestry examples. Multiple cropping as opposed to multiple uses is a necessary condition to agroforestry. Production diversification is not exclusive to agroforestry and does not help in defining agroforestry. The sole existence of economical interactions among the

Table 1-Facets of Agroforestry

Type	Social Forestry			Silvipasture		Forest Fanning & Agri-silviculture				
Class	Wind break Live fences	Recreation forestry	Energy Plantation Farm forestry	2-tier growth	Multi-storcyed canopy growth and its manipulation	2-tier forest fanning with dryland crops through agri-silviculture	Agro-Silvipasture	Fruit tree groves	Farm boundaries Wind breaks	Conservation and soil improvement forestry/bio-remediation
Structure	Multiple rows of close plantation of fuel/fodder trees	Creation of public parks. zoo and sanctuaries etc.	Close plantation of fast growing short duration fuel wood trees	Planting trees and grasses together	Planting trees, grasses. legumes and shrubs with organised plant geometry	Planting trees (short rota-tion), grasses. legumes and crops (dryland)	Growth of trees along with agricultural production	Groves of fruit producing trees	Plantation of less sturdy. short rotation. fast growing legume trees	Leguminous short rotation fast growing trees for nu-trient conservation and site improvement
Placement in land use	Perpendicular to prevailing fast desiccating winds 1 . Around rural/urban habitation 2. Road sides 3. Farm sides 4. Canal banks	Wastelands or public and common lands in rural/urban areas.	Sides of roads, canals and railways Public, private and common land	Degraded uneven wastelands with broken topography Swampy moist areas	1. Dryland cropping areas. 2. Flood and drought prone areas 3. Wasteland with almost even topogra-phy 4. Watersheds of dams, farms ponds and rivers	Dryland cropping areas with impoverished skeletal soils	For 2-3 years on forest and good soil condition	1. Along canal banks 2. Rural surroundings 3. Farm margins 4. Dryland areas	1. Field margins 2. Marginal wastelands 3. Flood and drought prone areas	On poor impoversihed crop lands, ravines, crop lands with increasing salinity, water logging.
Grains	1. Much desirable environment 2. Fuel-wood 3. Forage 4. Soil & water Conservation	1. Recreation 2. Soil & water conservation 3. Preserva-tion of genetic resources	Release of cow dung for manure	Pasturage for animal, Fuel-wood. Soil& Water Conservation and management	1 . Forage year round 2. Fuel wood 3. Conserva-tion of environment	1. Forage 2. Fuel wood 3. Grains ., 4. Soil improvement	1. Timber & wood resources 2. Food crops 3. Exploitation of conserved minerals & nutirents for crop production	1 . Better environment 2. Human nutrition 3. Income through sale	1 . Forage and fuelwood 2. Better environment. and soil improvement	1. Soil improvement 2. Soil & water conservation/ drainage improvement 3. Fuelwood & forage

Farmers

Perceived as more satisfying to the needs of domestic consumption or income from sale

Large farmer : Long term investment opportunity, diversified land use, commercial tree cropping, best option for absentee and lords

Medium farmer: An oppornity for vertical expansion to optimize land productivity and diversify output to meet the domestic needs and generate income.

Small farmer : A technology for generating high income and minimizing risks in cropping enterprise, generating long term assets for domestic needs.

Landless & marginal : Aavailability of more diversified on-farm employment, wood and NWEP based small industry, rural handicrafts.

Scientists

Crop production : Threat to grain crop production due to shade, allelopathy harbouring pests and diseases / birds.

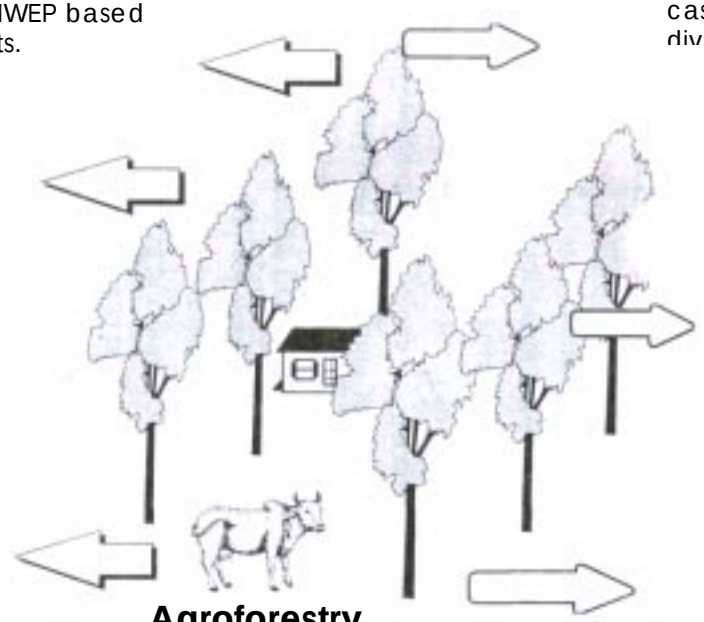
Soil : Efficient nutrient cycling, carbon sink and higher opportunity for carbon sequestration, bioremediation of polluted habitats, soil and nutrient conservation.

Ecophysiologist : efficient energy conversion, better microclimate, higher water use efficiency, opportunity for vertical integration of production functions, optimization of biomass production.

Social : opportunity for stronger social linkages, cash flow, improved living and feeding standards, diversified job/employment opportunities

Foresters

Potential line of defence against unabated depletion of forests under population pressure



Agroforestry

Ecologists & Environmentalists

A superior land use and land management system mimicking all components of a stable ecosystem combning conservation and production for sustainability

Land use Planners

A potential technology for degraded and polluted sites, an opportunity for fragile ecozones, a farming system for arid and semi-arid-zones

Planners and Donor agencies

Answer to rural needs for fuel and fooder & Market demands for wood and wood products.

Fig. 1 : Agroforestry is viewed differently by different people

components is not a sufficient condition to define agroforestry, biological interactions must be present. Similarly the term significant interactions among the components cannot be used objectively in defining agroforestry and, its use should be avoided. The presence of animal is not essential to agroforestry. Agroforestry implies management of at least one plant species for forage, an annual or perennial crop production. Once appropriate time limits are imposed on the system, time sequences involving at least two plant species with at least one woody perennial must be considered agroforestry. On the basis of this analysis, the final understanding about agroforestry is:

Agroforestry is a form of multiple cropping which satisfies three basic conditions (1) there exists at least two plant species that interact biologically, (2) at least one of the plant species is a woody perennial and (3) at least one of the plant species is managed for forage, annual or perennial crop production. Thus agroforestry is a land management system that optimises land productivity by involving positive interactions between its components in time and space where woody perennial is one of the components.

Historical Perspective

During clearing the forest for agricultural use, the trees were deliberately spared which, by the end of the growing season, provided partial canopy of new foliage to prevent the excessive exposure of the soil to the sun. Shifting cultivation in India is prehistoric and partly a response to agro-ecological conditions in the region. In about 700 B.C., man changed from a system of hunting and food gathering to food production. Horticulture as co-existent with agriculture is found to have been prevalent in India from early historic period (500 B.C. to 1st century A.D.) when a certain amount of share in garden crops started to have been enjoyed by the king for providing irrigation. Some stray references occur in different texts of the vedic literature. The cultivation of date palm, banana, pomegranate, coconut, ber, *aonla*, *bael*, lemon and many varieties of other fruits and requirement of live stock in agriculture and mixed economy of agriculture and cattle breeding may be traced in proto-history chalcolithic periods of civilization. The role of many common trees such as *Khejri* or *sami* (***Prosopis cineraria***), *aswattha (**Ficus religiosa),*** palasa (***Butea monosperma***) and *varana **(Crataeva roxburghii)*** in Indian folk life has been mentioned in ancient literature of *Rig Veda, Atharva Veda,* and other Indian scriptures. Jodha (1995) opined that traditional agroforestry systems manifest the rural people's knowledge and methods to benefit from complimentary uses of annuals and woody perennials on a sustained basis. It also indicates that the farmers have a closer association with trees than any other social group and promoters of forests.

Anecdotal Agroforestry Systems

The traditional systems/practices having diverse characteristics of agroforestry are listed in table 2. Most of these are anecdotal but in some, enough research has been carried out in the recent past.

Table 2: Some Common traditional agroforestry systems/practice

Systems/Practices	Agro-ecological adaptations
A. Agrisilvicultural systems	Woody perennials + Crops
1. Shifting cultivation	In Tropical forest areas
2. Taungya	In all regions
3. Home gardens	Mainly tropical regions
4. Plantation based cropping system	Mainly humid tropical regions
5. Scattered trees on farm lands	In all regions specially semi arid and arid regions.
6. Shelter belts and wind breaks	In wind-prone areas, all regions viz. Coastal, Arid, Alpine areas
7. Boundary plantation and live hedges	In all regions
8. Woodlots for soil conservation	In hilly areas, along sea coast and ravine lands
9. Trees on rangelands	Every where
10. Plantation crops with pastures	Mostly humid & sub-humid regions of South East Asia and South with less grazing pressure on plantation lands (Trees+crops+animals/pasture.
11. Industrial plantation with crops	Intensively cropped areas in Northern India.
B. Agro-silvo-pastoral systems	
12. Seasonal Forest Grazing	Semi arid and mountainous ecosystem
13. Acquaforestry	Low lands
14. Apiculture with trees	All through
C. Silvopastoral	
15. Silvipastures	Sub tropics and tropics with bioedaphic subclimaxes.
16. Horti-pastoral	In hilly orchards for soil conservation

Present agroforestry practices in India

The systematic research in agroforestry geared up after establishment of International Council for Research in Agroforestry (ICRAF) in 1977 (which was renamed in 1991 as the International Centre for Research in Agroforestry). In India, organised research in agroforestry was initiated during 1983 with the establishment of All India Coordinated Research Project on Agroforestry by ICAR at 20 centres and later establishment of National Research Centre for Agroforestry at Jhansi in 1988. At present 38 centres of agroforestry are working in the country.

Through ICAR centres, a Diagnosis and Design exercise for existing agroforestry practices in India has been conducted. The prominent and priority agroforestry practices in different regions are presented in tables 3. The prevalent systems and their species components are presented in tables 4, 5, 6 and 7. It is noteworthy that the system being same, species choice changes with the climate and edaphic variations.

Table 3: Prominent agroforestry systems in agroclimatic zones of India

Agro-climatic zones	Agroforestry Systems					
	Agri-silviculture	Agrihorti-silviculture	Agri-horticulture	Horti-pastoral	Silvi-pastoral	Specialised
1. Western Himalayan Region	4	4	5	4	4	-
2. Eastern Himalayan Region	5	3	5	4	3	5 jhum
3. Lower Gangetic plains Region	5	-	3	2	2	Energy
4. Middle Gangetic plains Region	4	-	2	-	-	Homestead
5. Upper gangetic plains Region	5	-	5	-	-	Agrihortisilviculture
6. Trans-gangetic plains Region	5	-	5	-	-	Agrihortisilviculture
7. Eastern Plateau & Hills Region	5	-	4	3	4	Block Plantation
8. Central Plateau and hills Region	4	-	5	4	4	Block Plantation
9. Western Plateau and hills Region	4	-	5	2	4	-
10. Southern Plateau and hills Region	5	-	3	2	4	-
11. East Coast plains and hills Region	4	5	4	2	2	Home garden/Shelter belt
12. West	4	5	4	2	2	Home-

Coast plains and Ghats Region						garden
13. Gujarat plains and hills Regions	4	2	4	3	5	Block Plantation
14. Western Dry Region	5	3	4	-	5	Shelterbelt
15. The Islands Regions	4	5	4	1	2	Home-garden

No. 1-5 indicate the priority practiced mode1= Least and 5= Highest

Table 4: **Agroforestry systems and preferred species in Western Himalayas**

Zones	**Sub montane low hills sub tropical**	**Mid-hills sub-humid**	**High hills temperate wet**	**High hills temperate dry**
Agroforestry Systems	Agri silviculture, pastoral, horti-silviculture	Horti silviculture, agrisilviculture, silvipastoral	Hortisilvicultural, silvipastoral	Horti silvicultural silvipastoral
Preferred Tree Species	Grewia optiva, Albizia chinensis, Bauhinia variegata, Celtis australis, Bamboo sp., Morus alba, Bombax ceiba, Anogeissus latifolia, Acacia catechu, Toona ciliata,	Grewia optiva, Celtis australis, Quercus leucotricophora, Bauhinia variegata, Ficus spp., Albizia chinensis, Acacia catechu, Anogeissus latifolia,	Quercus spp., Morus spp., Robinia pseudoacacia, Celtis australis, Alnus nitida, Populus spp.	Robinia pseudoacacia, Salix spp. , Alnus nitida , Populus spp, Quercus spp, Fraxinus spp.
Grasses	Saccharum munja, Eulaliopsis binata, Imperata cylindrica, Phragmites sp., Dichanthium annulatum	Apluda mutica, Themeda anathera, Chrysopogon fulvus, Heteropogon contortus, Dichanthium annulatum, Arundinella sp., Cynodon dactylon, Setaria glauca	Chrysopogon montanus, Heteropogon contortus , Cyndon dactylon, Andropogon spp., Phleum pratense, Phleum rubra, Poa pratense,	Poa alpina, Agrostis spp., Dactylis glomerata, Phleum pratense, Festuca spp.

Table 5:
Agroforestry systems and preferred species in Indo-Gangetic Plains

Zone / region	Agroforestry System	Preferred species		
		MPTS	**Fruits**	**Crops**
Punjab Lower hill zone (Kandi)	Agri-silvi	Acacia nilotica, Dalbergia sissoo, Acacia catechu, Ziziphus sp., Butea monosperma, Grewia optiva,	Ber	Pearl, millet, Sorghum, Sunflower
Alluvial zone	Agri-silvi	Anogeissus latifolia	-	Sugarcane, Wheat
	Farm boundary	Populus deltoides Eucalyptus spp	-	Rice, Wheat, Cotton, Potato
Haryana	Agri-silvi	Populus deltoides	Litchi, Mango	Rice, Wheat, Potato, Sunflower, Sugarcane
	Farm Boundary	Eucalyptus hybrid, Populus deltoides		
	Agri-horti	-	Mango, Citrus Ber	-
	Scattered trees	Prosopis cineraria, A.nilotica, A. tortilis, Dalbergia sissoo		Pearl, millet, Sorghum, Sunflower
Western U.P.	Agri-Silvi (random trees on farm)	Dalbergia sissoo, Acacia nilotica	Mango, Neem	Rice, Wheat
	Block Plantation	Populus deltoides, Eucalyptus sp.,		
	Agri-silvi		Mangifera indica, Emblica officinalis, Psidium guajava, Aegle marmelos	
	Horti-silvi	Populus deltoides Dalbergia sissoo, Albizia lebbeck, Acacia nilotica, Morus alba, Syzygium cuminii, Eucalyptus sp.		Rice, Wheat
	Farm Boundary	Poplars and Eucalyptus sp.		Rice, Wheat

Central U.P.	Agri-silvi (scattered and boundary) Farm boundary	Azadirachta indica, Dalbergia sissoo, Albizia lebbeck Acacia nilotica, Prosopis juliflora, Eucalyptus spp, Ficus religiosa, Derris indica, Acacia catechu, Madhuca latifolia, Bamboo sp.	Mangifera indica, Psidium guajava, Zizyphus mauratiana	Rice, Wheat
Eastern U.P.	Farm Boundary Agri-horti-silvi Orchards Homestead	Dalbergia sissoo, Eucalyptus sp. Dalbergia sissoo Madhuca latifolia, Dalbergia sissoo, Neem, Bamboo, Syzygium cuminii, Ficus sp.	Mango Mango, Guava Mango	Rice, Wheat Vegetables, Wheat
Bihar/ (NW districts)	Farm Boundary Shelter belt Agri-silvi Silvi-pastoral Agri-horti-silvi Silvi-agri Homestead	Dalbergia sissoo, Wendanlandia exerta (Banket) Dalbergia sissoo, Dendrocalamus strictus Dalbergia sissoo, Bombax ceiba, Tectona grandis Dalbergia sissoo, Acacia nilotica Morus alba, Terminalia arjuna Cassia fistula, Bombax ceiba Azadirachta indica, Dalbergia sissoo, Emblica	 Ziziphus jujuba Mangifera indica, Litchi chinensis, Emblica officinalis - Mango, Jackfruit, Litchi, Guava	Wheat, Gram, Rajmah, Castor Wheat, Winter maize, Kharif, Paddy Maize, fodder, Local grass Ginger, Turmeric
West Bengal	Farm boundary Homestead	Acacia nilotica, Terminalia arjuna, Azadirachta indica, Butea monosperma Azadirachta indica, Dalbergia sissoo, Leucaena leucocephala	Ziziphus mauratiana Mango, Jackfruit, Guava, Bael, Ber	Rice, Red gram, Black gram, Moong bean, Mustard, Maize, Sunhemp

Table 6:

Agroforestry systems and preferred species in arid and semi-arid areas.

Zone/ Region	Agroforestry System	Preferred Species		
		MPT's	**Fruit trees**	**Grass**
Arid	Agri-silviculture	Prosopis cineraria Tecomella undulata	Ber Date palm	Pearlmillet, Guar Til, Cowpea
	Silvipasture	Prosopis cineraria Prosopis juliflora Tecomella undulata	Ber	Cenchrus sp. Lasiurus sindicus
Semiarid	Agrisilviculture	Acacia nilotica Dalbergia sissoo Prosopis cineraria Azadirachta indica	Ber, Mango	Pearl millet Sorghum, Guar, Pigeonpea, Cowpea Til, Groundnut
	Silvipasture	Acacia nilotica Dalbergia sissoo, Prosopis cineraria		Seasonal grasses
Bundelkhand (including central plateau region)	Agri-silviculture, (boundary plantation is also included)	Butea monosperma Azadirachta indica Madhuca latifolia Albizia lebbeck Acacia leucophloea	Ber	Sorghum, Guar, Pigeonpea Cowpea
	Silvipasture	Acacia leucophloea Azadirachta indica Anogeissus pendula Butea monosperma		
	Block Plantation		Mango, Jamun	
Deccan Plateau	Agrisilviculture (includes boundary plantation)	Acacia nilotica Albizia lebbeck Acacia ferruginea		Sorghum Pigeon pea Pearl millet
	Silvipasture	Hardwickia binata Acacia leucophloea Prosopis juliflora		

Table 7:

Agroforestry systems and preferred species in tropical, humid and sub-humid zone

Regions / Zone	Agroforestry systems	Preferred species		
		MPTS	Fruit trees	Crops
Tropical High Lands	Home Gardens	Tamarind Jack fruit Drum stick	Coconut Mango	Guinea grass Para grass Tapioca Turmeric
	Farm boundary	Jack fruit Wild jack Teak Sesbania grandiflora Lawsonia inermis	Coconut	Paddy Tapioca Turmeric
Tropical Plains	Agri-silviculture	Neem Acacia nilotica Ailanthus excelsa	-	Groundnut Horse gram Cowpea Til
	Agri-Horticulture	Casuarina sp.	Sapota Mango	Groundnut Horse gram Cowpea Til
	Silvipasture	A. leucophloea A. nilotica A. planiformis	-	Cowpea Desmanthes virgatus Sorghum C. ciliaris C. setigerous
Coastal	Energy Plantation	Casuarina sp. A. planifrons Prosopis juliflora E. tereticornis	-	-
	Agri-silviculture	Casuarina sp.	-	Paddy Groundnut
	Silvipasture	A. planifrons	-	Sorghum Cenchrus sp.
	Silvi-horticulture	Casuarina sp.	Cashew	Cucurbit Bitterguard Snakeguard Pumpkin C. vulgaris
Humid, rainfall > 2500mm	Homestead	Silver oak	Coconut Arecanut	Pepper Coffee Tea Cardamum
	Silvi-Horti-Pasture	Casuarina sp.	Sapota Mandarin orange Guava Citrus Lime	Guinea grass Hybrid Napier

	Silvi-Horticulture	*Casuarina sp.*	Sapota Mandarin Orange Guava Pomegranate	-
Rainfall (1500 – 2500 mm)	Agri-silviculture	Teak *Ceiba pentendra* *Casuarina sp*	-	Paddy Cowpea Groundnut
	Homestead	Jackfruit Curry leaf *Bombax ceiba*	Coconut Mango Pome granate Guava Mandarin Orange	*Coriander* sp. Guinea grass Hybrid Napier *Amaranthus sp.*
Rainfall <1500 mm	Agri-Silviculture	*Ailanthus excelsa* *A.nilotica* *Ceiba pentendra*	-	Cowpea, blackgram, greengram, *Cajanus cajan* Groundnut Sesamum Sorghum Bajra

These systems have not been scientifically studied for detailed production attributes. Atul *et al.* (1994) studied the production potential of traditional agroforestry systems in mid hills of Himalayasin HP. They observed that fodder trees had more annual productivity of leaf and wood compared to the fruit or timber trees. Vegetable crops of Kharif season were high yielding compared to cereal crops. The crop productivity during rabi was independent of tree species.

Tree species priority in different agroclimatic zones shows that *Populus deltoides* and *Eucalyptus spp* have a higher priority due to fast growth, short cycle, adaptability and market demand. (Table 8).

Table 8 : **MPTS priority in different agroclimatic regions**

Agro-climatic Regions	Priority				
	1	2	3	4	5
1. Western Himalayan Region	*Grewia optiva*	*Populus ciliata*	*Toona ciliata*	*Casuarina australis*	*Acacia catechu, Robinia pseudoacacia*
2. Eastern Himalayan Region	*Michelia champaka*	*Alnus nepalensis*	*Gmelina arborea*	*Morus laevigata*	*Pinus kesiya*
3. Lower Gangetic plains Region	*Eucalyptus hybrid*	*Acacia auriculiformis*	*Gmelina arborea*	*Acacia nilotica*	*Azadirachta indica*
4. Middle Gangetic plains Region	*Populus deltoides*	*Anthocephalus cadamba*	*Eucalyptus* hybrid	*Dalbergia sissoo*	*Acacia nilotica Bamboo*
5. Upper gangetic plains Region	*Populus deltoides*	*Eucalyptus* hybrid	*Dalbergia sissoo*	*Anthocephalus cadamba*	*Leucaena leucocephala*

6. Trans-gangetic plains Region	*Populus deltoides*	*Eucalyptus* hybrid	*Dalbergia sissoo*	*Melia azadirach*	*Acacia nilotica*
7. Eastern Plateau & Hills Region	*Gmelina arborea*	*Tectona grandis*	*Eucalyptus* hybrid	*Casuarina equisetifolia*	*Leucaena leucocephala*
8. Central Plateau and hills Region	*Azadirachta indica*	*Eucalyptus* hybrid	*Tectona grandis*	*Acacia nilotica*	*Leucaena leucocephala, Hardwickia binata*
9. Western Plateau and hills Region	*Azadirachta indica*	*Acacia nilotica*	*Eucalyptus* hybrid	*Leucaena leucocephala*	*Tectona grandis*
10. Southern Plateau and hills Region	*Ailanthus excelsa*	*Eucalyptus camaldulensis*	*Tamarindus indica*	*Cieba pentandra*	*Casuarina equisetifolia*
11. East Coast plains and hills Region	*Casuarina equisetifolia*	*Gmelina arborea*	*Acacia mangium*	*Tectona grandis*	*Dalbergia sissoo*
12. West Coast plains and Ghats Region	*Casuarina equisetifolia*	*Eucalyptus* hybrid	*Acacia mangium*	*Terminalia tomentosa*	*Artocarpus heterophyllus* *Bamboo*
13. Gujarat plains and hills Regions	*Prosopis cineraria*	*Eucalyptus* hybrid	*Ailanthus excelsa*	*Dalbergia sissoo*	*Leucaena leucocephala*
14. Western Dry Region	*Prsopis cineraria*	*Acacia nilotica*	*Azadirachta indica*	*Ailanthus excelsa*	*Dalbergia sissoo*
15. The Islands Regions	*Casuarina equisetifolia*	*Gmelina arborea*	*Gliricidia sepium*	*Samania saman*	*Terminalia catapa*

Table 8 clearly shows that six tree species are common in most agro-climatic regions. These species are important on following counts: -

- Indigenous and highly adapted in the farming system.
- Short cycle of harvest and multi purpose nature
- Industrial value and market potential

The six species are: -

Populus deltoids	***Acacia nilotica***
Eucalyptus spp	***Bamboo spp***
E. camaldulensis	*Bambusa vulgaris*
E. citriodora	*Bambusa tulda*
E. globulus	*Bambusa nutans*
E. robusta	*Dendrocalamus.strictus*
E. tereticornis	*Prosopis cinerari*

Casurina equisetifolia

Thus it is clear that initial emphasis on these six species for large-scale adoption to increase system productivity will go a long way in supporting sustainable agriculture, meeting forest produce needs, increasing farm income through diversified agriculture and ecological security of the area.

Need For Agroforestry

During the recent past natural resource degradation has been rampant. The upcoming scenario calls for immediate action to check deforestation and land degradation. The following problems need to be addressed on priority basis: -

- Slash and burn agriculture being practiced in whole of the tropical world has been widely used in the north-eastern region and in the states of A.P. and Orissa. This practice under the demographic pressure has given way to land degradation, deforestation, decline in food production and climatic change. Excessive emission of green house gases is causing climatic change.

- Green revolution has encouraged monospecific intensive agriculture dependent upon chemicals, fertilisers, pesticides and irrigation leading to the problems of soil pollution, secondary salinity, water logging, pollution of water resources, emission of green house gases and land cover and land use change.

- Due to absence of treesin the non-forest areas, people are facing the problem of fuelwood,fodder and small timber. It is forcing them to burn animal dung and thus responsible for depletion of organic matter in soil and adding to global CO_2 pool.

Why farmers have been planting trees?

Trees as part of peasants' subsistence strategies have been historically an important component of the farming systems in several parts of India. The situations in which farmers protect, maintain and plant trees on farm lands and bunds are as under: -

- In semi-arid regions trees increase soil productivity and land sustainability through nutrient recycling and by providing mulch and shade for crops, thus complement agricultural production.

- The most widespread benefit from keeping trees on farms is the soil enriching effect of trees and protection against erosion.

- The trees also provide subsistence products, like fodder and other non-wood forest products besides meeting their needs. The surplus material can be sold fetching additional income.

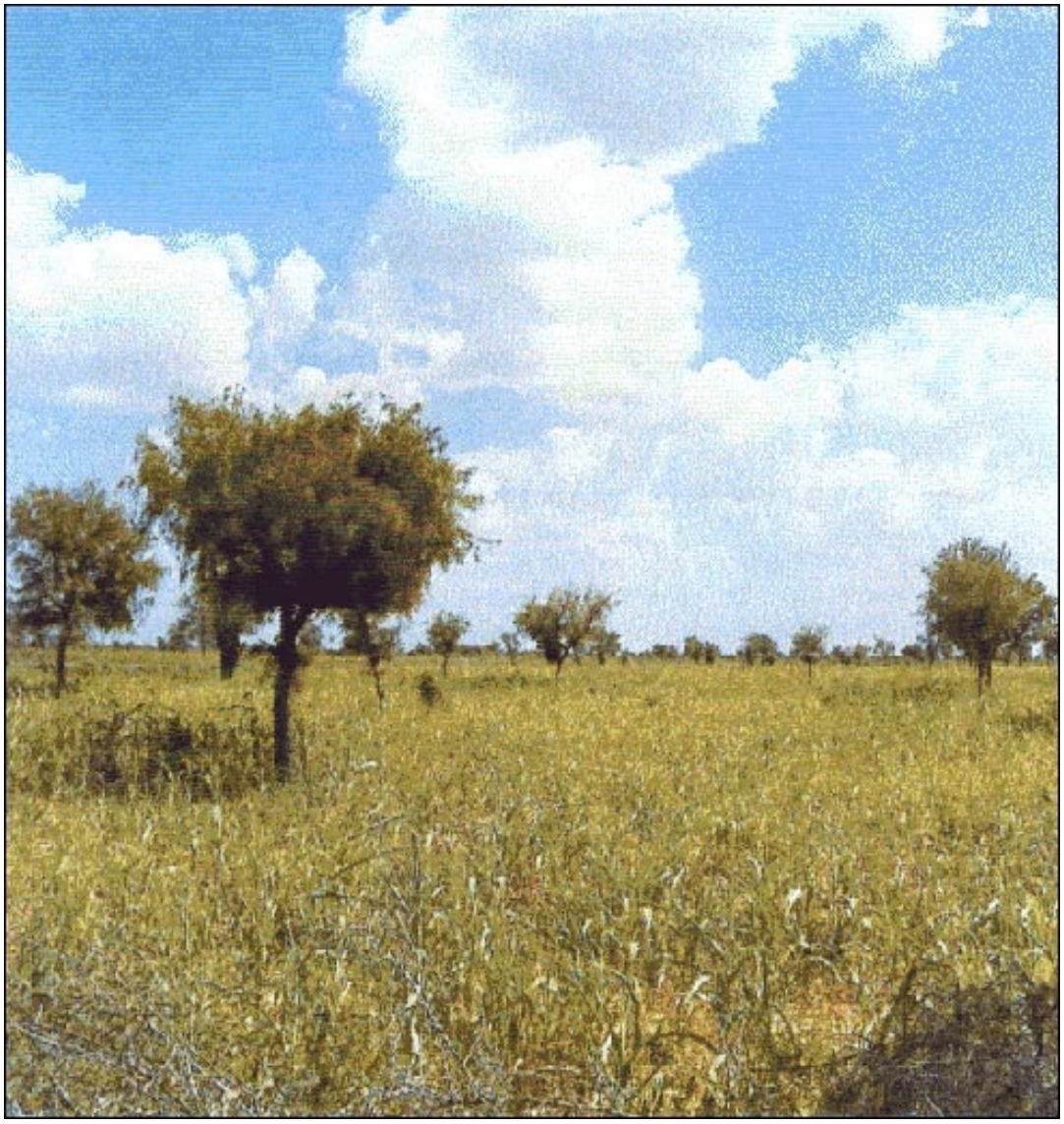
Eucalyptus species with field crop

Silivipastoral model with Acacia species

Populus species with wheat crop

Clump of Bambusa nutans

Shelterbelt plantation of Casurina species



Prosopis cineraria on farmland

- Trees are planted on farm boundaries, or inter-cropped with field crops with a view to get supplementary income from trees without much loss of the main crops.

- Homestead plantation increases overall income from land.

- Where income from agriculture is uncertain and inadequate and there is little possibility for farmer to seek work outside the village; in such conditions, even small farmers shift their lands to trees, which demand less labour and concentrate on wage labour for meeting their immediate consumption needs.

- Where trees substitute agricultural crops for increasing total profits from land.

The environmental, agro-ecological factors and socio-economic considerations determine the existence of a particular practice. In different areas with similar agroclimatic conditions, factors such as agrarian structure, population pressure, availability of labour and other production resources, production objectives, and market conditions may be the main determinants of the type and form of tree planting.

The purpose of tree plantation may be ecological and socio-economic to meet the consumption of family or cattle, or to generate cash through sale in the market. The intensity with which trees will be managed would differ in each case. Patterns of tree growing thus vary with farming system, soil capabilities, demand for tree outputs, and farmers' perception of market conditions.
Based on intensity of input application, in terms of labour, cash and management, which is applied to trees in comparison to annual crops it can be classified in three broad categories, which may also show overlaps depending upon the situation.

- Where trees are sought for soil enrichment and subsistence products, intensity of management may be low, with minimal inputs without intruding on other more desirable farm production.
- Where trees generate income, or saleable byproducts, a more intensive tree management may emerge, with crop and livestock production being partially adapted to include trees.
- Where tree crops are sought as a primary source of income, they may replace annual crops. Here tree growing may be pursued with intensive application of labour, irrigation, and fertiliser with a view to market them as any other cash crop.

Prevalent Agroforestry Illustrations

The following are important agroforestry illustrations: -

- In arid western Rajasthan, farmers protect khejri (*Prosopis cineraria*) and bordi (*Ziziphus spp.*) trees to increase soil productivity and land sustainability. These trees recycle nutrients and provide mulch and shade

for crops, and fodder for cattle, and thus complement farm production. *Prosopis cineraria* is a multi-purpose tree, providing fodder, mulch and even food (its leaves are eaten). Every part of this tree is used by the farmers. It is planted both on field boundaries and in the fields itself. Apart from improving soil fertility, the tree also binds the soil, decreases the velocity of hot summer winds, and provides shade to livestock and birds in the summer months.

- The seasonally dry tropical regions present farm households with a major problem of inter-year and intra-year variability of rainfall. Farmers adapt to this by building diversity and flexibility into their farming systems and household economies. Trees and livestock often play an important part in this. Thus in semi-arid villages of Mahendragarh (Haryana), multi-purpose trees like *Prosopis cineraria* and Kikar (*Acacia nilotica*) help in reducing risk caused by uncertain rainfall. With their access to moisture deep in the soil profile, trees can photosynthesise and produce foliage in years and seasons when annual crops fail. In drought years farmers can then fall back on livestock and artisan based activities, which require leaves, fodder and raw material obtained from them.
- In Thanjavur and Tiruchirapalli districts of Tamil Nadu, *Acacia nilotica* trees are cultivated on the rice bunds. It grows rapidly, as it is water tolerant, and benefits from fertiliser and irrigation applied to the field crops. In summer months farmers pay a nominal sum to herd owners to pen their animals in their fields. The goats eat tender shoots of *Acacia nilotica* and crop stubbles. In return, the farmer's fields are manured by the animals. Thus the traditional system involves sufficient ecological and economic interaction between the tree, crop and animal components.
- In about 100,000 ha of Coimbatore and Periar, where annual rainfall is erratic and averages only 600 mm, field is ploughed with the seeds of *Acacia leucophoea* after the first rains, and then sown with crops like horsegram or *Penniseyum glaucum*. If the rains continue favourably, the crops can be harvested as grains otherwise they are used as fodder. After about 10 years, the farmer thins out trees to about 60 to 100 per ha so as to allow sufficient sunlight to reach the understorey crops. The yield of sorghum growing under the tree is about 20 % higher than without the trees.
- *Prosopis juliflora* occurs widely on all wastelands of Tamil Nadu, but in Ramanathapuram, where rainfall is confined to the north-east monsoon, and substantial saline patches occur, it is used to reclaim fallow lands. These are allowed on farmlands for four years, after which an annual crop is taken for two years, and again *Prosopis* is allowed to invade the field. In addition, it is used for making charcoal, and it is estimated that 15,000 tonnes of charcoal is transported annually from Ramanathapuram to Chennai.
- Large cardamom (*Amomum subulatum Roxb.*) is a shade loving plant grown in the hill state of Sikkim and in Darjeeling district of West Bengal. About 30 tree species are used to provide shade to the cardamom plants, the most important being *Alnus nepalensis* (Utis), a deciduous, nitrogen fixing and fast growing tree which is also used for fuelwood and fodder. The quick decomposing leaf litter of *A. nepalensis* also fertilises the cardamom plants. The management input required for growing cardamom

is less than for rice or maize, but gives a higher return, and hence is preferred by farmers, specially those not living in the village. As cardamom plants are grown on steep slopes ranging from 35 to 81 percent, the system of growing trees also preserves soil.

- The hills of Uttaranchal are characterised by acute pressure on arable lands and a high density of human and livestock population. In addition to planting of trees on homesteads, a major practice is to protect trees which come up on terrace risers. The most common species is bhimal (*Grewia optiva*), which comes up naturally on the terrace risers and is protected by farmers. It is a multipurpose tree which yields fodder, fuel, and fibre. Leaves are also eaten. Fodder grasses and legumes are also widely grown, as farmers maintain large number of livestock. *Celtis australis* and *Morus serrata* are other farm trees in the hills (Tejwani 1988). These are raised primarily for fodder, but also provide small timber for making tools and fuelwood. As animal dung is the primary source of manure in the hills, making fodder available for cattle is an important economic activity, done by women. The average number of trees per household, between 16 and 30 is not sufficient for meeting family's requirement, forcing women to collect fodder and fuel from forests.
- *Casuarina* plantations have been a part of the rural landscape in southern coastal India for more than a century now. The best part of the tree is sold as poles or as urban fuelwood, and lops, tops and roots are consumed within the family. In addition, on coastal lands casuarina acts as a good wind break. On Orissa coasts, the fallen litter of this tree is sweeped by the landless and sold in the market as firewood and this is a source of income. Often land is ploughed and cropped for one or two seasons with leguminous crops before returning to casuarina. Thus the system involves sufficient ecological and economic tree-crop interactions.
- There are 40 million palmyrah trees in Tamil Nadu, 17.5 in Tirunelveli, 7 in Coimbatore and Periar, and 5.3 in Ramanathpuram (Jambulingam and Fernandes 1986). Usually the trees are randomly distributed on farm lands but are also planted on the bunds of paddy fields. Because of small crown, the effect of shading on understorey crops is negligible. The main product, *nera*, is obtained in the dry months of Jan-May when there is no other crop. 28,000 families are engaged in the processing of palmyrah products, which provides a good source of income when demand for farm work is low. Nera tapping starts when the tree is 14-16 years old. Daily yield from a tree is 2 to 2.5 litres. A farmer having 100 trees per ha can earn Rs 500-600 annually.
- Gamble (*Delonix elata*) is used on farm bunds or in village commons in Dharmapuri, South Arcot and North Arcot to provide green manure for rice fields. It also provides inferior fodder and is given to cattle in lean period.

In regions of high fertility and good rainfall like West Bengal and Kerala, small farmers usually maximise returns from land through multi-storeyed cropping, where perennial crops such as coconut, arecanut, rubber and pepper are inter-cropped with seasonal and annual crops like tapioca, bananas, pulses and vegetables. Trees are preferred which have multiple uses, especially yielding fruit, fodder and mulch and being suitable as supporting structures for the cultivation of pepper, betels and various climbers. This diversity also reduces

risks from pests and adverse weather, as they tend to affect different crops differently. An extension of cultivation of tall perennial crops such as coconut and arecanut, permits a judicious combination of a number of tree crops leading to better utilisation of vertical space. Thus, a multi-tier cropping system can intensify cultivation of both tree and agricultural crops.

With rising land prices and greater penetration of market processes there is a tendency in Kerala to increase commercial cultivation of cash crops, relying heavily on purchased inputs. Rather than grow trees as a complement to agriculture, the tree crops were then of shorter duration and aimed at meeting specific market demands. Other trees were being replaced with coconut, which did not provide fodder and green manure.

In village Kovilur (Tamil Nadu, India), many small farmers divert their dry lands from groundnut to cashew and Eucalyptus plantations, due to occasional failure of groundnut crop. Therefore, by planting tree crops, poor farmers were free to concentrate on improving their income through wage labour. The loss of groundnut crops did not hurt them financially as they could gain more from work outside the village. Adoption of farm forestry was therefore a search for a safe source of capital and income. Rather than produce for their subsistence needs, farmers channelled their labour to more profitable off-farm activities, while using their lands for tree crops requiring less labour and management.

In these examples, the involvement of small farmers in tree planting has been substantial. In fact, it has been argued that as farm size declines, the production objective changes from growing food to generation of income, with which small farmers buy food, and that the growth of agroforestry in many parts of the World is often a response to this change in production objectives.

The launch of farm / agro forestry programme in India

The tree planting programme in India, called farm forestry, was launched in the late 1970s to create more awareness about the benefits of tree planting. It was initially believed that farmers would plant only a few trees on homesteads or on uncultivated lands for fuelwood and fodder for their own use. However, farmers' response was quite different, both in scale and purpose of planting, from what was planned. Most trees came up on farm lands either as woodlots or on boundaries, and not on uncultivated lands. Against the original target of distribution of eight million seedlings to farmers in U.P. in the period 1979-84, actual distribution had to be stepped up to 350 million to meet farmers' demand (World Bank 1988). In Haryana, the area under trees on farms grew at a rate of 53 per cent per annum between 1975 and 1984 (NCAER 1987). In the Punjab, it was estimated that in the course of only ten years over three per cent of the net sown area had come under *Eucalyptus* (Dogra and Sandhu 1986). An evaluation of the Haryana farm forestry project showed that the problem was not in how to motivate farmers towards farm forestry, but in 'how to regulate the conversion of good agricultural lands to pure tree plantations'. As against the existing 49 million mature trees in Gujarat, in 1983-84 farmers planted 195 million trees in that state.

That is, in one year alone, farmers in Gujarat planted as many as four times the number of the total existing trees in the state.

During 1980-88 farmers in India raised about 10,550 million trees on private lands (Chambers *et al.* 1989). Independent estimates put the figure of survival around 60 per cent. A recent survey, albiet for a smaller sample, put this at 77 per cent. This is by all means an impressive achievement, and is reflected in the steep fall in the price of poles, and stabilisation in the price of fuelwood after 1985 in some regions of India.

Broad Features of Farm /Agro Forestry

Some widely known features of the farm/agro forestry programme are as under: -

- Under farm forestry, more trees were planted in commercialised and surplus producing agarian regions. The picture was radically different in subsistence oriented eastern states like Orissa, Bihar, and Madhya Pradesh where farmers remained comparatively indifferent to private tree planting, despite the fact that rainfall and soil conditions were more favourable to trees in the east rather than in the semi-arid west and north India.

- As regards the species planted, eucalypts (hybrids of *E. tereticornis*) was the most favoured tree with the farmers. Eucalypts grew straight, had a small crown, which allowed more trees to be planted per unit of area, and caused little shading when planted on field boundaries. It did not attract birds, was non-browsable, hence easy to protect, and yielded straight poles, which were perceived to have a good market. In the states of U.P., Haryana, Gujarat, and the Punjab, the percentage of eucalyptus in the total number of seedlings distributed by the Forest Department was 94, 96, 84, and 90 per cent respectively (NCAER 1987; Saxena 1991, Kapur 1990). Farm forestry in NW India meant for all purposes, planting of eucalyptus. Even when the Forest Department offered other 'fuelwood' species, farmers wanted only eucalyptus, so much so that many private nurseries sprang up during 1983-86 to meet the demand for seedlings. Therefore, whereas it is true that the department also lacked alternate choices in species, which might have had similar advantages as eucalyptus, it was the farmers' craze for the tree, which ultimately led to its over-production.
- *Eucalyptus* was planted more for sale as small timber, poles or pulpwood, than for use as fuelwood. Farmers preferred to sell the trees they grew and continued to use animal dung and agricultural residues for subsistence purposes.

Why Farm Forestry Systems became more popular?

Saxena analysed four different situations where farm forestry systems became most popular very rapidly. These include both agriculturally endowed regions and, dry and agriculturally backward areas as described below: -

1. North-west India - Greatest enthusiasm for tree planting was witnessed in the northern states of Punjab, Haryana, and western U.P., called the `green revolution' belt of India, where cultivation on good alluvial soils under assured irrigation was practiced. Here, mostly trees were planted on boundaries retaining cultivation of annual crops, but woodlot planting was attempted either by absentee landowners, or by resident large farmers on inferior soils.

The programme remained generally confined to large and medium farmers. The mid-term evaluation of the U.P. Social Forestry Project found that 'in general few small farmers had so far participated in the farm forestry scheme.' Another study of U.P. shows that farm forestry was more popular with relatively large farmers, absentee land owners including urban dwellers, and businessmen. 'Not only their orientation towards cash income was higher and their capacity to respond to new enterprises better, but also tree crops offer the advantages of ease in labour management. Market oriented farm forestry enabled the rich to save taxes on the unaccounted income from other economic activities, as incomes from forestry and agriculture are exempted from many taxes.'

2. Commercial regions - Farmers in the commercialised and cash crop growing regions of western and southern India planted trees as a woodlot substituting risky crops like groundnut or cotton. Regions where such change in land use have taken place, although on a small scale, are the productive deltas of rivers Mahanadi, Godavari, Krishna and Kaveri, and other areas of intensive irrigation development as are found in the lowlands of Gujarat, Maharashtra, and Tamil Nadu. These are also regions where labour shortages have featured after the success of the green revolution. Trees in this context appeared as a convenient landuse option to farmers as it allowed saving in labour costs and permitted greater flexibility in the timing of operations.

3. Regions close to pulp mills - Eucalyptus for sale has been grown in areas of low productivity surrounding the metropolitan town of Bangalore (Karnataka), where eucalyptus logs and poles are bought by the paper mills and construction companies. This area is predominantly semi-arid with uncertain rainfall, where eucalyptus has replaced an inferior foodgrain, ragi (Elusine). Unlike the two regions already described, the participation of small farmers in these districts in growing trees is substantial. In addition to pulp mills, a number of wood based small scale industries in Kolar are active in buying wood from farmers, which keep the prices remunerative for even small farmers.

4. Degraded lands unfit for cultivation - The last known area where farm forestry has succeeded is the semi-arid tract of West Bengal, consisting of districts Midnapur, Bankura and Purulia. These districts are agriculturally poor, land holdings are small and most of the production at farm level is to meet subsistence requirements of the farm households. The tree growing was a success because government allotted lands unsuitable for crops to the poor agricultural labourers, and encouraged them to plant trees by giving them subsidies.

Market incentives during the adoption phase

Factors, which encouraged farmers to plant trees for commercial ends viewing wood as a saleable commodity, are as follows:

Declining supply of wood - Till a few years ago, most of the commercial/industrial needs of poles, timber, and pulpwood were met from government forests. The trees from private and common lands were used to meet domestic rural demand for fuelwood, fodder and small timber. The market price was low and extraction costs were high. With deforestation, production from government forests declined over the years and was no longer sufficient to meet market demands. For instance, the recorded production of industrial wood in India in 1979-80 was 13.5 m cum, which fell to 6.44 m cum in 1984-85.

Rising prices of tree products - The decline in supplies and increase in demand in a growing economy resulted in sharp increases in prices. The all-India index of timber prices rose from 100 in 1970-71 to 946 in 1984-85, whereas the general index of wholesale prices rose from 100 to 338 during the same period (Chambers et al. 1989). In Gujarat, between 1978-83, the general price index increased to 312 (base 1970=100), but that of poles rose to 650. A U.N. report calculated that, during 1973-85, firewood prices in India at constant prices had almost doubled (UNDP 1986). An impression of widespread wood crisis was projected, which must have created hopes of further rise in wood prices.

Economic competitiveness of tree crops-- The abolition of zamindari and the success of 'green revolution' technology in several regions of India changed the nature of agriculture from a primarily subsistence oriented activity to a commercial activity, in which most inputs including labour are paid for, and a substantial part of output is produced for the market. Cropping decisions are now influenced by the perceived relative profitability of different crops, and in this changed scenario, growing of wood on farms for market appeared to farmers in many regions of India a more profitable option than annual crops.

In tune with the price trends described above, for those eucalyptus farmers who managed to get in on the market boom at an early stage, profits were outstanding, and the early adopters clearly did quite well. A FAO study (1986) quotes reports from Gujarat in which the IRR from eucalyptus on farms was calculated at 129 per cent for the first rotation, and 213 per cent for each successive coppice crop. Many businessmen and some senior government servants in the Punjab and Haryana bought degraded land with a view to use it for eucalyptus farming. Some financial companies too bought land, with a view to large-scale eucalyptus farming with capital borrowed from private individuals. During this period in India private urban capital was sought to be directly invested in rural areas through agroforestry companies.

The prices for other cash crops were particularly volatile during this period and the popular perception was that prices for wood would be far more stable than the key alternatives. In western U.P. for instance, the sugarcane price paid by sugar mills remained static at Rs 240 a tonne between 1980 and 1985,

despite the fact that the general price index rose from 212 to 315 (1970-71=100). The price paid by smaller unorganised jaggery units for sugarcane fluctuated a great deal in this period. Trees helped in saving in labour and supervision costs. In a government survey in Gujarat, where farm forestry had been extremely popular in the early 1980s, 51 per cent of farmers said that they planted eucalyptus as it was more profitable than annual crops, 35 per cent cited the increasingly uneconomical and risky nature of agriculture, and 10 per cent said they were motivated by shortage of labour (Patel 1984).

Labour constraints due to advent of intensive agricultural practices - In the agriculturally surplus producing regions, labour shortages began to feature after the onset of the green revolution. As wages increased due to increase in agricultural production, transactions costs went up. Secondly, intensive agriculture demanded equally intensive supervision, which tied farmers to the land. And finally, as productivity rose and tenants became more assertive, it became risky for absentee land-owners to outright lease out their lands. Trees in this context appeared as a convenient landuse option to farmers as it allowed saving in labour costs, permitted greater flexibility in the timing of operations, promised to improve profitability and, minimise the danger of losing control over land.

Other incentives

Incentives to promote agroforestry were provided by all the states, irrespective of agro-ecological conditions. The most prominent were as follows: -

- Subsidised seedlings
- Increase in the number of government nurseries
- Extension through motivators
- Survival incentives
- Increase in supervisory staff
- Subsidy to private nurseries

Constraints of Farm Forestry Development

During the period it was realised that the enthusiasm slowed down due lower output than expected from the plantations. This was mainly due to poor availability of non-descript variety of planting material, improper plant geometry, adverse effect on crop production and post harvest handling of the materials. While the policy constraints are discussed in the other Chapter, market imperfections were equally responsible formaking people dis-interested. In the semi-arid regions the case of mono-cropped millet and cash crops growing peninsular India is however different from fertile and humid eastern India. Tree growing here has been constrained by following factors: -

- Much of peninsular India is semi-arid, characterised by intense competition for moisture between crops and trees. Unlike *khejri* in Rajasthan's arid zone, suitable species which may have strong complementary effects between crops and trees have not been identified for the region.

- Young trees require protection from cattle, especially in the fallow season, when the village livestock is let loose to browse agricultural residues and stubbles. In Semi-arid areas villages spread over a large area in which individual fields may be far away from village huts, making protection further problematic. On the other hand, in irrigated villages a tradition is slowly emerging of herding cattle during the cropping seasons. Despite ecological necessity and the easy availability of marginal and degraded lands, protection of young seedlings is difficult in mono-cropped villages compared with irrigated villages.
- Most of India's forests are also located in areas of backward agriculture. Villages in this region of low productivity often have vast, though degraded, open access lands belonging either to forest or revenue department. Open access to public lands may vastly reduce the cost of obtaining tree goods for a gatherer, which may work to the disadvantage of a grower. Thus, the concept of trees as a free good to be obtained from public lands inhibits investment of personal labour, land and capital in tree planting.
- Lack of R&D was yet another reason for its failure. For many regions, suitable species were not researched, promising varieties/ improved planting materials were not available, planting geometry, management, crop association, etc were poorly understood. The tested models in their temporal and spatial framework were not perfected.
- Problems of land tenure were also important reason for declining interest in farm forestry.
- Poor extension facilities were also at the root of failure of farm forestry programme. The functionaries in the Social Forestry Deptt were neither properly trained for this new venture nor their mindset for extension was changed due to which the required thrust could not be maintained.

Lessons Learnt

The lessons learnt from farm forestry programme indicate that: -

- Tree planting was not persuaded in uncultivable lands but in cultivated—field and homesteads.
- Choice of alternative species for eucalyptus was not available in many areas.
- Survival rate of plants was very low due to poor quality seeds, seedlings and plantation management.
- The possibility of increasing area under tree crops could be through agroforestry.
- All wastelands, non-forest areas and degraded forest lands should be brought under silvipastoral system with suitable species for fuel and fodder production. This can be addressed through JFM.
- Ravines and sand dune areas may be treated by adopting integrated agroforestry techniques to raise the trees as well as grasses, legume and crops with emphasis on land reclamation.
- Denuded hill slopes like Eastern Himalayas, Sub tropical regions in Punjab, Haryana, H.P., J&K areas need to be planted with suitable tree species, to check further erosion.

- Coastal land afforestation through shelter belts on 8.4 million ha available in India in the form of narrow strip along the eastern and western coast of the country may increase the scope of area under this programme.
- India has extensive areas under mining leases spread over 19 states in Rajasthan, Bihar and Orissa etc. This could be brought under tree planting by reclamation of soil and proper package of practices.
- Dry, rocky and murramy areas in the peninsular India to the extent of 2.4 million ha may be planted with suitable tree species and grasses.
- Water-logged areas like swampy, marshy, saline muddy areas may be planted with trees by adopting proper drainage mechanism.
- Afforestation of land slips and land slides at Western ghats, Satpura. Vindhya ranges and Aravallis may be tried.

The following consideration should be kept in view for increasing the productivity:

- Choice of trees and their provenance suitable to that locality to be encouraged.
- Preference should be given to indigenous and fast growing species;
- Adopt correct spacing recommended to each species with reference to soil and climate;
- Crop combination in agroforestry should be selected with minimum negative interactions;
- Multi-tier system of crop combination could be practiced for effective utilisation of land as well as non-food crop production could be balanced;
- Ensure supply of quality seedlings /seeds to farmers by the agencies;
- Imparting training to farmers in crop and animal husbandry for better management of farming;

Agroforestry in subsistence regions and watershed management

The discipline of agroforestry has been ignored till recently by both Agriculture and Forest Departments of the government. Each department has a target to fulfil, and hence monocropping to the exclusion of intercropping is preferred by both the departments.

Huge targets (an afforestation target of 5 m ha during 1985-90 annually meant planting on an average 24000 trees in each village of India every year) forced the Forest Department to adopt strategies of inducing farmers to adopt high density plantations, rather than to popularise low input tree cropping which would produce more grasses and be complementary to agriculture. The technical package was accordingly designed to suit this, and seedlings which could be raised in 3 months were given priority over seedlings which require more time. As the number of permanent nurseries were not increased, institutional arrangement for the raising of MPTs requiring longer period at the nursery stage did not exist.

Links with watershed development

It is difficult to rehabilitate degraded lands without introducing moisture conservation and water harvesting measures. Such measures are needed for all rainfed areas put to biomass production. The soil conservation technology in India has so far focussed primarily on structural works for controlling and disposing of run-off rather than capturing the maximum amount of moisture in the soil and retaining it for as long as possible to support crop growth. It is better to adopt ***in-situ*** moisture conservation practices through planting of suitable grasses and trees which may also provide sufficient protection against erosion. Of late the use of khus grass and woody perennials along the contour has been a great success in rainfed plateau regions.

Fortunately, watershed approach and agroforestry research for different agro-ecological regions have gained momentum during past two decades.

One of the least understood but most useful concept is the issue of complementarities between forests and agriculture. If it is strengthened, the local community develops a stake in the preservation of forests, which can deter individual attempts at encroachments or degradation. Traditional agroforestry patterns are a reflection of farmers' own perception of complementarities between trees and crops, but the issue of complementarities between forests and agriculture is wider than that between trees and crops. To enrich this complementarity, one of the main objectives of forest management should be preservation of soil and moisture in a demonstrative fashion.

Soil and water conservation measures such as contour trenching, vegetative bunding, and small check-dams can enhance soil moisture and the accumulation of top soil, accelerating the rehabilitation of the micro-environment helping better regeneration and plant survival. The rehabilitation should first start from the upper catchment due to the following reasons:

- The landless and the poor who depend on upper slopes can benefit;
- Groundwater recharge begins at the earliest; and
- By the time the lower catchment is treated any debris and erosion running down from the upper catchment has been minimized.

Intersectoral coordination - Equally important are institutional constraints in watershed management programmes. Studies of similar other programmes show that planning, organisation and management have been issues of major concern in all projects. In particular, the impact of watershed treatments has been impaired by poor coordination between line agencies, and there has been a marked absence of land user participation in treatment planning and implementation.

Often in central India degraded land is owned by farmers, who may have large holdings, yet are poor. Therefore, incentives to large farmers in these areas are justifiable, as wasteland development results in increased net production and employment. In addition, some multi purpose tree species have huge downstream employment benefits. Additional incentives should be given for the

planting of such trees. In low productivity areas, programmes which improve productivity have better equity impact, than distributive programmes. There is another practical reason, why the rich farmers should not be ignored in land development programmes. Experience shows that programmes which involve every one in a village have a higher chance of success, than which are confined to a narrow group. Lastly, in watershed development it is mandatory to look at land as a unit of operation, and not at a class of farmers.

Conclusion

The success of agroforestry projects in India in the early 1980's combined with the fact that the 1988 Policy emphasizes planting of trees for industry on farms should have led to renewed emphasis on farm forestry. However, the new forestry projects of the 1990s have surprisingly reduced their focus on this. For instance, as against an achievement of 1,390,000 ha of farm forests established in UP in the previous projects, targets in the later project have been slashed to only 20,000 ha. The World Bank projects have concentrated attention in the on-going projects only on two issues, private production of seedlings, and removal of legal restrictions. Highly desirable as these are, not sufficient to motivate farmers to take to tree planting. Reasons why farmers gave up planting trees in commercial areas have to be understood and then corrective action taken.

The advantages in encouraging farmers to practice agroforestry on their lands are as under: -

- It saves marginal lands from further degradation and maintains or increases site productivity through nutrient recycling and soil protection.
- It increases the value of output per unit of land through spatial or inter-temporal inter cropping of trees and other species.
- By supplying raw materials (such as leaf compost) to agriculture directly and indirectly, and by producing food and forage for human and animal consumption, it complements and supplements agricultural production.
- It diversifies the range of outputs from a given area which increases self-sufficiency and reduces the risk to income from adverse climatic, biological or market impacts on particular crops.
- It spreads the needs for labour inputs more evenly seasonally, thus reducing the effects of sharp peaks and troughs in activity characteristic of tropical agriculture.
- The technology is simple, labour intensive, and requires little outside technical or financial support.
- Trees have many useful characteristics as `assets' for the poor - low investment cost, rapid appreciation, divisibility, flexible harvesting time, etc. - and are available to meet unforeseen contingencies.
- If there are strong and growing markets for tree products, a market oriented approach could enhance substantially the incomes of the poor farmers too.
- It can be taken up as a part-time activity by households and does not require a change in the occupation of the landholder.
- It promotes value-added activities in rural India, as several communities have traditionally been involved in supplementing their incomes through processing tree products.

- The program of tree growing does not invite hostility from the rural rich, which is inherent in land reforms and other distributive programs.
- Last, but not the least, as rural women are involved in meeting daily survival needs of their households by collection of forest produce, decline in the country's natural vegetation has directly affected the rural poor women. An increase in fuelwood and fodder production through multipurpose trees on their own farm and leased lands will certainly reduce drudgery and save their labour for other productive occupations.

Based on what has been discussed above following recommendations for promoting agroforestry / farm forestry, separately for the two agrarian regions in India are proposed: -

Commercial regions: In regions where agricultural surplus is produced and which are familiar with markets commercial agroforestry should be practised. About 10 m ha out of 46 m ha irrigated land in the country are facing the problem of waterlogging, soil erosion and salinisation. Agricultural production is stagnant and soil and water pollution due to excessive of chemicals in production is rampant. To circumvent these problems, adoption of agroforestry is crucial in this region. The following strategy should be adopted for development of commercial agroforestry in this region: -

- Emphasis on selection of elite clones of six selected species.
- Research on harvesting, seasoning, sawing, preservation, processing and new product development.
- Establish perfect marketing infrastructure and ensure support price through strong linkage between farmer and industry.
- It should also initiate schemes for linking farmers with industries, in ways similar to the linking of poplar growing farmers with WIMCO in north India. Similar tie-up with farmers is being tried by the ITC-run Bhadrachalam Paper Mills in Andhra Pradesh. The industry produces improved seeds, grows the seedlings in their nurseries, and gives them to the farmers for planting. Farmers get crop loans from the banks, and extension service from the industry. This example shows that improved planting material can improve productivity from 7 to 25 cu m/ha/year. A minimum price is guaranteed to the farmers by the industry, although farmers are free to sell their produce to any one they like.
- Improvement in R & D and application could result in production of thicker logs suitable for sawing. New uses of wood could be promoted such as utilizing wood for power generation through gasifiers.

Subsistence regions: There is no certainty of agricultural production in rainfed region. Due to poor vegetation and tree cover and farms lying vacant for long period during the year, wind erosion is common. Desertification is a serious threat to arid areas devoid of vegetative cover. Practising agriculture is uneconomic and migration from these regions to cities and other developed areas for want of employment further neglects the region. For holistic and integrated development of rainfed areas,it is crucial to adopt agroforestry. ‘Food For Work’ scheme for implementation of agroforestry in wastelands, commonlands, cultivable and uncultivable lands will improve food accessibility and ecology and economy of thr

area. It is proposed to adopt agroforestry in 18 m ha out of total 96 m ha rainfed reas in the country. Bamboo and medicinal plants which are hardy and suitable to this region should be given priority for additional income besides meeting basic needs of people.

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CHAPTER-III

JOINT FOREST MANAGEMENT (JFM)

Introduction

Poverty of the people, pace of degradation and loss of productivity form a vicious circle, which leads to decline in forest resources. This affects life-sustaining capacities of individuals, families and communities. The forest management systems developed and followed over a hundred years were rendered ineffective in the post independence era due to commercial over-exploitation and other anthropogenic activities.

To protect the forests and environment and meet people's needs it is obvious that Government policy and programmes need to be reoriented towards sustainable patterns of development (a philosophy now globally accepted).

The thrust area should be to prevent continuing degradation of the forests and to reduce demand and supply imbalances by increasing productivity of forests. Antagonistic relationships between the people and the resource managers needs to be reset on a new sound footing of sustainable human development in which villagers are associated with Government functionaries as a partner to uplift the socio-economic and environmental milieu of a particular area. Otherwise the degradation of the forest would continue in absence of adequate protection based on people's involvement or Participatory Forest Management.

In this context we must understand grass-root reality, as advocated by Mahatama Gandhi in following words: -

"Indian economy should be built from the bottom by a posterior method of securing rock bottom facts and drawing therefrom, by the most rigid process of reasoning, scientific conclusions which no amount of juggling could controvert".

For tribal development, there is a need to facilitate devolution of greater authority, minimising conflicts and to support new partnership among communities, government and private sector to ensure forest conservation and its sustainable use. Clarifying forest user's rights and responsibility and evolving adaptive policies and programmes are essential for successful implementation of JFM.

The philosophy of Joint Forest Management (JFM) is a development alternative wedded with socio-economic realities in a multiple cultural and ethnic set up to embark on a path of prosperity and productivity through the judicious use of limited natural resources on a sustainable basis. Its success depends on the endeavours of every collaborator more so on the part of already organised setup. It

is now widely accepted that rural people living in an around forest must be brought into the management process in order to ensure that forest protection activities succeed. This strategy involves participatory planning, encompassing participatory objective setting, to link conservation and development, strengthening of local institutional structures, management agreement, monitoring and review.

Forest Policies

In conventional forest management, man is seldom if ever recognised as a component of forest ecosystem except to the extent this impinges on the forests, which in forestry parlance is termed as biotic interferences. This had to be minimised if not altogether eliminated to keep the forest out of the harm's way. Forest management tended to ignore human factor. The basic contradiction in the policy adopted earlier was not being adequately responsive to the needs of communities living in and outside the forest areas, while its primary objective was the welfare of the people who essentially depended on forests, for their existence. Whether are not Forest Department could have moulded the policy to make it more responsive to community needs may be a matter of controversy, but the fact remains that something should have been done towards this direction much earlier. The state of economy of the forest-dweller depends in a major way on the health of the forests and they can be easily made to perceive this. National Forest Policy, 1988 however has not kept this matter vague. It laid emphasis on natural regeneration, preserving biodiversity and adopting management practices that help the local people.

To translate this basic policy the Government of India, Ministry of Environment & Forests issued an enabling Joint Forest Management (JFM) Resolution on 1st June 1990 for involvement of village community living close to the forest, in the protection of forest and development of degraded forest land. The policy resolution is placed at **Annexure-IV**. It also prescribed uses of benefit to participatory communities to meet their demands of forest produce and active participation in afforestation programmes. It paved the way for voluntary agency and non-governmental organization to be associated as an interface between the State Forest Departments and the Forest User Groups (FUG) for the revival, restoration and development of degraded forest.

The highlights of 1990 Resolution by Ministry of Environment & Forest, are summarized as below: -

- Developing partnership: between communities and Forest Departments, facilitated by Non-Governmental Organisations;
- Access and benefits: only to organized communities undertaking regeneration, with equal opportunity based on willing participation;
- Right to usufruct: all non-wood forest products and percentage share of final tree harvest to communities, subject to successful protection and compliance of conditions approved by the State;

- 10 years Working Scheme: micro-plans detailing forest management institutional and technical operations to be developed by community management organizations with local foresters and NGOs;
- Funding: From Forest Department programmes with encouragement to communities to seek funds from other agencies.

However, the outcome of the programme was largely influenced due to the following constraints.

- Attitude and ethos of the forest bureaucracy;
- Lack of understanding of Socio-economic and cultural value system of the locals;
- Gender issues and womens' representation;
- Inter-and Intra-village conflicts;
- Lack of statutory authority to local institutions;
- Inadequacy in meaningful people's participation;
- Coverage of only degraded forests under JFM;
- Donor-driven rather than need-driven programme;
- Target-oriented rather than people-oriented programme; and
- Sustainability (of productivity and consumption).

Subsequently in 1995, the 1990 Resolution was slightly modified to incorporate women and landless households as well as usufruct by the committee. It has been further revised on February 21, 2000 (enclosed as **Annexure-V).** The circular, inter alia, contemplates:

- Legal backup to the JFM committees,
- 50% members of the General Body should be women and
- Extension of JFM in good forests areas also with sharper focus on activities concerning NTFP management.

Progress of JFM as on April 30, 2001

Following the Government of India's June 1, 1990 guidelines to the state governments for involving local communities in the protection and development of the degraded forests, the JFM programme has now been widely adopted and appropriate Government instruments have been set up by the respective State Governments. As per information received from the various State Governments, as on 30.4.2001, there are 44,943 JFM committees managing 11,629,538.62 ha. of forests under the JFM programme in 26 states of the country as per table 1.

Table 1**: Extent of Joint Forest Management Programme (As on 1.1.2000)**

S.No.	State	No. of JFM Committees	Area under JFM (ha.)	Source
1	Andhra Pradesh	6706	16,79,084.00	SFD*
2	Arunachal Pradesh	13	5,810.00	SFD
3	Assam	101	3,060.00	SFD
4 &5	Bihar & Jharkhand	1675	935,065.50	SFD
6	Gujarat	1150	133,460.50	SFD
7	Himachal Pradesh	203	62,000.00	SFD
8	Haryana	351	60,744.42	SFD
9	Jammu & Kashmir	1599	79,273.00	SFD
10	Karnataka	1212	12,800.00	SFD
11	Kerala	21	4,000.00	SFD
12	Madhya Pradesh	9203	41,25,837.00	SFD
13	Maharashtra	502	94,727.99	SFD
14	Manipur	35	1,400.00	
15	Mizoram	129	12,740.00	SFD
16	Nagaland	55	627.00	SFD
17	Orissa	3704	4,19,306.00	SFD
18	Punjab	89	38,991.42	SFD
19	Rajasthan	2705	235,634.00	SFD
20	Sikkim	98	2,191.00	SFD
21	Tamil Nadu	799	224,389.00	SFD
22	Tripura	160	23,476.79	SFD
23	Uttar Pradesh	498	44,278.00	SFD
24	West Bengal	3545	4,88,095.00	SFD
25	Uttaranchal	7435	6,06,608.00	SFD
26	Chhatisgarh	2955	23,35,940.00	SFD
	Total	44,493	11,629,538.62	

* State Forest Department

Sustainability of JFM programme

Sustainability of JFM initiatives is being viewed as a matter of concern as also a challenge because sustainability can be assured only when there is genuine involvement of the community at each level. At present, the communities are performing their roles of protection of forest effectively. However, their roles in management, decision-making, access to information, etc. need to be further strengthened. The foundation for participatory management of forests has been laid. It is time to consolidate and build upon these initiatives so that the long-term security and development of forest can be ensured.

Studies have shown that the outcome of this institutional arrangement will, in general, be positive if: -

- The institution is rooted in the society's value system and developed with long-term objectives in view;
- It is supported by appropriate legal and policy environment;
- The technology, the institution and the environment are mutually harmonised;
- Common resources are left to the community, while simultaneously strengthening the institutions of local self-government; and
- Keeping the distributive effects in view, the less well-off sections of society are cushioned from the operation of market forces.

Specifically, an institution such as JFM is likely to succeed if, in addition to the general requirements just outlined, certain specific conditions are ensured, such as:

- Suitable forest patches are entrusted to well-defined user groups with stake in their management;
- Security of tenure as well as of long-term access to the benefits from the resources are assured to them;
- Stakeholders are also given a voice in the decision-making regarding the resources, and thus an incentive to accept limitations on individual rights as collective wealth-enhancing;
- Satisfaction of local needs and participation of all affected individuals/families are ensured, along with a built-in mechanism for conflict resolution;
- Adequate resources to sustain the programme over time are ensured; and
- A well-designed marketing strategy for the surplus forest produce is established.

Institutional Development

Institutional Development aims to improve the management of the sector through changing the approach of the forestry personnel from a predominantly regulatory role to one in which communities are treated as partners in the management of forest resources; increasing policy analysis capabilities; and improving the management skills of senior staff, supported by the introduction of improved management systems, for planning, implementation, monitoring and evaluation procedures, together with improved management information and geographical information systems.

Switching over from control to support system of management, treating forests as a part of the resources of the communities, modernisation of its nurseries, plantation and seed technology; promoting biodiversity conservation through eco-development and introduction of information technology as a management tool are some of the major initiatives. The training is to be done in the form of field workshops, and customised courses delivered by local, regional and national level institutions.

Human Resource Development

Keeping in mind the changing scenario in the Forest Department, it is of utmost importance that the department successfully re-orients itself of the needs of the ever-changing environment and this would primarily depend on the capabilities and attitudes of the staff of the Department. In that sense, the HRD efforts would prove to be the cutting edge. Obviously, no organisation can implement major policy, attitudinal and technological changes without the wholesale orientation and training of its staff and communities.

Most staff members may be trained in more than one subject which range from courses in basic computer application and advanced MIS and GIS applications, watershed management, soil and water conservation techniques and modern nursery and plantation techniques, to Participatory Rural Appraisal (PRA) and so on. The personnel to be trained include the senior-most and the junior-most functionaries as well as members of the communities and NGOs.

It was realised that merely by organising training programmes it would not be possible to bring about changes at a desired speed on sustained basis. This requires a systematic introduction of Human Resource Management and Development processes in organisations to help in harnessing human energies and potential for personnel development and organizational effectiveness. A meaningful HRD effort requires looking at the issues of Human Resources in an integrated manner right from the stage of recruitment to retirement and even beyond. Human Resource Development can play a pivotal role in the continuous and sustained development of the Department because ultimately the ability of the Department to reorient itself to the needs of every changing environment would largely depend on the capabilities and attitudes of the staff of the Department.

Successful JFM depends on a good relationship between the Forest Department and local communities so that they can work together to meet common objectives. This in turn requires new skills of analysis and understanding, with more of emphasis on listening and learning than traditional roles. Human resource development is required to bring following changes:

- Orientation and attitudinal changes for forestry;
- Motivation and sensitization of members of community (forest dwellers);
- Training through local NGOs: training of women and marginalised groups about JFM concept and participatory management;
- Skill training to artisans; and
- Other training such as carpentry, medicinal plants collection, marketing etc.

Organisational Development

A constant 'in house' thinking is essential for organistional development, which at present is lacking in most of the government departments. To overcome this and to work for systematic transformation of the system, a JFM wing should be established in each state under the charge of a senior officer. This wing should also act as an information dissemination centre for extension activities and link up technological upgradation of management regime for better productivity and multiple returns from forests.

JFM programme would succeed provided it adopts following approaches:-

- Each area is developed based on the concept of the enterprise system to achieve economic, environmental and social objectives in a properly balanced manner.
- JFM committees posses necessary administrative, managerial, professional and financial freedom.
- Such committees are autonomous, innovative, accountable, transparent and flexible to meet the ever changing situations and are result oriented.
- Processing and marketing of forest produce is ensured.
- Cultivation of bamboos medicinal plants and Multipurpose Tree species get priority.
- Programme is launched in mission mode to ensure success.
- 'Food for work' scheme is linked to JFM to ensure accessibility of food to forest dwellers.

Monitoring of JFM

Monitoring of JFM is important from the point of view of its successful implementation. Before deciding specific methods for monitoring, it is important to identify key issues, which shall provide basis for the monitoring. Such issues may include: -

- Sustainable forest management;
- Process responsiveness;
- Environmental factors;
- Economic viability;
- Institutional development;
- Micro-plan formulation and implementation;
- Working of mission mode programme.

The choice of appropriate method is critically important not only for the success of monitoring exercise, but also for the future of JFM. The method must be suitably tuned to its objectives and relevant issues. As there are a large number of complex issues and JFM is being implemented in areas with heterogeneous situations, there could be various methods. Any method for monitoring shall

consume resources. Giving due importance to optimization of resources, monitoring and stage of development of JFM, following three methods may be used broadly for monitoring of JFM in the country:

- Comprehensive Monitoring
- Mid-term Monitoring
- Six-Monthly In-House Monitoring

The JFM programme should be monitored and coordinated at the state and district levels. The state level monitoring should be done by a State Level working group to be headed by the State Forest Minister with representatives from the Departments of SC & ST, Welfare, Rural Development, Agriculture, Horticulture, Soil Conservation, Animal Husbandry, Minor irrigation, Small Scale Industries, etc. The state level working group will also review the implementation of the micro plans and ensure tie-up for funding the same. At the divisional level, the working group should be headed by the concerned Conservator of Forests, who is also the chairman of the Forest Development Agency. A representative of local NGO should also be involved at the divisional level. A standard format for monitoring at the division/district and state level should be evolved. The JFM Network set by the Ministry of Environment and Forests should hold regular interactions with this group. Green India Authority should commission studies through independent agencies for evaluation of JFM programme in different states.

The micro-plan shall be prepared as per the 21st February 2000 guidelines issued by the MoEF jointly by the JFM committee and the concerned forest official(s). It will be a comprehensive document and shall cover activities, inter alia, aiming at sustainable management of not only the forests but also all land and water based resource management activities. The micro-plan once approved shall be placed before the District Level Coordination Committee (DLCC), Zila Panchayat or Forest Development Agency (FDA) for mobilization of financial resources. Each state will formulate a coprehensive JFM project for assistance under RIDF of NABARD.

Future Strategy

During the last ten years, JFM programme has been started but it is yet to be adopted all over the country. The area covered under JFM programme and the number of JFM Committees have increased manifold during the last 10 years. However, success of the programme mainly depends upon the continued commitment on the part of all the stakeholders. It has been observed that people are more responsive in areas where there is scarcity of the biomass resource and where rural developmental activities have been linked with the JFM programme. As a vehicle of Rural Development, JFM programme in future hold key to forest regeneration and coservation of biodiversity. To deal with this, the Government of India had recently advised the states to constitute Forest Development Agencies (FDA) on the lines of DRDAs. This will link up the JFM with the rural development

activities and would institutionalise the participation of the people in the resource management. This will not only ensure flow of funds to the JFM institutions on a regular basis but would also cater to their other livelihood needs specially asset creation and employment generation.

In order to mobilise financial resources attempts should be made to tap the external funding from multilateral and bilateral agencies. International Fund for Agricultural Development (IFAD) has the mandate to cater to the developmental needs of the poor and therefore would be willing to support the programme. IFAD has the experience of funding the tribal development projects in India, which included the natural resource management as a livelihood enhancement programme for the poor. Another multilateral funding agency would be the Asian Development Bank (ADB), which may consider their involvement in the programme as a part of their livelihood resource enhancement for poverty alleviation, which is one of their focus areas. Bilateral funding from various known sources, which are supporting natural resource management and development programmes in the country, can also be lined up. The activities should be focused on development of land-based resources for raising medicinal plants, agro-forestry and other similar income generation activities.

Afforestation pool fund available with NAEB needs to be merged with the proposed Green India Fund with an initial grant of Rs.500 crore from the Government of India. This fund can be expanded by tapping other internal and external sources. Tax-free bonds can also be floated to mobilise resources for this fund. Exemption from income tax for donation for this fund can also be considered. NABARD model of funding for JFM in Andhra Pradesh needs to be extended to other states. For mobilisation of resources the major states like Madhya Pradesh, Uttar Pradesh, Andhra Pradesh, Orissa, Rajasthan, Maharashtra and Tamil Nadu need to prepare projects individually. For smaller states of Northeast, umbrella projects can be prepared. Greening India Authority will have to maintain a “Shelf of Projects” to be posed to donors for their support.

Transparency in JFM on the pattern adopted by Andhra Pradesh is crucial (details as per **Annexure-VI**). The question of equity especially sharing of benefits should be made transparent. The various resolutions of the states are still ambiguous on this. These should be clear by earmarking a certain percentage of the net sale proceeds as share to the JFM Committees.

Management of JFM Forest

To meet the goals of JFM programme, the forests to be managed must be carefully identified and suitable management regimes evolved. In a given area over a period of time, the management prescriptions of JFM would be different for different types of forests. For example, the degraded forests will have to be treated by preparing a comprehensive microplan which should give equal weightage to silvicultural and livelihood needs of the people. For good forest areas in the same

locality, the JFM programme would on the other hand aim at sustainable management of non-timber forests products. The existing silvicultural practices will, therefore, need to be modified to meet these management objectives. Coverage wise also, the JFM need to be focussed to the areas close to village boundaries. Other common lands, panchayat lands and even private wastelands should also be covered under the JFM approach through integrated land development programme. Department of Land Resources should survey and identify wastelands available in the country so that a well-planned afforestation programme is launched through JFM/Tree Grower Cooperatives etc.

The Government forests to be earmarked for JFM should be surveyed, mapped and classified as JFM forests. These forests should have a separate set of rules and working schemes. The Working Plan Committee's recommendations also be kept in mind to make JFM a part of Divisional Working Plan. Keeping this into consideration, the 15 million ha of degraded forests having root stock and available within the village boundaries should be brought under this category. Forest areas beyond the radius of 5 to 6 km from the village boundaries are not suitable for JFM. It is physically not possible to manage them under the JFM. Such forests should therefore, be sustainably managed under scientifically prepared working plans. The management options for such forests should have a vision for meeting the global, national and regional goals. This requires investments in superior technology and intensive management regimes at par with best managed forests in the world.

Research Needs

The success of Joint Forest Management would not only depend upon the extent of people's participation, but the management regime and technology adopted. The ICFRE and its Institutes would have to work on the following aspects to provide new silvicultural and management options for the JFM forests: -

(1) **Socio-economic Aspect:** A socio-economic profile of villages & forest resources including the bio-diversity need to be evolved to prepare socio-economic indices for the management. This should also include the level of dependency on forests and existing level of benefits being enjoyed by the people and its co-relation with the carrying capacity of the forests. Special efforts should be made to document the traditional knowledge on the flora and fauna. Research projects on various social aspect of JFM may be sponsored to the Institutions engaged in social sciences.

(2) **Technological Aspect:** Improvements in soil and water management and biodiversity will be one of the important functions of the Joint Forest Management Committees. Specific techniques of water harvesting, recharging the acquifers, soil and land improvement coupled with increase in the productivity, biodiversity assessment and enhancement would need to be developed. A combination of short and medium rotation and coppice system needs to be evolved for a variety of species being planted under JFM. Special efforts should be made to evolve

necessary clonal propagation and planting techniques of shrubs and herbs and other NTFP yielding species. As the focus of management in future would be on NTFP, research work on the sustainable regeneration and non-destructive harvesting must be carried out. At present, very little is known about this. To answer these questions a location specific approach would have to be developed and inter-disciplinary team of scientists, economists, sociologist and ecologist should be constituted to undertake the research work through suitable local level research institutions.

(3) **Processing of Timber & NTFP and Marketing Mechanism:** Many of the secondary species would be produced under JFM and very little is known about their wood properties and use of these species. Moreover, sawing of timber and other wood working technology like ammonia fumigation, seasoning, preservation techniques etc. developed so far by the ICFRE need to be further developed for these species also. This should be done with proper extension linkages for better value addition of such products. The storage and processing technology of most of the NTFPs has been neglected by the forestry researches so far. This trend is required to be reversed and site & product specific technologies are needed for better return from NTFPs.

The focus of JFM would be on sustainable management of Non-Timber Forest Products (NTFPs) and this will also be the main source of earning for the beneficiaries. One of the important responsibilities of the JFM Wing in the Forest department should be to develop harvesting and marketing linkages with the consumer industries. This will also ensure local storage and improvements in processing. The M.P. Government has recently passed "The Madhya Pradesh Laghu Van Upaj (Gram Sabha Ko Swamitwa Ka Sandan) Vidheyak, 1999". This Bill endows the ownership rights of Minor Forest Produce to the Gram Sabha. It would be appropriate if the Government of India prepares a uniform bill for the whole country.

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CHAPTER- IV

RESEARCH AND TECHNOLOGY DEVELOPMENT

In this chapter, aspects pertaining to research and technology development in the area of agroforestry and plantations in degraded areas are discussed. Traditionally, a number of agroforestry systems are in practice in different eco-regions of India. The combination of *bajra* and *khejri* in arid regions, combination of *Alnus nepalensis* and large cardamom in northeastern hills, home gardens of Kerala are common examples. The climatic and soil variations, small size of holdings and high population (livestock and human) are identified as the major constraints in agriculrural and agroforestry research and development. In order to meet the diverse requirements, optimisation of land productivity on sustainable basis coupled with environmental amelioration, investment in research and technology development is considered vital.

The research initiative on multi purpose trees (MPTS) and their incorporation in farming systems with a focus on soil conservation was started in early sixties. Indian Council of Agriculture Research (ICAR) institutes viz., Central Arid Zone Research Institute (CAZRI) Jodhpur, Indian Grassland & Fodder Research Institute (IGFRI) Jhansi and Central Soil and Water Conservation Research and Training Institute (CSWCRTI), Dehra Dun were pionners in this field. Subsequently, other research institutes of ICAR, State Agricultural Universities (SAUs) have taken up such programmes, generating useful information. Presently, in addition to the above ICAR is running an All India Co-ordinated Research Project on Agroforestry (AICRP) at 38 centres across the country. A separate ICAR research organisation National Research Centre for Agroforestry (NRCAF) is also working on these aspects.

Similarly, tree improvement work in India began around early sixties at various state forest institutes under the forest department. The various institutes under Indian Council of Forestry Research and Education (ICFRE) have geared themselves to bring about tree improvement by developing Seed Production Areas (SPAs), Seedling Seed Orchards (SSOs), Clonal Seed Orchards (CSOs), vegetative propogation techniques and mass multiplication approaches using recent technologies. ICFRE has also developed a good biotechnology group at its institutes. Research on tissue culture of trees was initiated in late 1970s with emphasis on teak and eucalyptus for which protocols were developed. These institutes have taken up a number of species for mass multiplication through tissue culture. The approach is to develop strategies for production of planting stock of good quality in adequate numbers.

However, research knowledge is advanced most rapidly through better understanding of selected basic social, biological, and physical processes and their interactions. The study of existing operational systems in use by farmers is the first key to understanding the interactions basic to agroforestry. The development and

implementation of agroforestry research programs requires leadership and organization. These are the essential characteristics of good management, which includes leading and organizing program development, implementing studies, and synthesizing results into information that is useful to clients.

The critical issue for the successful model is matching of tree and crop species. Tree species should be selected based on management objectives, site conditions, biological properties, cultivation techniques, adaptability of the species to sites, relationship between trees and crops, their economic value and markets, and adaptability by local farmers (Pathak and Roy 1992).

The success of any model depends upon rhizosphere ecology, particularly rhizosphere microbial community. It is well established that each plant species harbour specific rhizospheric communities and there are marked strainal differentiations in response to host plant root exudates. Further, the roots produce a variety of chemicals that act as soil conditioners. Inoculation of trees and crop species with their specific rhizospheric microbial consortia would result in sustainable management of agroforestry and other plantations in degraded areas..

Technological Aspects

The success of agroforestry and plantations will depend on application of the followiung technologies: -

- Identification and development of suitable technology package for production of quality planting material for propagation of identified species.
- Development of adaptable management prescriptions for planting, maintenance, harvesting, processing and trade.
- Promotion of scientific and technologies research on protection, use of bio-fertilizer, adoption of IPM system.
- Extension technology for promoting public awareness, education and training on various aspects.
- Identification of institutes in the country for carrying out research on various aspects. During the deliberations of the Task Force the nodal Institutes for each of the species in the country have been identified as under: -

S.No.	Name of Species	Nodal Agency
i)	*Acacia nilotica*	NRCAF, Jhansi
ii)	*Bamboo species viz.,* *Bambusa vulgaris* *Bambusa tulda* *Dendrocalamus strictus*	TFRI, Jabalpur & IMRF Jorhat
iii)	*Casuarina equisetifolia*	IFGTB, Coimbatore
iv)	*Eucalyptus species* *E. citriodora* *E. globulus* *E. robusta* *E. tereticornis*	IWST, Bangalore TNAU, Coimbatore KFRI, Peechi FRI, Dehradun
v)	*Populus deltoides*	GBPUAT, Pantnagar/ FRI, Dehradun
vi)	*Prosopis cineraria*	AFRI, Jodhpur

Technologies for Production of Superior Quality Planting Material

The planting material such as seeds, seedlings, clones, hybrids, improved cultivars/varieties available are generally of poor quality. Their average survival rate is not more than 60%. There is a need for systematic and time bound action for raising planting stock with adequate Research and Development (R and D). It is suggested that the nodal agencies should ensure that only the elite clones identified should be propagated. In addition to the new technologies like Tissue Culture, the conventional propagation methods should also be adopted. For establishment of the plants in the field, latest technologies and management practices related to use of Integrated Nutrient Management (INM) and Integrated Pest Management (IPM) should be adopted.

Supply of Superior Quality Planting Material

The following thrust areas are identified for ameliorating supplies of superior quality planting material: -

- Identification of superior phenotypes/genotypes and collection of their germplasm.
- Vegetative and seed route production of planting material.
- Tissue Culture.
- Improved nursery practices including bio-fertilization, disease and pest management.
- Safe transport and distribution of seedling.

Clonal Technology

Seed grown seedlings generally result in low productivity. Advanced management systems coupled with superior technology inputs are required for increasing the productivity. On the technological side, cloning of superior genotypes is a viable option. By cloning, large number of "superior" trees can be obtained at considerably lower cost and short space and time. The development of clonal varieties of the potentially useful tree species would provide many opportunities in terms of genetic gain, growth rate, timber quality and resistance to pests and diseases, etc. Clonal propagation, a sustainable technological intervention for improving productivity of plantations, has been developed for several tree species. The technology involves selection of superior plants and their clonal propagation for raising quality plantations. Clonal propagation has several advantages, such as large-scale multiplication, uniformity of plants and higher yields. Under rainfed conditions, productivity of Eucalyptus hybrid clones is 20-40 cu m/ha/year as against 5-6 cu m/ha/year from seed sources.

Out of the six tree species identified for commercial agroforestry and plantations technologies have already been developed for mass cloning of *Acacia nilotica, Dendrocalamus strictus, Casuarina equisetifolia, Eucalyptus* hybrid, *Populus deltoides*, and *Prosopis cineraria*.

Use of Bio-fertilisers

Through a concerted R and D effort it has been well established that mycorrhiza play an important role in the establishment of the recalcitrant tree species in the soil. A technology package for the mass propagation of VAM fungi has already been developed through the support of DBT. The biofertilizer has been tested on a number of crops including the tree species identified. This technology has already been transferred to industries for commercial production.

Biopesticides Application

Biopesticide technology is being largely used under the IPM programme for control of pests and disease of economically important plants. With the efforts of a number of groups under the programmes supported by DBT, 10 Candidate Biopesticide formulations have been developed and successfully demonstrated in the farmers' field. These have been mainly on crop plants. The efficacy of a baculovirus based technology has been tested for the management of a forest tree insect pest - Teak defoliator. The different formulations have not yet been tested on the species selected under the study. However, some of the existing formulations could be tried in the demonstration plots.

Biotechnology and Planting Stock Improvement

Currently, annual growth rate in forestry in India is as low as 0.5-0.7 cu.m. per ha per year compared to global average of 3 cu m per ha per annum. However, it has been shown that the application of appropriate technology can raise growth rates to significantly higher levels. ICFRE is aiming to increase tree productivity from 0.7 cu m to 2.5 cu m. In order to attain this, planting stock improvement programme is very important. Also, the growing concern for environmental issues will restrict plantation forestry in future to limited areas. Under such compelling conditions the choice of proper genetic material becomes crucial.

About one and a half billion trees are planted annually in India but records indicate that survival is sporadic and often poor by international standards. There are many reasons for low survival rates. Major ones pertain to poor quality of seed, due to the lack of properly identified seed sources, and inadequate seed harvesting and cleaning procedures. Bio-technology/Vegetative propagation is important in forest tree establishment, but is constrained by the lack of properly selected parent trees. The massive quality seedling production is further limitation.

Plant tissue culture offers enormous potential for multiplying large quantities of elite planting material. The technology is an adjunct to the conventional method of propagation. The Department of Biotechnology has also setup pilot scale tissue culture facilities for mass cloning. The protocols have been developed for all specified species proposed under agroforestry and plantations.

The traditional propagation practices are not adequate to meet the increased demand of bamboo propagules. The ICFRE has developed a protocol using tissue culture technology for large scale rapid multiplication of bamboo viz., *Dendrocalamus strictus, Bambusa bambos, Dendrocalamus membranaceous* and *Dendrocalamus asper*. The technology developed can produce thousands of plants from a small plant segment in short time. The protocols developed are highly reproducible and tested for last five years. These protocols represent fastest multiplication cycles (15-20 folds in 3 weeks *D. asper*) ever reported in tissue culture system.

Biodiesel: A Potential Diesel Blending Component

Background

Environmental factors are becoming the main driving force for better fuels and quest for alternatives. Two or three per cent oxygen present in diesel fuel has been seen to reduce particulate emissions by 15 to 20%. Vegetable oil mono-esters (biodiesel) contain about 11% oxygen and virtually no sulphur or aromatics. It also has a high cetane, usually above 50. Therefore, biodiesel, by acting as oxygen containing fuel components, provides substantial reduction in the particulates and

carbon monoxide emissions from diesel engines. A strong interest is, therefore, being seen on the use of biodiesel as diesel engine fuel and diesel fuel extender.

Biofuel is a new motor fuel that is beginning to emerge on the international scene in the wake of passage of the Clean Air Act amendments of 1990 and the energy policy act of 1992.

World Capacity And Production Of Biodiesel

A total of 85 production plants are in operation all oveer the world. These include over 30 small capacity plants in the range of 500-3000 tonnes and several big scale industrial plants in the capacity range of 10,000-1,20,000 tonnes. About 44 plants are in operation in Western Europe with Italy being the leading country with 11 plants, whereas 29 plants are in operationin Easterrn Europe with Czechia leading with 16 plants. North America has 8 plants and 4 plants are in operation in rest part of the world.

Over all capacity has grown from 1,11,000 tonnes in 1991 to 12,86,000 tonnes in 1997 and about 13,66,000 tonnes in 1998 worldwide. Western Europe until 1997. The strongest increase of capacity development in 1997 and 1998 is in the USA. Additional capacity is expected to be installed in the near future in Japan and in the leading palm oil countries like Malaysia and Indonesia.

Biodiesel is commercially available in the world market. Oil from rapeseed is the raw material of choice and is leading with a share of over 80% (USA and France). Other raw materials used are palm oil (Malaysia), linseed oil, olive oil (Spain), cottonseed oil (Greece). *Jatropha curcas* oil (Nicaragua), beef tallow (Ireland), used frying oil (Australia) other waste oil and fats (USA).

Current Status

Use of plant and vegetable oils as a source of energy appears promising as these bio-oils come under renewable sources. For a seed oil to be classified as a potential candidate, it should not only be non-edible and under exploited but should also be available in quantities substantial enough to meet a sizable percentage of the current diesel fuel requirement of the country. The seed bearing plant should also have a wide range of adaptability to variety of climate & soil; preferably waste lands, with low gestation period. One of the plants which qualifies the above requirements in *Jatropha curcas Linn* belonging to the *Euphorbiaceae* family.

Jatpropha curcas

Jatropha is a large genus of herbs, shrubs and trees distributed in the tropical and subtropical parts of the world, chiefly in Africa and America. About nine species have been recorded in India. *Jatropha curcas* is a large shrub, 3 to 4 meters high, occurring almost throughout India in a semi-wild condition. It is well adapted to arid

and semi-arid conditions, has low fertilizer and moisture demand and can come up on stony, gravelly or shallow and even calcareous soils. It can be conveniently propagated from seeds as well as branch cuttings. It starts yielfing seed in irrigated conditions in the first year and in rainfed conditions in second year and come to full fruition in fifth year and has a long productive period of around 30 years. Seed yields of 1000 and 3000 kg per hectare are expected in the fifth year under rainfed and irrigated conditions respectively. The oil content is 25-30% in the seed and 50 to 60 % in the Kernel. *Jatropha* oil cake is rich in proteins (35%) but is reported to contain some toxic constitutents. The cake, containing 4.44% of nitrogen, 2.09% of phosphorous and 1.68% of potassium, has potential as a rich organic fertilizer. The leaves and bark and *Jatropha curcas* yields a dark blue dye which is reported to be used for colouring cloth, fishing nets and lines.

Because of its excellent drought resistance the plant is suitable for preventing soil erosion and shifting of sand dunes. It makes an ideal choice for ecological as well as economic development of wastelands in the tropical and sub-tropical regions. Because of the prospects of curcas oil availability in sizeable quantities and multiple uses to which other parts of this plant can be put to, systematic studies on cultivation and management, selection and multiplication of elite germplasm practices, seed/oil potential, oil extraction technology, development of the oil/modified oil as diesel fuel and detoxification of the meal/cake are some of the aspects which need to be looked into.

Species Details

The six species identified for agroforestry and plantations are described as under: -

1. *Acacia nilotica*

Acacia nilotica is a very important fast growing, multipurpose tree species suitable for semi-arid to arid climates. This is a fast growing tree under favourable condition. It grows about 2-3cm in diameter each year. The wood is a very popular fuel on the Indian subcontinent and large quantities are consumed as firewood and charcoal. It has also been used extensively to fuel locomotive and river steamers and it powers the boilers of some small industries as well. The calorific value of sapwood is a 4,800 kcal, while that of heartwood is 4,950 kcal per kg. The wood is heavy (specific gravity. 0.67-0.68) and trees coppice occasionally.

Acacia nilotica sub sp *indica* is widely distributed in Punjab, Harayana, Uttar Pradesh, Gujarat, Madhya Pradesh and Maharastra. Performance of sub sp *indica* is very good in these states and seed production is very high in Punjab, Harayana and Maharashtra. Some good sites have been identified in Punjab, Harayana, and Maharashtra for high seed production. No systematic studies done at national level in different states to identify exact location for high and quality seed production area to be done.

Acacia nilotica sub sp *cupressiformis* has narrow and erect crown, which has cypress like appearance. This subsp has been popular in agroforestry and farm forestry plantation. The subsp has been widely planted on farmlands in the states of Uttar Pradesh, Harayana, Rajasthan, Maharashtra, Madhya Pradesh and Gujarat. Some good sites should be selected for quality seed production in these states.

Natural reproduction

Natural reproduction is through seed and seedling coppice. The animals feeding on pods disperse the seeds, which germinate during the monsoon months. Adequate light conditions, weed competition, soil conditions and moisture availability determine good establishment since excessive moisture supply causes damping off and, vice versa, prolonged drought following germination kills the seedlings. Soil aeration and drainage are important factors since impeded drainage and compacted soil do not provide a favourable site for germination and regeneration. Seedlings require protection from browsing animals in the initial stages. Wild animals such as deer, antelopes and hare, damage regeneration, therefore, such areas need to be fenced effectively.

Artificial propagation

Direct sowing: Though direct sowing is common, the results are not very encouraging, due to browsing, weed competitions and inadequate soil moisture. This may be done by broadcasting (seed rate 2.5-3.0 kg per /ha), dibbling in lines, patches or mounds in June (seed rate 1.0 kg/ha). Plantations can be raised by direct sowing or by seedlings raised in containers but the former is more common. Naked root seedlings give poor survival since the long taproot may be damaged during planting, as root pruning is not considered beneficial.

Planting of container raised plants: Pretreatment of seed before sowing softens the hard seed coat and thus facilitates good germination. Seed soaking in cooled boiled water for 24 hours and for 48 hours in cold water is recommended, however, prolonged immersion does not reduce germination capacity. Normally, it takes 1-2 weeks for the seeds to start germination while seed treatment with gamma radiation is recorded to reduce germination and subsequent growth of seedlings. Two or three treated seeds are sown in each polythene bag, about 1.5 cm deep in February-March, 3-5 months before transplanting. Excessive watering is avoided in the first month; shading is necessary to prevent surface drying. Planting pits are 30-50 cm^3 spacing 3m x 3m or 4m x 4m. When planted on bunds or field boundaries, linear spacing is 5-10 m. it is also a common method for planting along roadside strips, for which one-year old seedling are used.

Technology for Planting Material/Seedling Production

For plantation on wastelands direct sowing is done in patches dug 20 cm deep at a spacing of 3m x 3m or half filled pits (50m x 30cm deep) prepared during

March-April and winter, respectively. During the onset of rains the pit is half filled with soil and sowing is done on the slopping soil. The unfilled part of the pit provides soil moisture to the germinating seeds. About 10 -12 seeds per pit or patch are used, The seed rate being 1 kg per ha germination is completed within a fortnight, showing 60 - 70% germination. Two seedlings in the first year and one in each of the two subsequent years recommended. Seedlings are thinned out at the time of weeding to a distance that keeps their height apart. Sowing on mounds and ridges is followed in waterlogged situations and flood plains of rivers. Ridges about 2.5 cm high are prepared 5m apart with provision for proper drainage. Pre-flood sowing or sowing after flood subsides is recommended. On ravines and hill slopes trenches are dug to catch the rainwater. Depth of trench and type of filling affects seedling establishment. The type of filling is considered more important than the depth of the trenches since with increase in water storage capacity, seedling mortality increases though the height and collar diameter of the surviving plants increase. The seedbeds at flush or below the ground level are better than seedbeds above the ground level. A 60 cm deep trench has been found better than 45 cm or 75 cm depth. A double trench system provides maximum water availability. Adoption of an 8m long, 60 cm wide and 60cm deep trench with a double trench system is recommended. These contour trenches are made well in advance monsoon rains and spaced 2 m from end to end and 5 m along the slope. Sowing is done in July in a single row at a spacing of about 5cm and about 2.5 – 3 kg seeds sown per ha.

Biofertilizer Association

Dual inoculation with *Glomus mossae* and *Rhizobium* at 30,60,90 ppm phosphorus increases growth and nodulation of *A.nilotica* compared with single inoculation with *Rhizobium.* Similarly, nitrogen fertilizer also increases growth of seedlings upto 10 g per poly bag.

Research Needs

- International cooperation for exchange of germplasm.
- Identification of elite tree and promising provenances based on multilocation trails of provenances and plus tree progenies.
- Establishment of seed orchards in various localities for supply of quality seeds.
- Standardization of nursery techniques for mass multiplication of elite trees.
- Identification of promising *Acacia nilotica* based agroforestry systems.
- Development of suitable cheap and economic technique to establish this species in wasteland and degraded lands.
- Conserve plant biodiversity available in *A. nilotica.*
- Mode of pollination and reproductive biology should be studied.

2. Bamboo

Bamboo is a group of fast growing woody perennial grasses represented by 23 genera and 125 species in India. It grows abundantly almost all over India, except in Kashmir valley, represented by 23 genera and 125 species. Several exotic bamboos also grow very well in many part of India. Bamboo constitutes 12.8 per cent of the total forest area. The total annual production of bamboo is estimated to be 4.5 million tons, second only to China. Bamboo forms rich belt of vegetation in well drained parts of tropical and subtropical habitats and rise up to 3700m of altitude in the Himalayas. About 50 percent of the bamboo produced in India grows in north–eastern region and West Bengal. Area of natural distribution of bamboo in the country is given in the following Table 1: -

Table 1
Distribution of Bamboo in India

S.No.	State/Region	Area %	Growing Stock %
1	North-East	28.0	66
2	Madhya Pradesh	20.3	12
3	Maharashtra	9.9	5
4	Orissa	8.7	7
5	Andhra Pradesh	7.4	2
6	Karnataka	5.5	3
7	Others	20.2	5

Out of 23 genera that grow in India, the principal bamboo genera are: *Arundinacia, Bambusa, Chimonobombusa, Dendrocalamus, Dinochloa, Gigantochloa, Indocalamus, Oclandra, Oxytenanthera, Phyllostachys, Pleioblatsus, Pseudoxytenanthera, Schizostachyum, Semiarunadinara, Sinobambusa,* etc. Of all the genera mentioned the genus *Bambusa* is the widely distributed in India. It occurs wild or cultivated in plains and low hills from the Himalayan region to southern tip. The next widely available genus is *Dendrocalamus*, which occurs in south and central India and the dry hills of North India, as well as in Northeastern states. ***Bambusa, Oxytenanthera*** and ***Dinochloa*** are widely distributed in the Andaman and Nicobar Islands. Genera like *Arundinacia, Indocalamus, Oxytenanthera, Schrizostachyum* and *Melocanna* also grow well in Western Ghats and North- eastern region. The availability of some important bamboo species in India are given in the following Table 2: -

Table 2

Distribution of Some Important Bamboo Species in India

Species	Availability % Growing Stock	States
D. strictus	45	Meghalaya, Manipur, Nagaland, Orissa
M.baccifera	20	Assam, Manipur, Meghalaya, Mizoram, Tripura
B. arundinacia	13	Nagaland, Karnataka, Orissa
D. hamitonii	7	Arunachal Pradesh, Assam, Nagaland
B. tulda	5	Arunachal Pradesh, Nagaland, Tripura
B. pallida	4	Arunachal Pradesh, Nagaland, Tripura
Rest	6	

Propagation Techniques

The following methods are used worldwide for propagation of bamboo.

Method	Countries
Offset, Rhizome	India, Bangladesh, Sri Lanka
Culm Cutting, Split culm cutting	India, Philippines, Thailand, Sri Lanka
Marcotting, Ground layering	Bangladesh, Philippines
Branch Cutting, Pre-rooted and Pre-rhizomed Branch cutting	Bangladesh, Philippines
Micro-propagation	India, China, Thailand

Offset, Rhizome: Basically offsets consist of rhizome, root and a portion of the culm. Usually 2-3 culm nodes are kept and rest of the culm discarded. Offsets are extracted from 1.5-2 year. Old culms and directly planted in the field at the beginning of the rainy season. The cut surface of the culm is sealed by paint/polythene/cowdung to prevent desiccation and fungal attack. However, the number of offsets that can be extracted from a clump is limited; which may be 5-10 depending on the size of the clump. The other method is the rhizome planting where the whole culm portion is discarded and only the rhizome with roots is planted. The success percent is less than that of the offset method.

Culm Cutting, Split Culm Cutting: Culm segments extracted from 1-2 year old culms, having a single node or more than one node are planted in the nursery beds to develop whole plants. Usually two noded cuttings are prefered as they can be suitably treated with rooting hormones. The season of planting and rooting media are very important. Cuttings are taken just before or during the time when growth begins in the clump. This varies from place to place i.e. Feb-May. The rooting media should be porous. Root initiation can take place even in coarse sand, however, a mixture of soil, sand and farmyard manure (FYM) is preferred as the media has to

support the plant upto six months, when the rhizome development takes place. The plants become field worthy only when they have all the three parts viz. Shoot, root and rhizome.

Marcotting, Ground Layering: Marcotting otherwise called 'air layering' involves bending a 1-year old culm by making a undercut at its base. The branches at the nodes are pruned to about 2.5 cm in such a way that the dormant buds are not injured. A mixture of garden soil, moss and leaf mould is placed around each node and then wrapped with a polythene strip or coconut fibres, tied at both the ends.

On the other hand ground layering involves bending the culm to the ground and covering the whole culm with soil. After initiation of shoots and roots from nodes, they are severed from the culm and placed in the nursery bed for rhizome development. April and May are considered to be the best period for layering.

Branch Cutting/ Pre-rooted and pre-rhizomed Branch Cutting: Branch cuttings with 2-3 nodes and the rhizomatous swelling are extracted in April-May from 1-2 year old healthy culms and the secondary branches pruned to about 2.5 cm length. The cuttings are vertically planted on the raised beds in nursery or in big size polythene bags containing soil mixture. The cut end is sealed with paraffin wax or cowdung to prevent desiccation. Overhead shade is provided till root initiation occurs. Watering is done twice a day, in the morning and afternoon.

Micro-propagation: Micro-propagation of *B. vulgaris* is yet to be perfected. Through axillary branching and using single mode segments from mature clumps as the explants; upto 70 per cent bud break was achieved on MS medium fortified with BAP and Kinetin. Multiplication is best achieved on MS medium supplemented with BAP and Kinetin.

Planting and Harvesting

Application of different doses of fertilizers does not adversely affect the quality of bamboo, strength of bamboo and specific gravity of bamboo. The bamboo can be harvested 4-5 years after its' planting if it is planted by using rhizomes. If the bamboo is planted by using seedlings then minimum 8-10 years are required for getting the harvestable bamboo. Once the bamboo is ready for harvesting, then every year one can harvest 6-10 bamboos from each culm depending upon the management practices followed. The bamboo gives yield upto 30-40 years as per the species planted. Secondly, if the bamboo is planted by using the rhizomes then that new plantation will come to the flowering on the same day when that original culm will flower.

Promising Clones

Clonally Propagated Cuttings (CPC) of *D. strictus, B. tulda* and *B. vulgaris* also besides those of *B. nutans* are available to meet out requirement of planting stock of bamboo.

Bambusa. nutans and *B. vulgaris* from three sources viz. Bastar, Sidhi and Sarguja have been found most suitable by the Tropical Forest Research Institute (ICFRE). For providing the material initial funding will be required to develop tissue culture facilities and for further multiplication through macro-proliferation of rhizomes and maintenance of planting stock.

Research Needs

- A large marshy area is lying vacant along the creeks and sea shores of the Arabian sea and the Bay of Bengal. At present no suitable bamboo genotype is available for the cultivation under such situations. Therefore, the research work for the selection of bamboo species suitable for khar land/ coatal lands needs to be undertaken.
- The research on mass multiplication of quality planting material of bamboo is necessary. The massive programme for raising planting material is necessary.
- The flowering and seed setting is observed in most of the bamboo species after 30 to 40 years. The seed remains viable for very short period. It is necessary to make research and develop the techniques to maintain the viability of seeds and some technique for inducing early flowering and seed setting which could facilitate mass multiplication needs to be developed.
- The information on use of biofertilizers in bamboo are scattered. It is almost necessary to develop the bamboo based agroforestry systems, which will facilitate to raise the area as well as production of this valuable timber plant.
- In most parts of country, different species of bamboo are available. It is necessary to develop the bamboo based agroforestry systems based on species available in a particular area, which will facilitate to raise the area as well as production of this valuable timber plant.
- There are many uses of bamboos. Many products and articles are prepared from bamboo. It is necessary to arrange for the training programmes regarding the use of bamboo for development of small-scale industries.
- Bamboo cultivation needs to be brought under Employment Guarantee Scheme (EGS), followed in the state of Maharashtra. The necessary research needs to be undertaken on this aspect.
- The research work for selection of plus culms for quality pulp, early and every year flowering, good height and diameter needs to be undertaken as also biomass production from unit piece of land.
- The research work to study the pulp quality needs to be undertaken.
- Research work on different pests of bamboo needs to be undertaken.
- Development of bamboo composite and laminates.

3. Casuarina equisetifolia

It is a large evergreen tree with a straight stem and numerous long slender, drooping jointed 6-8 angled leafless branchlets arising from rough woody branches.

The jointed branchlets, which are partly deciduous, are green and perform the functions of leaves. Leaves are minute, scale like and arranged in the form of an exfoliating in longitudinal strips. Wood is very hard, liable to crack and split; used sometimes for poles and rafters, but chiefly for fuel. In general appearance, the Casuarina resembles a feathery conifer. Under favourable conditions, it attains a height of 32 m or more.

Casurina is a suitable tree for agroforestry and JFM due to multipurpose nature as well as its nitrogen fixing ability. There are more than 86 species of Casuarina and most of them are grown in Australia as well as in pacific islands. It is indigenous to sandy shores and dunes along the coast of Chittagong, Malayan peninsula, Pacific islands and Northern Australia. Casuarina is fast growing, drought resistant tree with desirable stem, crown and branch characteristics for agroforestry. It is also planted as shade trees in coffee plantation and provide large quantities of mulch which would reduce moisture loss, suppress weeds, improve soil structure and cation exchange capacity and increase nitrogen level. Crown is long and thin and, therefore, can withstand wind of high velocity. The foliage consists of modified branchlets termed as cladodes and leaves are reduced to small scales. As a result, the interception of light by the crown is minimised and the water loss by transpiration is also considerably reduced. While Casurina is the ideal species for coastal areas, its environmental compatibility and efficiency in arresting moving sands, tolerating saline situations and salt laden winds and meeting people's demands as an agroforestry species has been unequivocally established. Though Casuarina grows under varied conditions of soils and climate, the species prefers tropical humid climate where the mean annual temperature is 28°C and rainfall 3100mm to 600mm. It grows well in soils of coastal sand, river alluvium, sandy loam, red loam and hard laterite.

Development of the method of rooting cladode segments of *Casuarina* by ICFRE has cleared all the previous hurdles in the way of mass clonal propagation. ICFRE has established a Casuarina network for implementation of Casuarina improvement works. A sizeable number of clones have been identified, cloned and assembled in clonal banks. Seed Production Areas, Clonal / Seedling Seed Orchards and Vegetative Multiplication Gardens have been established by ICFRE for the State Forest Departments which can generate sufficient material to meet the quality planting material requirements of agroforestry sector. However, there is a need to establish closer links between ICFRE and user agencies for skill upgrading and capacity building of the latter and to actually produce the quality planting material in requisite numbers. The network needs more generous funding.

Promising Planting materials

As far as *C. equisetifolia* is concerned, it is an introduced species from Australia mainly for fuel-wood, charcoal and scaffoldings. Many of them have developed into land races in parts of Orissa, Andhra Pradesh and Tamil Nadu. There are over 200 clonal material maintained as germplasm in IFGTB. A large

number of seed accessions from different parts of the country as well as different parts of the world are maintained as seedling seed orchard under the control of IFGTB, Coimbatore the provenances from Egypt, Kenya, Papua New Guinea, Philippines, Vietnam, Thailand, Malaysia are being assessed. In the strict genetic sense, elite plant material are yet to be developed as elite refers to provenances, progeny tested with high level of GCA and high level of productivity with dominant quantitative traits. Practically such material is unknown in *Casuarina*.

Propagation techniques for True Type Performance

Propagation practiced in general is through seed route as well as clonal technology. As *C. equisetifolia* is dioecious. it is easy to manipulate them genetically. Clonal propagation is done using stem/cladode cuttings which can be made to root to the extent of 90 per cent if juvenile and 60 per cent if mature and the performance is true to type, provided the propagated material is planted under similar edaphic and climatic conditions, changes in either or both factors may adversely influence the growth. However, highly reliable and dependable propagation methods both through seed and clonal material are available. Technology for producing suitable planting material as well as seedling material is perfectly developed. It is possible to develop root trainer and containerised nurseries and large-scale nurseries and nursery practices are perfected in IFGTB.

Biofertilizer Association

Casuarina has *frankia* association and it is well investigated. Being a nitrogen fixing species belonging to non-leguminous group, it improves soil nitrogen and the roots develop a strong association with different mycorrhize. Large volume of literature is available. It may be mentioned that for developing clonal or seed raised plants, comprehensive potting mixture with a combination of biofertilizers has been developed in IFGTB, Coimbatore and are performing very well. The technology has been transferred to farmers.

Available Research Infrastructure

Lab facilities for seed testing, seed propagation, clonal propagation facility to produce nearly 25000 to 50000 plants per annum exist. Nursery technology, pest and disease management in nurseries, pest and disease management in post planting approaches have all been completed. Infrastructure and equipment are also available for advanced areas like embryogenesis and for quality seedling production.

Management

This varies from soil to soil and plant to plant as well as in terms of practices. In coastal area, it is planted at 1m x 1m and harvested in the 4^{th} or 5^{th} year whereas in inland it is done at 2mx2 m and harvested in 6^{th} year. Ploughing before planting and providing water every 15 days in dry months is critical for success. There are

many private nurseries in and around Cuddalorem, Tamil Nadu, which actually provide 60 per cent of the planting materials for the country. If quality seeds can be ensured to these nurseries, the productivity will jump. Other techniques such as pruning in 2nd and 3rd year and providing water in drought season are important. In Agroforestry systems, it responds maximally due to-adequate ploughing and fertilization provided to the crop. Most importantly it does not seriously affect the growth of agricultural crops and require very little attention.

Promising Clones

The assumption is that annual planting target for Casuarina alone in the coastal region, mainly on Eastern Coast, is 50,000 ha/yr. It will include the planting operation of forest department as well as agroforestry by farmers. Therefore, the total requirement comes out to be 50,000 x 3,000 = 15,00,00,000 or 15 crores of plants. Ten percent of this will be consisting of clones and 90 per cent from seeds.

It is possible to produce such a quantum of planting stock provided various agencies are charged with the work and adequate advance is provided with a minimum of six months to one year of forward planning. The agencies that can take up this work on a large scale are Andhra Pradesh Forest Department where almost all the clones of the country are assembled which includes IFGTB, ITC, Tamil Nadu and Andhra Pradesh clones as they are a member of the Casuarina network. They have a collection o216 clones from the various places in the coastal region of Andhra Pradesh, Tamil Nadu in collaboration with the IFGTB. The best clones suited for coastal regions are:

S.No.	Clone No.	S.No.	Clone No.
1	CP-0401	16	APKKKK-6
2	CP-1501	17	APKKKK-10
3	CP-1101	18	APKKKK-11
4	CP-0302	19	APKKKK-12
5	CH-0304	20	APVSYM-4
6	CP-0108	21	APVSYM-6
7	CH-2303	22	APSKSK-1
8	CH-2602	23	APSKS-2
9	CP-0203	24	APVZVZ-1
10	CP-0110	25	APVZVZ-3
11	CH-0905	26	APVZVZ-8
12	CH-3702	27	APVZVZ-9
13	CP-3501	28	APVZVZ-10
14	APKKKK-1	29	APKKKK-20
15	APKKKK-5		

These clones can be planted preferably in Agroforestry systems or in block plantations in the coastal areas. With regard to production from seeds there are a number of, villages in Tamil Nadu in and around Cuddalore and Chidambaram

namely Aalappakkam, Aandikuzhi, Nochikdadu, Naduthittu, Devanampatnam etc. where the villagers grow several lakhs of seedlings of Casuarina on contract basis. They may be provided the quality seeds to the extent of atleast 30-50 per cent from seed orchards of Casuarina from Andhra Pradesh and Tamil Nadu. They may be asked to get the work done through an appropriate organization and supply the seedlings. Several lakhs of Casuarina seedlings can be transported as naked seedlings to long distances. Therefore, the Casuarina planting has to be organised on a massive scale.

Research needs

- Assess the growth rate of provenances and clones with reference to bole, branch and biomass.
- Develop methods for fingerprinting of clones, provenances and hybrids.
- Develop comprehensive regeneration techniques for introduction of salinity tolerance using molecular biology/genetic engineering.
- Develop method for suppression/prevention of flowering in clonal material to enable them to develop vegetative growth.
- Advantageously utilize the capability of cuttings to flower so that quality seeds can be produced on a large scale.
- Develop Casuarina tree-crop interaction in agroforestry systems to optimise the yield of both tree and the crop.
- Provide improved technologies to different farmers and implement the same through different NGOs.
- Develop a comprehensive programme to domesticate the species.

4. Eucalyptus spp

Eucalyptus are evergreen woody plants. There is a great contrast between the morphology of adult and juvenile leaves. The inflorescence, a cyme consists of minute flowers. Its chromosome number is 2n –22. Adaptability is a prized quality possessed by Eucalyptus. It can survive in adverse climatic conditions. The major use of Eucalyptus is for wood fibre and cellulose paper production. *Eucalyptus tereticornis* is widely planted in India in almost all the states.

Availability of Quality Planting Material

ICFRE, through its national-level network of Institutes has developed guidelines for establishment of Seed Production Areas, Seedling Seed Orchards, Clonal Seed Orchards, selection and evaluation of superior clones, clonal propagation under ex-vitro and in-vitro conditions and establishment of mist chambers/vegetative multiplication gardens etc. Infact, it has provided consultancy to Andhra Pradesh Forest Department Corporation Ltd., Hyderabad for the mass production of superior planting material of Eucalyptus including establishment of propagation facilities which is a perfect success story of transfer of technology. It has

proven that the best way of transfer of these technologies is the establishment of close cooperation through such bilateral arrangements. ICFRE, State Forest Departments and several universities have already identified numerous Candidate Plus Tree of Eucalyptus, which, if used under a coordinated tree improvement project, with ICFRE as the nodal Implementing Agency will lead to fulfilment of the superior quality seed/planting material requirement of the entire country. The fact is that the technologies are available and the necessary spadework for creating facilities in the field to a large extent has also been completed. But the actual capacity building in the user agencies is needed to turn the wheel of these technologies.

Germplasm

To conserve germplasm aiming at conserving broad spectrum of variability and to act as reservoir for present and future needs different species of Eucalyptus are being conserved either at FRI, Dehra Dun and or at IFGTB, Coimbatore. This could mean conserving genes with wider adoptions to environmental extremes those responsible for special traits e.g. morphological superiority, grain structure and texture of timber, disease tolerance capability, different types of wood density etc. Vegetative propagation of the selected material in germplasm bank, vegetative multiplication garden, maintenance of germplasm through tissue culture and preservation of seed can preserve such material in a particular climatic condition.

At FRI Dehra Dun, the germplasm of following species of Eucalyptus is being maintained:

E. alba	*E. kirtoniana*	*E. punchtata*
E. citroidora	*E. maculata*	*E. racimosa*
E. camaldulensis	*E. microcarys*	*E. robusta*
E. gamphocephala	*E. minata*	*E. saligna*
E. grandis	*E. naudiana*	*E. sidroxylon*
E. gummifera	*E. paniculata*	*E. tereticornis*
E. intermedia	*E. platyphylla*	*E. torelliana*

In addition to FRI, Dehradun; IFGTB, Coimbatore is maintaining a large collection of Eucalyptus clones which are morphologically superior and supposed to be faster in growth rate in the form of Vegetative Multiplication Garderns (VMG). FRI has contributed in collection of approximately 70 Australian *Eucalyptus tereticornis* (plus a few of *E. camaldulensis*) and arranged planting them at 6 different locations in India viz. Raipur (M.P.), Baruipur (W.B.), Ludhiana (Punjab), Hissar (Haryana), Bhubneshwar (Orissa) and TNAU, Coimbatore (Tamil Nadu). These exotic introductions are expected to be very valuable towards selection of high yielding types.

Similarly, IFGTB, Coimbatore has a large collection of plants from Australian seed sources from which 200 clones have been selected and are under

multiplication for large-scale trials. Under the initiative of FRI, Dehra Dun. TNAU, Mettupalaym, (Coimbatore) has selected approximate 35 *E. tereticornis* and *E. camaldulensis* superior types that seem to be highly superior and are expected to be put under plantation trail shortly. These selections from local Mysore gum hybrids are likely to yield superior production. The sources of germplasm are for plantation purposes for improving the yield having wider genetic base.

Macro-propagation

If superior clones of eucalyptus, selected carefully from the natural or breeding populations, can be propagated in large numbers at low cost, then the ramets from these selected clones can be used directly in plantations to ensure that the superior growth characteristics of the clone are retained. The vegetative propagation of eucalyptus, thus, would ensure improvement in the yield and quality, shortening of the rotation period and overcoming some of the biological problems hindering raising Eucalyptus plantations on stress sites. The potential of vegetative propagation for yield improvement in Eucalyptus was realized to 64 cu m per ha per year in *Eucalyptus grandis*. Many countries all over the world have already initiated projects on producing high quality clones of Eucalyptus. In India also, the work on vegetative propagation was initiated at the Forest Research Institute, Dehra Dun, WIMCO Seedlings ltd. (UP) besides a number of other agencies. Various methods of vegetative propagation of Eucalyptus viz., rooting stem cuttings, layering, grafting and several other methods have been tried which are described in the following paragraphs.

Promising Clones of *E. tereticornis*

Seed Production Areas, Seedling Seed Orchards and Clonal Seed Orchards are considered an appropriate step towards the tree improvement performance since seed collected from all these strata give higher productivity. To avoid the genotype x environment interaction, seeds from the local SSPA's, SSO's, CSO's are encouraged to use for plantation purposes in the respective zones.

Under the World Bank Project (FREEP) of the ICFRE 168 ha area had been established as SPA's/SSO's/CSO's.

Other than this each State Forest Department also have their own selection of SPA's etc. Therefore, it is assumed that the availability of improved seed will not be a constraint to plant the wasteland area in large scale.

Location	SPA Area (ha)	CSO (in Area in ha)	SSO Area (in ha)
FRI, Dehradun	21.80	17.00	6.00
IWST, Bangalore	10.00	2.00	0.00

IFGTB, Coimbatore	25.00	14.20	14.50
AFRI, Jodhpur	10.00	4.00	15.00
IFP, Ranchi	0.00	5.00	23.50
Total	66.80	42.20	59.00
Grand Total			168.00

Based on the recent researches, many hectares of seed stands in Eucalyptus tereticornis were identified and have been converted into Seed Production Areas. Similarly Seedling Seed Orchard and Clonal Seed Orchards have also been established.

5. POPLAR

Poplars represent a significant component of the world's renewable resource of the 21st century. Poplars with their characteristic pipal like deltoid leaves are becoming an integral part of North Indian agricultural landscape. There are six *Populus* species indigenous to India growing along watercourses in the higher hills, valleys and also on hillsides exposed due to landslides, etc. their distribution in nature is as follows:

Populus ciliata	:	Temperate and sub-temperate region of Himalayas; altitude: 1200-3500 m.
Populus laurifolia	:	North-West Himalayas; altitude: 2400-4000 m.
Populus gamblei	:	Eastern Himalays (Sikkim, North Bengal, Arunachal Pradesh); altitude: 400 –1300 m.
Populus euphratica	:	North-West Himalayas; altitude: Upto 400 m.
Populus alba	:	Western Himalayas; altitude: 1200-3000 m.
Populus jaquemontiana Var. glauca	:	Eastern Himalayas (Sikkim, North Bengal); altitude: 1500-3200 m.

Among the six species *P. ciliata* and *P. gamblei* are fast growing and offer a potential to meet the increasing demand of wood for packing cases and for other industrial uses; *P. euphratica* is seen to be thriving well in the cold desert region of higher Himalayas. Other species grow slow but yield good quality wood.

Since poplars prefer longer hours of daylight, the natural zone of poplars lies only from 31^0N latitude and upwards. Therefore, exotic poplars are initially introduced in India in area between 28^0Nto 31^0N. Now these exotics (mostly few clonal selections of *Populus deltoides*) are becoming an important part of agroforestry systems in some districts of Punjab, Hariyana and Uttar Pradesh. Poplar is a large tree reaching well over 25 m in height and 100 to 130 cm in girth at breast height (GBH) in a period of 10 to 12 years. The tree develops a tall and straight pole. The main branches are simple and spread fairly wide resulting in a conical crown. Abundant foliage makes the crown quite dense. The tree is

deciduous between November to March, the period varying from 3 to 4 months. Flowering is normally during April-May.

Propagation Techniques for True to Type performance

Individual plants in the genus *Populus* are either male or female therefore; their seeds produce a large number of hybrids. This character offers excellent opportunities for improvement and selection. To produce true type of plants they must invariably be propagated vegetatively.

Poplars are generally raised by vegetative means using cuttings. Cuttings are derived from one-year-old shoots from lower two-third portion or from nursery grown one year old plants, during the dormant season. Cuttings from the diameter of cuttings (22 cm long) varies from 2-3 cm. Cuttings can safely be drawn at any time from the middle of January. Both ends of the cuttings should be sealed by wax, as protection against moisture loss. To some extent root cuttings also can be used for raising nursery. The cuttings must be submerged in fresh water immediately after preparation and kept for 28 hours. Prior to planting, cutting, should be drenched with Aldrin (39 EC thoroughly mixed in 100 litre water) emulsion. Thereafter the cuttings are also treated with Emisanan organomercurial fungicide (250 g Emisan in 1000 litre of water).

Technology for Planting Material/ Seedling Production

Seed collection and storage: The spikes ripen during June/July and the branches bearing spikes are cut and collected shortly before the seed is about to shed. The capsules are dried for 2 to 3 days. Cotton with seeds is collected and seeds are separated manually from the cotton. Seeds collected from the middle one third portion of the tree give significantly higher germination as compared to seeds collected from lower and upper portion. Poplar seeds remain viable for about three weeks when kept at room temperature. Viability of seeds can be prolonged to one year from three weeks if the seeds are stored in sealed bottles and kept in refrigerator. Properly dried seeds with 4 to 5 per cent moisture content stored in vacuum packed jars and kept at a temperature of 10 to 20^0C prolong the seed viability by 3 to 5 years.

Sowing: Raising of the plants by sowing seeds is generally practiced for tree improvement. *Populus gambeli*, which is difficult to propagate by vegetative means, is generally by sowing seeds in the nursery. Seeds may be sown in enameled trays using sterilized river sand and soil as germination medium. The best medium being sterilized 2 parts of soil and 1 part of river sand. The trays along with the sterilized medium are soaked/drenched in water and the seeds are sown on the surface of the medium. These trays are covered with polythene sheets for two to three days, this facilitates the seed germination. The polythene sheets should be removed after the initiation of germination, this provides profuse germination (may be around 80 to 90 per cent with higher survivals.)

Pricking out : Pricking out is generally done when the seedling are 5-6 cm tall, which is attained in about one month after seed sowing. The seedlings are pricked out into polypots kept under shade and watered twice daily. Growth of seedlings is fairly rapid and in two months time they attain a maximum height of 50 cm with an average of 30 cm.

Planting of cuttings: The cuttings are inserted vertically in well-prepared nursery beds. The usual spacing between cuttings is generally kept at 50 cm or 60 cm and between rows 60 to 80 cm. One ha nursery can have about 25,000 cuttings along with provisions for inspection paths, etc. The entire length of cuttings should be inserted into the soil keeping one bud above ground level. The soil around each cutting should be compacted gently but firmly without injuring the bark. The nursery raised plants called entire transplants (ETP's) attain a height of about 3 to 4 meters in one growing season. These are utilized for planting in the field.

Irrigation: Irrigation should be provided immediately after planting the cuttings. Thereafter, irrigation can be extended to 15 days interval depending upon the type of soil and the requirement, till onset of the monsoon. Proper and effective drainage of excess water is essential during rainy season to prevent logging and collar rot. After rainy season is over, 1-2 irrigation per month will be sufficient.

Weeding: Poplars are very susceptible to competition of weeds, therefore, regular weeding as per schedule is obligatory to reduce competition, and improve the moisture and nutrient uptake by plants.

Planting Practices

Site selection and its preparation: The following points may be kept in mind, while selecting sites suitable for poplar plantation:-

- Site should be well drained; low lying areas that are subject to water logging should be avoided.
- Assured irrigation facility should be available.
- Fertile loam or slit loam rich inorganic matter should be preferred.
- Heavy clay soils, very sandy soils, saline and alkaline soils should be avoided.
- Areas with high water table are best sites for poplar plantation.
- Soil pH over 5.5 is essential and below 5.5 is marginal and should be avoided.
- Areas selected for poplar plantation should be above 28^0N latitude.
- Areas that known to be prone to termite infestation should be avoided.
- Poplars are strong light demanders so in areas affected by the shade from the existing trees should be avoided.

The month of January and February are the best for transplanting poplars from nursery to the field. A good site and soil preparation operations include

ploughing the land and disc harrowing followed by running the cultivator. After preparation of land, well-aligned pre-planting irrigation channels 5 m apart from centre are prepared. Such channels will facilitate optimum and timely irrigation of poplar irrespective of the irrigation requirement of the intercrop.

Poplars grown as pure crop are generally raised in compact blocks at spacing of 4m x 4m and in combination with agricultural crops spaced at 5mx4m.

Digging of pits: Digging of pits along pre-planned irrigation channels at prescribed spacing should be done after alignment. The pit digging should be completed before receiving the plants from the nursery. The depth of the pits should be kept one metre from the ground. Pits are made with specially designed augers or tractor driven augers and should have a diameter of 15 cm.

Planting stock: Poplars are planted in the field by cuttings, sets, barebatelles, Entire-transplants, Polypot plants and stumps. From the trials made during the last 20 years, one year old nursery plants called “Entire transplants (ETPs)” 3 to 4 m in height were adjudged best for planting in the field. Prior to uprooting ETP’s, the nursery beds should be given light irrigation 7 days in advance to facilitate easy digging and prevent any injury to the plants. All side branches on the ETP’s are removed and the lateral roots with mat interfere in placing the ETP’s in the pit are pruned to within 10 cm of the main stem.

Handling of ETP’s: The Entire-transplants (ETP’s) immediately after digging are placed in storage pits filled with fresh water for 48 hours. Special care is required during handling and transportation over long distances to prevent breakage or damage to the stock. Prevention of moisture loss and dehydration of the ETP’s is of utmost importance. Therefore, care must be taken to cover the roots with wet gunny cloth during transport as a measure to protect the ETP’s against drying out. Prior to planting the ETP’s a length upto 1 m from the roots is soaked in Aldrin emulsion (250 ml Aldrex 30 EC in 100 litre water) or in Endosulphan (50 ml in 100 litre water) for 10 minutes as protection against termite attack. Thereafter the ETP’s are placed in Emisan solution (250 gm Emisan in 100 litre of water) for 20 minutes to prevent fungal infection.

Transplanting into pits: The top soil removed from pits should be mixed with two kg farm yard manure, 50 gm of single superphosphate, 25 gm of Muriate of potash and 15 gm five per cent Aldrex dust. The ETP’s are planted in one meter deep auger holes. The holes must be refilled completely with the above said planting mixture and the soil well packed. Good contact between root and soil is important to eliminate air pockets and ensure good establishment. Planting must be completed as early as possible during January-February and prior to flushing of buds on the stock.

Bio-fertilizer association

Increasing emphasis on sustainability in agriculture and forestry is redefining the role of Arbusculer-mycorhizal (AM) fungi in plant –soil system. Plant growth and productivity are rooted in the soil and quality of soil depends on its nutritive status as well as on the diversity and viability of its biota. AM fungi viz., *Glomus, Gigaspora, Sclerocystis, Acaulospora* etc. colonize roots of several crops, fruit and forest tree species and play a key role in soil fertility, plant development and plant health. Mycorhizal plants have several advantages over non-micorihizal plants. The microrhizal plants of the same species need less fertilizer, which stand heavy metal and acid–rain pollution, grow better on saline and infertile soil of marginal lands at high elevation. They are more resistant to soil borne plant pathogens and diseases, high soil temperature, pH and transplantation shocks. Besides these AM fungi, in the rhizosphere of the plants and tree species a number of indigenous plant growth promoting rhizobacteria (PGPR) including nitrogen fixing bacteria, phosphorous solubilizing bacteria and other biological control agents also coexist and interact with each other and with the host plant. Thus, they are also considerable tools developing new plant management system in agriculture in order to ensure adequate levels of food production with satisfactory reduction in chemical fertilizer and pesticides.

Availability of Promising Clones

The Forest Research Institute, Dehradun (ICFRE) has developed new clones through the introduction of new germplasm from USA in 1997 and breeding (control crosses). These will be subjected for multilocational testing in the field through coordinating centres. Clonal Testing (60 clones) is already in progress at 25 centres covering different agro climatic regions of 15 states. Final assessment/evaluation will be made available by 2002-2003. However, the following clones can be safely planted in large scale except in the irrigated lands.
G-48, L-34, L-200, S7C15, S7C20, S7C8, 82-35-4, 113324, 421-2, ST-124, ST-67, ST-72 and A-13.

6. *Prosopis cineraria*

Prosopis is a genus of shrubs and trees distributed in the arid parts of the tropical and sub-tropical regions of the world. Two species occur in wild in India viz. *P. chilensis* and *P.cineraria.* An exotic species, *P.chilensis* has become naturalized in many parts of the country. *P.cineraria* is a small to moderate size tree, evergreen or nearly so, with light foliage and rather slender branches around with conical spines. It does not ordinarily exceed a height of 12 m and a girth of 1.2m, the maximum recorded being 18m and 5.4m respectively.

The tree prefers a dry climate and the most important areas of its distribution are characterized by extremes of temperature. It grows in Punjab, Rajasthan, Gujarat, U.P., Tamil Nadu and Karnataka. In Punjab, it occurs throughout the alluvial plains and within this region the tree occurs most plentifully in the drier areas where the normal rainfall is 10-25cm. In peninsular India, where the normal rainfall is found to vary from 50-90 cm the tree grows well. It also occurs with black cotton soil in association with other trees.

The tree is a strong light demander. The young seedlings are sensitive to frost older plant are drought resistant. Natural regeneration through seeds is confined to moist places, but in the dry situations the tree regenerates itself by root suckers. Growth of the seedling for first few years in slow, but subsequent growth up to an age of 40-60 years is moderate. The tree attains an average girth of 80 cms in 30 years.

Propagation Techniques for True Type Performance

There are major two ways of clonal propagation known as macro propagation and micro propagation. Some research has been carried out to develop clonal propagation techniques for *Prosopis cineraria* by using both the ways, the details of which are as follows:

Macro Propagation: Air layering is reported to have 70-80 per cent success rate when carried out by treating with Seredix B_3 (IBA) and used moss as a rooting medium. These rooted plants were detached from the parent tree and transferred to polybags. After three months 70% of the rooted plants survived in polybags.

Study revealed preliminary results and success in air layering in *P. cineraria.* Detailed studies also were carried out on twig thickness, plant growth regulators and covering material that affect air layering of 40 year-old *P. cineraria*. They suggested suitable range of twig thickness for air layering was 10 to 15mm. Seredix B_3 was found superior than 100 ppm IAA. Moss was found a better covering material compared to clay. The suitable months for air layering were July and August. Cuttings having 15 mm diameter resulted in maximum root number (13) and root length (18cm).

Seasonal variation in rooting response and best hormones for including rooting are found. The cuttings are prepared from six-months old seedlings. The better season for rooting is February to May than August to November. Combination of NAA, IBA with thiamine at equal concentration (4mg/l) induced maximum rooting.

Micro Propagation: Studies were conducted on micro propagation of *Prosopis cineraria* by using hypocotyls segment. Hypocotyl segments (0.8n - 1cm) were excised from 7-10-days-old in vitro grown seedlings and inoculated on to MS medium supplemented with differed concentration of auxins (0.1-3mg/l) IAA and NAA along with (1.0-5.0mg/l) Kn. Multiple shoot differentiation was obtained after

three months of growth on 0.25mg?I NAA and 4.5 mg/I Kn. These microshoots are rooted on whites medium containing 3.0 mg/I IBA and 0.04 mg/I Kn. Plantlets were transferred to soil. Theses explants were cultured on MS medium supplemented with 3.0 mg/I each of NOA and NAA. Initially shoots were rooted (80%) on modified MA medium containing 3.0 mg/I NOA. Through this methods, 5-7 fold multiplication is achieved by uncalculating shoot segments of rooted shoots. About 30% plants survived on transplantation to field.

Root segments of three to four months old seedling and 4-yr-old trees are used for micro propagation. Root segment of about 1-3 mm diameter and 1-1.5 cm length are sub calculated on MS medium containing 3.0 mg/I NOA. Adventitious shoot buds are produced which gave rise up to 3-8 shoots in 20-30 days. Rooting of shoots obtained after sub calculating on MS medium of same composition in 30 days. Various factors influence the successful micro propagation of *P. cineraria* such as seasonal; variation, explants nature, plant growth regulator, culture orientation and culture conditions

Technology for Planting Material/ Seedling Production

Studies on water and fertilizer requirements of seedlings of *Prosopis cineraria* in the nursery showed that alternate day watering @ 20 cc per G.I. tube of 22.9 cm height and 6.9 cm diameter with fertilizer application of one gm urea +1 gm Diammonium phosphate per tube was found to be ideal practice for promoting all growth characters of tree seedlings. With this practice 10 litres of water per tube was required during the entire growth season. Above ground growth of *Prosopis cineraria* was too slow initially in terms of height and number of leaves per plant but it produced the maximum shoot dry weight 9.5 gm/plant. Application of fertilizer application with daily and alternate day watering showed better growth of seedlings whereas growth of seedlings was adversely affected by third day watering with fertilizer application.

Biofertilizer asociation

The symbiotic association of endomycorrhizae (Vascicular Arbuscular Mycorrhyza - VAM) occurs naturally in trees, herbs and shrubs. About 90% of the plants are mycorrhizal in nature. The species such as *Prosopis, Acacia, Azadirachta, Tecomella, Euphiorbia caducifolia Capparis deciduas* and *Calotropis procera* are highly mycorrhizal in natural habitat. *Prosopis cineraria* is one of the important tree species that has been selected as a major tree species for the area of research including “bio-fertilizer” aspect.

Management practices

The villagers in Western Rajasthan frequently lop trees of *P. cineraria* in order to obtain leaves for animal fodder. It supplies the bulk of the leaf fodder to cattle, camels and goats. This tree is heavily lopped in seasons when no other green

fodder is available. Farmer in Rajasthan who practice agroforestry prefers this particular tree species and the trees are generally lopped twice a year. A moderate sized mature tree of *P. cineraria* yields about 4.5 kg of dry leaf forage. Lopping should start only after the tree attains a minimum canopy, which takes about 8-10 years.

A study was conducted at AFRI to find out the effect of lopping on the growth and fodder production of *P. cineraria*. Four intensities of lopping treatments were imposed: control (no lopping); slight (1/3 crown lopping); moderate (2/3 crown lopping); heavy (complete crown lopping leaving only the leading shoot). Lopping was carried out twice a year in the months of June and December.

It was observed that minimum dbh increment was in the case of complete lopping. This indicates that successive complete lopping may be detrimental to diameter growth of the trees. The analysis of variance showed that lopping treatments applied did not have significant effects on the dbh and height growth of *P. cineraria.*

The lopping as such had brought about a marked decrease in the fodder yield in all lopping treatments applies, which indicated that ht practice of successive lopping reduces fodder yield.

The study revealed that the degree of lopping as such has no significant effect on the year height and dbh growth and fodder yield. However, mean annual percent increment in diameter growth, although not statistically significant, was generally lowest in the case of complete crown lopping. Therefore the practice of annual lopping brought down the annual fodder yield considerably. Hence, a gap of one or two years may be advisable for sustained fodder production and to recover from injuries, if any, during lopping. Lower two-third crown should be lopped leaving one-third for producing nutrients for the until new leaves emerge.

Research Needs

The research needs for the species have been identified and discussed as below: -

Seed Technology: Success of any type of afforestation programme to enhance the productivity not only depends upon the right type of species but also on the quality of the seed. The term quality is used to enhance the seedling parameters of the seed e.g. more germination, more value added products from the seed, early and in mass emergence during seed germination, better and sturdy seedlings. Improvement refers only genetic improvement of the seed but this is true only in case of agricultural seeds, where almost all the crops are annual and improvement can be expected within a short span of time. However, in case of forestry, unlike agriculture, the crop rotation is very long. Hence improvement refers for both type of improvement e.g. genetic and non-genetic improvement. Genetic improvement is a

stepwise process and starts with selection and trials. Selection means an area selection e.g. seed production area or provenance selection or individual tree (candidate plus tree) selection.

In case of non-genetic improvement, seed cleaning, seed grading and uniform seedling production are included. Most of the works related with non-genetic improvement of species are described for temperate species and the literature for tropical, especially for arid region is scanty. The research needs for *P. cineraria* for non-genetic improvement are as under.

- Testing of variability of seed parameters for the seed of various agro-ecological regions of its occurrence.
- Pre-treatments before sowing the seeds.
- Relationship between various seed testing parameters with the quality of seedling production.

Tree breeding and genetics: The following research needs are identified for genetic improvement.

- Studies on the geographical variations through provenance trails.
- Studies on the propagation techniques including tissue culture.
- Studies on genetic identification through DNA finger printing.
- Studies on the selection of CPTs and establishment of Seed Orchards and conducting of progeny trails for Elite Tree Selection.

Economic Productivity: Studies on estimation of fuel wood yield per ha or per tree on the basis of stand density and rotation age need to be undertaken. The height and dbh growth with reference to age can also be modelled keeping in view the number of stems/ ha and site quality. Estimation of pod production/ha/yr is required for a given canopy area/tree under various spacing. Also, it is desirable to measure the variation in pod production/tree or per unit area in irrigated plantations in comparison with rain fed conditions. Undertaking such studies in plantations of various spacing can help in optimising the fodder production per unit area.

Biofertiliser Application: The following research is needed on bio-fertiliser association.

- An extensive survey is required to estimate status of VAM fungi and *Rhizobium* strains associated with *P. cineraria* at different zones.
- Isolation, identification and multiplication of VAMF and Rihzobium strains .
- Mass multiplication pure and mixed culture of VAM and Rhizobium strains collected from different climatic zones.
- Mass production of quality seedlings for planting in different areas.
- Compatibility test VAM/Rhizobium in agroforestry systems with agricultural crops.
- Demonstration trials are needed to layout at different harsh climatic zones; mining areas, saline areas and rocky sites.

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CHAPTER V

PROCESSING, MARKETING AND TRADE

Introduction

Marketing has evolved as a means for satisfying demand and in its widest sense it comprises of the whole technology of identifying and satisfying wants and needs of the society. The basic function of marketing is to direct flow of goods from producers to the final users. This function is performed within a certain environment which itself is dynamic. Marketing as a science is relatively young and its application in the forestry sector has not yet been realized in real sense. Wood as a resource, largely produced in forests owned by the Government, has certain unique characteristics. For certain applications, it can be used in the form it is produced with practically no processing, whereas in some other applications it passes through several processing stages some of which are quite sophisticated.

Traditionally, almost all forest products required by the society came from village forests or trees growing in the vicinity of habitations or alternatively from the forests owned and managed by the state forest departments (SFDs). Due to the need for growing more food for the increasing population most of the erstwhile village forests and tree lands close to villages have been brought under the plough. This is evident from the increase in area under cultivation from about 90 million hectares to 142 million hectares. Consequently, pressure on forests increased many folds not only to due increasing social needs resulting from increase in population, rising living standards but also to the fact that an important proximate source of forest products was no longer there. It is also well known that the forest capital in our country has decreased to an alarming condition, both quantitatively and qualitatively, due to multiple reasons, prime reason being over exploitation and low investments in management of forests under the myth of inexhaustibility. Present supplies of wood and other forest based products, from natural forests are very low compared to the demand. Many of important wood based industries are using imported materials draining out precious foreign exchange resources, but this can not be a permanent solution. Of late it has been increasingly realized that to meet the requirement of wood and other forest products it has become imperative that people at their own initiatives grow trees. People's participation in management of natural forests, particularly those that are situated within a reasonable distance from villages through Joint Forest Management programmes is being successfully tried. Today lot of emphasis is being given on farm forestry activities but the desired results are not forthcoming. Many reasons are being attributed to this. One important factor is the lack of active participation of the people in such schemes. To secure active involvement of the people in tree growing it is imperative that tree farming yields better economic return to the growers.

There are a large number of materials and products for which we have to depend on forests, either natural or man-made. These include poles/bamboo and small timber for rural housing, timber for manufacturing, sawn-wood and wood composites e.g. plywood/particle boards/block boards/bamboo-ply for housing, construction, transport, packaging sectors, bamboo and hardwoods for all type of paper and paper products, fodder, fuel wood, non-timber forest products, plant extracts for medicines etc. Bulk requirement of wood is of sawn-wood and wood composites in housing, transport sectors and packaging. Fuelwood is produced as an important byproduct from all timber/wood production systems.

Unfortunately, due to poor infrastructure and marketing facilities available for the disposal of forest produce coming out from farm/agro forests and forests under Joint Forest Management (JFM) system producers are not able to get remunerative prices. It is, therefore necessary that while evolving strategy for development of agroforestry and JFM in the country, creation of effective marketing infrastructure for anticipated products must be an integral part of any such strategy. An efficient marketing/infrastructure support would go a long way in evolving a sustainable forest production system and would act as a great motivational factor to people for active participation in the tree growing and forest development programmes.

Better knowledge of market opportunities for forest products, particularly from agroforestry and JFM system, is necessary, especially among farmers and small traders. There is a need to recognize and use the appropriate means of taking full advantage of market opportunities. Very often produces from these production systems have specialties, including product characteristics, distribution channels and services and a proper knowledge about them is very important for their effective marketing.

Product Characteristics

In order to define the role of marketing the products from agroforestry and JFM production systems, knowledge of the structure of the products/services that are likely to flow from these sectors is very essential. It is also important to identify the products and services to be marketed. Furthermore, since there are number of stakeholders involved in the entire activity, their role and capability in handling different marketing functions need also to be known. The six species identified for major thrust in agroforestry and JFM programmes are:

- ***Acacia nilotica,***
- ***Bamboo species,***
- ***Casurina equisetifolia,***
- ***Eucalyptus species,***
- ***Populus deltoides,***
- ***Prosopis cineraria.***

A brief description of each of these six species including their availability, uses, processing for value addition, etc. is given below.

Acacia nilotica

Acacia nilotica (linn), locally called Babul, is an important species belonging to the genus Acacia that comprises of trees, shrubs and climbers having very characteristic prickles and stipular spines. There are more than 1200 species of Acacia that occur naturally all over the continents except Europe and Antarctic. ***A.nilotica*** is the most important tree species not only in Indian subcontinent but also in the continent of Africa and many Middle East countries. ***A.nilotica*** is widely distributed in the subtropical and tropical Africa from Egypt, Mauritania southwards to southern Africa and in Asia eastward to India. The species is exceedingly varying in nature and is recognized into 9 subspecies with distinctive morphological, ecological and geographical features. In India these subspecies grow naturally in most parts of arid and semiarid regions, including Andhra Pradesh, Bihar, Gujarat, Haryana, Arunachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharastra, Orissa, Punjab, Rajasthan, Tamil Nadu & Uttar Pradesh. ***A.nilotica*** subspecies ***cupressiformis*** has been popular in agroforestry and farm forestry plantations and has been widely planted on farmlands in several states including Uttar Pradesh, Haryana, Rajasthan, Maharashtra,, Madhya Pradesh, and Gujarat.

Properties:

A.nilotica is an evergreen tree usually 20-25m in height with clean bole up to 5-6.6m. Branches are thin and body covered with thorns. Sapwood is pale and yellowish white and is distinct from heartwood that is light red or pinkish brown with darker streaks. The colour often turns deeper on exposure. The wood is hard and heavy with average density of about 785kgs/m^3 at 12% moisture content. It is coarse textured and have interlocked grains. The wood is dull and somewhat rough without any specific odour or taste.

Timber of ***A.nilotica*** is hard, tough and difficult to saw, but have strength properties comparable to teak. Taking the value of teak as 100, some of the strength properties of ***A.nilotica*** are: weight-118, bending strength-93, beam stiffness-84, shear strength-151, hardness-135, nail and screw holding power-113. Mechanical properties of air-dried wood of ***A.nilotica*** at 12% moisture content are: MOR-894 kg/cm^2, MOE-112800 kg/cm^2, maximum crushing strength-536 kg/cm^2, shear strength parallel to grain: radial-168 kg/cm^2 and tangential-192 kg/cm^2.

Utilization:

The logs develop surface cracking and end splitting during storage. It should, therefore be converted and stacked for air seasoning during or just after rain. Wood is moderately refractory but can be seasoned well. It takes about 16 days to kiln

season 2.5 cms thick planks. The charge has to be steamed twice during seasoning to avoid surface crack.

The heartwood of ***A.nilotica*** is very durable, especially after seasoning and lasts well even in outside locations. However, the sapwood is easily attacked by insects and it decays rapidly. Acacia wood belongs to durability class II and treatability class I, indicating that this species is moderately durable having average life of 5-10 years under graveyard test. Heartwood is treatable but complete penetration of preservative cannot be obtained for dimension greater than 6 cms.

The wood is mainly used in constructional work for posts, rafters, beams and doorframes. It is one of the most preferred timber for all types of agricultural implements like ploughs, arrows, crushers, rice pounder, and is extensively used in cart making, for yokes, shafts, wheels and body work. Babul wood is also recommended for certain types of sports and athletic goods like clubs, wall bars, parallel bars etc. It is an excellent fuel wood, having calorific value of 4793 calories for sapwood, and 4946 calories for heart wood. The wood is also good for making paper and pulp. ***A.nilotica*** trees also yield gum, called “Indian Gum Arabic”. Tannin is also extracted from babul bark. Being excellent fodder, the leaves, pods and twigs are lopped extensively for this purpose. The leaves, bark, gum and pods of ***A.nilotica*** are used for medicinal purposes. Thorny branches of babul are useful as fencing material for fields.

Babul is usually available in small logs only, but in some districts larger logs are also available. It is available throughout the drier regions of North, Central and south India, the best source of supply being Punjab, Haryana, M.P., U.P., Gujarat, Maharastra, Rajasthan and Karnataka. Precise information about the current timber prices is not available. However, since babul wood is generally used locally, there are wide variations in the prices depending on length and girth of the logs.

Bamboo

Bamboo is a fast growing woody grass. It belongs to the family Poaceae. There are 75 genera and 1250 species of bamboo spread in temperate, and subtropical regions, except in Europe, in altitudes varying from sea level in tropics up to 4000 meters in temperate regions. The size of bamboo varies from grass to giants of 40 meters in height and 30 cms in girth.

Bamboo grows abundantly almost all over India, except in Kashmir valley, represented by 23 genera and 125 species. Several exotic bamboos also grow very well in many part of India. Bamboo constitutes 12.8 per cent of the total forest area. The total annual production of bamboo is estimated to be 4.5 million tons, second only to China. Bamboo form richs belt of vegetation in well drained parts of tropical and subtropical habitats and rise up to 3700m of altitude in the Himalayas. About 50 percent of the bamboo produced in India grow in north–eastern region and West Bengal.

Out of 23 genera of bamboo those grow in India, the principal bamboo genera occurring in India are: Arundinaria, Bambusa, Chimonobombusa, Dendrocalamus, Dinochloa, Gigantochloa, Indocalamus, Oclandra, Oxytenanthera, Phyllostachys, Pleioblatsus, Pseudoxytenanthera, Schizostachyum, Semiarunadinara, Sinobambusa, etc. Of all the genera mentioned the genus Bambusa is the widely distributed in India. It occurs wild or cultivated in plains and low hills from the Himalayan region to southern tip. The next widely available genus is Dendrocalamus, which occurs in south and central India and the dry hills of North India, as well as in Northeastern states. ***Bambusa, Oxytenanthera*** and ***Dinochloa*** are widely distributed in the Andamans and Nicobar Islands. Genera like Arundinaria, Indocalamus, Oxytenanthera, Schrizostachyum and Melocanna also grow well in Western Ghat and North- eastern region.

Properties:

The woody portion is present in the form of a hollow tube. The outer portion contains high proportion of silica and is very hard. The density of bamboo varies from 400 to 800 kg/$m^{3,}$ from species to species, as also within a species. The moisture content of immature bamboo is uniform throughout, but in mature bamboo decreases with height.

Mechanical strength of bamboo depends on species and climatic conditions of the locality, its age and moisture content. Various strength properties in green and dry conditions of bamboo from different states of India show that dry bamboos are stronger than green bamboos and comparable to teak. Among the Indian species ***Dandrocalamus strictus*** is the strongest one.

Present Scenario of Bamboo Utilization

Bamboo is an important cultural feature in many parts of India. Since the beginning of the civilization bamboo has played an important role in daily lives of people in India. Bamboo craft is one of the oldest cottage industries primarily due to versatility, strength, lightness and easy workability of bamboo with simple hand tools. Bamboo has been put to use for various applications ranging from construction to household utilities and have more than 1000 documented uses including an important industrial use in paper and pulp manufacture. Due to plethora of essential uses, it has been aptly described as “poor man’s timber”. “green gold”, “friend of people”. “the cradle to coffin timber”, “Green Gasoline”. The major sectoral uses of bamboo as analyzed in the Monograph on Bamboo by Dr.D.N. Tewari (1992) are given in Table 1. It is clear that the major industrial use was in paper manufacturing. However, over the year proportion of bamboo in paper manufacturing is on decline due to increasing use of hard woods of plantation origin and availability of imported paper pulp. During the last decade technologies for manufacturing new panel materials have been developed and few industries have

also been established. However, total consumption of bamboo in these products is not very significant.

Most other uses have been largely local/traditional, although very important but with very little value addition. Financial value of most of these uses is difficult to assess since they are non-market based. More over, for these uses there is *no regular assessment of demand and supply* and consequently, no focused approach to promote bamboo growing/processing to meet the domestic requirements or to explore their export potential. Needless to mention here that China with much lower area under bamboo is now recognized a world leader in bamboo products trade. India, with a much larger bamboo resource, has very high potential for development of bamboo products and there is need to harness this potential through result oriented and coordinated strategy for development of bamboo. The major uses of bamboo are shown in the following Table 1: -

Table. 1

Major Uses of Bamboo

Use	Percent Consumption
Paper Pulp	35.0
Housing	20.0
Non-residential	5.0
Rural uses	20.0
Fuel	8.5
Packing, including baskets	5.0
Transport	1.5
Furniture	1.0
Other wood industries	1.0
Others, including ladders, staff, etc	3.0

Production:

Total bamboo area in India is about 10 million ha having an average annual productivity of 0.33 tonnes/ha. The estimated bamboo production in the country is around 4.5 million tons. Major industrial use of bamboo has been by pulp and paper mills. However, since the paper industries have switched over to hardwood, bamboo consumption by paper mills has been on decline. Large quantities of bamboo are generally used locally in housing, fishing rods, as props in orchards, and vegetable gardens and in handicraft sectors.

Recent technological developments have given birth to new generation products like bamboo mat board, bamboo mat wood veneer board, bamboo mat roofing sheets, bamboo laminates etc. Other potential bamboo based industrial products are: -

- Bamboo laminates or bamboo wood having very high use potential in flooring and furniture etc for which work is in progress at IPIRTI.
- Bamboo particle boards currently being manufactured at one unit in Meghalaya but for this no R&D and training facilities are available in the country.
- Bamboo charcoal and activated bamboo charcoal.
- Edible bamboo shoots and beverages.

Bamboo Composites and Laminates: Status of Technology Development

Considering fast growth, high strength, bamboo is being rediscovered throughout the world as a potential natural raw material for future. In recent years, R&D efforts have been intensified for the development of bamboo composites suitable to be used in place of wood and wood composites.

Bamboo Mat Based Technologies: In India, several cost effective technologies have been developed at IPIRTI, Bangalore for manufacturing sheet materials having properties similar or even better than plywood made from fast growing plantation wood. These technologies are not only environment friendly but also people friendly as they have immense employment generation potential, particularly for women in bamboo growing areas. Technologies now available for industrial adoption are: -

- **Bamboo Mat Boards (BMB):** A cost effective technology has been developed for manufacture of thin BMB sheets up to 6 mm thick as alternate to plywood sheet. BMBs are waterproof, resistant to insect and fire, dimensionally stable, and possess excellent physical-mechanical strength properties. At present four units are manufacturing BMB and IPIRTI has signed MOU for transfer of technology to one unit in Maharashtra. BIS has already brought out an Indian Standard on BMB for General Purpose.

- **Bamboo Mat Veneer composite (BMVC):** BMVC is a variant of BMB and makes use of veneers from fast growing plantation wood for manufacture of higher strength structural panels. Use of veneers in place of bamboo mats up to 40% makes the panels economic for thickness more than 6mm. BIS has already brought out an Indian Standard on BMVC for General Purpose.

- **Bamboo Mat Corrugated Sheet** is a very high potential material for roofing as a substitute for Asbestos Cement Corrugated Sheets (ACCS), which are considered to be carcinogenic and have been banned in many countries. It promises to revolutionize roofing system in the country as also in several other counties.
- **Bamboo Mat overlaid particleboard:** Processes have been developed for overlaying wood/rice husk particleboard with bamboo mat that enhances their application potential.
- **Bamboo Mat Moulded Article (BMMA)** such as trays.

Potential Applications of Bamboo Mat Boards

Construction:

As building interior in housing, in paneling in place of plywood, ceiling: Both thick and thin bamboo boards are suitable for partitions and coincides with either wooden or an aluminum frame work.

Design and development are essential to utilize the full potential for bamboo mat boards for such applications as door skin in flush doors, structural uses – roofing, web construction, prefab and portable shelters, packing, modular partitions, etc.

Bamboo Mat Roofing:

Two ply bamboo mat boards made from CCB treated commercial bamboo mats have been used in an experimental house. BMB being light, rigid and strong requires only very nominal structural framework of wood and bamboo. A bituminous coating was applied. The bamboo mat board roof has given satisfactory services for over 12 years without much maintenance. It has been assessed that with periodical maintenance with weather proof coating, 3 ply preservative treated bamboo board can give a satisfactory service life over 20 years under tropical conditions.

Door shutters:

It is easy to make low cost paneled door shutters by laminating panels of bamboo mat boards and sites and rails of thin sections of wood with either gluing or nail gluing. A 7-ply 5mm thick board is adequate in a single panel shutter whereas 3-ply, 2.5 mm thick board can safely be used in a double door shutter having a maximum panel width of 30 cm. Thin bamboo mat board of 2-ply and 3-ply make excellent skin for hollow core functional flush doors due to high modulus of rigidity and good impact resistance of the board. A few experimental door shutters used under exterior conditions are still in good conditions after 12 years.

Structural Building Components:

Exploratory studies have demonstrated that bamboo boards are suited for structural components like barrel vault, arch panel and silos. Here the flexibility of bamboo mat board can be exploited advantageously by shaping it into arches or cylinder or even folded plates with a view to enhance the stiffness of the structure.

Bamboo Mat Corrugated Sheets:

This product is an alternative to AC, GI and FRP sheets. Sheets are not only ecofriendly, but also posses high strength and are resistant to weathering. Being light and easy to work, they require light supporting structure and suitable for construction of shelters in earthquake and other disaster regions.

Bamboo Mat Board for Grain Storage Bins and packaging:

One and half ton capacity grain storage bins made from BMB were tested at CFTRI, Mysore. It was found that when Paddy/Sorghum is stored in these bins under conditions of rainfall 100 cm, humidity 70- 85%, and temperature 25-28^{o} c

there was no ingress of moisture or reduction in bulk density. The materials maintained colour & odour. The bins are amenable for fumigation and rodent proof (no nibbling even after 15 days in rattery). There was no appreciable reduction in germination capacity.

Apple packing cases developed at IPIRTI using bamboo mat board can replace 60% of wood content and saving of cost 15-20 %. Bamboo mat can also replace plywood for drums in packing. Bamboo has also been used in making rodent proof grain storage bins.

Bamboo for housing:

Bamboo whether in round or split form is suitable for walling, roofing and flooring. Its high strength/weight ratio, flexibility, easy availability, workability, low cost makes it useful for low-rise constructions.

In collaboration with TRADA Technology Ltd., U.K. IPIRTI has evolved bamboo based housing system. Few demonstrations houses meters have been constructed at the Institute and at Karnataka Building Centre, Chikkabettahally, Bangalore. These houses were constructed from corrugated bamboo mat sheet as roof and the supporting structure is bamboo truss rafters on bamboo and /or casurina poles at 1.22m intervals. Wall panels consist of split bamboo grid with chicken-mesh plastered with cement mortar.

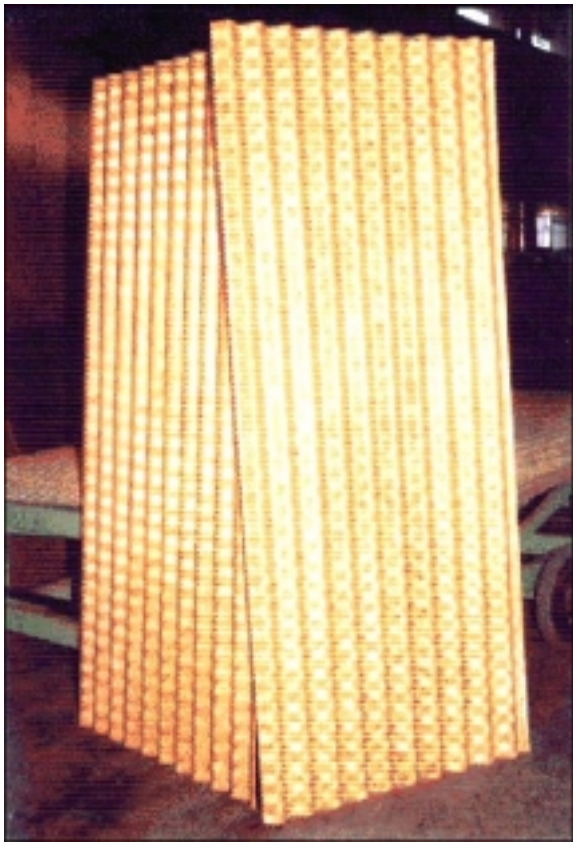
Bamboo Laminates and Particle Composites

Bamboo laminates/particle boards are manufactured products from bamboo, which do not involve weaving and hence are less labour intensive. Particleboards do not require any particular bamboo species and /or culm size. On the other hand, for making laminates species with certain minimum wall thickness will be required. At present, one factory in NE is manufacturing bamboo particleboards; however, there is no R&D facility anywhere in the country.

Bamboo laminates or bamboo wood is especially useful for flooring and furniture applications. Due to their wood-like appearance, it has high market potential and better market acceptability. For bamboo laminates research is in progress at IPIRTI, Bangalore under a project funded by MoEF.

In addition, there is a need for R&D for adaptation/development of technologies for other value added products. Some such products are:

(i) Bamboo curtain board overlaid with wood veneer for furniture and structural applications,
(ii) Bamboo strip boards overlaid with wood veneers and /or overlays suitable for specialized application in transport vehicles, railways,
(iii) Bamboo particle boards bonded with organic synthetic resins and inorganic binders,



Bamboo mat corrugated sheet

Flush door made from Bamboo mat board

Mounded Bamboo trays

A cot made of finger jointed, Bleached
rubber wood and Bamboo mat board

(iv) Bamboo wood boards bonded with mineral binder for specialized applications to substitute wood wool boards.

Reconstituted Wood from Bamboo

FRI, Dehradun has developed a laboratory technology for manufacturing destructured reconstituted wood from a Dendrocalamus strictus having appearance akin to wood. Moreover, it can be sawn, planed, bored, shaped, moulded, nailed and screwed with machines and tools with ease and can be finished with paint and polished. This product offers possibilities for use as substitute of solid wood where directional strength properties are main requirements as in case of structural timbers for use as doors window frame, beams and many other load bearing structures.

Casurina equisitifolia

Casuarina was introduced in the coastal regions of India to meet the supply of firewood to steam locomotives during the last century. Since then it has gained its importance as an important fuel wood species in the peninsular India. Although it is essentially a tree of coastal plains, it has also been cultivated in interior Karnataka, Tamil Nadu and Andhra Pradesh. Casuarina has been identified as a species for environmental control such as sand dune stabilization, shelter-belts, erosion control and reclamation of poor soils. In addition its industrial and domestic uses were also better understood. Because of its multiple utility and ready marketability casuaria have become most popular among the farmers.

Casuarina plantation in coastal area is used as savior from flying sand which otherwise covers cultivated field, roads and other inhabited lands and also in shelter-belts in coastal regions. The highly branched swinging twigs of casuarina reduce the wind energy very well. About 2 to 3 rows of casuarina belt can strip off a high strong wind of its force, leaving the leeward air still. A shelter-belt of 30ft high can reduce the velocity for a distance of 130m. Casuarina belts also protect the soil by reducing wind speed. Casurina can grow well in poor soil and can improve the soil.

Properties

The wood of casuarina is in general hard and heavy and difficult to saw. It is not a good source of timber for wood and furniture. Drying causes split, crack and warpage. However the timber can be used to make tool handles, ornamental items, rough farm construction, etc. In fact the timber has great demand for scaffolding, centering, roofing and also as mine props.

Utilization

Among the industrial uses casuarina species are used for manufacture of paper, rayon as wood for making small articles and tanning. The pulp obtained from casurina is used for making wrapping and printing papers. Casuarina wood

produces better rayon grade pulp than eucalyptus pulp requires less bleaching, higher fibre strength and yield is also higher.

Economy

The most common use of casuarina is as fuel wood. The wood is dense and burns slowly with great heat and no smoke. Its calorific value is about 500 kcalories. Casuarina stumps form excellent charcoal. Casuarina loses only 2/3 of their weight in conversion of wood to charcoal as compared to 3/4 parts in case of other wood species. Some of the casuarina species can also be used for fodder under distress conditions.

Eucalyptus

Eucalyptus is a native of Australia and was introduced in India in the Nilgiri Hills of Mysore in 1790. Gradually this species has been planted on a larger scale and at present forms a major component of the planting programme of the people in general. Large scale plantation have been raised in Punjab, Haaryana and U.P. Various species are also grown in Assam, M.P., Bihar, Kerala and Maharastra. Eucalyptus is an evergreen tree with wide ranging usefulness available for exploitation. Eucalyptus can grow in wide climatic ranges – from coastal areas up to 2000 meters altitude, tropical to warm temperate climates and a rainfall range of 400 to 4000 mm. Eucalyptus species that are widely grown in India are *E.teriticornis, E.camaldulensis, E.grandis, E.citriodora, E.globulus and E. hybrid.*

Eucalyptus species ranges in height from dwarf multi-stemmed trees called “mallees” usually growing in dry or poor sites, to tall shaft – like trees up to 100m in height formed in cool temperate, winter rainfall areas. A very wrong notion that Eucalyptus depletes the water reserves has been highlighted out of propaganda by the media. Although this misconception does not have any scientific basis, it has adverse effect on the tree growers. In fact eucalyptus takes up soil moisture from greater depths than pine and the soil does not suffer from critical stress of soil moisture. Eucalyptus improves both the physical and chemical condition of the soil.

Properties:

The specific gravity differs significantly with locality varying from 0.539 to 0.640. In young plantation grown trees there is no clear trend in the variation of specific gravity from bottom to top due to juvenile wood. However specific gravity tend to increase from pith outward.

Eucalyptus timber develops cracks due to differential stress behaviour of different layers of a log. The outer trunk of a green Eucalyptus log is in a state of tension along its longitudinal axis and the inner wood in a corresponding state of compression. Due to the differential stresses when a longitudinal straight portion is cut from the tree to from a log it gets curved with its convex edges facing the pith.

Processing:

Eucalyptus offers some problems in processing. Surface cracking and splitting, warping and collapse are common seasoning defects since this species is refractory to air or kiln seasoning. However, these defects can be reduced considerably through chemical seasoning and air drying before kiln seasoning. SDR process (Saw-dry-resaw) also improves sawing quality of eucalyptus. E. hybrid seasons well when sawn radially compared to tangential sawing. Ammonia fumigation techniques developed by Forest Research Institute, Dehradun makes it possible to give different colours to eucalyptus wood and thereby enhancing its appearance and marketability.

Utilization:

Eucalyptus has been used for timber, poles, veneer, pulp, fuel and for chemical products like essential oils and oxalic acid. There was a time when eucalyptus was untouchable as a furniture timber. But at present it is a common species in house and furniture making. It is also being increasingly used as poles. Although veneer peeled from eucalyptus is rough, improved gluing method has made it possible to make plywood from eucalyptus veneer. Eucalyptus has been evaluated for particleboard and fibreboards without loss of quality though not without treatment. The blended eucalyptus bark hard boards have also been made. E. hybrid wood is also being used for manufacturing paper and rayon grade pulp. As pulpwood, the younger, low-density eucalyptus is preferred to older and denser wood. Air-dried eucalyptus wood burns with a calorific value of 4700 to 4800 kcal per kilogram. Thus short coppice rotations can provide voluminous fuel wood of high calorific value which can still be improved when turned into charcoal with 7900 kcal per kilogram of charcoal. Eucalyptus leaves are an important source of essential oil.

Eucalyptus plantations were raised by Forest Departments in several states for meeting the demands of firewood and pulpwood for many years. Raising of eucalyptus by plantation on community land, farm land and industrial plantation is also very popular. Eucalyptus is receiving special attention to achieve very high yields of 50-60M^3 per ha/year.

Pricing behaviour:

Eucalyptus has been the most widely planted exotic species in plantations as well as in government plantation programmes for production of pulpwood and for fuel. In spite of the species being widely criticised on various counts, it continues to be a preferable plantation species in agroforestry sector and other plantation programmes in various parts of the country. There have been wide fluctuations in the prices of eucalyptus over a period of time and space due to the fact that there are no organized markets for wood in general and wood obtained from agroforestry in particular. Due to dispersed production, both in time and space, with small

quantities being produced by individual farmers sale procedures do not have any standard practice. Moreover, the production is also not systematized. Consequently, there are large variations in quantities available for sale from any particular area or region at any given point of time. The situation is generally exploited by the middlemen and local traders and the price fixation in most cases been found to be not in the best interest of the farmers. The following cases will illustrate the point.

Punjab & Haryana:- Punjab and Haryaya are among the few leading states in tree farming. Main species planted are eucalyptus and poplar. In the early 1980's farmers in northwest India planted eucalyptus (hybrids of E.*tereticornis*) family for sale as small timber, poles, and pulpwood. Wood was transported to Himachal Pradesh for packaging, and to Haryana and U.P. for manufacturing paper. In Punjab and Haryana there was huge surplus of wood. In Punjab farmers were compelled to sell their produce at throw away prices of Rs. 250/ per tonne. In Haryana, the farmers could not obtain even Rs. 15 per tree against expected price of Rs. 100. As a result, many farmers gave up tree plantation after 1987 as they failed to realize anticipated returns. It is reported that in the state only 4 million seedlings from nurseries were sold in the year 1988 as against the peak distribution of 43 million plants in the year 1984 . The state governments came to the rescue by purchasing wood through state owned forest development corporations of support prices higher than the market prices. However, the closure of plywood factories in the North Eastern states in 1996, proved to be a great opportunity for the farmers in the whole north western region as a large number of small scale plywood and veneer units have been established in Haryana, Punjab. Now wood is being transported from all over the region to the plywood units in the area.

Uttar Pradesh*:* Large-scale eucalyptus plantations were undertaken by farmers on their farms with the inception of mass plantation scheme started in 1976. Later on this scheme was incorporated in Social Forestry scheme launched in 1979. When the eucalyptus crop matured the farmers faced difficulty in getting remunerative price and there was perceptible fall in the interest amongst the farmers for further plantations. In the year 1990 U.P. Forest Corporation entered into the market to purchase standing eucalyptus trees of the farmers with declared support price. In the beginning the corporation did get sizable quantity of eucalyptus timber especially in western U.P. The local contractors who were exploiting the farmers by way of offering ridiculously low price of standing trees started feeling themselves to be outside the market. The farmer started bargaining with the contractors and got more price than what was offered by the Forest Corporation. It is fair to conclude that with the entry of the Forest Corporation into the purchase of eucalyptus trees grown in agroforestry, the exploitation of farmers was eliminated. They started getting better prices as compared to previous years and the people at large regained the confidence and were motivated to continue the plantation program. The corporation successively revised the support price of not only eucalyptus but also for other species including Poplar, Khair, Shisham.

The price of eucalyptus logs (Rs. per m^3) obtained by farmers in Karnatraka, U.P. M.P., Maharashtra and Haryana during last few years are depicted in the following Table 2: -

Table. 2

Prices of eucalyptus logs

State	1995	1996	1997	1998
Karnataka	2000	NA	4000	4000
U. P.	3350	NA	4590	5000
M. P.	9500	6800	6950	7200
Maharashtra	9000	6700	7190	7500
Haryana	3800	3250	3250	4500

The prices have followed the pattern of a roller coaster ride. The regional differences in prices are the most noticeable feature. The unusual increase in prices has been due to variations in girth and wood quality. However, during the past 3 years, the prices have increased by 4% to 25% per annum in case of almost all the States. The average increase in prices is about 6-8% per annum for eucalyptus.

Poplar

Poplar is one of the fastest growing species and can achieve growth up to $50m^3$/ha/year and can be harvested on 6-12 years rotation. It can be grown well under various agroforestry systems in different parts of the country. Poplars are widely cultivated on the field boundaries, roads, lands, riverbanks etc. *Populus* genus occurs mainly above 31° N latitude. There are six indigenous species viz., *Populus ciliata, Populus laurifolia, Populus gamblei, Populus euphratica, Populus alba, Populus jaquemonliana*. Among the exotic species which are grown well in India are *Populus deltoides* and *Populus euramericana*. Poplar is well cultivated in Uttar Pradesh, Punjab, Haryana, Jammu and Kashmir, Himachal Pradesh, West Bengal, Arunachal Pradesh and also in southern states.

Poplars have a peculiar form and growth habit. Its branches grow relatively close to the stem and comparatively leafless throughout the winter. Due to this reason, it intercepts much less solar energy and rainwater particularly in winter months. These characters make poplar ideally suited for culture as an agroforestry tree species. Many exotic poplars, especially *P. deltoides* that has exhibited faster growth has already been widely grown by farmers along with agricultural crop in U.P., Punjab, Haryana, Jammu & Kashmir. Farmers in these states are growing poplar along with cash crop like, sugarcane, wheat, maize, potato, gram, lahi, pea, soyabean and several fodder crops.

Poplar has come to occupy a unique and important position in the rural economy in several parts of India. Poplar is a large tree reaching well over 25m in

height and 100 to 130cm girth in a period of 10 to 12 years. It is shallow rooted and the root system spreads widely. The tree develops a tall straight bole. The tree is deciduous; the leafless period varies from 3 to 4 months. Poplar needs deep, well-drained and nutrient rich soil. It cannot tolerate water logging and is also susceptible to drought. On an average poplar can yield 10-30 m^3/ha/yr on a short rotation of 6-7 years.

Properties

Anatomically it is difficult to distinguish different species of Populus. Sapwood is nearly white, broad, heartwood pale yellowish white, turning yellowish grey or brownish grey. Poplar is medium density hardwood with an average specific gravity of 0.441(on dry wt./green volume basis). Average moisture content in P.deltoides is 145 and varies from species to species. Modulus of rupture is comparatively low varying from 310- 450 kg/cm^2.

Processing

Poplar can be seasoned well-25mm thick plank of P.deltoides can be dried in a steam heated kiln from a moisture content of 75 percent to 10 percent in a period of 7 days. However seasoning of planks results in drying degrade in the form of bow, spring and twist though they are free from surface and end cracking. Quality of timber can be improved by adopting SDR (saw-dry-rip) process followed by high temperature drying. Poplar wood has been analysed to be non-durable (class III) but easily treatable (class a) timber using water borne chemicals like PCP, CCA, CCB.

Utilization

Poplar, which was being used mainly for match-splints has suddenly found more profitable use in plywood and prices have increased significantly. Now, Poplar is the most promising timber for industrial and other applications in the northwestern states, where it is largely grown in agroforestry sector. It is widely used as wood poles, packaging, making veneer and plywood, fibre board, cement bonded board, in the manufacture of artificial limbs, matches and sports good. Among all the plantation species poplar is being widely used for manufacture of panel products in the north and north-western states in the country at present, where a large number of small scale plywood factories have mushroomed. Almost all classes of plywood can be made from poplar. However, for manufacturing durable plywood using poplar requires technology intervention for more efficient utilization of poplar wood.

Although poplar does not fully meet the requirements of timber for utilization as structural timber as per IS:883/1970, it may be used for non-load bearing structural uses such as false ceilings, partitions and almirah shelf planks. The light grain in poplar can be improved by ammonia fumigation.

Economy and Trade

In poplar tree wood contributes 58 per cent and thus has got high industrial value. Due to non-availability of timber from forest, poplar has become the prime source of raw material for wood based panel industry in Northern India and farmers getting remunerative price for poplar very often exceeding the return available from agricultural crop. The net present value (NPV) and the benefit/cost ratio was found to be the highest at Rs.11,046 and 3.22 respectively at 12 percent interest with 8 years rotation in case of poplar plantations with agriculture on farm land as compared to Rs.7235 and 2.15 and Rs.3208 and 1.51 obtained in case of poplar plantation with agriculture and forest lands respectively. The income estimated from poplar plantations raised under agroforestry indicated a gross returns of Rs.4.11 lakhs (Rs. 19,500 from agriculture and Rs. 3.91 lakhs from trees) or a surplus of Rs.2,.0 lakhs per hectare in 8 years with an allowance for interest on investment @ 15 percent. Poplar under agro forestry thus constitutes a varitable "Saving Bank" which the farmers can convert into liquid funds anytime after it is ready for harvesting.

The poplar based industry may be divided into two categories – users of large dimension logs and users of small dimension logs. Sawmills, panel industries use large dimension logs and small wood is used by pulp and paper mills or as fuel wood. Poplar growers sell the timber through middleman or directly to the industries. In rural area it is the middleman who purchase trees. The trees are generally sold on weight basis. The middlemen perform all activities like felling, conversion into logs, grading, transporting to market. In recent years 'mandis' have come up in Northern India where poplars are being sold. All sorts of facilities exist in these markets like, sawing, storage, handling, transport and banking. Industries like wood based panel industries, paper mills and match industries have come up for direct purchase from growers.

Prosopis cineraria

Prosopis cineraria (Khejri) holds an important place in the economy of Indian desert. This is the only leguminous tree that grows well in deserts against all odds of climatic conditions. The new foliar growth, flowering and fruiting are borne by it during the extreme dry months (March-June) when all other desert trees may be seen as leafless and dormant. This peculiar behaviour of this tree is not fully understood. The plant sheds its leaves gradually through cold months. It is most common, medium sized tree of Indian Desert and can be recorded on most of the landforms except the hills and saline depressions. Because of its economic value the tree is left standing in the arable land, its population being regulated by the farmers. Being well adapted to prevailing climatic conditions and its wider ecological amplitude, this tree may be seen from 150 mm to 500 mm rainfall zone. Its optimum density, referred elsewhere, can be seen between 350-400 mm rainfall tract.

Properties

The sapwood is large and white heartwood scanty brown to purplish brown, straight to slightly inter-locked grained, medium to coarse- textured, strong, tough, very hard and heavy. The density ranges from 769 – 945 kg/m^3.

Processing

The wood seasons well with care. 2-3 cm thick planks require 16-20 days to kiln-season and require to be steamed twice. The wood is not durable and is viable to insect attack.

The timber turns well and considering its hardness it is not difficult to saw and work. Fairly smooth surface can be obtained by hand planing. It takes stains, paint and polish well and can be brought to a fine finish.

Utilization

Till now the timber is of local importance only but with the increase in area under plantation, commercial supply will be available from Punjab and Rajasthan.

The wood is suitable for interior construction work, such as columns, roofs, doors and windows and for wheels and hubs of carts, agricultural implements, tool handles, small turnery articles and well-curbs.

In dry and arid regions, it is a source of fuel having high calorific values; sapwood: 5003 calories, and is used for making charcoal. The wood ash contains 31 percent of potassium salts and may be used as a source of potash.

The pods are used as fodder for livestock. Pods may be eaten green, dried or after boiling.

The bark has a sweetish taste. The bark and galls, formed on the leaves, are used for tanning. The leaves are much lopped for fodder. They are also used for green manicuring. The flowers are mixed with sugar and administered to prevent miscarriage.

The tree exudes a gum from the cut end of the branches that resembles the mesquite gum.

Prices of Wood used in Pulp and Paper Industry

Prices of bamboo have experienced a moderate growth in the 1997-98 financial year. The price paid by industry has been recorded to be 4% higher than the price in 1996-97. Price of eucalyptus has also been dwindling gently. The percentage fluctuations have been ranging between 5 to 30% per annum exception

being the year 1997-98 when it prices declined marginally compared to the previous year. Prices of Poplar and Pine wastes have been reflected jointly by the industry. During the year 1994-95 and 1995-96 the prices showed declining trend compared to the previous years. However, again the prices bounced back and started showing a growth of about 12% in 1996-97 and further 8% during 1997-98 as shown in the following Table 3.

Table 3
Market prices of some important plantation woods

Year	Bamboo	Growth (%)	Eucalyptus	Growth (%)	Poplar/ Pine Waste	Growth (%)
1993-94	1965	-	1490	-	3407	-
1994-95	2050	4.0	1944	30.0	2558	-25.0
1995-96	2190	7.0	2420	24.0	1857	-27.0
1996-97	2460	12.0	2537	5.0	2087	12.0
1997-98	2560	4.0	2517	-1.0	2262	8.0

Source: Chemprojects report

The above studies clearly bring out wide variations in prices of agroforestry timber. The variation in prices is so much that at times growers/farmers may get very high price for their produce and at some other times they have to sell their produce on throw away prices. Although the market prices of any commodity are bound to vary depending upon the demand supply position, large scale variations in the case of crops with long gestation period, as is the case with agroforestry tree crops, work as a severe detriment to the development of the sector. Such wide variations can be greatly avoided by evolving a proper market information system and an effective marketing mechanism. On one hand these initiatives will help in plantation of suitable species commensurate with the expected demand for industrial processing. On the other hand growers will get information about different markets for their produce and facilitate correct evaluation of value of their produce and thereby enhancing their competitive bargaining power while selling the produce. It is also worthwhile to ensure that the market mechanism creates some primary processing facilities close to the growth centers of the raw material so that long distance transportation of bulk material can be optimized and farmers also get the benefit of such value addition.

Processing Technology

Wood as produced in agroforestry or JFM production system has to pass through various degrees of processing for manufacturing products to meet the societal needs. The processing has necessarily to take care of two important aspects, namely the demand for various forest/wood based products and the

characteristics of the raw material i.e. wood and other forest products that are to be produced from the agroforestry or JFM areas.

Demand for wood and wood products:

The major requirement of wood is for timber in housing and transport sectors and as fuel wood. It continues to be a major energy need. The National Forestry Action Plan (NFAP) –India, which is a comprehensive strategy and action plan of 20 years, projects the annual requirement of timber for house hold sector at 60.4 and 66.6 million cubic meter (cum) in the years 2001 and 2006 (**Table 4**). In the same years total timber requirements have been assessed to be 73 and 81.8 million cum.

Table 4
Annual Requirement of Timber for Household and Agricultural Sector (in million cu. m.)

Category of Use	2001	2006
Housing and Allied Domestic Uses **Rural** **Urban**	 **31** **8**	 **34** **9**
	39	**43**
Furniture **Rural** **Urban**	 **6.3** **4.1**	 **7.0** **4.6**
	10.4	**11.6**
Agricultural implements	**11**	**12**
Total	**60.4**	**66.6**

It is worth while looking into some basic facts that are relevant for development of marketing strategies. The major industrial uses of agroforestry wood are in Saw Mills and Furniture; Paper and Pulp; Plywood and other panel products; Packaging; Match industry; Handicrafts; and Sports goods. Total demand of timber in the country has been estimated to be 73 million m^3 in 2001 and 81.8 million m^3 in 2006 by the Forest Survey of India (FSI, 1996).

In addition to these major sectors of wood use, there are several other areas of wood use upon, which depends the livelihood of a large number of people concentrated in different localities. They include fishing boats, tools, sports goods, matchsticks, toys, etc.

Chemprojects Design & Engineering Pvt. Ltd. New Delhi, have undertaken a comprehensive estimation of industrial wood requirements under a **Study on Forest Industry**, sponsored by the Ministry of Environment and forests, Government of

India. The Draft Final report has been submitted to the MOEF. Sub reports 3 & 4 of the study are titled " Study of Forest Based Industries" and "Demand Scenario for Raw Material by Forest Based Industries" respectively. Against this demand (see table 5), production from forests has been estimated to be 26 and 29 million m^3 respectively in the years 2001 and 2006 leaving huge gap between demand and supply. Similarly the fuel wood requirement is estimated to be of the order of 225 million tons and 250 million tons in the years 2001 and 2006 against which recorded production from forest is expected to be only 17 million tons. Three non-commercial energy sources – wood, animal dung and agricultural residues still meet 95% of the fuel needs of rural areas. Fuel wood share is estimated to about 60% in rural areas and 35% in urban areas. There is a huge gap between demand/consumption and recorded production that continues to be a major cause of degradation of forests. However, development of AgroForestry /JFM sectors depends to a large extent upon selection of species that are amenable to industrial processing for manufacturing value added industrial products and seeking fuel wood production as a byproduct from this activity. The industrial demand as assessed by the latest assessment (Chemprojects, 1999) is given in **Table 5.**

Table 5
Demand Projection of Wood Based Industries

Sl. No.	Industry	Demand 2000	Installed Capacity *Wood-based /Total*	Conversion Factor *For RWE*	RWE Demand 2000 *M m^3*	RWE Demand 2010 *M m^3*
1.	Paper & Pulp	4.30 M tons	1.60 / 4.30	1 : 2.8	4.48	15.40
2.	Newsprint	0.9 M tons	0.263 / 0.54	1 : 2.8	1.78	3.42
3.	Rayon Grade Pulp	0.45 M tons		1 : 5.5	2.50	3.10
4.	Construction	77 M m^3		1 : 1.67	9.70	15.20
5.	Packaging				4.62	6.40
6.	Furniture	1.4 M m^3		1 : 1.82	2.52	4.62
7.	Automobile	1.23 M m^3			0.19	0.41
8.	Agricultural Implements				2.12	2.50
9.	Railway Sleepers	35393 no.			0.03	0.22
10.	Sports Goods	.09 M m^3			0.35	0.98
11.	Handicraft				0.45	0.65
12.	Plywood	2.0 M m^3	368.5 M m^2	1 : 2.3	17.25	24.84
13.	Decorative V		25.76 M m^2		0.27	0.43
14.	Particle	0.071 M	0.11 M m3	1 : 2.0	0.14	0.22

	Board	m3				
15	MDF	0.071 M m3	0.12 M cum	1 : 2.0	0.14	0.22
16.	Match Box	1072B boxes			2.30	3.00
17.	Mining				3.20	4.00
16.	Misc.				5.73	9.47
	TOTAL				57.77	95.07

Export- Import Scenario

Traditionally import of wood and wood products has existed for specialized materials or to supplement the industrial requirements viz. tea-chest plywood for tea-packaging, teak logs from Burma, now Mynamar, paper pulp. With growing awareness about the importance of forests and their conservation, in many states felling of trees in natural forests have been restricted drastically. To meet the raw material needs of the Wood based industries, Government liberalized policy on import of timber on OGL. This policy not only gave a breather to the wood based industries but also resulted in development of additional industrial growth in coastal areas due to ease of availability of imported timber. Industries were generally sure of government supply of timber raw material from natural forest and never realized the importance of agroforestry as an alternative source of raw material. However, now they are compelled to look at the agroforestry wood as the source of wood raw material for their industries.

Fortunately, with increasing public awareness for conservation of natural forest agroforestry has gained importance. Many small scale industries have been established based on plantation grown timber in many parts of the country specially north –western part of India where massive plantation of eucalyptus and poplar have been raised by farmers. However, the growers were not getting remunerative price for their produce due to the absence of unorganized marketing system.

Wood import under OGL has resulted in increasing trend for import of wood raw material and many wood based industries have started depending on imported wood material from unsustainable sources.. Moreover, the produce from the imported timber is sold mainly in domestic market and there is practically no export of products against import. Table 6 shows the export-import position of wood and wood based raw material in the country.

Total import of wood and other wood raw materials have been growing to alarming heights. On the other hand, growth of export is very low. Export is less than one tenth of import. The situation is a matter of great concern as on the one hand it is a avoidable drain on the country's foreign exchange reserves, and on the other hand it is detrimental to the growth of utilization of farm wood and is therefore adverse to the interests of farmers. Without generating productive employment in rural areas alleviation of poverty and hunger may not be possible.

The acceptance of the plantation growth timber as raw material by the wood base industries and their potential to produce standard products by adopting improved technology show rays of hopes to come out of the present export-import situation. Growing of timber has become an important alternative/supplemental farming practice in many states including Haryana, Punjab, U.P., M.P., A.P., and Maharastra. Many state governments have also come forward with incentives for tree growers and also to develop system to ensure remunerative prices for farm wood. However, to give a boost to tree growing activity as a means for import substitution, certain policy initiatives are necessary.

1) To impose heavy import duty on such wood products which are/can be produced within the country to meet domestic needs.
2) Enhance R&D efforts to manufacture quality products from plantation grown wood and other renewable fibres for import substitution.
3) Export of wood and natural fibre based products promoted through incentives and simplification of procedure.
4) Evolution and implementation of minimum mandatory material and product standards. This is necessary to enhance consumer acceptance for plantation wood based products and better acceptance of such products in international markets.

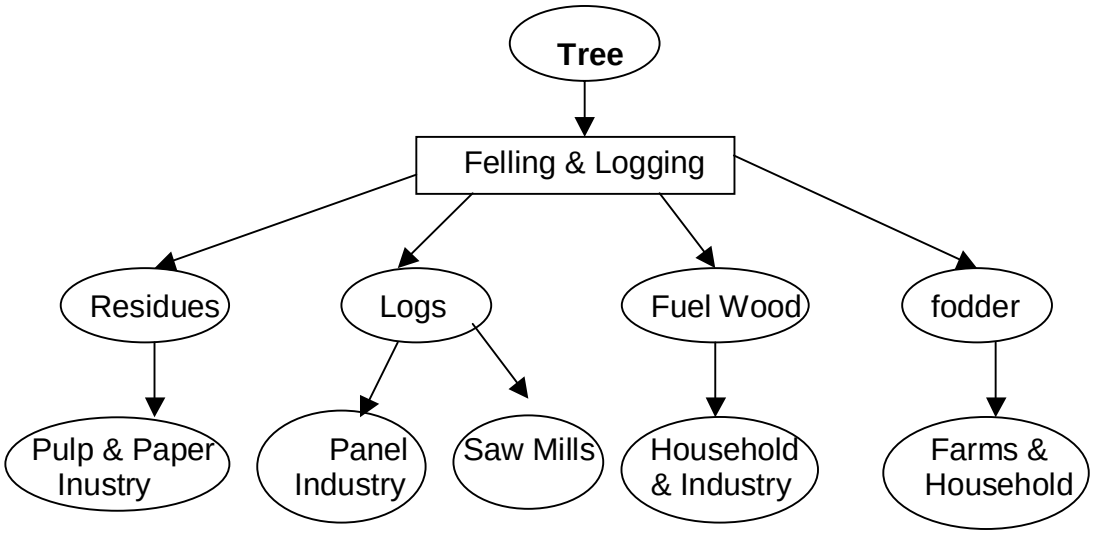
Table 6
Export- Import of Wood & wood Products

Products	Unit	1997-98		1998-1999		1999-2000	
		Import	Export	Import	Export	Import	Export
Round Wood	$1000M^3$	697	86	-	-	-	-
Saw logs							
Sawn wood	Rupees in crore	-	-	753	109	928	188
Veneer logs							
Pulp wood							
Wood Based Panel	$1000M^3$	47	14	-	-	-	-
Plywood	Rupees in crore	-	-	821	119	1008	203
Particle board							
Fibre board							
MDF							
Veneer sheet							
Wood Pulp	$1000M^3$	297	2	-	-	-	-
	Rupees in crore	-	-	991	143	1089	216
Paper	$1000M^3$	666	16	-	-	-	-
Paper board							

Newsprint Writing paper Packing paper	Rupees in crore	-	-	1957	283	1778	359

Wood Processing

A generalized flow chart for processing of tree into wood products is given below:



Research & Technology Requirement for Wood Processing

The technology requirement for processing of wood from agroforestry and JFM areas can be analyzed in several broad areas on the basis of nature of intermediate materials made form wood in the process of manufacturing consumer goods. These broad categories are sawn timber, wood based composites, composites from wood residues, natural fibers and agro residues, and bamboo composites. In addition, processing of Non Timber Forest Products and fuel wood are also to be considered.

Enhancing Service Life for Agroforestry(AF) wood

In all the wood products, a common denominator is service life that needs to be enhanced due to inherent low natural durability of most plantation timbers as they are highly susceptible to macro and micro-organisms such as borers, termites and fungi. Preservative treatment of timber from AF production system is therefore very essential irrespective of the nature of end product, other than fuel wood, i.e. poles, sawn sizes or composites. Unless this is done, the need for quick replacement of products made from such wood is bound to put heavy pressure on the resources. Expected life expectancy of non-durable wood species varies between 2-15 years depending on the hazards involved. Contrary to this, after effective treatment the material can be expected to give a minimum service life of 10 years even under the

most adverse conditions. On an average, preservative treatment increases the service life by about 4 times (**Table 7 & 8**) and thus, is a very low cost approach to reduce demand or alternatively, increasing wood production.

Table 7
Life Expectancy of plantation wood and Treatment costs for Different Uses

Use	**Expected Service life** (in Years)		**Treatment Cost** (Rs. /cum.)
	Untreated	**Treated**	
Mines	2	10	300
In the Open			
Contact with ground	5	25	450
No Contact with ground	10	40	300
Marine waters	2	10	600
Cooling Towers	3	15	450
Inside location			
Ground contact	8	40	240
Out of ground contact	15	50	150

(Source*:* Legislation support for rational use of wood by Satish Kumar, TDA Vol. XLIV – No.2, 1998)

Table 8
Influence of treatment on life cycle of wood

Product/Use	**Quantity used (Million cum.)**	**Untreated Average service life (years)**	**Treated Average service life (years)**
Plywood	1.0	5	15
Other Panels	5.0	5	15
Housing	7.0**	10	40
Mines	3.0*	2	10
Furniture	0.2	15	30
Packaging	3.5	2	5
Cooling Towers	1.0*	3	15
Marine	1.0*	2	10
Miscellaneous: Buses, Lorry bodies, Fence-posts, etc.	3.0**	5	15

*Sensitive areas of use **Heavy requirement of timber

(Source: Legislation support for rational use of wood by Satish Kumar, TDA Vol. XLIV – No.2, 1998)

Protection of logs

Protective end-coat has been developed and is being used by the industry to save logs from loss due to end split, decay and attack by fungus and pinhole borer. Treatment schedule for storage of logs either in pond or log yard has also been worked out.

Treatment of sawn timber

Extensive work has been done at Forest Research Institute (FRI) for finding out suitable method for treatment of all types of timbers. Different chemicals that may be used for treating timber for various end uses have also been studied and have been prescribed in the respective BIS Standards along with treatment schedules.

Treatment of Veneers

Green veneers are susceptible to attack by mould/fungi if these are not properly dried/treated within 3-4 days. Due to fungus/mould attack veneers develop yellow, green or black color which results in deterioration in veneer quality as well as create problem in bonding during panel production. IPIRTI has developed effective chemicals and treatment schedules to prevent this.

Treatment of Panel Products

Extensive work has been done at FRI and IPIRTI on preservative treatment of wood based panel products. Glue line and panel treatments are being widely studied and further studies are in progress for the species that are newly finding their use in panel product manufacture. Unfortunately, in India timber and timber products that are available in the market are largely untreated. This is partly due to consumer ignorance about the consequences of using non treated timbers, and partly due to the fact that although industry is aware of the techniques as well the consequences, it does not consider the activity remunerative and the standards are only voluntary. It may be mentioned here that although pressure treatment facilities of about three million cum are existing in different states of the country, actual use is only one third of the installed capacity. It is therefore necessary that treatment of timber and other wood products, particularly of plantation origin be either made mandatory or a system of incentives and disincentives be evolved.

Model Saw Mill with improved Machinery and Technology for processing small girth logs

Logs from Agroforestry and JFM production system will generally be of lower girth compared to logs available from natural forests. Hence, it is necessary to develop saw-milling process and equipment suitable for sawing small diameter logs.

IPIRTI has established an improved sawing system for processing small diameter plantation logs. The system mainly consists of providing suitable attachment to the existing narrow band saw machines for converting it into an initial breakdown headrig saw and an improved band re-saw with fence and feeding attachments. A double edger, simple trolleys and conveyer systems have also been developed. The critical component of the system are: i)narrow band headrig saw with frames and rollers, guide rings on rollers, saw table, wire system for table movement, variable feeding system; ii)improved band saw; and iii)double edger machine.

These modifications will facilitate initial straight breaking down cuts and further accurate re-sawing of the blocks or cants with proper control over sawn timber thickness and quality with minimum sawing variation. The additional attachments can be fabricated locally. With the above modifications sawn timber recovery can be increased by about 10 percent.

Critical components of a Model Saw Mill

Narrow band headrig saw: Basic machine is a conventional band saw machine with improvement in wheels, reduced distance between the wheels, improved guide pin system, reduced table base level, strong base frame, device for lubricating and cleaning and a 20-25 HP motor instead of 10-15 HP motor, as used in conventional headrig saw.

Log feeding attachments: Frame and rollers, guide rings on rollers, wire system for table movement, variable feeding system from 5.5 meter to 35.0 m per minute and a fence which facilitates further conversion (re-sawing) of timber in the same machine.

Improved Band Saw: Re-saw machine is attached with a feeding system and a fence to be given to it. This fence is different from the fence attached to the headrig band saw. Simple in-feed and out-feed roller conveyers are also to be provided to increase the capacity of machine to 6-7.5m^3 of timber per shift.

Double Edger Machine: This machine is hardly used in any sawmill in India. But this machine should be an integral part of a sawmill to get plank of proper edge and width. Substantial sawing in wood raw material and increased productivity can be obtained by using a double edger machine in sawmill.

The machine cost for a model sawmill for different production capacities are estimated to be:

Production Capacity		Machine Cost
2.5 - 3.0m^3	-	Rs.2,00,000
6.0 - 7.5m^3	-	Rs.3,50,000
10.0 - 12.0m^3	-	Rs.5,00,000

Wood Based Composites

Wood composites promise to be of great significance in better utilization of wood particularly from fast growing plantation timbers from which it is difficult to get high dimensions required for various applications. Thus through appropriate processing technology plantation timbers which have low natural durability, low density, lesser dimensional stability, may be converted into durable, strong and structurally stable panel material of higher dimensions. Through use of new technology for adhesives, mechanics and industrial processes and process control, composites can move beyond dependence upon the species/properly related issues of solid wood.

The major wood based composites are:

1. Layered composites comprising of Plywood, Block board (BB), Flush Doors (FD), Lamin board, batten board, Lumber core boards, Laminated Veneer Lumber (LVL).

2. Particle composites comprising of (A) Particle Board(PB) – single layer, three layers, graded, Oriented Stranded Board(OSB), Flake board(FB), etc., and (B) Fiber Boards (FB), Insulation Board (IB), High Density Fiber Board(HDFB) and Medium Density Fiber Board(MDF).

3. Composites based on wood residues, natural fibers and Agro residues.

R & D efforts need to be focused on:

- *Spindle less peeling lathe:* Smaller girth logs are most efficiently peeled into veneers using this type of machine. Studies at pilot plant/factory level have shown that veneer production is 30-50% higher in a spindle less peeler compared to conventional peeler with low girth logs.
- *Finger jointer*: Scarf jointing is used elsewhere in the world in wood based panel industry. But such machines are too costly for low capital intensive wood based industry in India. Finger jointing of smaller length veneer for mid-core in panel manufacture is the only way out. Finger jointer has already been developed in our country for solid timber and can be indigenously developed for veneers also.
- *Veneer tenderizing equipment* / techniques to enhance dimensional stability.
- Standardizing *prophylactic* and *preservative* treatments at various stages to enhance durability.
- Development of *application techniques* for using panel materials made from plantation timbers and other renewable fibers for different end use applications, keeping in view the functional requirements of various end products.
- Development of *densified panels* for flooring/seating in transport vehicles, railways etc.

Marketing Channels

There are no organized markers for timber from forest. In fact, never did such a need arise to create a marketing system for timber and other forest products. Traders/industry who used to get their needs through license or quota of timber through auctions or long term leases from SFDs to be produced from designated forest areas. Local people generally obtain the products required by them in the form of ***nistar*** or other such form of concessions from nearby forests regulated by SFDs. In the areas where agroforestry/JFM have been successful effective marketing mechanism is yet to develop.

Marketing needs of agroforestry/JFM products are different from that of products from government forests for many reasons, namely

- Production of the material in a scattered manner,
- Buyers not aware of the quantum and location of raw material,
- Buyers and producers unknown to each other,
- Different pricing of same material at different places by different buyers,
- Seasonal price variations guided by demand and supply situation.

The result is obvious: the middlemen eating up the cream while serving as link between growers and buyers and growers/farmers not getting appropriate price for their produce. Such a situation is bound to continue unless an effective marketing mechanism is put into operation. This has already been experienced at several places where farmers did not get remunerative price for timber produced by them and even had to sell at throwaway prices. The present marketing practices are an admixture of: -

1. Sales through auction in the open market (mandis)
2. Direct supply to industry on a pre-fixed price.
3. Sales to be the middlemen/agents

The increasing dominance of supplies from agro/farm forestry sector has resulted in creation of wood markets close to the industry. Yamuna Nagar in Haryana and Saharanpur in U.P. are examples of such markets. These markets are located either within the Agricultural Product Marketing Centers' yards or some other nearby place. The farmers are required to bring their harvests to these markets generally without any prior information/arrangement for their sale. The traders normally have their offices in the vicinity. Immediately on arrival of wood, they inspect the quality and bidding starts. The highest bidder is the successful buyer, who makes the payment to the farmer and the wood is delivered to the buyer's stockyard. The traders have developed their own grading and selling systems and sale the product in unprocessed form to the industries or process in saw mills which may be some times owned by traders themselves. In case a particular trader does not own a

sawmill, he gets the logs processed at some local sawmill on job work basis. The sawn sizes are sold to consumers as per their requirements.

Some farmers have developed direct links with the industries and supply wood directly to the industry on mutually agreed terms and conditions. In some cases the industries supply saplings to the farmers on subsidized rates with assured buyback arrangements for the wood at the time of harvest. Under this system, the industry on one hand is sure of supplies of raw materials and on the other, the farmers are assured a minimum price for the produce. However, such linkage is generally seen between medium/large scale farmers and industry. The small/marginal farmers particularly adopting boundary plantations are not in position to have direct links with the industry. Hence, this segment which comprise of very larger numbers sale their products to the middlemen or the agents. These agents, normally are local traders/individuals, who make the purchases on tree basis, which has no relation with the specifications and its market value. The farmers with relatively poorer bargaining power and trade knowledge are duped by these middlemen who in return makes substantially high trade mark up. The system, however, saves the farmers from logistic and trade related headaches. Farmers sale the standing trees to the middleman who in turn takes responsibilities of harvesting, logistics etc.

The problems of the farmers start right from the time of harvesting. Farmers require permission for felling of trees, followed by transit pass for movement, in some cases even within local boundaries. In some states, certain species have been exempted from some regulations but still the process of harvesting and transportation of wood raw material is at best quite cumbersome. Moreover, these regulations introduce costs upon the growers as a result of increased transport times and opportunity costs but also coasts upon the local governments and forest departments for administration and enforcement of the regulations. ***Such rules and regulations need to be liberalized uniformly throughout the country.*** The Table 9 shows some of the constraints faced by farmers in disposal of forest products from their farmlands:

Table 9
Constraints in Disposal of Farm Woods

Problems	A. P.	Assa m	Gujar at	Haryan a	J& K	M.P.	Maha - rashtr a	Karn- ataka	Oriss a	U.P .	W.B.
Felling Permission	Ye s	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Transit pass	Ye s	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Compulsory sale to govt.Agencies	No	No	No	No	Yes	Yes	Yes	No	Yes	No	No
A % of sale value paid to owner	Yes	No	Yes	No	No	No	No	Yes	No	No	No
FCC Payment to Owner	No	No	No	No	No	No	No	No	No	No	No
Market Information Provided	No	No	No	No	No	No	No	No	No	No	No
Support Prices	No	No	No	Yes	No	No	No	No	No	No	No

These constraints work negatively and farmers, particularly the small and marginal get discouraged from growing trees on their own land. As a result they have very little option but to sell standing trees to the local middlemen who exploit them on pricing front. This mostly results in distress sales. ***An effective and organized marketing support system, coupled with other policy initiatives, can reverse the situation and work as an incentive for tree growing.***

It is suggested to create forest produce marketing facilities on the pattern of markets for agricultural products managed either by farmer cooperatives or the State Forest Departments.

Common facility Centres (CFCs)

Considering the specific nature of forest products coming out from agroforestry, it is necessary to process them with adequate and appropriate technological inputs. Such inputs are essential for primary processing for conversion into sawn sizes or veneers (for making composites) and seasoning and preservative treatment to enhance service life in respect of timber. It is desirable that primary processing is done close to the production areas. Preliminary processing and grading of NTFPs that will be produced in the sector also needs to be done efficiently so that they do not loose value during storage.

Small scale processing units in the nature of Common Facility Centres (CFC) within 5-10 kilometer radius of growth centres will help the farmers as well as the wood processing industry in procuring raw material for further processing. The CFCs will also serve as effective links for marketing of agroforestry forest products. In addition, these centres will have storage facilities for semi-processed wood and non-wood forest products obtainable from agroforestry. At these processing units the farmers can take their produce for conversion into logs of standard sizes for further processing into sawn sizes, veneers etc. as well as for necessary seasoning and

treatment. They can take back the timber required by them for their own use after due conversion and treatment as also the left over end/side cuts for use as fuel wood and the excess quantity can be offered by them for sale. Thus the farmers will not only get better quality and more durable material for their own use, but also get better price for their produce.

The primary processing centres are very essential due to the fact that the fast growing plantation species are generally less durable and also have large proportions of tension and juvenile wood. Use of such timber without basic processing and treatment greatly reduces quality of out put and useful service life of the products made from it and thereby results in inefficient use of already scarce material. Fast deterioration of untreated wood also accelerates the return of carbon to the atmosphere and thus negates the efforts of carbon sequestration.

Moreover, since such units will be located in rural areas they will contribute to reducing the migration of rural people to urban centres seeking employment. In addition the employment opportunities created by these units through their mere presence may generate considerable economic activity.

Benefits of CFCs

The main benefits of CFCs to the farmers and growers are:

Generation of employment
Partial processing will generate wood residues that form much needed fuel for the rural people. Only 40% of a tree can be converted into logs suitable for sawing or peeling. The conversion factor from logs to sawn timber and panel products is 60% and 50% (max). During sawing plenty (10-15%) of sawdust is produced.
If sawing and seasoning can be done locally, seasoned timber can be used by local carpenters for making door/window frames/shutter, furniture, packing cases agriculture implements and also by artisans for handicrafts, toys, etc.
Making core frames for block boards and flush doors, which are dominant panel products to be manufactured elsewhere, will add value to agro forestry timber.

Infrastructure at CFCs

Keeping the above mentioned objectives, the following primary processing facilities are required at a CFC.

A small scale saw mill:

The raw material requirement of a SSI scale saw mill to be established at CFC with a minimum production capacity of 5 m^3 per day (per 8 hour shift). The capacity can be increased to 10-12 m^3 per shift per day. Considering conversion of sawn wood from plantation logs to be 60 percent requirement of wood comes to 8.33 m^3 per day. The stem which produces timber constitutes 60 percent of above ground bio-mass of a tree. Thus for a SSI scale sawmill the tree volume required is

6300 m^3 per annum. An area of 3500 ha. on which agro forestry is practiced can supply the above volume of wood on regular basis.

Studies on Kadam (*Anthocephalus chinensis*) has shown a 10 year old plantation tree can yield on an average a volume of 0.188 m^3 of timber suitable for sawing or peeling/slicing. As has already been discussed a volume of 6300 m^3 of timber is annually required a running a sawmill producing 5 m^3 of sawn timber. Number of plantation trees which can yield these volumes on 10 years rotation are 33510. Hence this number of trees have to be harvested yearly to feed a sawmill unit producing 5 m^3 of sawn timber per day. If each plantation site, as shown earlier is harvested at an interval of 5 years, then a plantation area having 166550 number of trees would be required to the proposed SSI sawing unit at CFC. With the capacity of growing 50 trees around a bund of 1 hectare of land the total area required for growing 166550 number of trees is 3331 hectare of land. Therefore minimum land area under agroforesty to feed the smallest unit of sawmill producing 5m^3 of sawn timber per day per shift comes to about 3500 hectares.

Storage facility for logs and sawn timber

Seasoning and treatment facility:

Such facility is absolutely necessary taking into consideration the low durability and lower dimensional stability of timbers available from short rotation plantation species. The size and capacity of seasoning kiln and treatment plant will depend on the raw material available in the hinterland of a CFC and subsidiary infrastructure as discussed below.

Primary processing facility for NTFPs:

In addition to these, the following subsidiary facilities may be established on need basis.

1. Toy Manufacture: Manufacture of wooden toys by artisans is an old profession both in urban and rural areas. Very often manufacturing units are limited to family members or at best in the form of a cottage industry. The artisans or the cottage industry owner cannot reach the consumer or a market to get remunerative price for their products. Wherever the industries have already been built up, CFC can act as a facilitator in this regard by providing timber at reasonable rates and market links.

2. Block board and flush door core manufacturing unit : In India manufacturing of wooden core for block-board and flush door is done manually by carpenters and the process does not involve high technology. However, setting up such a unit at CFC requires preconditions such as preservative treatment and seasoning facilities. With very less capital investment such unit can result in additional financial benefits to the local people.

3. Veneering Unit: Farmers income can be enhanced by converting logs into veneers that will be used as raw material by panel industry. However, such a unit will

be required where wood is in surplus, the species are suitable for peeling and there is industrial demand for veneers.

4. Bamboo Mat Weaving: Traditionally bamboo mats are being made by rural people and very little training is required to learn the trade. Bamboo mat is the raw material for industry manufacturing BMB and allied products. CFC can act as manufacturing and marketing centres of bamboo mats.

Institutional Support

From the above discussion it is evident that in prevailing conditions of unorganised markets, the farmers are bound to sell their agroforestry produces at the price fixed by middlemen/traders who manipulate marketing transactions in such a way that the farmers are at a great disadvantage. More often than not, private traders usually exploit them by providing loans and advances for consumption in hour of need and thus a form of commitment is made for forward trading of their produce at lower than market prices. Very often these items are subjected to phenomenon of distress sales.

Policy framework:: Institutional support to marketing is provided basically on two levels. At the highest level are the government policies and the regulations governing their implementation. In the case of agro forestry/ JFM forest products marketing the implementation of trade policies, industrial policies, policies for importing wood and wood products, and forest policies in particular has the greatest impact due to the specific nature of the produce.

At the operational level, institutional support comprises the various co-operative arrangements among producers, forest services, standardisation organisations, product quality monitoring and control institutions, research institutes/universities, extension and other human resource development services, banking and credit services, marketing information services, transport and communication networks, etc. Most of the institutional support is provided by government or other public organisations and is therefore to a large extent beyond the reach of individual farmers. Agroforestry activities usually fall within the sphere of several ministries such as national planning, agriculture and forestry, trade and industry, health and education etc. Co-ordination of work at the national level is one of the preconditions for the successful development of the sector, marketing of agro forestry produces.

Technology inputs: Considering the general characteristics of the fast growing tree species generally planted by farmers technology input is very essential to make quality products. Through effective research it is possible to broaden the market of some plantation products into speciality products i.e. treated wood products with enhance dimensional stability and service life; development of quality composite panel materials like plywood/block boards using poplar; development of new products/materials like bamboo mat board and bamboo wood veneer composites,

bamboo mat corrugated sheets; development of appropriate techniques for joinery and furniture industry. Such efforts might lead to new marketing opportunities.

*Institutional Linkages***:** With a view to eliminate all forms of age-old exploitation and ensure faster growth of rural economy, greater emphasis is being given on the implementation of various economic programmes for developing organised rural based institutions. Large Sized Agricultural Multi-purpose Co-operative Societies (LAMPS), Adivasi Co-operative Societies (ACS), Forest Labour Co-operative Societies (FLCS), Primary Agricultural Credit Societies (PAS) have been set up to provide integrated credit cum-marketing support to the farmers. In majority of the tribal dominated states, Tribal Development Corporation/Federation and Forest Development Corporation (FDC) were organised for procurement and marketing of different natural products collected by the farmers. One of the cardinal objectives of such institutions is to undertake marketing functions not only to narrow down the price spread between producers and consumers but also to eliminate the exploitative and non-functional margins of the traders and commission agents. These state level apex institutions formulate the policy for procurement and marketing for specific commodities to safeguard the interest of the farmers. National Co-operative Development Corporation (NCDC), National Bank for Agriculture and Rural Development (NABARD) and National Agricultural Co-operative Marketing Federation of India (NAFED) have also play a stellar role in planning, financing and developing marketing infrastructure in rural areas.

Emerging Issues: Several emerging issues relevant to agroforestry/JFM sector are:

a. Whether the existing pattern of linkages of producers of agroforestry/JFM production system with industries where the production and marketing activities are at subsistence level, are functioning in the right direction? What motivations, behavioural, administrative co-ordination and the business logistics approaches need to be considered in agro forestry areas?

b. At present the growers in agroforestry and participants in JFM production systems lack in technology adoption, finance and contemporary skills. Under these conditions what should be the role of state intervention in uplifting the economy of agroforestry/JFM producers through organised efforts. There is need to draw a policy of the government towards upgrading the skills and providing applicable technology at par to their socio-economic conditions.

c. The co-operative extension work needs a dynamic start in agroforestry sector. The NGOs may be entertained in such field where a social and personal approach is required instead of an administrative out look on the development of rural co-operatives.

Since the tree crops require land as a major capital resource and longer gestation periods than agricultural crops the farmers need security of land and land

tenure system and financial support during the intervening period between planting and harvesting.

Industrial wood raw materials produced in agroforestry/JFM need to be transported to factories. In most states there are rule regulating cutting of trees on private lands and transporting logs/timber and other forest products due to the fact that same tree species are either found naturally or planted in government forests. In many cases prices of timber and other forest products supplied to industry are either subsidized under old legal arrangement or pricing mechanism has hidden subsidies. Thus farmers on one hand face problems in selling their products due to procedural bottlenecks and on the other hand they had to compete with subsidized government rates. Development of agro forestry sector necessitates removal of these constraints through long term institutional arrangement rather than temporary measures.

Farmers may be imparted training in post harvest processing and potentials of product diversification so as to get the benefits value addition, particularly when the demand for raw produces is low. Since there is no mechanism for matching the production with demand there are wide variations in prices due to production glut and middlemen exploit farmers. Owing to low natural durability of most plantation timbers and non availability of even primary processing facilities near production areas the farmers are not in a position to hold on to their produce in the event of sudden fall of prices. There is therefore, a need for creation of some multi-purpose institutional arrangement, by dovetailing this activity in any of the existing collective agency, with following aims:

- Enabling the farmers to get right orientation in producing the wood specially for the purpose for which it is intended with right quality and in tune with anticipated annual/seasonal market demands, both for domestic and export markets. The production system need to be matched with anticipated demands of the industrial raw material.
- Making available information and training on planting, harvesting and post harvest primary processing techniques.
- Facilities for primary processing for value addition as well as enhancing their bargaining power in the market, and also getting properly treated (for dimensional stability and durability – enhance service life) timber for their own use.
- Facilitate the farmers to organize themselves into groups for bulk marketing by collection of their produce at some common place that will also facilitate sourcing of raw material by industries and thus creating direct producer-consumer links.
- Creation of standardized measuring system for the different produces. Many farmers sell in units where purchasers assess the value by weight of the produce. In such cases there is uncertainty due to timings of weighment and transport causing concern to farmers.

- Evolving suitable log-grading system and facilitate such grading of logs to determine correct price.

Above all, constraints due to restrictive land/forest rule and regulations need to be removed for free flow of agro forestry produces from production centers to the consuming industries and/or consumers. Minimum quality standards for various intermediate and finished products need also be ensured so that the efforts of tree growing are not negated by manufacture of sub standard materials and products. Wasteful industrial practices also result in lower financial return to the growers of primary raw material i.e. wood.

Marketing Information System

There is growing evidence to suggest that planting of trees for commercial ends had increased in the early 1980s. Several factors may have led farmers to view wood as a saleable commodity. The decline in wood supplies from forests and increase in demand in a growing economy have resulted in sharp increases in prices of wood and wood products. Moreover, the success of "green revolution" technology in several regions changed the nature of agriculture from a primarily subsistence oriented activity to a commercial activity, in which most inputs including labour were paid for, and a substantial part of output was produced for the market. Cropping decisions are now influenced by the perceived relative profitability of different crops, and in this changed scenario, growing of wood on farms for the market is seen to be a more profitable option than annual crops in many regions.

Economic benefits that can be derived from agroforestry/JFM products will have to be identified as a major opportunity for the community for practicing tree farming. The farmers are mainly producing the primary raw material i.e. wood that is partly consumed by the growers themselves for their own needs and surplus is sold for value addition involving processing. A major vehicle for making available the financial benefits of the activity to the growers is effective market information. Since the markets are generally informal and consumption centers are generally far away from the places of production of the primary raw material, it is difficult for local people to have access to information about potential markets and have little control over the prices they receive.

A proper forest product market information system (FPMIS) would empower local producers and traders by providing more transparent information on agroforestry products and thereby making it more profitable to produce, manage and sell. The major users of the FPMIS will be a large body of farmers/producers scattered through out the length and breadth of the country. The traders of wood and wood products and the processing industry will be the other stakeholders in the FPMIS. The FPMIS need to be a low input system that would be sustainable controlled and managed by users, with very little need for external investment or maintenance.

A marketing information system is a structured approach to collecting, analyzing and communicating information about markets and marketing aiming at increasing market transparency for users and enable them to make more informed production and marketing decisions. For AFMIS, primary information needs are in respects of (i) markets including demand, end-uses, supply of both primary raw material and processed goods, and (ii) marketing factors which comprise of marketing and distribution channels and prices. What kind of information is the most important will depend upon local needs and priorities and the user's position in the marketing chain.

Kind of information FPMIS can provide

Marketing Information	Market information
* Product characteristics * Distribution channels * Promotion alternatives * Prices * Payment alternatives	* Existing markets * Size of market * Demand and supply position * Ultimate product users

Systematically collected and analyzed information is seldom available in India except for few selected products and market. Much of the information on agroforestry products is collected from the resource side or at the processing level. Even this information does not easily reach a broad cross section of the lowest level operators. Increased attention will have to be paid to collect all relevant information from primary and reliable sources.

The demand of many agroforestry produces is a demand derived , i.e., final consumption takes place after a great number of successive loops in the production-product –marketing chain. In order to understand better the actual needs and wants of the customer in the market, the specific values that customer associated which the products offer should be investigated and disseminated by FPMIS.

Users who implement FPMIS should find that they are better able to

- Make informal marketing decision for Agro forestry produce
- Negotiate with others in the marketing chain
- Organize production and sale of Agro forestry produce
- Facilitate group discussion and decision making for disposal of AFP

Ultimately, as users gain more information and learn how to exploit that information they should find way to increase the profitability of the activity.

Establishment of FPMIS

While every MIS will differ in its details, in general there are three steps in setting up a MIS, which are applicable to setting up AFMIS also.

Step I: **Select the MIS location and identify the MIS participants**
Criteria to evaluate potential sites:

- Is there an expressed local need and interest in using marketing information for disposal of the produce?
- Are there any products produced above the level of subsistence?
- How easy is it to access data about markets and marketing of the produce and products?
- Is there an organization in place that can participate in the MIS and what is its degree of cohesion?

Criteria to identify the MIS participants:

- Who is involved in marketing of the produce?
- Who has expressed an interest in marketing of produce?
- Who lacks marketing information and could best benefit of using MIS?

Step II: Assess the local situation
The types of background information to be collected in the initial assessment:

- Profile the local product economy.
- Assess marketing knowledge and interest in the produce.
- Assess organizational structure and management capacity to carry out the MIS.
- Determine availability of marketing information on the produce and assess its quality.

Step III: Designing and implementing the system

- Choose the objectives of the FPMIS.
- Select the information the FPMIS will provide regarding the produce.
- Decide which information sources will be used.
- Decide how to organize the collection and analysis of data.
- Choose how to communicate the results to the users.
- Design training activities for primary users.
- Establish a monitoring system for FPMIS.
- Anticipate the FPMIS evaluation.

Marketing Model

The marketing model proposed here depicts the different types of markets for the raw material as well as primary processed products. The markets like domestic, regional and export will consume the surplus raw material. Although the domestic consumption by the farmers that does not necessarily go through the marketing system is also considered here just to take account of the produce value. This consumption may be in the form of raw materials per se or in the form of processed one for producers own consumption. The marketing channels considered here are limited up to the consuming industries and have not been dealt further because the

industries/other consuming agencies have their own marketing mechanism that has little relevance to agroforestry sector *per se.*

The domestic market is envisaged as the geographical location covering a sizeable quantity of marketable surplus collected from the locality that may encompass a village/block/division of forest as the case may be in respective situations. The produce will be collected either through a co-operative marketing society or any other such agency that may be operating in the area or created specially for the purpose of assembling, grading and subject to other marketing functions. From the collection centers the produce will be diverted to preliminary processing for value addition and then to consuming industries. The residual material will be marketed to local traders/consumers. The next channel will be to the marketing federation or regulated markets and other authorized institutions for bulk sales after grading and standardization of the produce. Then this will be forwarded to the State Forest Corporation for further marketing.

In another channel under domestic marketing, the farmers could directly sell their produce to the industries or agencies that made formal contract with growers as forward marketing mechanism. Besides, the co-operative societies/other institutions could also sell the produce to these agencies. This mechanism would provide a wide scope and independence to the producer as well as institutions to market their produce with more freedom.

The regional markets may be conceived as neighboring jurisdiction or taluk or district as case may be, where the produce would be forwarded by the Marketing federations/Regulated markets to State Forest corporation and then to the consuming industries.

The State Trading Corporation or any other such organization will deal with the export marketing of agroforestry produces either in raw or processed form.

Conclusions/Recommendation

From the foregoing discussion it is clear that marketing can play a very significant role in development of agroforestry/JFM sectors and as such it is central to the future growth and development of the sector. The complexity of interactions between the people, the economy, and the environment necessitates that marketing of agro forestry/JFM products should embrace a wide range of issues. The foremost is the development of people-industry relationships requiring high levels of joint planning, efficient market network, and long-term commitment for effective research for development of new/value added products. The following specific actions are suggested in this direction.

Policy-legal aspects

The legal and procedural framework including land ceiling, tree felling and transit rules, regulation of saw mills, which is a great source of market imperfection in agroforestry/JFM should be reconsidered and modifications necessary to promote and develop these sectors should be made. Farmers may be issued identification cards stating all basic details about his area under tree cultivation, tree species planted with year of plantation, nature of expected produce etc to facilitate transport of wood so produced.

Government should stop all types of subsidies on supply of wood and other forest produces that are produced in these sectors to industries. Government should also provide support prices and other incentives to agroforestry produces at par with agricultural crops.

There is a need for evolving mandatory minimum standards for wood products in general and products made from agro/JFM wood in particular, to ensure the most efficient use of wood.

The industries based primarily upon agroforestry/JFM produce should be given the status of agro industries and such wood and wood based industries need to be promoted through credit and marketing support.

Technological aspects

Identification of short rotation tree species suitable for different agro climatic conditions and prevalent agricultural practices and development of appropriate processing techniques to use wood from these species for manufacturing standard value added products and consumer goods should be a continuous process.

New products from agro/JFM wood, including composites in combination with other natural fibers, need to be developed to increase the value of the wood through effective research and development.

Development of suitable technology packages, including primary processing that can be taken up by the producers themselves close to production centers will help enhance income to producers and needs to be done on priority.

Wood use for power generation through gasifiers may an important area of research to meet the power needs in interior areas as also in small-scale industries.

The institutes specially mandated for wood products research viz. Indian Plywood Industries Research and Training Institute, Bangalore; Forest Research Institute, Dehradun; Institute of Wood Science and Technology, Bangalore need to be strengthened. National Research Centre for Agroforestry at Jhansi and Centre for Social Forestry & Ecorehabilitation at Allahabad should be upgraded as national

institutes for imparting training and extension work. Moreover, Institutes of CSIR having infrastructure for research related to wood and wood products and other similar Government institutes should also be co-opted through efficient networking.

Extension aspects

Research institutes and forest department should organize intensive training programs for farmers in various identified thrust areas in tree growing, product development and marketing viz.,

- Selection of suitable tree species
- Grading, standardization and quality parameters of wood and wood products.
- Post-harvest processing technology for forest produces.
- Value-added produces through technology input that can be done locally.
- Product diversification technology
- Creation of awareness about the properties of reconstituted wood products to enhance their acceptability.

For such training programme, in addition strengthening the specialized/dedicated training institutes viz. Forest Research Institutes, Dehradun; Indian Plywood Industries Research and Training Institute, Bangalore; training facilities at the State Forest Service Colleges of Government of India may also be used.

Infrastructure/facilities

Creation of adequate farmer industry relationship and effective marketing infrastructure is absolutely essential for growth and development of agro forestry/JFM sectors. This includes common multi-purpose market place (mandies or regulated markets) in identified growth centres with forward linkages with processing industries to work as link between producers and consumers and dissemination of information on planting and processing techniques.

Evolution of forest product marketing information system will enable the farmers make informed decisions relating to what to plant and when to harvest and where to sale and thereby maximize financial returns accruing to them from the activity.

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CHAPTER- VI

Legal and Policy Issues

Introduction

The policy framework of the Social Forestry programmes in the country was based on the report of the National Commission on Agriculture (NCA, 1976), which recommended using private farm land and community lands for growing fuel wood and fodder to meet rural people's subsistence needs. However, the experience of the past decade is that the main motivating force behind farm forestry has been growing wood for the market. On the other hand, forest lands are still being used by gatherers. The National Forest Policy (NFP) of 1988 gave a thrust to farm forestry by laying down that, as far as possible, forest-based industry should meet its raw material needs by establishing a direct relationship with the farmers. This, in a sense, accepts the present pattern of the use of private land and reverses the recommendations of the NCA, which favoured commercial plantations on forest lands and tree planting for meeting the subsistence needs on private lands of the rural people. The NFP objectives could be achieved by supporting the individual with credit, technical advice, harvesting and transport services and allowing farmers to carry out unrestricted felling, logging, processing, transport and marketing of forest produce. Legal and policy support should strengthen the growth of private forestry sector.

The government strategy on farm forestry succeeded only in agriculturally progressive regions and not in subsistence-oriented regions. Whereas in south Gujarat and western UP a high proportion of farmers adopt farm forestry, the situation is different in subsistence regions of eastern UP, Madhya Pradesh, Orissa and Bihar.

Agroforestry is being aimed at production of commercial wood through involvement of farmer for domestic and export market besides meeting their household needs and for environmental stability. The basic issue is to address the challenges of sustainable livelihood, ecological security and employment generation. **It also has an agenda for export promotion and import substitution through this enterprise.**

The stakeholders

Three broad groups of stakeholders are interested in agro/ farm forestry: landholder, industry and government. An understanding of their broad objectives is required to assess the extent of their successful efforts. What is it that motivates each of these groups?

- Landholders generally aim at more profitable and sustainable properties that will also contribute positively to wider community goals and meeting the needs of timber, fuel wood, small timber, agricultural tools and poles, etc. without compromising with the objective of crop production.
- The absentee landlords who are mostly in government jobs, or other business away from their native place wish to use it as long-term investment and secure the title on land.
- Industry generally aims to secure high quality, economic and reliable supply of forest products.
- Government generally aims at balancing private and public interests for regional development, reduce environmental degradation, and reduce the national trade deficit in forest products. It also aims at augmenting per unit area productivity of tree crops to meet the gaps in demand and supply of wood and non-wood products.

The Expected Benefits?

Agro/ farm forestry offers the following benefits to different stakeholders: -

Landholder

- Increased farm productivity – by providing more shade and shelter from harsh weather for livestock, pastures and crops;

- Improved natural resource management – by controlling rising groundwater, wind and water-induced soil erosion, and spread of weeds;

- Increased sources of income – to increase household income;

- Improved use of existing farm labour and financial resources – by integrating with other farm activities;

- Reduced farm expenditure – by using tree products on farm, such as timber for fencing, firewood and buildings;

- Increased conservation values – by contributing to wildlife corridors and ecological buffer zones;

- Improvement of degraded landscapes-often leading to higher property values;
- Improved regional environmental and economic values, increased carbon sequestration, improved organic matter in the soil, better nutrient recycling, especially with off-site benefits (e.g. increased local employment, improved water quality in the region);

- Improved lifestyle appeal of farm life;

- Less labour demanding, so less of labour problems; and also round the year employment guarantee to the households;

- Productivity from marginal, sub marginal & degraded lands.

Industry

- Increased supply of an economic and reliable source of raw material;

- Improved access to future supplies;

- Improved quality of forest products suited to processing;

- Improved cost-efficiencies for processing (e.g., no need to purchase land);

- Supply in the proximity of industry.

Government

- Increased opportunities for regional development – with improved farm productivity, profitability and increased employment with forest management and processing industries;

- Reduced costs in long-term financial support to the agricultural sector (e.g., Rural Adjustment Scheme);

- Improved environmental management at a farm, regional, national and international scales- with direct and indirect benefits (e.g., assisting control of 'greenhouse' gases and improved water quality);

- Reduced contention between industry environmental groups, and landholders – by providing benefits to all groups;

- Reduction in imports due to increased raw materials and increase in export due to quality products from the farm.

What Constitutes "SUCCESS' in Agro/ Farm Forestry?

Furthermore, there is a great diversity of expectations from agro/ farm forestry among the landholders, industries and governments. Landholders can operate as individual or collectively (e.g. grower cooperatives), industries can include small-scale local processors or international processors and government can operate at local, state and national levels. Also, when attempting to judge whether farm forestry is successful, it is important to remember that the people involved may change their objectives over the years. For example, markets may alter and force

changes to the products required. As the farm business changes, so economic calculations of the farm forestry enterprise will need to be adjusted.

Success may be assessed in terms of better use of farm labour, positive environmental changes, and increased financial returns. It has spatial and temporal dimensions. For example, what might seem like a business failure if judged after three years might become a business success after 15 years. In general, however, 'successful' farm forestry is perhaps best seen as incremental improvement and the likelihood of long-term profitability and sustainability – be it from the perspective of landholders, industry, or the governments.

Characteristics of a successful Agroforestry Programme

A good agroforestry model should meet high standards of productivity, sustainability and adaptability. The success depends upon: -

- Remunerative price for the produce and market perfection;
- Research and marketing support from Govt. agencies, Industries & Agricultural Universities and Colleges, ICAR and ICFRE Institutes;
- Liberal marketing system and sustained demand;
- Institutionalising trade;
- Unrestricted felling, transportation, processing and marketing;
- Increased research on short rotation multipurpose trees;
- Policy and legal instruments in force to safeguard the interest of stakeholders.

Constraints to Agro/ Farm Forestry Development

Legal Restrictions

- A major constraint, which has emerged in the farm forestry programme, is the whole legal arrangements, which put restrictions on tree felling, transportation and sale. At present, in a number of States, restrictions have been imposed on tree felling. The legal provisions, due to historical reasons, are scattered in revenue laws, forest laws and laws specially created for the purpose. This is a strong disincentive for tree growing by farmers and in diversifying the species grown. There is a great deal of variation in these laws from state to state. The restriction applies selectively to species, regions and nature of land holding. In Tamil Nadu, for example, there are restrictions on felling of some tree species marked as 'royal trees', like teak, black wood, ebony and sandal wood, which cannot be felled without permission of the Forest

Department, irrespective of whether the trees are grown on private or government land. Similar restrictions exist in case of Karnataka and UP. These restrictions are particularly hard on small farmers who have little access to bureaucratic system for obtaining permits.

- Transit restrictions are embodied in the Forest Act and rules and regulations framed there under by different States. They are basically designed as measures to prevent government forest from pilferage. Legal requirement for obtaining permit to transport timber/ wood to the market encourages involvement of middlemen. However, several liberalizations on the basis of proximity to forests and type of species are possible. The species which are not found in forests and whose wood is distinct can be exempted from transit restrictions. Similarly, in areas away from forests where there is no threat of pilferage from forests, transit restrictions can be liberalized.

- Many States have taken steps for liberalization of these restrictions. For example, *Eucalyptus* and Poplar have been exempted from the category of requiring felling permit in some parts of UP and in many States but this is not widely known to the farmers. The number of species which can be felled without permit needs to be greatly enlarged to include all species (including fruit trees) which farmers grow on their own land. If any restriction on natural forest species is felt necessary, it may be confined to areas adjacent to natural forests.

- There is no doubt that easing restrictions will result in large-scale adoption of farm forestry. However, there are two schools of thoughts regarding returns to the farmers. While one sect argues that easing restrictions will lead to greater return to the farmers, the other argues that given the nature of the trading operations, restrictions may not play any role in returns to the farmers but may just increase the cost in the market and removing restrictions may just lower the price in the market through competition among the traders. To take two examples, i) the selling price of eucalyptus hit the lowest in Gujarat the year restriction were removed, and ii) in spite of the fact that Haryana and Punjab have no restrictions, prices fell in the year restrictions were removed/relaxed, in other states.

Flow of Institutional Finance

Institutional funding is very important in areas where a farmer-industry nexus is to be established. However the experience in the last 10-15 years shows that the flow of institutional finance into forestry program has been minimal. There are many reasons for this. Some important ones are: -

- There is a dearth of technical and economic data on different farm forestry models, which make it difficult to evaluate the bankability of various kinds of

farm forestry projects. Urgent steps need to be taken to work out economics of various farm forestry models.

- The lending banks do not have adequate capability to assist in formulation and appraisal of projects for farm forestry. Capacity building of bank staff needs to be undertaken along with build up of infrastructure.

- Producers and banks often find the associated risk unacceptable. Banks feel that they are not adequately covered against default. There is also no insurance system to guard against the loss to producers and banks against various natural calamities.

Poor Farm Forestry Extension Programme

The extension agency should be supported by a strong research unit which would identify suitable species, prepare yield and volume tables, fix rotation, establish demonstration and collect useful data for the user farmer. This has not reached such a level to make it a real motivating force.

Agroforestry and Farm forestry extension is a specialized activity and needs a separate infrastructure with a systems bias.

Marketing of Farm Forestry Produce

State Forest Development Corporations (SFDCs) were established in each state with a view to eliminating the private contractor. The roles and responsibilities of SFDCs differ from State to State. However, they have not proved very efficient in marketing. They use four modes of product disposal such as public auction, allocation, supply order to public undertakings and retail sales.

National Forest Policy, 1988 sought to discontinue the practice of raw material supplies to industries at concession. However, SFDCs are still one of the dominant suppliers of timber to industries at administratively controlled prices. This acts as a disincentive to farmers both in terms of price as well as volume. The floor prices of SFDCs neither reflect the market prices nor their supply captures the market trends. For instance, in the State of UP, the poplar wood supplied by the Forest Corporation is the cheapest and accounts for about 77% of the total procurement by WIMCO (about 18000 cum per year), while farm-produced poplar is meeting about 8% of the procurement. Remaining portion comes from a South Indian soft-wood species.

Industrial Policy

India's industrial policy with regard to forest based industries followed, till recently, the patterns of protection to domestic industries. This was manifested by imposing heavy import duty on paper and paper products, and panel products which

made the landed cost of international paper higher than domestic price. As a result of this protection, domestic prices of these products are much higher than international prices. Due to the protection given, domestic industries have remained inefficient by being small in size leading to diseconomy of scale, and continuing with outdated technology. They did not have any compulsion to be efficient in the absence of external market threat. The import duty on paper was as high as 150%. Industries' complacency was further accentuated by the concessional supply of raw material at below market prices. Several issues have been taken into account in shaping new industrial policy of the country such as removal of compulsory licensing requirements in many industries, removal of barriers for import of raw-material and so on.

Import and Export Policies

The existing import-export policies were formulated for a period of five years (1997-2002) with the following objectives (Chemprojects, 1999): -

- Accelerating the transition to a globally oriented economy with a view to derive maximum benefits from increasing global opportunities;

- To stimulate sustained economic growth by providing access to essential raw materials, intermediates and components and capital goods required for augmenting industrial production;

- To enhance the technological strength of the industry and services, thereby improving their competitive strength;

- To provide consumers with good quality products at reasonable prices.

The present import and export polices have resulted in: -

- Reduction in the import tariff of a number of forest based raw materials and finished products resulting in increased volume and value of imports.

- The large-scale import has, to a great extent, helped to bridge the demand and supply gap, and allowed the industries to utilize some of their idle capacities. As a result of zero duty on logs, imported timber is cheaper than domestic timber by bout 20-30 %. As a result, both farmers as well as the Forest Development Corporations are finding it difficult to dispose off their timber.

- Ban on export of primary and unprocessed wood-products has proved a dis-incentive for the private tree growers due to falling prices. It is reported that such ban on export has resulted in illicit felling and smuggling in the Eastern bordering states. Further, export ban on valuable timber has caused loss of foreign-exchange earnings.

- Tariff on import of capital goods has been a discouragement to forest-industry modernization and green field projects.

Box 1: India's Industrial Policy and Impact on Forest-Based Industries

In 1997-98, the number of industries subject to compulsory licensing has been reduced from 14 to 9. Plywood, venners of all types and other wood-based particles board, medium density fiber board/blockboard and paper and newsprint (except baggasse based units) has been removed from requirements of compulsory licensing. The investment ceiling of plant and machinery for small-scale industrial undertakings has been enhanced to Rs. 30 crores. The list of the industries eligible for foreign direct investment has been expanded.

Other policy measures announced for reviving industrial investment are: -

Reduction in income tax and corporate tax.

Reduction in excise duties on intermediaries and customs duties on raw material.

Reduction in Bank rates and cash reserve ratio.

Even though licensing procedure has been done away with the forest-based industries growth has not been stimulated owing to the provision of in the National Forest Policy which states that

No forest-based industries, except that at the village or cottage level should be permitted in the future unless it has been first cleared after a careful scrutiny with regard to assured availability of raw material. In any case the fuel fodder and timber requirements of the local population should not be sacrificed for this purpose.

The new industrial policy has not helped in the forest-based industries growth. Five out of the seventeen broad groups have registered negative growth rates during April-February 1997-98 of which the wood and product industry have shown the highest negative growth rate (-8.6 percent).

The other most important policy, which has had impact on the forest-based industries, is the liberalization of the wood and wood products imports. Logs and sawn wood are allowed to be freely imported to India, which has to a large extent released the pressure from natural forests.

Adopted from: Chemprojects, 1999

Box 2: Need For a Review of Import Policy of Paper and Paper Products

The paper industry has warned that the present import policy for some items of the industry could act as disincentive adversely affecting the survival and growth of the industries. The industry claims that the 100 years old industry is on the verge of closure on account of certain policies. The industry has an annual turn over of Rs. 9000 crores and contributed to Rs. 17000 crores to exchequer. The industry, which has been registering an annual growth rate of 7-10 percent is struggling to even reach 4 percent.

The sudden reversal in the fortunes of the industry has taken place on account of the government effecting: -
Drastic reduction in the customs duty, from 140 percent to 20 percent till recently (within a short span of 3-4 years) and

Doing away with the rate for newsprint.

The World Trade Organization (WTO) mandated an overall rate of 40 percent to be achieved by 2005, but the Government of India chose to reduce the duty rate much below WTO rate, which is to be achieved progressively. The industry is now faced with clandestine imports, which is threatening the survival due to the difference between duty rates of news print and paper. The tariff duty applicable on various items of the industry and industry demand is given below :

Categories	**Customs duty before last budget**	**Present duty after budget**	**Industry demand**
Paper & Paper Board	20 percent	30 percent	40 percent
Special Customs Duty	Nil	4 percent	Nil
News Print	10 percent	5 percent	40 percent
Glazed News Print	5 percent	Nil	40 percent
Light Wood Free Coated	20 percent	Nil for publisher	40 percent

Adopted from Chemprojects, 1999

The new policy has opened up the market for logs, processed timber and forest-based industrial products such as pulp and paper products. Due to the large scale import of logs and pulp, prices of domestic timber, especially farm-grown *Eucalyptus* have fallen, while that of high value timber like teak and Sal have remained high.

One of the primary obstacles for the industries' performance has been the lack of high quality raw materials. The main drawback of agro-based residues

includes seasonal fluctuations in raw material supply, high transport and storage costs along with inferior quality products. The possibilities of increasing high-quality recycled fibre imports will be limited due to increasing utilization of wastepaper in the source countries. Hence, the above scenario necessitates a stable policy for supply of raw material from private growers through providing right kind of price and policy incentives.

Therefore, the situation calls for the review of import policies on two grounds. Firstly, the long-term impacts of low import price on the profitability of farm forestry and social forestry programmes need to be addressed. Secondly, the wisdom of a liberalized import policy, which drains valuable foreign exchange, and also which may not be sustainable due to WTO's insistence on sustainable forest use certification and pressure of environmental groups in the source countries.

Export of Forest-based Products

India has a comparative advantage in the export of high-value timber like rosewood, sandalwood, etc., and the export ban has deprived the country of this advantage. There is a need to expand the export of processed products such as sports goods (hockey-sticks, cricket bat, rackets, etc.), handicrafts, utilizing the trees raised under farm-forestry.

Apart from timber, there are a wide variety of forest-based products with export potential such as fatty oils (mango kernel oil, Cashew shell oil, Sal fat and so on), essential and aromatic products (lemon grass oil, sandalwood oil, palmarosa oil, etc.), medicinal plants, gums and resins, tans and dyes, fibres and flosses, bamboo and cane and so on which could be conveniently taken up under farm-forestry.

Policy Support to JFM

The concept of people managed forests in India gained popularity less than two decades ago when governments realized that forests can not be managed without the cooperation of the communities living in and around them. This led to widespread adoption of Joint Forest Management (JFM). The National Forest Policy of 1988 took note of the importance of protecting the livelihood security of the people who live in and around the forests, along with the ecological and environmental objectives of forests management. This policy brought with it a new dimension of people care: people living in and around forests became the stakeholders in forest management. Consequent to the 1988 Forest Policy, the Central Ministry of Environment & Forests issued detailed guidelines to state governments on June 1, 1990, to involve village communities living close to the forests, in the protection of forests and development of degraded forestland. It also prescribed usufruct benefits to participatory village communities to meet their demands of forest produce and active participation in afforestation programmes. It paved the way for voluntary agencies and non-governmental organizations to be associated as an interface

between the FD and the local village communities for the revival, restoration and development of degraded forests.

The success of new institutional arrangement depends on: -

- The institution is rooted in the society's value system and developed with long-term objectives in view.
- It is supported by appropriate legal and policy environment.
- The technology, the institution and the environment are mutually harmonized.
- Common resources are left to the community, while simultaneously strengthening the institutions of local self-government.
- Keeping the distributive effects in view, the less well-off sections of society are cushioned from the impact of exposure to the market.

Specially, an institution such as JFM is likely to succeed if, in addition to the general requirement just outlined, certain specific conditions are ensured, such as: -

- Suitable forest patches are entrusted to well-defined user groups with stake in their management.
- Security of tenure as well as of long-term access to the benefits from the resources are assured to them.
- Stakeholders are also given a voice in the decision making regarding the resources, and thus an incentive to accept limitations on individual rights as collectively wealth-enhancing.
- Satisfaction of local needs and participation of all affected individuals/families are ensured, along with a built-in mechanism for conflict resolution.
- Adequate resources to sustain the programme over time are ensured.
- A well-designed marketing strategy for the surplus forest produce is established.

Suggested Action Plan

- Farm forestry has an immense potential for meeting various demands for forest-products, besides generating handsome monetary returns. The models adopted in different States have exploited only a small potential of farm-forestry and agroforestry grossly because of lack of awareness and infrastructure support.

- Lack of market intelligence and timely delivery of information to farmers is, one the bottlenecks which needs to be removed.

- For effective extension a number of mass communication tools specific to farm forestry need to be developed. Mass communication tools have been revolutionized after the induction of computers, audio-visual aids and multi-media projections in the application.

- The Forest Department at present lacks the expertise in market information analysis; and also its experience in extension activities has not always been successful. Capacity building of the Forest Department and other stakeholders in analysis and distribution of information on market trends for farm forestry products in particular and in extension techniques in general, would go a long way in large-scale adoption of farm forestry by farmers.

- In view of the above, there is an urgent need to device a farm forestry extension strategy at the national level covering the following aspects.

- Development of an agroforestry and farm forestry extension program for State Forest Departments and private extension agencies.

- Production of appropriate extension materials to sensitise the users.

- Better understanding the current markets and marketing systems for wood products.

- Building the capacity of State Forest Departments in the analysis and dissemination of market information to farmers.

- Development of institutional mechanism for deployment of extension strategy.

Legal Provisions

- The Acts, Rules and Regulations of State Governments should be so amended that restrictions on felling, transit and conversion of agroforestry trees from farmers land are removed.

- The agroforestry species for commercial production should initially be limited to six ie. *Eucalyptus, Poplar, Casuarina, Acacia nilotica, Bamboo* and *Prosopis cineraria*.

- The States should amend Land Ceiling Act to exempt the farmland under agroforestry from land ceiling.

- The market of agroforestry products should be regulated through Mandi Parishad Act and the Forest Corporations of the State. A provision of buy - back guarantee must be provided to farmers.

- The Saw Mill Acts in different States should be so amended so that low horse power Saw Mills (upto 3bhp.) could be installed easily for conversion of small timber at the place of production. It will facilitate value addition of forest produce at production level.

- Amendment in the Rules banning the installation of new agroforestry-based industries is strongly recommended.

- The quality of seedlings & clones should be controlled through suitable Agroforestry Nursery Act & Rules, so that the farmers get standard and certified planting stocks.

Policy

- National Forest Policy 1988 envisaged that forest based industries should meet their raw material needs by establishing direct relationship with farmers.

- The Forest Departments in their plantation programmes, should plant only long rotation species like Sal, Teak etc. as against the short rotation crops preferred for farm forestry in that area. Many state governments have initiated steps in this direction.

- The government should stop subsidies on government supply of wood to industries, thereby motivating industry to buy from farmers at a remunerative price. The Forest Corporation and Department should instead encourage farm forestry cooperatives.

- There is a lack of system of collection and dissemination of market information. As a result, farmers are ignorant about marketing and prices. It was observed in case of UP that, while different uses require different grades of timber and offer different prices accordingly, the farmers are selling their timber on standing tree basis without their grading. On the other hand, intermediaries are performing this task and able to earn more.

- Provision of support price for farm-grown timber to check exploitation of farmers.

- Establishing institutional mechanisms for developing linkages between farmers and industry.

- The Energy Policy of the country should recognize the significance of agroforestry in supplying timber, small wood, fuel wood and other local industrial fuel wood needs of the area.

- The tariff on import of timber and wood products should be regulated to encourage their domestic production.

- Bamboo and bamboo products should be brought under positive list of export.

- Institutional finance through NABARD and other banks be provided to needy farmers under low interest rates.

- The proposed National Land Use Commission should recognize agroforestry as a scientific alternative land use for increasing productivity, reclamation of soil and sustainable land development.

- Agroforestry crop of farmers must be provided insurance cover at low premium.

- Agroforestry should be promoted on a concept of Industrial catchment. Its linkage with industries should have the same financial incentives as industries themselves. Agroforestry should be treated as infrastructure for Industrial development.

- In line with Prime Minister's emphasis on linking education with development, agroforestry is the ideal beginning with a view to bring environmental awareness and improved agricultural land productivity. It is proposed to involve all Agriculture Colleges Universities for growing improved seedlings on a self-sustained and regular basis. A seed money of Rs. 5 lacs may be provided initially for three years to develop nursery infrastructure and as a revolving fund.

- For all technical and marketing information and for demonstration the farmers should use the nurseries at ICAR and ICFRE Institutes, Universities & Colleges.

- The farmers should be given a scientific package of practices for nursery, planting, thinning, felling, transportation and sale.

- The quality of seedlings, clones etc. should be controlled through Agroforestry Nursery Act & Rules made there under.

- All benefits of subsidies, loans, grants and benefits of rural development schemes must flow for farmers adopting agroforestry.

- Agroforestry Consortium/ Board should be created at National level to plan, boost and tackle the problem of linkage between industries, farmers, financial institutions, research, marketing, import and export of timber & other forest products.

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CHAPTER – VII

Financial Resources

Introduction

In order to have 1/3rd of the total reported land area of the country (305.7 m ha) under forest/ tree cover, it is necessary to have approximately 100 m ha under forest or other tree plantations. Presently, 63.73 m ha are under forests, of which 25.50 m ha are degraded. Only 37.73 m ha area is under good forest cover. However, it is estimated that about 20 m ha outside the forest area has been brought under tree cover through various tree planting programmes taking the total area under tree cover to 57.73 m ha. Therefore, another 43 m ha are required to be brought under tree cover within and outside forest areas through Greening India Programme.

Inadequate financial resource has been one of the major reasons for continuous deterioration in forest resource. The allocation to the forestry sector has not shown increase in real terms. Flow of funds from Employment Generation Schemes of Ministry of Rural Development to afforestation activities has reduced significantly (Rs.240 crores in 1989-90 to Rs.34 crores in 1995-96). Allocation of plan funds to forestry sector has been less than 1% of the total plan outlay of the country as well as the State plan outlay as against the desired share of 4% to 5%. This is required to be addressed with definite strategy and options.

Greening India through agroforestry practices in non-forest lands and regeneration of degraded forest area under JFM initiatives is viewed as programme to ensure ecological security, employment generation, food accessibility and livelihood resource enhancement. The upcoming problems of agricultural wastelands viz., water logged, saline sodic and eroding degraded lands may require agroforestry as a bio-remediation measure. Apart from generating non-monetary environmental benefits, agroforestry generates high income and minimise risk in cropping enterprise. It provides long term investment opportunities, diversified land use and commercial tree cropping. Tree farming also generates diversified onfarm employment and supports forest based industries supplementing supplies of their raw material. In the context of fragile eco zones agro-forestry has special significance in arid and semi-arid and mountainous zones to be developed as a farming system with spectacular gains. In fact agroforestry is the best solution for wastelands development and for practising sustainable agriculture, being no more an option but imperative.

Regeneration of degraded forest areas through JFM is gaining fast popularity. Almost all States have started JFM covering an area of about 11.629 m ha managed by 44,943 committees. In Andhra Pradesh, it is one of the components for institutional finance support under Rural Infrastructure Development Fund (RIDF).

Flow of Funds for Greening Purposes – Current Status

Government Funding

Tree plantation programmes outside forest areas have been supported mainly under two programmes viz., (i) Social forestry; and (ii) Wasteland development schemes of National Wasteland Development Board (NWDB), now Department of Land Resource (DOLR) under Ministry of Rural Development. Whereas funding of social forestry schemes have been operated by different states under externally aided projects, the wastelands development schemes is a centrally sponsored one under the Ministry of Rural Development. Ministry of Environment & Forests through National Afforestation and Eco-Development Board is funding three major plantation schemes viz., Integrated Afforestation and Eco-Development Projects (IAEP), Area Oriented Fuelwood and Fodder Projects (AOFFP) and Non Timber Forest Produce (NTFP). All these schemes are required to be implemented with full community participation based on JFM approach. However, the area of operations of these schemes as per the mandate of NAEB is limited to the forest and fringe forest areas. The physical and financial targets of NAEB supported schemes during the 9th Plan Period are given below: -

Table 1: Schemes of NAEB

Name of the Scheme	Physical Target (area in ha.)	Financial Target (Rs. in crore)
Integrated Afforestation and Eco-development Project	2,26,925	247.00
Area Oriented Fuelwood and Fodder Project	3,46,532	135.00
Non-Timber Forest Produce including Medicinal Plants	50,000	80.50
Tree and Pasture seed Development		6.00
Grant-in-aid to Voluntary Agencies		8.00

Funding from non-forestry sector up to Seventh Five Year Plan of the rural development schemes viz., RLEGP and NREP had the provision of earmarking 20% of their budget for tree planting but this provision was withdrawn in Eighth plan, which was restored under the JRY scheme. DPAP, DDP, IWDP with the total Ninth Plan outlay of Rs.1125.64 crores has agroforestry and afforestation as one of the components. Under Technology Development, Extension and Training scheme (TDET), agroforestry projects are also sanctioned for implementation in community land, government land and private farmers wastelands. Under Investment Promotion Scheme (IPS) funds are provided for implementation of agroforestry projects in non-forest wastelands only.

In addition, Department of Agriculture and Co-operation implements certain programmes in non-forest land, which include tree plantation and agroforestry component. These programmes include:

- Soil conservation in catchment of river valley project;
- Integrated watershed management in the catchment of flood prone rivers;
- Watershed management for shifting cultivation in North East
- Other integrated watershed projects including externally aided projects.

The current annual availability of funds for tree planting and regeneration of forest cover through various schemes and programmes is summarised in the following Table 2.

Table 2. Current Annual Fund Availability for Tree Planting/ Regeneration of Forests

Sr. No.	Particulars	Rs. in crores
1.	Integrated Afforestation and Eco-Development Project Scheme	33.00
2.	Fuelwood and Fodder project Scheme	40.00
3.	Development of Non-Timber Forest Produce including Medicinal Plants	11.00
4.	Integrated Wastelands Development Projects	85.00
5.	Tree Planting and Regeneration Component under Externally Aided projects	450.00
6.	Tree Planting Effort under Rural Development Schemes	140.00
7.	Grant-in-aid scheme (NAEB)	1.55
8.	Association of ST and Rural Poor in Regeneration of Degraded Forests	2.10
9.	Eco Task Forces	5.00
10.	Technology Development Extension and Training Scheme	6.00

11.	**Investment Promotional Scheme**	**3.00**
12.	**Support to NGOs/VAS**	**4.00**
13.	**Afforestation/Regeneration Component of State Plan Forestry Budgets (60% of total forestry outlay)**	**690.00**
14.	**Soil Conservation in Catchments of River Valley Project**	**81.00**
15.	**Integrated Watershed Management in the Catchment of Flood Prone Rivers**	**48.00**
16.	**Watershed Management for Shifting Cultivators in North Eastern States**	**15.00**
	Total Annual Availability	**1614.65**

External Funding

There are 10 externally aided afforestation projects under implementation by various State Governments with a total outlay of Rs.2839.34 crores. In addition there are two central sector projects being implemented by the Ministry of Environment and Forests with the project cost of Rs.487.40 crores. Most of these externally aided projects are finishing by the end of this year.

Private Sector Initiatives

The private sector initiatives contributing to the development of tree plantations include wood based industries, tree co-operatives, plantation companies, NGOs and individuals. Private forestry initiatives have greened more than 10 million hectares of area. Among Corporate Sectors, WIMCO Seedlings Ltd. is pioneer in the field of tree farming and agroforestry. The company has done good work for the development of poplar in the northern belt of India. Their schemes of poplar development have been supported by institutional finance as raising of poplars are highly economical and profitable ventures. Apart from WIMCO, ITC Bhadrachalam, Kitply Industries, J K Paper Mill, Harihar Fibre, West Coast Paper Mills, Star Paper Mills and other paper and pulp wood industries have promoted raising of their raw material. Tree Co-operatives mainly in the States of Gujarat and Maharashtra have added to the greenery of India through mobilisation of private and group resources but the size of investment is not known precisely.

A large number of plantation companies have come up during the last one-decade or so collecting sizeable funds from individuals with the promise of raising plantations and paying rich dividends thereof. According to SEBI the amount raised by such 50 selected plantations companies was of the order of Rs.2010 crores.

However, the greening efforts through these mopped-up funds from public do not appear commensurate to the funds collected.

There are a number of NGOs who are involved in the tree planting activities but their role is mainly of facilitators. Only few are involved in growing quality planting material and distribution. Individual farmers with larger holdings have also invested in tree plantations as agroforestry and block horticultural plantations, timber and other tree crops.

Institutional Finance

Only a small amount of Rs.21.05 crores has been reported to be funded through Agricultural and Rural Development Banks under the category of wastelands and dry land development so far. NABARD has sanctioned refinance to the forestry and wastelands activities starting with Rs.988 lakhs during 1982-83 reaching the peak of Rs.2905 lakhs during the year 1990-91. There has been almost a continuous decline thereafter in the amount of refinance reaching the level of Rs.945 lakhs in the year 1998-99. This clearly indicates that there has been a fall in demand of credit to this sector from 1990-91. The ground level credit to the sector would be about 10 to 20% more in excess of the refinance amount.

Different types of schemes refinanced by NABARD may be grouped in two categories i.e., farm forestry and agroforestry. Farm forestry schemes relate to raising trees on individual farmlands and in conformity with National Forest Policy. NABARD refinances schemes for raising trees on cultivable wastelands. Various schemes receiving support of NABARD under this category are fuelwood plantations/ pulp wood plantations, horticultural crops, medicinal plantations, fodder development schemes, nursery development schemes, shifting cultivation control schemes, tassar/ lac cultivation, sisal plantations, captive fire wood plantations schemes by tea estates, bamboo plantations, etc. Whereas farm forestry was primarily meant for individual farmers, a number of wood based industries have also raised such plantations of individual wastelands through tie-up arrangements on mutual sharing basis. The examples of such arrangements are ITC Bhadrachalam, Papers Board Ltd. in Andhra Pradesh, Straw Products Ltd. in Orissa, etc.

Under the category of agroforestry, trees are raised along with agricultural/ horticultural crops, grasses etc. on the same piece of waste/ marginal/ agricultural lands and the example of such scheme is WIMCO's Kadamb plantations project in Assam and West Bengal. NABARD approves farmforestry/ agroforestry/ watershed development schemes for wastelands development based on technical feasibility and financial viability and schemes having the basic objective of producing fire wood, pulp wood, fruits, small timber etc. NABARD fixes targets for wastelands development annually.

RIDF Funding

Under Rural Infrastructure Development Fund (RIDF) – V, NABARD agreed to fund JFM projects to be implemented through 'Van Samrakshana Samithis' (VSS) in the State of Andhra Pradesh. The Government of Andhra Pradesh sought the assistance under RIDF-V of Rs.50 crores (raised to Rs.65 crores subsequently) covering 14 districts and 1366 VSS with an area of 136000 ha. The project has the following components:

- Treatment Practices
- Support Services
- Training
- Administrative Cost.

The average unit cost adopted per ha varied from Rs.4,000/ha to Rs.6,660/ha depending on the area.

Potential Identified

Base PLP (Potential Linked Plan) for Ninth Plan Period (1997-98 – 2001-2002) prepared by NABARD indicates the credit requirement of the order of Rs.80016.65 lakhs under forestry and wastelands development. (**Annexure VII**). The estimated credit needs for plantations and horticulture for the same period is Rs. 690194.96 lakhs (**Annexure VIII**). It is assumed that the bulk of the forestry, wastelands development programme and about half of the plantations and horticulture may fall under agro/ farm forestry.

Performance Review

The schemes of NABARD for farm forestry/ agroforestry have met with very limited success and the refinance under this sector during the last 5 years averages out to about Rs.10.8 crores, which is too meagre an amount for such a large country. The probable reasons considered for this is the internal rate of return for such activities which varied from 17.5 to 24% and which could easily be affected by adverse weather or market trends. Other factors may be the longer gestation period of tree farming and uncertainties because of the poor quality of lands on which such plantations were generally raised.

A study by IIFM Bhopal on the disbursement of loans by banks for farm forestry in Orissa and Maharashtra pointed out the following weaknesses:-

- It took between 6 to 18 months for sanction of loans. This delay seriously inhibited the enthusiasm of the tree planter.

- The local banks do not take the responsibility for providing assistance on technical matters. They send the application to NABARD, which shifts the risks of the failure of the project from the financing bank to NABARD.
- Value of land on which trees are sought to be planted is much less than the loan applied, hence farmers are asked to arrange for collateral.
- The tree crop is required to be insured at a very high premium, which is a heavy burden and reduces the profitability of the scheme.
- Credit is not linked with forward and backward linkages.
- As per the guidelines of NABARD, farm forestry can be raised only on wastelands, and not on productive farm lands. As government has not classified any lands as private wastelands, in each case of loan, the Revenue Department has to certify that land is unsuitable for crops.

Financial Requirement

Requirement of Fund

Financial resources required for greening of the degraded forest and non-forest lands would be of the order of Rs.4800/- crores in a year as against the current availability of Rs.1615 crores. Therefore the additional funds requirement to the tune of Rs.3185 cores will have to be met from various source sectors including plan and non-plan budget of the Central and State Governments, afforestation/tree planting components of the Rural Development and Wastelands Development schemes, Watershed management programme of Agriculture Department, Externally aided projects having tree plantation components, financial institutions and private sector sources. Looking to the current status of financial resources made available for afforestation and tree planting programmes, this amount is quite substantial. Innovative funding arrangements are therefore proposed to fund the Greening India Programme. In view of limitation on availability of funds through budgetary sources greater reliance is placed on institutional sources as also on non-cash support like food for work.

The estimates of the total financial requirement for a 10-year timeframe are given in Table 3.

Table 3: Financial Requirements for Greening India

(Rs. in crores)

Programme	Total For 10 years	Annual requirement				
		Total fund required	Labour wage Component (60%)	Labour Wage		Net cash Component A-B+D
				Food Component	Cash Component	
		(A)	(B)	(C)	(D)	(E)
15 m ha of degraded	10500	1050	630	315	315	735

forest under JFM @ Rs.7000/ha						
10 m ha Irrigated agr. lands @ Rs.10,000/ha	10000	1000	600	-	600	1000
18 m ha Rainfed agr. lands/ culturable wastelands @ Rs.15,000/ha	27000	2700	1620	810	810	1890
Total	**47500**	**4750**	**2850**	**1125**	**1725**	**3625**
Funds required for Research, Extension, HRD, etc.	500	50	-	-	-	50
*Fund required for Storage and distribution of food grains (infrastructure strengthening)	562.5	56.25	-	-	-	56.25
Grand Total	**48562.50**	**4856.25**	**2850**	**1125**	**1725**	**3731.25**

*5% of food component (Rs 1125)

Strategy and Approach

Separate strategy will be adopted for greening of different categories of land. In case of non-forest lands the strategy would involve a massive tree plantation drive largely through multiple agencies depending upon the ownership and status of land. It is presumed that greening of rainfed and other culturable wastelands (18 m ha) will be covered under the schemes and programmes of the Ministry of Rural Development (Department of Land Resources). Greening of irrigated lands (10 m ha), roadside, canal side plantations and other community forestry plantations will be carried out by the social forestry wing of the State Forest Departments. In case of degraded forest land with good rootstock (15 m ha) the greening (through

regeneration and rehabilitation) would be mainly through the institution and initiatives of JFM by special wing of State Forest Departments.

National Forestry Action Programme (NFAP) stipulates afforestation of the degraded forest and non-forest lands in a 20 years time frame covering rehabilitation of 30 m ha of degraded forest land and plantations of another 30 m ha of non-forest lands by State Forest Departments. The operation would involve annual target of 3 m ha as against the current annual target of about 1.2 m ha. This quantum jump representing an increase of 150% will have many implications in terms of resources viz., financial, human and institutional. Any single Ministry or Department may not be able to launch such a big programme. Keeping the above in view, the Task Force recommends the strategy of Greening India mainly under two approaches: -

- Under JFM regenerating and planting of degraded forest lands with natural root stock to the extent of 15 m ha i.e. @ 1.5 m ha in a year and
- Covering 10 m ha of irrigated agricultural land and 18 m ha rainfed culturable wastelands under agroforestry/ social forestry system. These categories of land outside forest areas would be the cultivated lands, degraded lands, road side lands, absentee agricultural lands and area around farm bunds etc., which would be available exclusively for social and farm forestry. Express highways, rural roads and large number of major and medium irrigation projects are likely to be completed in the first decade of new millennium. Circumstances warrant greening of all these project areas. Thus the total coverage would be @ 2.8 m ha per year for ten years.

Institutional Mechanism

In order to carry out the gigantic task of Greening India in a 10 years time frame i.e., by 2011, a **Green India Authority** would be set up in the Planning commission of India. This Authority will have powers for effective coordination, monitoring and evaluation of the programme. The authority will be supported by 8-10 Consultants who will work out various details, feasibilities and provide feedback on execution of the programme. The Authority will also operate the **Green India Fund** to be created**.**

Funding through “Food for Work” Scheme

Afforestation/tree planting programme being labour intensive, with about 60 per cent of cost component as wages provides considerable scope for funding the tree planting activities through ‘food-for-work’ scheme. In fact a number of forestry schemes in different states have been implemented under World Food Programme (WFP). Food surpluses currently available in the country can gainfully be utilised for such work which will solve the problem of food wastage and storage on the one hand and reduce unemployment and hunger besides the demand of cash component to implement the Green India Programme on the other. In the core tribal areas life is a continuous struggle against hunger, malnutrition, polluted drinking

water, infection, disease, ignorance, oppression, naxalite and violent conflicts. They would like to join the global market as producer of medicinal plants, bamboos and multipurpose tree species.

The recently concluded Indian Science Congress having its focus on food, nutrition and environmental security has recommended that the food surplus has to be managed and used to augment infrastructure and create employment for the rural poor. The extent of funding of Green India Progrmme through "food for work" scheme would be 50% of the wage labour, which would reduce the overall requirement of funds through budgetary and institutional sources. However, the arrangements for storage and distribution of food for work especially in the remote rural and tribal areas will need strengthening of the existing storage and distribution arrangements or even creation of desired facilities. Therefore, about 5% of the total funding requirements will have to be added towards meeting the above cost. As an incentive for the labour to get involved in the Greening India Programme, a wage bonus of about 15% to 20% may also be included. Considering the average daily wage rates in the forest areas being Rs.50/-, an increase of about Rs.10/- may be taken as a bonus.

Funding for development of degraded forests under JFM

Regeneration/planting of degraded forest area under JFM has now become an eligible component for support under Rural Infrastructure Development Fund (RIDF) operated by NABARD. With a view to accelerating completion of agricultural infrastructure projects, RIDF was set up in NABARD from April 1995 primarily to support the on-going projects related to medium and minor irrigation, soil conservation, watershed management and other rural infrastructure projects including rural markets, godowns, cold chains, etc. During 1999-2000 a change in the policy relating to RIDF provided promotion of financing of project of PRIs/ NGOs/ SHGs. During the same year NABARD accepted the proposal of funding JFM initiatives in Andhra Pradesh and agreed to fund to the extent of Rs.50 crores initially. For JFM the funding is to be done on the same terms and conditions i.e., 7 years repayment period with 2 years grace period where interest @ 11.5% will be paid. The modus operandi will include preparation of a project report by the Forest Department and its appraisal by the funding agency i.e., NABARD. The funds for RIDF are loaned to NABARD by commercial banks towards meeting of shortfall of their financing the priority sector, which NABARD uses for on-lending to various State Governments, and therefore repayment is fully secured. Under this arrangement the constraints on availability of funds is not anticipated. It is expected that to the extent of 20 per cent of funding under RIDF (of about Rs.5000 crores annually) can be available to support JFM provided states come up with proposals. A sample of Terms and Conditions for RIDF funding as also for implementation of JFM activities are given in **Appendix-II.**

Funding of Greening Programme on Non-forest Lands

This component will be supported by government funding through budgetary provisions as also through institutional sources and ”food for work” scheme. Agroforestry development can be financed by commercial and co-operative sector banks under refinance support of NABARD. With the adoption of viable agroforestry models backed with technological and extension support, agroforestry is expected to attract institutional finance. For soliciting Bank support specific projects and feasibility studies will be required and this can be organised through the consultants supporting Green India Authority.

Along with availability of credit at an affordable rate of interest availability of qualified manpower with the financing institutions is also necessary in order to vet and process the project proposals. Qualified and trained personnel are required by financing institutions for this purpose.

Development of farm forestry and tree plantations on other culturable wastelands will have to be funded through various programmes and activities of Ministry of Rural Development, Ministry of Environment & Forests and Ministry of Agriculture. The relevant schemes are JRY/ EAS/ DPAP and DDP, which together have a substantial outlay under each five-year plan. A large part of funds under these schemes are allotted for tree planting programmes. Under Integrated Rural Development Programme (IRDP) and Technology Development, Extension and Training (TDET) Scheme resources can be harnessed to provide training to women for raising nurseries. Integrated Wastelands Development Project (IWDP) of the Department of Land Resources is specifically meant for tree planting activities in non-forest wastelands on watershed basis. Similarly, funds available under Agriculture Department schemes of soil conservation, watershed management, river valley project, shifting cultivation etc., can also be channelised for tree planting programme.

Commercialisation of Agroforestry: Private Sector Initiative

It is necessary to involve wood based industries for popularising various agroforestry models among the farmers. Poplar agroforestry has been very much successful in Northern States, but we do not have similar agroforestry model for other parts of the country except Eucalyptus and Casuarina. It was because of the success of these trees in Agroforestry, credit support was provided by banking institutions. Hence, there is tremendous scope for promoting viable agroforestry models for different agro-ecological regions of the country through tripartite arrangement among industries, banks and farmers. Research Institutes under ICFRE and ICAR have developed a number of agroforestry models but these are mostly restricted to research farms. These models need to be taken to cultivators field. In order to solicit Bank finance for tree farming, identification of technically feasible and financially viable agroforestry models for different agro-ecological

regions of the country have been worked out by the Task Force sub-committee (**Appendix-I**).

Marketing

Marketing network is the key to success of agroforestry. The respective state governments through Forest Development Corporations or similar organisations should set up marketing outlets in rural areas. Wood based industries may also open outlets for purchase of agroforestry produce from the farmers.

Extension Service

Provision of spearhead team of extension experts capable in motivating people, organising training and guidance in marketing of their products through continuous interaction with farm leaders will be of tremendous help. Besides, workshops on agroforestry in different parts of the country involving farmers, bankers, scientists and government officials would help in popularising the viable models.

Financing of Agroforestry: Line of Action

- NABARD, over a period of time have been preparing district-wise reports entitled Potential Linked Plans (PLPs) where economic activities for credit support are identified. Such district-wise schemes are consolidated at State level in the form of State Focus Reports. Review of such PLPs can be made to identify the agro/ farm forestry schemes to be taken up for implementation with the support of institutional finance. While preparing PLPs for the next five year plan/annual plans, agro-forestry may be included as a separate head for identification of district-wise potential and estimation of credit needs.

- The 'shelf of projects' for different regions should be limited to six specified species so that appraisal becomes easier. Although the agro-forestry model will be available for different agro-climatic regions, location specific agro-forestry projects will be required for individual financial sanctions. Regional Rural Banks (RRBs) should be included among credit institutions for Agroforestry Development.

- In areas where farmers have standing trees, there is requirement for considering such trees as assets for guarantee during financing and there should not be any need for the collateral security. Differential interest rates/interest subsidy may also be considered in appropriate cases.

- Farmer organisations with homogenous activities like self-help group, agroforestry co-operative may be desirable for a better agroforestry development and ease of financing by the banks. In the PLP, district level

credit plan of regional banks should also be prepared with separate head for agro-forestry and target may be fixed for each area.

- Wherever agroforestry financing is considered on wood catchment basis, a tripartite linkage between the bank, industry and farmer may be a highly viable system for credit support and ensuring the financial viability of the venture. Industries can also fund certain component of the projects.

- Since it is expected that agroforestry initiative will meet the requirement of imports substitution and export, export oriented units/projects in prime areas of high productivity for each species may be identified where suitable incentive is provided in the form of quality nursery, seasoning/ processing of wood and value addition so that full potential is exploited. Since agro-forestry starts giving output right in the first year from the associated crops an annual pay back for its management is possible. Sizeable savings are expected through import substitution, which is over Rs.8000 crores per annum. This can meet a large part of funds requirement for Greening India.

- A separate cell of agroforestry may be required to be created in NABARD as also in some of the banks to properly process the projects and provide appropriate financing for the agroforestry development.

Green India Fund

In order to take advantage of the tree planting component of various programmes there has to be effective synergy and co-ordination between the activities and funding of the MoRD, MoEF and those of the Department of Agriculture and Co-operation for which an appropriate institutional mechanism needs to be evolved. It is proposed that a Green India Fund granting Rs. 500 crores by Planning Commission of India is created under the Green India Authority and the existing 'Fund' lying inoperative with the Ministry of Environment & Forests is merged with the Green India Fund. This fund will act as a funnel for internal as well as external sources and would be operated by the Green India Authority.

External Assistance

Ministry of Environment and Forests is implementing 10 externally aided projects currently. However, recently there were 19 externally aided projects under implementation in 13 States of the country with a total approved assistance of Rs.4227.28 crores and the annual assistance ranging from Rs.450 crores to Rs.500 crores. Main donor agency to the forestry sector projects have been the World Bank, OECF Japan, DFID, EEC, UNDP, Germany and SIDA. However, rough estimates indicate that external funding in the forestry sector will decline to Rs.300 crores by 2002-03, unless special efforts are made in this regard. Externally aided projects have given a boost to the development of this sector but the external assistance were not the additionality rather a part of the State plans outlay. In view

of the sizeable requirement of funds for the Greening Programme, external assistance may have to be operated on a different pattern to make the additional resources available for the purpose. A 'shelf of projects' for external assistance can be developed by the Green India Authority and posed to donors and multilateral funding institutions as per requirements.

Conclusion

- In order to have 1/3rd land area under tree cover rehabilitation and planting of 43 million hectares will be done under Greening India Programme in a 10 years time frame. The break-up of 43 m ha would be as below: -

  - 15 m ha of degraded forests to be covered under JFM;
  - 10 m ha of irrigated land;
  - 18 m ha of rainfed areas to be covered under agroforestry system.

- Estimated total requirement of funds for greening would be of the order of Rs.48,000 crores which works out to Rs.4,800 crores per annum. About 30 per cent of this requirement would be funded through 'food-for-work'.

- Mobilisation of funds through institutional sources would be under RIDF operated by NABARD and other co-operative, commercial banks and RRBs who will finance viable agroforestry projects with assured market.

- For the purpose of effective coordination and spearheading the programme at the national level a Green India Authority with statutory powers would be set-up in the Planning Commission.

- In order to channelise funds from various domestic and external sources for the purpose of Greening India, a Green India Fund would be set up with Green India Authority in the Planning commission. An initial grant of Rs 500 crore should be provided by Govt of India as seed money.

- Since most of the externally aided projects are completing by this year-end, efforts should be made for sanction of new projects.

- Ministry of Food & Civil Supplies should provide sufficient food grain under 'food for work' scheme for the implementation of JFM and agroforestry projects. The total requirement of food grain would be of the value of Rs 1125 crores annually over a period of ten years.

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CHAPTER VIII

CONCLUSION AND RECOMMENDATIONS

Forests and trees are required for protecting both the environment and the human habitat. Forests help in maintaining ecological balance and conserving biodiversity, protection of watersheds, aquifers and medicinal plants, influencing weather and climate patterns. It can also support a self-sustaining process of nutrients cycling, nitrogen fixation, organic matter additions, enriching of soil and improvement of drainage. Simultaneously, forest products are vital for the welfare of rural communities, while helping to meet their basic needs for wood, food, fuel fodder, fibre and organic fertilizers. As an inseparable component of the total land use system, forestry has significant inter-relationship with agricultural, pastoral and food producing systems. Through soil and water conservation it can protect fragile ecosystems (mountains, deserts, coastal areas, islands, etc.) and can promote sustainable agriculture. All forestry activities generate employment and income and ensure food accessibility through "Food for work" scheme, hence capable of empowering women, tribals and other weaker sections of the society.

Due to inexorable human and cattle pressure on the forests about 41% of forest cover of the country has already been degraded resulting in land degradation often severe in the upper watershed areas, loss of biodiversity and carrying capacities and escalating poverty. Poverty and environmental crisis are thus closely interlinked calling for holistic approaches and solutions. There is a dire need to identify present institutional weaknesses, research needs, financial inadequacies, legal and policy constraints, participatory mechanisms and other problems for the development of forest/ tree cover and greening the country.

To reverse the process of forest degradation and improving greenery the following efforts have been made in the past: -

- Indian Constitution was amended and forestry was made concurrent subject. Article 48-A stated, 'The State shall endeavour to protect and improve environment and safeguard the forests and wildlife of the country'. Article 51-A (G) enshrined as fundamental duty of each citizen 'to protect and improve the natural environment including forest, lakes, rivers and wildlife, and to have compassion for living creatures'. Similarly 73rd and 74th amendment of the Constitution authorized Panchayats and Urban local bodies to promote social forestry and urban forestry.

- National Forest Policy (1988) was adopted with the basic objectives of-

i) Efforts to be made to bring one-third geographic area of the country under forest and tree cover by plantations on all categories of lands for increasing ecological and environmental security.
ii) Increasing forest/ tree cover through massive afforestation and social forestry, Joint Forest Management and agroforestry through involvement of people and private initiatives.
iii) Increasing productivity of forests through molecular biology, biotechnology, forest produce research, processing and preservation technologies, marketing, etc.
iv) Encouraging efficient utilisation of forest produce and maximising substitution of wood (by renewable sources such as bamboo products).
v) Creating a massive people's movement with the involvement of tribals, women and other poor for their empowerment, employment generation and ensuring food accessibility.

- National Agriculture Policy (2000) was adopted with following objectives: -

i) The unutilised wasteland will be put to use for agriculture and afforestation.
ii) Areas of shifting cultivation will receive special attention for their sustainable management.
iii) Integrated and holistic development of rainfed areas will be promoted by conservation of rainwater through vegetative measures on watershed basis and augmentation of biomass production through agro and farm forestry with the involvement of the watershed community.
iv) Agroforestry and social forestry are prime requisites for maintenance of ecological balance and augmentation of biomass production in the agricultural systems. Agroforestry will receive a major thrust for efficient nutrient cycling, nitrogen fixation, organic matter addition and for improving drainage. Farmers will be encouraged to take up farm/agro forestry for higher income generation by evolving technology, extension and credit support packages and removing constraints to development of agro and farm forestry.

- With the State-owned forest lands becoming unable to meet the needs (direct and indirect) of the people, private forestry initiatives have been started by planting trees in wasteland, agricultural land, institutional land and non-forest public and private lands. Apart from the natural plant association predominantly of trees and other woods vegetation, the scope of forestry has widened to include tree (block and line) plantations, groups of scattered trees, agroforestry plots, small woodlots, urban tree planting and also wild lands which do not support tree population.

- The rapid increase in greenhouse gases in the atmosphere, large-scale deforestation, loss of biodiversity, severe land-degradation, increasing floods and droughts and environmental pollution have become subjects of serious global concerns. The overall impact of these phenomena is likely to result in a change of climate, depletion of ozone, a rise in sea-level, changes in agricultural output and loss of biodiversity, ultimately leading to an ecological crisis, capable of affecting the entire biotic species of this planet. Hence forestry has evolved from tree management to management of complex ecosystems covering both flora and fauna and their development and sustainable use.

- Today, forestry has a wide spectrum of interfaces and multi-dimensional array of impacts. The situation calls for new and in-depth knowledge about forest resources, their use and non-use values, externalities, their management and conservation, and inter linkages of forestry with other sectors. Physical developments that are poorly conceived, planned and implemented, are the causes of many of today's severe environmental problems affecting soil, water, flora and fauna, and integrity of ecosystems vital for human welfare and security.

- The emphasis on sustainability resulted from recent experience of planners that development, which does not conserve the environment, would not be sustainable. From a national policy point of view, sustainability is not an option but imperative. Equity and efficiency are aspects highly relevant to the concept of sustainability. **No strategy to conserve the forest ecosystem would be successful unless needs of the least advantaged and most vulnerable sections of society are met.**

- The local people living in and around forest areas enter forest in their neighbourhood for meeting some of their primary needs. This relation is as old as humanity and the forest-people interface is the direct outcome of this interaction. Any law will not easily alter this reality. The community would use forest through overt or covert means. The illegitimate nature of the interaction brings in dehumanising influence on the associating people and forest protection staff, poisoning the entire social life. The outcome is nothing less than a catastrophe. It will adversely affect the people and the forest. Legitimisation of participation of people in sustainable management and benefit sharing is a step in the right direction.

- Faced with looming raw material shortage, the corporate private sector has started investing in research and development and exploring innovative methods (eg. several companies have started outgrower schemes) for ensuring raw material supply. Several companies are engaged in research and development of improved higher-yielding clones.

- There is ample evidence that given the right environment, farmers could easily green the country and meet the raw material needs of forest-based industries. There is a need for countrywide review of all laws and procedures related to tree felling, transport and sale, and those found to be constraining agroforestry should be amended. Availability of credits, quality planting material, market and remunerative prices will go a long way in spreading agroforestry.

- India is a signatory of all declarations, conventions, protocols and principles but without much perceivable effect. Department of Forestry was started as early as in 1984. For developing research and technology on all aspects of forestry (scientific, technological, economic, social, environmental and institutional) the Indian Council of Forestry Research and Education was started to keep dynamism of the sector and to support sustainable development. However, the situation of forestry has reached a critical stage. It is necessary to muster new strengths to address the existing and emerging challenges.

Growing Trees Outside Forest Areas

The per capita availability of forests in India is one of the lowest, 0.08 hectares, against an average of 1.07 ha for developed countries and 0.64 hectares for the world as a whole. While there has been improvement in controlling deforestation (As per Forest Survey of India Report for 1999 the forest cover increased by 3896 sq km since the previous assessment of 1997) but forest degradation or qualitative loss of forests is continuing. Immediate action is needed for regeneration, rehabilitation and afforestation of existing forests and its production and management with the involvement of people under Joint Forest Management.

Forest resources and forest lands should be sustainably managed to meet the social, economic, ecological, cultural and spiritual human needs of present and future generations. These needs are for forest products and services, such as wood and wood products, water, food, fodder, medicine, fuel, shelter, employment, recreation, habitats for wildlife, landscape diversity, carbon sinks and reservoirs and for other forest products.

"Sustainable forest management will ensure that the values derived from the forest meet the present day needs while at the same time ensuring their continued availability and contribution to long term development needs". Such management should be able to harmonise forest management policies and to develop a pragmatic, realistic and beneficial conservational forestry system to optimise the socio-cultural, ecological, environmental and economic values of the tropical forests.

The reason for having 33.3% area under tree has been elaborated in the forest policy of 1952 and it is on the basis of proportion of forests in the Europe and the World at that time. The same goal of 33.3% was pursued in the NFP, 1988 also

but with a subjective difference. While NFP, 1952 emphasised to increase forest area to a minimum of one-third of the country's area, the NFP, 1988 envisaged that the national goal should be to bring one-third area under forest and tree cover. The policy makers of NFP, 1988 were aware of the fact that forest area cannot be extended to one-third of the country's total area and hence they replaced words `forest area' of 1952 policy with `forest and tree cover' in the 1988 policy.

Trees are to be grown outside the forest areas to meet the following factors: -

Climatic

- Greenery
- Temperature and radiation
- Wind movement
- Humidity
- Precipitation
- Absorption of greenhouse gases and release of oxygen.

Edaphic

- Conservation of soil and increasing fertility.
- Agroforestry for efficient nutrient cycling, nitrogen fixation, organic matter addition and for improving drainage.
- Reclamation of degraded and fallow lands as well as problem soils.
- On grazing land increasing availability of animal feed and fodder and avoiding compaction of soil.
- Rehabilitation of shifting cultivation for their sustainable development.
- Greening deserts, `Usar' lands and rehabilitation of mined areas.

Hydrological

- Infiltration;
- Recharge of ground water;
- Moisture retention;
- Integrated Watershed Development;
- Improving drainage of command areas

Environmental

- Reducing atmospheric pollution
- Protection against chemical-air contamination
- Noise protection
- Checking droughts, floods, falling ground water table.
- Greenery, shade and improving living conditions

Quality of life

- Meeting fuelwood, fodder, fibre, timber, bamboo and non-timber forest produce needs of the people.
- Ensuring "Health for All" through supply of medicinal plants.

- Assured supply of raw material to small-scale industries for generation of employment and income to the people.
- Supply of timber and bamboos for construction of earthquake proof houses.
- Green belts of plants having high pollution tolerance and dust trapping capacity can help us to live healthy.
- Coastal shelterbelts can save us from expansion of seawater and frequent cyclones.
- Shelterbelts and afforestation programmes can check the advance of deserts.
- Integrated Watershed Development Programme through vegetative measures will check soil erosion, moisture conservation, ground water recharge, fodder production and promoting sustainable mountain development.

Agroforestry Promotion

The National Agriculture Policy, (2000) clearly states, "**Agriculture has become a relatively unrewarding profession due to generally unfavourable price regime and low value addition, causing abandoning of farming and increasing migration from rural areas**." Hence the Policy stresses, "**Farmers will be encouraged to take up farm/agro-forestry for higher income generation by evolving technology, extension and credit support packages and removing constraints to development of agroforestry**."

Rural people have been practising tree planting in their farms and homesteads, to meet household requirements for fuel, poles, timber and medicinal plants. With the advent of social forestry, diversification in agriculture was encouraged to generate high income and minimise risks in cropping enterprises.

For promoting agroforestry, it is recommended that: -

- Rather than having a uniform strategy for the whole country, commercial agroforestry strategy should be adopted in irrigated districts of the country.

- A separate strategy should be developed for rainfed areas for environmental security, sustainable agriculture (production and economy) and food accessibility.

- Suitable species for commercial agroforestry may include *Acacia nilotica*, *Bamboo* species, *Casuarina equisetifolia*, Eucalyptus species, *Populus deltoides* and *Prosopis cineraria* for different climatic, edaphic and agricultural conditions.

- Specific institutes have been identified (details in Chapter IV) for tree improvement and development of clones of specified species.

- Corporate private sector may be encouraged to take up research and development in tree improvement work, development of better clones and micro and macro propagation of quality planting material.

- About 100 NGOs may be identified to carry out clonal propagation of seedlings for distribution to farmers at appropriate prices and carrying out extension work. Extension activities should include organisation of farmers, providing them training in planting technique, protection measures and other silvicultural operations.

- Technological development to diversify usage of agroforestry species will help to ensure a ready market; for example bamboo is getting rediscovered as a potential raw-material for the development of bamboo composites suitable to be used in place of wood and wood composites.

- Bamboo technology missions should be started keeping in view the impending gregarious flowering, followed by mass mortality of all bamboos, forest fires, famines and insurgency. Circumstances warrant formulation of emergency plans, harvesting and processing of bamboo prior to their flowering.

- As more and more farmers are taking up agroforestry, export-import policies should be modified to encourage agroforestry product marketing. Import of all items of forest produce is allowed on OGL, similarly exports of all forest produce should be permitted.

- A system of market regulation to be put in place, including a mechanism of periodic review in order to protect the interest of both producer and consumer of agroforestry produce.

- A suitable market information system needs to be introduced to inform farmers about the major buyers, prevailing prices trends, procedures etc.

- All existing laws, executive orders related to tree felling, transport, processing and sale should be amended to facilitate agroforestry as encouraging and profitable enterprise.

- Commercial agroforestry may be planned in 101 districts covering 10 m ha of irrigated area. On annual basis, one million ha should be brought under Multipurpose Fast growing tree species identified by the task force. The scheme of NABARD for farm/agroforestry should be expanded and investment of Rs.1000 crores per year should be ensured.

- It is proposed to cover 18 million ha of rainfed areas on watershed basis under agroforetry for conservation of soil and water and plantation of hardy species such as Eucalyptus, Bamboo and Babul. On annual basis 1.8 million ha is proposed for afforestation under various schemes of Rural Development, NAEB and 'food for work' scheme. An investment of Rs.2700 crores will be required on yearly basis.

- Major states may establish Agroforestry Cooperative Federation for increasing bargaining powers of the farmers in marketing of agroforestry products.

- Wood based industries should continue supply of quality planting material to farmers and ensure suitable buy-back arrangement.

Rehabilitation of degraded forests under JFM

The biomass and growing stock of wood in the natural forests of India is 93 ton/ha and 47 m^3/ha respectively, as against an average of 169 ton/ha. and 113 m^3/ha for developed countries. Thus productivity of Indian forests is far below the developed countries and on the top of it these forests are expected to sustain the forest produce needs of one billion people.

About 40% population is directly dependent on forests for meeting their basic subsistence needs viz. food, fodder, fuel, fibre, fertilizers etc. Due to increasing population and other pressures about 31 million ha of forests has degraded (less than 40% crown density).

Due to inability of government agencies to stop or reverse the degradation process, a greater role of private sector has been envisaged – local communities on State forest land and farmers on non-forest lands. The National Forest Policy of 1988 took note of the importance of protecting the livelihood security of the people who live in and around forest, along with ecological and environmental objectives of forest management. This policy brought with it new dimensions of people care and people living in and around forest area became the stakeholder in forest management. Emphasis was laid on involvement of people in regeneration, protection and management of forests with sharing of benefits.

Rehabilitation of degraded forests is possible through people's participation in regeneration/plantation, protection (JFM) for social/ commercial production. For this potential to be realised and sustained in the long run it is recommended to ensure the following conditions: -

- Suitable forest patches are entrusted to well-defined user groups (the poor and forest-dependent group) with stake in their management.
- Security of tenure as well as long access to the benefits from the resources is assured to them.

- Silvicultural prescriptions followed for management of JFM forests are sustainable and the supply of forest produce is in line with demand.
- Stakeholders have a voice in decision-making regarding the resources, and thus an incentive to accept limitations on individual rights as collectively forest wealth enhances.
- Satisfaction of local needs and participation of all affected individuals/families are ensured, along with built-in mechanism for conflict resolution.
- Adequate resources to sustain the programme overtime are ensured.
- A well-designed marketing strategy for the surplus produce is established.
- Meeting subsistence and livelihood needs of forest-dependent communities should be the first charge on JFM areas; only after they have been met should commercial needs be met.
- Ecologically fragile areas should not be looked upon for meeting any commercial needs. However, if such areas are brought under JFM, the community should be clear about the kind of benefits/returns to be expected from the start.
- The demand-supply situation for products from JFM forests should be re-examined: the presumption that demand exists and will absorb all new supplies does not seem valid. To realise the full potential of the forests a combination of practices need to be applied ranging from policy changes to changes in marketing infrastructure, change in the product mix being harvested, or introduction of new forest based industries to use the produce harvested.
- Among States, only Andhra Pradesh has issued Government order on 22.9.2000 for the involvement of industries in supporting VSS (a form of village forest protection committee) in rejuvenation of degraded forest areas. This practice should be adopted by other states as well for improving marketing of JFM produce and enhancing the economy.
- JFM has resulted not only in improvement of status of forests but also helped the VSS members in improving their economic status. In the meeting of the State Investment Promotion Board (SIPB) held on 31.12.1999, it was decided that the industries interested in the forest-based raw material should be identified and a tie up should be worked out with the VSS so that both are benefited. On this decision some industries like, ITC Bhadrachalam, Reliance Industries and Murugappa Industries have shown interest in supporting VSS in regenerating the degraded forest areas and providing marketing through buyback arrangement. Concerted efforts are needed to tie up raw-material supply to industries by VSS.
- Special projects may be prepared by States to rehabilitate 15 million ha of degraded forest areas in 10 years period. NABARD funds can be availed under Rural Infrastructure Development Fund (RIDF) –V, External aided projects can also be formulated.

- Under “Food for Work” scheme JFM areas can be greened by ensuring employment generation and food accessibility to people. However, the food component should be only 50% of the total wage.

For the success of JFM following arrangements are necessary: -

- Legal back-up to JFM Committees
- 50% members of the general body and 33% in the executive with at least one office bearer should be women.
- The technology, the institutions and the environment are mutually harmonised.
- Extension of JFM in good forest areas also (crown density about 40%) for production of medicinal plants, bamboos and other improvement forest produce needed for poverty alleviation.
- Conflict resolution mechanism
- Integration of microplan with working plan
- Appropriate institutional & financial mechanism
- Monitoring and evaluation.

Research and Technology Development

Mankind has always drawn on the richness of forests primarily for food, medicine and various raw materials. Science, the precursor of technology is not any more a free enterprise. The mushrooming scientific journals talk of soft science, but the cut edge technologies are either protected by patents or come with a heavy price tag, making it impossible to adopt them. Transfer of technology programmes eventually happens to be product-marketing exercise. This scenario creates a unique niche for a professional scientist to develop new technologies so as to add value to the rich biodiversity around him/her or in short bio-prospecting.

As a creative activity, forest science now needs mastering thoughts and methodologies evolved in culturally different mindscapes. It is time that we get fascinated by technologies that help the starving get their bread and to ensure soil, water clean air, greenery and shelter for our people. The progress, prosperity and peace will stay with us as long as we follow conservation ethics with technological and marketing advantages.

At present performance of forest plantations in the country, in terms of survival, growth, yield has been poor. The Mean Annual Increment (MAI) of forest plantations varies from about 2 m^3/ha/year for valuable timber species to about 5-8 m3/ha/year for Eucalyptus and other fast growing species. This may be compared to an MAI of over 10 m^3/ha/year generally and about 50 m^3/ha/year for good quality industrial plantations in different countries, over 70 m^3/ha/year has also been reported in certain cases. By any measure the performance of forest plantations in the country is far below the potential.

Inadequacies in site selection and site-species matching, poor planting stock, lack of proper maintenance and protection (from fire, grazing, pests, diseases) lack of timely tending/ thinning, delays in fund allocation supply of inputs and lack of adequately trained staff are some of the causes of low productivity which is a matter of ecological and economic concern.

Logging and processing technologies are generally inefficient, and cause a high amount of waste. It is surprising that while on the one hand there is wasteful use of raw material, on the other hand forest-based processing units have large unutilised capacity and importing bulk of raw material. Wood based industries in India are in the grip of serious raw material shortages. The factors contributing to the inadequate performance of wood-based industries include technological obsolescence, inappropriate machinery and its inadequate maintenance, lack of spare parts, low productivity of labour, lack of trained management cadre, over-capacity and over capitalisation, and poor quality of products.

About 40% of energy demand in the country is met through sources such as fuelwood, biomass and cow-dung. Fuelwood use in open hearths is conspicuously inefficient due to considerable heat loss. Improved stoves and modified methods of cooking can reduce fuelwood needs.

Seasoning and preservative treatment can increase the life of solid wood products. Policy incentives for modernisation of technology, and recycling of wastes, regulations regarding use of seasoned and treated materials, promotion of standard sizes and designs for bulk products such as wooden doors, windows, and school furniture and such other measures will help to improve efficiency in wood production and utilization.

The impending gregarious flowering will result in death of bamboo stocks followed by fire, famine and insurgency. For avoiding this national calamity emergency plans have to be formulated, for systematic utilization of bamboos before they flower. High quality bamboo germplasm may be collected (appropriate species which are reported never to have flowered) and planting material to be produced through biotechnological and conventional means. Bamboo plantation will ensure greenery, soil and water conservation and long-term ecological security for the country.

There is growing demand of medicinal plants for crude drugs, health products, pharmaceuticals, food supplements, cosmetic etc. in the national and international markets. International markets of medicinal plants are over US $ 70 billion per year, which is growing at the rate of 7%. Medicinal plants can be viewed as possible bridge between sustainable economic development, affordable health care and conservation of biodiversity in forest areas. Intensive research on medicinal plants will generate employment and income, improve health and happiness of people besides boosting export.

There is worldwide trend towards the use of bio-diesel as a substitute for diesel due to environmental problems. Untitled States Energy Policy Act provides for 30% motor fuels to be from non-petroleum sources by 2010. *Jatropha curcas*, having a large potential to be raised on fences in tropical climate in our country can be used for production of bio-diesel on commercial scale. Because of the prospects of curcas oil availability in sizeable quantities and multiple uses to which different parts of this plant can be put to, systematic studies on cultivation and management, selection and multiplication and elite germplasm practices, seed/oil potential, oil extraction technology, development of the oil/modified oil as diesel fuel and detoxification of the meal/cake are some of the aspects which need to be looked into.

Forest product research is another area, which calls for attention. Value addition through primary and secondary processing and marketing will increase employment and income and improve social welfare and alleviate poverty in backward areas.

In Indian philosophy there is no contradiction between action and the percept and, therefore all branches of science and technology at all times aim at creating a respectful disposition for all the elements closely connected with human beings. Science and technology is a powerful means to create a new, humane, non-exploitative peace loving social order.

It is, therefore, recommended to carry out following research and technology development efforts: -

- Protecting existing forest/trees from fires, diseases through suitable silvicultural practices.
- Increasing productivity and forest density by promoting regeneration, enrichment plantation, rehabilitation, afforestation, soil and water conservation through involvement of people in regeneration and protection and sharing of benefits.
- Selection of suitable clones (High yielding and disease resistant) for different edaphic and climatic conditions; development of technology for propagation of seedlings and extension work.
- Application of bio-fertilizers and bio-pesticide for boosting production and control of pests and disease.
- Forest-products research for value addition, new product development, and designs and downstream processing.
- Developing new generation products of bamboo composites and laminates for exports.
- The Role of plants as a source of drugs or novel molecules for use in medicine for prevention, alleviation or cure of diseases, and in the elucidation of many fundamental and unique physiological or biological processes of living organisms have created resurgence of interest all over the world.

- Researchers on all aspects of economics, social, environmental and institutional.
- Measures to sustain JFM beyond the project period have to be conceptualised for increasing sustainability, generation of productive employment and alleviation of poverty.
- Government should immediately mobilize funds for the scientific management of dense forests for optimum increment. There has been hardly any investment since last two decades for maintenance of dense forests. If these are further ignored, many problems of forest hygiene will appear like recent one in Madhya Pradesh where one million borer-affected Sal trees had to be felled.

Institutional Arrangement

For the purpose of addressing the different components of Greening India Programme, the following mandates are proposed for concerned Ministries/ departments.

Department of Agriculture and Co-operation

- It will provide marketing infrastructure/facilities for agroforestry/ JFM produce. This includes common multi-purpose market place (mandis or regulated markets) in identified growth centers with forward linkages with processing industries and dissemination of marketing information.
- A scheme on shifting cultivation is being implemented by the Department for north-eastern region with a meager outlay. It is suggested that an innovative scheme on shifting cultivation may be launched for the whole country by the Ministry of Tribal Affairs and the present scheme of the Ministry of Agriculture and Cooperation may be merged with the proposed one.

Indian Council of Agriculture Research

- It will provide agro-technique for agroforestry in rainfed areas. The National Research Centre for Agroforestry, Jhansi will particularly provide research and technological support and marketing strategy for development in rainfed areas. For this purpose, the Centre should be upgraded to an institute of national status.

Indian Council of Forestry Research & Education

- Development of suitable models for rehabilitation of degraded forests through Joint Forest Management.

- Identification and development of suitable technology package for propagation, planting, harvesting, processing, etc for important agroforestry species.

- Forest Research Institute, Dehradun and IWST, Bangalore should be strengthened to carry out forest products research on seasoning, processing, quality improvement and new product development of agroforestry and JFM produced wood. They should develop quality standards and designs for new products.
- Promotion of commercial agroforesty in the high potential districts, where irrigation facility and other infrastructure are developed. For this purpose, Centre for Social Forestry and Eco-rehabilitation, Allahabad should be upgraded to a national institute for commercial agroforestry.
- It should promote technology extension, public awareness, education and training on various aspects of agroforestry and JFM.

Indian Plywood Research Training Institute, Bangalore

- It should develop new generation products of bamboo composites and laminates for domestic and export market.

Indian Institute of Forest Management, Bhopal

- It should carry out socio-economic research on JFM and agroforestry.

National Bank of Agriculture & Rural Development

- It should facilitate the state governments in formulation of JFM projects and their assistance under RIDF.
- Adequate investment should be ensured for implementation of agroforestry projects in irrigated and rainfed areas.
- A separate cell of agroforestry/JFM should be created in NABARD for providing adequate thrust to this sector.

Department of Land Resources

- The ongoing Integrated Watershed Development Project should provide adequate thrust on JFM and agroforestry in rainfed areas.
- It should concentrate on raising of multipurpose trees to meet fuel, fodder and small timber needs of people.

Department of Bio-technology

- It should identify elite clones of six important agroforestry species ie. *Populus deltoids, Eucalyptus* species*, Casurina equisetifolia, Acacia nilotica, Prosopis Cineraria & Bamboo* species.
- It should standardize micro and macro propagation techniques, identify bio-fertilizer association and IPM technique for these six species.
- It should establish demonstration plots for field trial of tissue culture raised planting material of these species.

Department of Commerce

- Free import of forest produce adversely affects the development of agroforestry in the country. Suitable tariff should be imposed on import of forest produce (annual import is over Rs. 8000 crore) in the country to safeguard in the interest of farmers who are practicing agroforestry & JFM.
- Now, free import of all forest produce has been allowed in the country, similarly the export of all forest produce should be permitted without any restriction.
- Concerted efforts should be made to boost export of herbal and bamboo products, which have great potential to improve economy.

Ministry of Tribal Affairs

- It should act as a nodal agency for convergence of schemes intended for development of tribals.
- A separate scheme for rehabilitation of shifting cultivation should be launched under "food for work" scheme to improve food accessibility and socio-economic development of the people who are practising shifting cultivation.

Ministry of Food and Civil Supply

- Providing sufficient food grain for implementation of JFM and agroforestry projects. Total requirement of food grain would amount to Rs 1125 crore on annual basis over a period of ten years. It will judiciously utilize surplus food grain and ensure food accessibility and employment generation.

Department of Industrial Policy and Promotion

- Small-scale industries based on forest produce should be promoted on priority basis.
- Large-scale industries such as paper and pulp, rayon, etc should be encouraged to develop and use alternative raw material such as bamboo in tie with farmers and forest department. Bamboo is likely to be available in great quantity due to impending gregarious flowering of bamboo in north-eastern states and therefore, a master-plan for its systematic harvesting is imminent.
- Large number of saw mills and plywood factories that have been closed under Supreme Court direction, should be motivated to use bamboo as raw material.
- People living in and around forests are poorest of the poor and these areas are pockets of least industrial development. Indusrialisation of backward areas through setting up of growth centres in forest rich areas should be promoted.

Ministry of Environment & Forests

- Two separate departments, ie. Department of Forests and Department of Environment should be created in the Ministry. The bifurcation will not impose any additional liability. The National Afforestation and Eco-development Board (NAEB) should be abolished and the proposed Department of Forests should implement all its schemes.
- It should formulate policy and guidelines for successful implementation of Joint Forest Management under 'food for work' programme to ensure greenery and economic development of people dependent on forests.
- It should suggest guidelines for modification in legislation and regulation to allow unrestricted felling of trees, logging, transport, processing and marketing of forest-based produce by beneficiaries.
- It should formulate suitable projects to mobilize sufficient fund for implementation of JFM and agroforestry programme.
- A national policy on grazing should be formulated.

Planning Commission

- Creation of Green India Authority in the Planning Commission. This Authority will carry out effective co-ordination, monitoring and evaluation of the Greening India Programme. It will also operate the Green India Fund. An initial fund of Rs 500 crores should be allocated to Green India Fund as seed money.

State Governments

- They should remove restrictions on felling and transits of trees and processing of forest-based produce and establishment of forest-based industries that are using agroforestry/ JFM raw material.
- They should formulate JFM projects for assistance under RIDF operated by NABARD.
- They should remove the constraints in marketing of forest-based produce and improve marketing infrastructure for forest produce on lines of agricultural produce.
- They should formulate emergency plans for harvesting, processing and utilization of bamboo in view of its imminent gregarious flowering.

CONCLUSION

India supports more than 16% world's population on 2.5% of the global geographical area, with a land-man ratio that is one of the lowest for any country. Land being a finite resource, there have been pressing needs to convert forest lands into other forms and uses. Development of trade and marketing and facilities for transportation of goods increase the demand for forest products of both wood and

non-wood origin. Population increase, urbanisation and economic/income growth have brought in new demands and consumption pattern, spurred by development of mass markets. Land transfers, non integrated nature of land use policies and practices, as well as uncontrolled and unsustainable use of forest resources resulted in accelerated deforestation, resources wastage and forest degradation. These reduce the area under forest cover during the last 70 years on a scale much larger than ever been before.

The impact of loss and degradation of forest are in the form of soil erosion, losses on biological diversity, damage of wild life habitat and degradation of watershed areas, deterioration of quality of life and retention of option for development. The vast potential of forest and other available lands as major resources for development is not fully realised. The greening of suitable areas involve its component activities, is an effective way of increasing public awareness and participation in protecting and managing forest resources. It should include the consideration of land use and tenure patterns and local needs and improvement including following activities: -

- To maintain existing forest through conservation and management, sustain and expand areas under forest and tree cover through the rehabilitation, regeneration, afforestation, re-forestation and tree planting, with a view to maintain or restoring the ecological balance and expanding the contribution of forest to human needs and welfare.

- Carrying out re-vegetation in appropriate mountain areas, islands, bare lands, arid and semiarid lands and coastal areas for combating desertification and preventing erosion problems and for other protective functions through Joint Forest Management.

- Promoting Agroforestry for increasing tree cover to improve the sustainable agriculture.

- Promoting and supporting the downstream processing of forest products to increase retained value and other benefits. Improving environmentally sound methods and practices of forest harvest which are ecologically sound and economically viable including planning and management, improved use of equipment, storage and transportation to reduce the wastage of wood and non wood forest products.

- Establishing linkages between producer and forest based industries for improving economy and generation of employment.

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Annexure-I

No. MPC/E&F/99
Government of India
Planning Commission

Yojana Bhavan, Sansad Marg
New Delhi –110001.
Dated :

Subject: Constitution of Task Force on Development of Agro-forestry for improving Ecology, Sustaining Agriculture, Diversify production and alleviation of poverty.

It has been decided to set up a Task Force to provide policy directives, legal support, equitable marketing system to agroforestry for sustainable agriculture, diversified production, thriving of forest based industry besides improving bio-drainage of the land and economy of farmers. The composition and terms of reference of the Task Force are as under.

I. COMPOSITION

1.	Dr.D.N.Tewari, Member, Planning Commission	Chairman
2.	Dr.N.C.Saxena, Secretary, Planning Commission	Member
3.	Secretary, Department of Land Resources, New Delhi	Member
4.*	Dr.P.L. Sanjeev Reddy, Principal Adviser, Planning Commission	Member
5.	Dr. (Mrs.) Manju Sharma, Secreetary, Deptt. of Biotechnology	Member
6.	Shri Bhaskar Baruan, Secretary, Agriculture & Co-operation.	Member
7.	Secretary, Ministry of Environment & Forests.	Member
8.	Shri N.K. Sinha, Secretary, Animal Husbandry & Dairy Dev.	Member
9.	Secretary, Ministry of Food Processing Industries.	Member
10.	Shri Devi Dayal, Special Secretary, Banking.	Member
11.	Shri C.P. Oberoi, Special Secretary & Inspector General,MoEF.	Member
12.	Director General, ICAR, New Delhi	Member
13.	Director General, ICFRE, Dehradun	Member
14.**	Mrs J. Khanna, Pr Adviser (E&F),Planning Commission.	Member-Secretary
15.***	Dr. A.P. Dikshit, General Manager, AFC Mumbai.	Member
16.****	Dr P.S. Pathak., Director. IGFRI, Jhansi.	Member

II. TERMS OF REFERENCE

1. Inventorisation of agro-forestry models, and their adoption for soil and water conservation and increasing the productivity of the land.
2. Supply of quality seeds and planting material demonstration of agro-forestry techniques, sustainable management and processing measures.
3. Development of equitable marketing system of agro forestry produce and forest based industries.

4. Suggesting policy and legislative measures for felling, transportation and marketing of trees.
5. Suggesting measures for incentives and financial security to the tree growers to protect them from the fluctuating market price and damages due to natural calamities and pest damages etc.
6. Promotion of scientific and technological research for felling, sawing, processing of agro-forestry produce and reducing waste generation.
7. Identification of agencies, structures and systems for speedy and cost effective implementation.
8. Identification of critical areas in watershed, command area, DDP, DPAP, rainfed area etc for inclusion in agro-forestry development.
9. Identification of various existing as well as new drought resistant and value added species suitable for producing items for export and promoting employment, income and bio-diversity.
10. Identification of fodder species & pasture seed production.
11. Delineation of a "normative architecture for change and development", harmonizing main goals, guiding principles, main objectives and various sub components of the scheme facilitating sequential and calibrated execution of the agro-forestry scheme within a specified time frame.
12. The Task Force may invite inputs suggestions from other experts and agencies.
13. The non-official members will draw their TA&DA from the Planning Commission as per the rules and regulations of TA/DA as applicable to Grade-1 Officers of Government of India.
14. The Task Force may submit its report within 15 weeks from the date of constitution.

Sd/-
(Arvind Kumar)
Director (Administration)

Copy forwarded to:

1. Chairman and all members of the Task Force.
2. PS to Deputy Chairman, Planning Commission
3. PS to Minister of State (P&PI)
4. PS to all Members, Planning Commission.
5. Sr.P.P.S. to Secretary, Planning Commission.
6. All Principal Advisers/Advisers, Planning Commission.
7. Administration (General), Planning Commission.
8. Accounts-I Branch, Planning Commission.
9. Information Officer, Planning Commission.
10. Library, Planning Commission.
11. PS to Director (Administration)

Sd/-
(Arvind Kumar)
Director (Administration)

* He attended only the first meeting due to his transfer from Planning Commission.

** Pr Adviser, Mrs J. Khanna continued as Member-Secretary on transfer of Sri Pradeep Kumar, Adviser, Planning Commission.

*** Dr. A.P. Dikshit, General Manager, Agriculture Finance Corporation, Mumbai was co-opted as a Member.

**** Dr P.S. Pathak, Director, Indian Grassland and Fodder Research Institute, Jhansi was co-opted as a Member.

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Annexure-II

MEETINGS OF THE TASK FORCE

Six meetings of the Task Force on Greening India through Agroforestry and JFM were held. The participants and the major decisions of the meetings are given below.

First Meeting: 16 September 1999.

Participants:

1. Sh. K.C.Pant, Deputy Chairman, Planning Commission
2. Dr. D.N.Tewari, Member, Planning Commission
3. Dr. N.C. Saxena, Secretary, Planning Commission
4. Dr.P.L. Sanjeev Reddy, Principal Adviser, Planning Commission.
5. Dr. Manju Sharma, Secretary, DBT
6. Mrs. S. Nair, Addl. Secretary, Department of Agriculture & Cooperation.
7. Sh. Pradeep Kumar, Adviser (Env. & Forests), Planning Commission
8. Ms. Mira Mehrishi, Joint Secretary, Ministry of Environment & Forests
9. Sh. M.K. Sharma, Addl.I.G.F. Ministry of Env & Forests.
10. Dr. A.P. Dikshit, General Manager, Agriculture Finance Corporation, Mumbai
11. Sh. G.B. Singh, DDG (NRM), ICAR, New Delhi
12. Sh. P.C. Bhatia, ADG (Agronomy), ICAR, New Delhi
13. Sh. P.S. Rana, Joint Secretary, Ministry of Rural Development.
14. Dr. V.K. Taneja, AHC, Department of Animal Husbandry and Dairying,
15. Dr. Lalit Kumar, Dy, Adviser (E&F), Planning Commission
16. Sh. N.K. Singh, Dy. Adviser (E&F), Planning Commission
17. Sh. B.N. Srivastava, RO (E&F), Planning Commission

Major Decisions:

1. Dy Chairman, Planning Commission addressed the committee and called for an integrated approach for land resource development and enlisting people participation in the programme. Member, Planning Commission, outlined various issues concerning integrated land development and advocated agroforestry for sustainable agriculture, environmental upgradation and socio-economic development.
2. After discussion on the subject, it was decided to constitute 8 sub-committees to deliberate on various issues.

   1.Policy & Legislation – Dr. N.C. Saxena, Secretary, Planning Commission
   2.Linkages with various organisations – Dr. Sanjeeva Reddy, Pr. Adviser,
   3.Technology (Identification of important species) – Dr. G.B. Singh, DDG,
   4.Biotechnology Support – Dr. Manju Sharma, Secretary, DBT
   5.Processing Technology - Shri M.K. Sharma, Addl IGF & DG, ICFRE

6.Marketing & Trade – Ms. S. Nair, Addl. Secretary, DAC
7.Preparation of shelf of projects – Dr.A.P.Dikshit, GM, AFC, Mumbai.
8.Coordination aspects – Shri P.S. Rana, Joint Sec, Ministry of RD.

3. The Chairpersons of respective sub-committees were requested to submit their reports by third week of October 99.

Second Meeting: 30 November 1999

Participants:

1. Dr.D.N.Tewari, Member, Planning Commission.
2. Dr.N.C.Saxena, Secretary, Planning Commission.
3. Shri Pradeep Kumar, Adviser (E&F), Planning Commission.
4. Shri C.P.Oberai, IGF & Spl Secretary, MoEF.
5. Dr Manju Sharma, Secretary, Department of Biotechnology
6. Shri R. S. Shukla, CCF, Social Forestry, Lucknow
7. Dr. A.P. Dikshit, General Manager, Agriculture Finance Corporation, Mumbai
8. Dr. P.S. Pathak, ADG (Agroforestry), Indian Council of Agricultural Research
9. Shri R.L.Java, Retired PCCF, Baroda.
10. Ms S. Nair, Additional Secretary, DAC, Ministry of Agriculture
11. Shri Amar Prasad, Additional Commissioner (F), Ministry of Agriculture
12. Dr. S. Bhaskaran, Deputy Director, NIAM, Jaipur
13. Dr.S.K.Nath, Scientist, IPIRTI, Bangalore
14. Shri Alok Kumar, Director, Banking, Ministry of Finance
15. Shri A.K. Sinha, Director, MORD
16. Shri Arvind Kumar, AIG (Forests), NAEB, MOEF
17. Shri J.D.Sharma, DIG(F),Department of Land Resources, MORD
18. Dr.K.S.Rao, Director, Institute of Wood Science & Technology, Bangalore.
19. Shri A.K.Bansal, IFS, Director, IPIRTI, Bangalore
20. Dr.Renu Swarup, Principal Scientific Officer, DBT
21. Dr. Lalit Kumar, Deputy Adviser (E&F), Planning Commission
22. Dr.Anupam Joshi, Consultant (E&F), Planning Commission
23. Shri B.N. Srivastava, Research Officer (E&F), Planning Commission
24. Dr. O.P.Sharma, Research Officer (E&F), Planning Commission

Major Decisions:

1. The reports of the different sub-committees constituted in the first meeting were presented and discussed. The Chairman suggested revising the reports on these lines and submitting the report by 30th December 1999.

2. It was also felt that a small group be constituted to work out the details of suitable species for different agro-climatic regions in the country based on parameters like export feasibility, import substitution, local suitability, demand

of industries etc. This group would be co-ordinated by ICAR and will submit its report within 30 days.

Third Meeting: 8 February 2000

Participants:

1. Dr. D.N Tewari, Member, Planning Commission
2. Dr. N.C. Sexana, Secretary, Planning Commission
3. Mrs. J. Khanna, Pr. Adviser (E&F), Planning Commission
4. Shri R.C. Jhamtani, Jt. Adviser (E&F), Planning Commission
5. Dr. Renu Swarup, Pr. Scientific Officer, Department of Bio-technology.
6. Shri R.S. Shukla, CCF (Social Forestry), Lucknow.
7. Dr. A.P. Dikshit, General Manager, AFC, Mumbai.
8. Shri Amar Prashad, Addl. Commissioner, Ministry of Agriculture.
9. Shri A. K. Bansal, Director, IPIRTI, Bangalore.
10. Shri M.K. Sharma, DG, ICFRE, Dehradun.
11. Shri S.K. Srivastava, AIGF, DoLR, Ministry of Rural Development.
12. Shri O.P. Sharma, Senior Scientist, ICAR, New Delhi.
13. Shri R.L. Java, Retd. PCCF, Gujarat State, Gandhinagar
14. Shri N.K. Singh, Dy. Adviser (E&F), Planning Commission
15. Dr. O.P. Sharma, Research Officer (E&F), Planning Commission
16. Dr. Anupam Joshi, Consultant (E&F), Planning Commission.

Major Decisions:

1. A consensus was arrived on six species viz. *Bamboo* species, *Eucalyptus hybrid, Populus deltoids, Casurina equisetifolia, Acacia nilotica, Prosopis cineraria* for initial thrust.

2. It was decided to constitute four other sub-groups on important issues. The first sub-group would study issues related to research and technology development of the six agroforestry species. Secretary, Biotechnology, will head this sub-group.

3. The second sub-group would examine the demand and supply situation of forest produce and will suggest specific recommendations for their development and marketing. This sub-group will be headed by DG, ICFRE.

4. The third sub-group would identify the legal provisions in Acts, Regulations and policies that obstruct the development of agro forestry and would suggest modifications. This sub-group would be headed by Shri R.S. Shukla, CCF (Social Forestry) Lucknow.

5. The fourth sub-group would work out an Action Plan for the development of agroforestry and would include the recommendations of the other sub-groups. This sub-group would be headed by Smt. J. Khanna, Principal Adviser (E&F), Planning Commission.

6. It was decided that each sub-groups will submit the report latest by 28th February so that it could be used as inputs by the Action Plan sub-group and for follow up discussions for the next meeting of the Task Force. The Task Force members agreed to hold the next meeting on 15th March 2000 at 11.00 a.m. in Yojana Bhawan.

Fourth Meeting: 15 March 2000

Participants:

1. Dr. D.N. Tewari, Member, Planning Commission.
2. Mrs. J. Khanna, Pr. Adviser (E&F), Planning Commission.
3. Mrs. Manju Sharma, Secretary, DBT.
4. Mrs. S. Nair, Addl. Secretary, Ministry of Agriculture.
5. Shri M.K. Sharma, DG, ICFRE & Addl. IGF, MoEF.
6. Shri Amar Prashad, Addl. Comm. Ministry of Agriculture.
7. Shri Shekhar Agarwal, Joint Secretary, Banking.
8. Shri Rajiv Chaudhary, Dy. GM, NABARD, New Delhi
9. Shri P.S. Pathak, ADG, ICAR, Krishi Bhawan, New Delhi.
10. Dr. Subramanayam, Director, DOLR, Ministry of Rural Dev.
11. Shri A. K. Bansal, Director, IPIRTI, Bangalore
12. Dr. S.K. Nath, Scientist, IPIRTI, Bangalore
13. Dr. V.K. Taneja, AHC, Deptt of Animal Husbandry & Dairying.
14. Dr. Renu Swarup, Pr.Scientific Officer, DBT, New Delhi.
15. Dr. A.P. Dikshit, Gen. Manager, AFC, Mumbai
16. Shri R.L. Java, Former PCCF, Baroda.
17. Shri N.K. Singh, Dy. Adviser (Forests), Planning Commission

Major Decisions:

1. The recommendations of the four sub-committees were discussed in the meeting and various modifications were suggested.

2. Dr. A.P.Dikshit, General Manager, AFC, Mumbai stressed the need to activate the financial institutions for promoting credits in this sector. He felt that it was necessary to analyse the inadequacies of financial institutions, as many of them did not have adequately qualified manpower or suitable guidelines for promoting this sector. The Chairman suggested the constitution of a sub-group to analyse the constraints of finance in this sector

and suggest measures to overcome them. The sub-group will be headed by Shri P.S. Pathak, ADG, ICAR.

3. It was felt that forward and backward linkages for production and distribution of planting stock were crucial to successful implementation. The Chairman suggested constituting another sub-group to be headed by DDG (Extn.) ICFRE, Mr. Singsit to suggest measures to achieve the objective of supply of quality planting material.

4. It was also decided that each sub-group would modify its report in the light of discussions and submit by 30th April 2000. It was also requested that the reports of additional sub-groups constituted would also be made available by this time limit.

Fifth Meeting: 22 May 2000.

Participants:

1. Dr.D.N. Tewari, Member, Planning Commission, New Delhi.
2. Mrs.J. Khanna, Pr.Adviser, Planning Commission, New Delhi.
3. Shri R.C. Jhamtani, Joint Adviser, Planning Commission, New Delhi.
4. Dr. M.S. Haque, DGM (Forestry), NABARD, Mumbai.
5. Dr. A.P. Dikshit, Gen. Manager, AFC, Mumbai.
6. Dr. P.S.Pathak, ADG, ICAR, Krishi Bhawan, New Delhi.
7. Dr. Renu Swarup, Pr.Scientific Officer, DBT, New Delhi.
8. Shri R.S. Shukla, CCF (Social Forestry) Lucknow
9. Dr.V.K.Bahuguna, DIGF, MoEF, New Delhi.
10. Shri R.M.Singhal, Deputy D.G (Research), ICFRE, Dehradun.
11. Dr.V.K. Bhatia, Scientist, IIP, Dehradun.
12. Shri Shankar Ghosh, Consultant, New Delhi.
13. Shri Sushanto Mittra, Consultant, New Delhi.
14. Dr.S. Subramanyam, Scientist, Deptt. of Land Resources, MoRD.
15. Shri Amar Prasad, Addl.Commissioner, Ministry of Agriculture, New Delhi
16. Shri A.K. Bansal, Director, IPIRTI, Bangalore
17. Shri D.C. Khanduri, DIGF, MoEF, New Delhi.
18. Shri J.Prasad, Dy. Commissioner, Deptt. of AH & D, New Delhi.
19. Shri N.K.Singh, Dy. Adviser, Planning Commission, New Delhi.

Major Decisions:

1. The revised report of different sub-groups was discussed in the meeting. Dr.V.K. Bhatia of IIP, Deharadun, made a presentation on the use of *Jatropha curcas* oil for bio-diesel production. There is a worldwide trend towards the use of bio-diesel as a substitute for diesel due to environmental considerations. United States Energy Policy Act provides for 30% motor fuels to be produced from non-petroleum sources by 2010.

Jatropha has a large potential for raising on fences in tropical climate in out country. AKV, Akola has done a good work on this subject, hence it was identified as a nodal agency to prepare a paper on this species.

2. The next meeting of the Task Force was fixed on 4th July 2000 and it was decided that reports of all sub-group should be made available by the 25th June 2000.

Sixth Meeting: 4th July 2000.

Participants:

1. Dr. D.N.Tewari, Member, Planning Commission
2. Dr. N.C. Saxena, Secretary, Planning Commission
3. Shri Amar Prasad, Addl. Commissioner, Ministry of Agriculture, New Delhi.
4. Smt. Mira Mehrishi, Joint Secretary (NAEB), Min of E&F.
5. Dr. P.S Pathak, ADG ICAR, Krishi Bhavan, New Delhi.
6. Shri. R.M. Singhal, Dy.DG (Research), ICFRE, Dehradun
7. Shri A.K. Bansal, Director, IPIRTI, Banglore
8. Shri J. Prasad , Dy. Comm.(F&F), Min.of Agriculture, Deptt. of AH&D
9. Shri. M.K. Sharma, Add. I G F, Ministry of Env.& Forests.
10. Shri R.S Shukla, CCF (Social Forestry), Lucknow, UP.
11. Dr. A.P Dikshit, General Manager, AFC Mumbai.
12. Shri R. Chaudhary, DGM, NABARD, New Delhi.
13. Shri R.C Jhamtani, Jt.Adviser (E&F), Planning Commission
14. Shri. N.K. Singh, Dy. Adviser (F), Planning Commission
15. Dr. Anupam Joshi, Consultant (E&F), Planning Commission

Major Decisions:

1. A broad outline of the chapters in the final report was discussed and it was decided to include the following chapters. The first chapter, 'Introduction' will deal with the natural resource degradation (like land, water, forest and bio-diversity), the production system and resource use including the emerging trends and would discuss the lessons from past and propose a strategy for future. The Chairman kindly consented to write this chapter.

2. The second chapter will deal with 'Agroforestry and Farmforestry'. Dr. P.S Pathak, ADG, ICAR agreed to write this chapter.

3. The third chapter will deal with ' Joint Forest Management'. Shri M.K. Sharma, DG, ICFRE consented to write this chapter.

4. The fourth chapter will be on ' Research and Technology'. It will deal with adoption of suitable technology, application of bio-technology in production of

quality planting material and research and development support for sustainable development of six identified agroforestry species. The nodal institutes have prepared monograms on individual species and the same shall be appended with this chapter. Shri R.M. Singhal, DDG (Research), ICFRE, Dehradun accepted to finalise this chapter.

5. The fifth chapter will be on ' Demand and Supply'. This chapter will include the demand of forest wood produce, its optimal utilization, processing, imports substitution, export prospects, supply to forest based industries and the gaps in demand and supply. Shri.R.S Shukla, CCF, Social Forestry, Lucknow will write this chapter.

6. The sixth chapter will deal with ' Marketing and Trade'. This chapter will deal with the marketing infrastructure and the trade practices, import and export, the modality for development of marketing network, etc. Sri A. K. Bansal, Director, IPIRTI, Banglore will prepare this chapter.

7. The seventh chapter will be on ' Policy and Legal issues'. It will discuss the constraints in legal and policy matters, restrictions on felling and transport of trees and establishment of wood based industries, rules and regulations affecting the development of agroforestry, etc. Dr. N.C Saxena, Secretary, Planning Commission kindly consented to prepare this chapter.

8. The eighth chapter will be on ' Financial Resources'. It will deal with fund mobilization through private, public, domestic and external sources. Dr A.P Dikshit will prepare this chapter.

9. The ninth chapter will be on 'Strengthening of Institutional framework and HRD'. The chapter will deal with training, extension, monitoring and evaluation. Mrs. Mira Mehrishi, Joint Secretary, MoEF will write this chapter.

10. The Chairman consented to prepare the last chapter on 'conclusion and recommendations'.

11. The Chairman proposed to organize three regional seminars in different parts of the country for widely disseminating the recommendations of the Task Force. The dates of seminars would be finalized later.

12. The Chairman thanked all the members of the Task Force for their valuable suggestions and active participation in discussion. This was the last meeting of the Task Force.

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Annexure-III

Highlights of the three Regional seminars organised for consultation and wide dissemination of the Task Force Report

1. Place : Chandigarh
   Date : 6th September, 2000
   States covered : Himachal Pradesh, J&K, Punjab, Haryana, Gujarat & Rajasthan.
   Organisers : Planning Commission
   : Indian Council of Agriculture Research.
   Participants
   1. Shri Shanta Kumar, Union Minister of Food & Civil Supply.
   2. Dr. D.N.Tewari, Member, Planning Commission
   3. Shri Roop Singh, Minister of Forests, Himachal Pradesh.
   4. Shri Kanji Bhai Patel, Minister of Forests, Gujarat.
   5. Shri Peerzada Ghulam Ahmed Shah, Minister of Forests, Env. & Fisheries, Jammu & Kashmir.
   6. Secretaries, PCCFs and other government officials & representatives from NGOs, Industries, Corporations, Farmers, etc.

The seminar was inaugurated by Shri Shanta Kumar, Union Minister of Food & Civil Supplies followed by his inaugural address and addresses by other State Ministers. The executive summary of the Task Force Report was circulated in advance to all participants. The draft report was presented in the seminar by Shri N.K.Singh, Deputy Adviser, Planning Commission. It was followed by panel and general discussion.

Major Recommendations

- Funds should be earmarked for research, education and extension of agroforestry in Agricultural Universities.
- State Forest Corporations should be entrusted the job of project formulation, fund mobilisation, processing, marketing and trade promotion.
- The minimum support price may be considered to safeguard against wide fluctuations in prices of agroforestry produce.
- The farmers should be associated in discussions, seminars and workshops and regular training may be organised for them.
- Women should be inducted at various levels in State Forest Departments.
- Research & marketing aspect should be given highest thrust. Marketing institutions like NAFED, TRIFED, NCDC, etc to be supported and strengthened.
- Regional Rural Banks should be involved in financing projects based on viable agroforestry models.

- Media and Information Technology should be used for promotion and extension activities.
- Linkages should be established between farmers and industries on wood catchment basis.
- Sustainable agriculture is the main support to Indian economy. Greening India Programme is the mission for sustainability, ecological integrity and livelihood security.
- All Ministers complimented the Chairman of the Task Force for an excellent report and looked forward to its successful implementation.

2. Place : Bangalore
Date :12th September, 2000
States covered : Karnataka,Tamil Nadu, AP, Kerala, Orissa, Maharashtra, Goa, Pondicherry, Andaman & Nicobar.

Organisers : Institute of Wood Science Technology, Bangalore
: Indian Plywood Industries Research &Training Institute, Bangalore

Participants
1. Shri T.R. Balu, Union Minister of Env. & Forests.
2. Dr. D.N.Tewari, Member, Planning Commission
3. Shri T.B. Jayachandra, Minister of Agriculture, Karnataka
4. Shri K. H. Ranganath, Minister of Forests, Karnataka
5. Shri Subhash Thakare, Minister of Forests, Maharashtra
6. Shri P.S. Kadam, Minister of Industries, Maharashtra
7. Shri R.A. Deshmukh, Minister of Agriculture, Maharashtra
8. Shri Amar Prasad Satpathy, Minister of Agriculture, Orissa
9. Shri Mohan Dharia, Ex-Dy Chairman, Planning Commission
10. Shri Anna Hazare, Padamshree Awardee, Maharashtra
11. Secretaries, PCCFs & Centre and State Government officials, representatives of NGOs, Industries, Press, etc.

The inaugural address was delivered by Shri T.R. Balu, Union Minister of Envrionment & Forests and followed by addresses by other Ministers, Secretaries, PCCFs and Experts. The executive summary of the Task Force report was presented by Shri N.K.Singh, Deputy Adviser, Planning Commission. It was followed by panel and general discussion.

Major Recommendations

- Government of India should provide funds for Greening India Programme as State Governments may not be able to meet the full requirement.
- The Greening Programmes should address poverty alleviation, land degradation, soil and water conservation, import substitution and export promotion.
- A nodal Ministry /Organisation should be identified for coordination.

- Funds spent on import of forest-based produce should be utilised for Greening India Programme.
- Suitable Agroforestry Models should be developed and bamboo should be promoted.
- Entire village community should be involved through the Gram Sabha as against any group in the village.
- All restriction on felling and transport of trees should be removed.
- Procedure for registration of societies under JFM should be simplified.
- Greening India Programme should be declared a National Programme.
- Agroforestry & JFM should be brought under Employment Guarantee Scheme.
- All D-Class lands in Maharashtra should be brought under agroforestry. Forest Cess (7%) paid to Zila Parishad may be utilised for Forestry works.
- Medicinal Plants should be promoted under JFM.
- Standardisation and necessary preparation are required to face the challenges when WTO provision becomes operative in 2003.
- Successful experiments of industrial support to agroforestry may be replicated in other areas.
- NABARD has adequate Rural Infrastructure Development Fund. State Government should come forward to utilise this fund for viable agroforestry and JFM projects.
- Promoting the fruit species like amla, imli, etc for nutritional security.

3. Place : Lucknow
Date : 30th September, 2000
State covered : Uttar Pradesh, Madhya Paradesh, Bihar, West Bengal, Sikkim and North Eastern States.

Organisers : Forest Department, UP

Participants
1. Shri Babulal Marandi, Minister of State for Env. & Forests.
2. Shri Rajdhari Singh, Minister of Forests, Government of UP.
3. Shri D.T. Lepcha, Minister of Forests, Sikkim
4. Shri Indrajit Patel, Minister of Housing and Environment, MP
5. Dr.Manju Sharma, Secretary, DBT, Government of India.
6. Shri C.P. Oberoi, I.G.F, Min of Env & Forests
7. Shri V.K.Dewan, Pr.Secretary, Forests, Uttar Pradesh
8. Shiri Chandi Prasad Bhatt

The inaugural address was delivered by Shri B.L.Marandi, Minister of State for Environment & Forests, Government of India and followed by addresses by various State Ministers and Secretaries to Government of India. The executive summary of the Task Force report was presented by Shri N.K.Singh, Deputy Adviser, Planning Commission. It was followed by panel and general discussion.

Major Recommendations

- Timely availability of funds is important and should be considered by the Task Force for recommending suitable arrangements.
- Traditional species including fruit trees are to be considered under the programme.
- JFM to be made more practical.
- Medicinal Plants have been traditionally important and for their desired development tie-up with the pharmacies would be necessary.
- In view of paucity of resources with the State Government of Sikkim direct funding by Planning Commission for the programme is suggested.
- JFM is to be pursued through a Mission approach; it has a great potential in the state like Sikkim.
- Village Forest Committees are to be formed and supported, as these are helpful in checking forest fire and illicit felling in Madhya Pradesh.
- Grant-in-Aid may be considered for forestry also on the pattern of horticulture.
- Forestland should not be used for raising raw material for industries. Industries should prefer tie-up with farmers for supply of raw material.
- Creation of Forest Department at the Centre is welcomed. Creation of a separate Forest Department by bifurcation of the Ministry of Environment and Forests is necessary.
- Creation / Setting up of Green India Fund is a very good proposal and this would enhance funding to the sector which is currently very limited.
- Establishment of 'Gram Van' in each of 2 lakh forest fringe villages.
- Survival of plants should be the target and not the plantation; a practical approach is more desirable.
- Local species are to be preferred over the exotic one. Return on investment is a factor to be considered.
- Develop a 2 ha medicinal herb garden of threatened species on different locations.
- Set up a good institutional framework to adequately address the research and technology needs.
- Marketing support to agroforestry on wood catchment basis should be ensured.
- Linkage is to be established with livestock promotion and fodder production. A National Grazing Policy should be formulated.

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ANNEXURE-IV

No.6-21/89-FP
GOVERNMENT OF INDIA
Ministry of Environment and Forests
Department of Environment, Forests and Wildlife
Paryavaran Bhavan, CGO Complex, B-Block

Lodi Road, New Delhi
Dated : Ist June, 1990

To,
The Forest Secretaries
(All States/UTs)

Subject: Involving of village communities and voluntary agencies for regeneration of degraded forestlands.

Sir,

The National Forest Policy, 1988 envisages people's involvement in the development and protection of forests. The requirements of fuelwood, fodder and small timber such as house building material, of the tribals and other villagers living in and near the forests, are to be treated as first charge on forest produce. The policy document envisages it as one of the essentials of forest management that the forest communities should be motivated to identify themselves with the development and protection of forests from which they derive benefits.

2. In a D.O. letter No.1/188-TMA dated 13th January, 1989 to the Chief Secretary of your State, the need for working out the modalities for giving to the village communities, living close to the forest and, usufructory benefits to ensure their participation in the afforestation programme, was emphasized by Shri K.P. Geethakrishnan, the then Secretary (Environment and Forests).

3. Committed Voluntary Agencies/NGOs, with proven track record, may prove particularly well suited for motivating and organising village communities for protection, afforestation and development of degraded forest land, especially in the vicinity of habitations. The State Forest Department's Social Forestry Organization ought to take full advantage of their expertise and experience in this respect for building up meaningful people's participation in protection and development of degraded forestlands. The Voluntary Agencies/NGOs may be associated as interface between State Forest Departments and the local village communities for revival, restoration and development of degraded forests in the manner suggested below:

(i) The Programme should be implemented under an arrangement between the Voluntary Agency/NGO, the village community (beneficiaries) and the State Forest Department.

(ii) No ownership or lease rights over the forestland should be given to the beneficiaries or to the Voluntary Agency/NGO. Nor should the forest land be assigned in contravention of the provisions contained in the Forest (conservation) Act, 1980.

(iii) The beneficiaries should be entitled to a share in usufructs to the extent and subject to the conditions prescribed by the State Government in this behalf. The Voluntary Agency/NGO should not be usufructory benefits.

(iv) Access to forest land and usufrutory benefits should be only to the beneficiaries who get organized into a village institution, specially for forest regeneration and protection. This could be the panchayat or the Co-operative of the village, with no restriction on membership. It could also be a Village Forest Committee. In no case should any access or tree pattas be given to individuals.

(v) The beneficiaries should be given usufructs like grasses, lops and topes of branches, and minor forest produce. If they successfully protect the forests, they may be given a portion of the proceeds from the sale of trees when they mature. The Government of West Bengal has issued orders to give 25% of the sale proceeds to the Village Forest Protection Committees. Similar norms may be adopted by other States.

(vi) Areas to be selected for the programme should be free from the claims (including existing rights, privileges, concessions) of any person who is not a beneficiary under the scheme. Alternatively, for a given site the selection of beneficiaries should be done in such a way that any one who has a claim to any forest produce from the selected site is not left out without being given full opportunity of joining.

(vii) The selected site should be worked in accordance with a Working Scheme, duly approved by the State Government. Such scheme may remain in operation for a period of 10 years and revised/renewed after that. The Working Scheme should be prepared in consultation with the beneficiaries. Apart from protection of the site, the said Scheme may prescribe requisite operations, e.g. inducement to natural regeneration of existing root stock, seeding gap filling, and wherever necessary, intensive planting, soil-moisture conservation measures etc. The Working Scheme should also prescribe other operations e.g. fore-protection, maintenance of boundaries, weeding, tending, cleaning, thinning etc.

(viii) For raising nurseries, preparing land for planting and protecting and trees after planting, the beneficiaries should be paid by the Forest Department from the funds under the Social Forestry Programme. However, the village community may obtain funds from other Government agencies and sources for undertaking these activities.

(ix) It should be ensured that there is no grazing at all in the forestland protected by the village community. Permission to cut and carry grass free of cost should be given so that stall-feeding is promoted.

(x) No agriculture should be permitted on the forestland.

(xi) Along with trees for fuel, fodder and timber, the village community may be permitted to plant such fruit trees as would fit in which the overall scheme of

afforestation, such as aonla, Imli, mango, mahua, etc. as well as shrubs, legumes and grasses which would meet local needs, help soil and water conservation, and enrich the degraced soils/land. Even indigenous medicinal plants may be grown according to the requirements and preferences of beneficiaries.

(xii) Cutting of trees should not be permitted be permitted before they are ripe for harvesting. The forest department also should not cut the trees on the forestland being protected by the village communities except in the manner prescribed in the Working Scheme. In case of emergency needs, the village communities should be taken into confidence.

(xiii) The benefit of people's participation should go to the village communities and not to commercial or their interests which may try or other interests which may try to derive benefit in their names. The selection of beneficiaries should, therefore, be done from only those families, which are willing to participate through their personal efforts.

(xiv) The Forest Department should closely supervise the works. If the beneficiaries and or the Voluntary Agency / NGO fail or neglect to protect the area from grazing, encroachment or do not perform the operations prescribed in the Working Scheme in a satisfactory manner, the usufructory benefits should be withdrawn without paying compensation to anyone for any work that might have been done prior to it. Suitable provisions in the Memorandum of Understanding (MOU) for this purpose should be incorporated.

Yours faithfully

Sd/-
(Mahesh Prasad)
Secretary to Government of India

Copy for information and necessary action to:

1. Principal Chief Conservator of Forests/Chief Conservator of Forests(All States/UTs).
2. Additional Secretary, National Wasteland Development Board, Ministry of Environment and Forests, New Delhi.
3. Chief Conservator of Forests (Central) of all Regional Offices located at: Bhubaneshwar, Bangalore, Bhopal, Shillong, Lucknow, Chandigarh.
4. All DIGFs including N.W.D.B., New Delhi.
5. All Officers of the Ministry of Environmental and Forests.

Sd/-
(K.M.Chadha)
Joint Secretary to Govt. of India

Copy for information to the:

1. Secretary (Co-ordination), Cabinet Secretariat, Rashtrapati Bhavan, New Delhi.
2. Secretary, Department of Rural Development, New Delhi.

Sd/-
(K.M.Chadha)
Joint Secretary to Govt. of India

ANNEXURE-V

No.22-8/2000-JFM (FPD)
Government of India
Ministry of Environment and Forests
(Forest Protection Divisions)

Paryavaran Bhawan, CGOCompelx,
Lodi Road, New Delhi.
Dated: 21st February 2000

To

The Secretaries
Forest Departments
(All States/UTs)

Subject: Guidelines for strengthening of Joint Forest Management (JFM) Programme.

Sir,

As per the provisions of National Forest Policy 1988, the Government of India, vide letter no. 6.21/89-PP dated 1st June, 1990, outlined and conveyed to State Governments a framework for creating massive people's movement through involvement of village committees for the protection, regeneration and development of degraded forest lands. This gave impetus to the participation of stakeholders in the management of degraded forests situated in the vicinity of villages. The joint forest management programme in the country is structured on the broad framework provided by the guidelines issued by the Ministry. So far, during the last ten years, 22 State Governments have adopted resolutions for implementing the JFM programme in their respective states. As on 1.1.2000, 10.24 million ha of forests lands are being managed under JFM programme through 36075 committees.

2. The JFM programme in the country was reviewed by Government of India from time to time in consultation with State Governments, NGO's and other stakeholders in view of several emerging issues. In order to further strengthen the programme, the State Governments may take action on the following suggested lines.

(A) Legal backup to the JFM committees:

i) At present, the JFM committees are being registered under different names in various States as per the provisions contained in the resolutions. Except in a few States where the committees are registered under the relevant acts, in most of the states there is no legal back up for these committees. It is, therefore, necessary that all the State Governments register the JFM or village committees under the

Societies Registration Act, 1860 to provide them with legal back up. This may be completed by 31st March 2000. Completion of such formation of existing JFM committees may please be reported to this Ministry.

ii) There are different nomenclatures for the JFM committees in different States. It would be better if these committees are known uniformly as JFM committees (JFMC) in all the states. Memorandum of Understanding, with clearly defined roles and responsibilities for different work or areas should be separately assigned and signed between the State Governments and the committees. All adults of the village should be eligible to become members of the JFM Committees.

(B) **Participation of women in the JFM Programme:**

Considering the immense potential and genuine need for women's participation in JFM programme, following guidelines are suggested for ensuring meaningful participation of women in JFM.

(i) At least 50% members of the JFM general body should be women. For the general body meeting, the presence of at least 50% women members should be a prerequisite for holding the general body meeting.

(ii) At least 33% of the membership in the JFM Executive Committee/ Management Committee should be filled from amongst the women members. The quorum for holding meeting of such Executive/ Management Committee should be one-third of women executive members or a minimum of one whichever is more. One of the posts of office bearer i.e. President/ Vice-President/Secretary should be filled by a woman member of the Committee.

(C) Extension of JFM in good forest areas:

For better resource planning and collective management distance from the village and dependency on forests should be the main criteria for allowing JFM programme to operate. Therefore, JFM programme should cover both the degraded as well as good forests (except the protected area network). The micro plan or treatment plan and memorandum of understanding should be different for degraded forests and good forests (crown density above 40%). In good forest areas, the JFM activities would concentrate on NTFP management and no alteration should be permitted in the basic silvicultural prescription prescribed in the Working Plan but to promote regeneration, development and sustainable harvesting of NTFP which can be given free or on concessional rates as per existing practice in degraded areas under JFM. The benefit sharing mechanism will also be different for the good forest areas. The JFM committees will be eligible for benefit sharing for timber, only if they have satisfactorily protected the good forests for a minimum period of at least 10 years and the sharing percentage should be kept limited to a maximum of 20% of the revenue from the final harvest. The felling of trees and harvesting of timber will be as per the provisions of the working plan. A certain percentage of revenue from

final harvest should be ploughed back in the silviculture & management of the forests. The extent of good forest areas to be allowed will depend upon the number of village household and should be restricted to a maximum limit of 100 ha and generally limited to 2 km from the village boundary. For degraded forests also as far as possible JFM should be forest concentrated on areas upto 5 km from the village boundary. The implementation of JFM in good forest areas shall be done in a phased manner on pilot basis. The pilot areas may be monitored closely for a few years and based on the feedback and success achieved the programme can be extended further in consultation with the Central Government. Before allowing the good forests on pilot basis, all the degraded forests of that locality should be covered simultaneously.

(D) Preparation of micro plan in JFM areas:

(i) In case of new working plans a JFM overlapping working circle should be provided to incorporate broad provisions for micro plans. The achieve this flexible guidelines should be evolved for preparation of local need based micro plans. For this purpose, the working plan officer will work in tandem with the territorial DFO and CF for finalisation of the prescriptions of the JFM overlapping working circle. The microplans should be prepared by the Forest Officers and Village Forest Protection Committees after detailed PRA exercise and should reflect the consumption and livelihood and livelihood needs of the local communities as well as provisions for meeting the same sustainably. It should utilise locally available knowledge as well as aim to strengthen the local institutions. It should also take into account marketing linkages for better return of NTFPs to the gatherers and should also reflect the needs of local industries/ markets. This should be done with due regards to the environmental functions and productive potential of the forests and their carrying capacity as also their conservation and biodiversity values.

(ii) In areas where the existing working plans are in force (till their revision in future), for incorporation of micro plans in the working plans, a special order may be issued by the PCCFs for implementation of the micro plan. In these areas, micro plan should aim to ensuring a multi product and more NTFP oriented approach. Without changing the basic principles of silviculture, deviations may be approved in the existing working plans if necessary. To ensure this, the concerned DFO and CF should dovetail the requirement of micro plans with the working plans.

(iii) The micro plan should also take into consideration and provide suitable advice for areas planted/to be planted on community lands and other Government lands outside the notified forest areas including in the district council areas of North East.

(iv) Infrastructure/Eco-development under micro plan should form a separate entity for funding it through concerned development agencies.

(E) Conflict resolution:

In order to resolve conflicts in the functioning of JFM committees and to maintain harmony among different groups participation in the JFM, State

Governments may constitute divisional and state level representative forums or working groups. The forum/group should include representatives from all the stakeholders including NGOs. The model prescribed by the Andhra Pradesh Government for this purpose is a case in point for consideration.

(F) **Recognition of Self-initiated groups:**

The community groups in may places in Orissa, Bihar, Gujarat, Andhra Pradesh and Karnataka are performing the essential functions of forest protection and regeneration. These groups need to be identified, recognised and registered as JFM Committees after proper verification of records and enquiry. The period of their existence and duties performed for protection and regeneration should be suitably assessed and proper weightage given to them for deriving benefits under the JFM programme.

(G) Contribution for Regeneration of Resources:

For long-term sustainability of resources, it is essential that a mechanism is created for ploughing back a certain percentage of the revenue earned from final harvest. Fro this purpose, no less than 25% of the share of village community should be deposited in the village development fund for meeting the conservation and development needs of the forests. A matching contribution may be made by the forest department from its share of such sales. There should be transparent mechanisms for computation of income for sharing the benefits between different stakeholders.

(H) Monitoring and Evaluation:

Concurrent monitoring of progress and performance of this programme should be undertaken at Division and State level. Evaluation of the programme should be planned at an interval of 3 years and 5 years at Division and State level respectively.

Yours faithfully

Sd/-

(C.P. Oberai)
Inspector General of Forests & Special Secretary

Copy for information and necessary action to:

1. Principal Chief Conservator of Forests/Chief Conservator of Forests (All States/UTs).
2. Special Secretary, National Afforestation and Eco-development Board, Ministry of Environment and Forests, New Delhi.
3. Secretary, National Wasteland Development Board, Ministry of Rural Development, New Delhi.
4. Chief Conservator of Forests (Central) of all Regional Offices located at Bhubaneshwar, Bangalore, Bhoplal,Shillong, Lucknow, Chandigarh.
5. DG, ICFRE, Dehra Dun.
6. Director, Indian Institute of Forest Management, Bhopal.
7. Director, Indira Gandhi National Forest Academy, Dehra Dun.
8. Director, Forest Survey of India, Dehra Dun.
9. Director, Forest Education, Dehra Dun.
10. Director, Wildlife Institute of India, Dehra Dun.
11. All Officers of the Ministry of Environment and Forests.

Sd/-

(Dr. V.K.Bahuguna)
Dy. Inspector General of Forests

Annexure VI

Transparency in JFM

This is the most crucial part of the programme. By tradition, forestry operations were executed by the department by engaging a petty contractor. The expenditure was incurred by the FRO and his staff. People were paid daily wages and they were not concerned with the estimate of work and the expenditure incurred under the various components. But soon, a joint accounting system was introduced under the JFM programme in which, all expenses to be incurred in a VSS were first credited to a joint account of the VSS opened at the nearest scheduled bank. The Chairperson of the VSS and the forest SO, who is designated as Secretary of the Managing Committee, were authorised to sign cheques to make payments to the VSS members for the work executed. Although this system made the VSS Chairperson aware of the financial transactions, it was discovered that in many VSSs, the details were not discussed and disclosed to other members. Therefore the transactions remained confined to the Secretary and the Chairperson, and this gave rise to suspicion. The other members did not know about the total estimated amount and what was paid to them. In order to bring about greater transparency, the system was improved by supplying a copy of the estimate to the managing committee, and by writing on the wall and other prominent places, the details of the expenditure incurred for everybody to know. Although this method improved the transparency to some extent, it did not go all the way. It was difficult for every VSS member to know how the amount shown as expenditure was actually utilised and whether the people were paid the entire amount shown as expenditure incurred. Many had doubts in their mind but did not speak out. A few cases came to light where the VSS President signed blank cheques and the SO drew the amount and booked the expenditure without the full knowledge of the VSS. In order to clear all doubts and utilise government funds in the most transparent manner, a circular was issued detailing the various step for withdrawal and disbursement of money in the VSS account in the following manner:

- There must be a general body meeting once every three months. Achievements of the last quarter and the programme for the first quarter should be discussed and approved at this meeting. For this purpose, April-June will be the first quarter for which the general body should meet in March. If the general body is not convened and programmes are not approved by the general body after each quarter, the Managing Committee will be dismissed and a new one formed.
- The Managing Committee should meet as often as possible and invite other members also to discuss the action plan for each month as per the work plan. The proceedings of the meeting should be recorded in the minutes book. The minutes book should be written by the forest Guard.

- The work should be executed by the VSS members only. No contractor should be brought by the FD. If in any case, some skilled workers are to be brought from outside, payment should be made to them by the VSS President only, after duly discussing the details in the Managing Committee and recording it in the minutes book. No payment should be made by the FRO or FD directly to any contractor.
- Before drawing funds from the VSS account, a resolution should be passed by the Managing Committee indicating the works done and amounts to be paid. This should be recorded in the minutes book. In the absence of such a resolution, neither the VSS President no the Secretary of the VSS (SO) is entitled to draw any money from the bank account. Whenever a resolution is passed for drawing money indicating the works done for which payments are to be made, a copy should be sent to the FRO by the SO. This will keep the FRO aware of the works done and funds drawn.
- Soon after drawing the funds from the VSS account, it should be reported to the Managing Committee either on the same day or the next day along with the passbook so as to ensure that the Managing Committee is aware of the funds drawn. The funds should be disbursed to the VSS members either on the same day of withdrawal or latest by the next day. Withdrawal of funds and the date fo disbursement should be recorded in the minutes book. In future, VSS members should be trained in maintaining the check measurement book and work register at the VSS level itself.
- For all works executed by the VSS, a muster-roll register should be maintained on a permanent basis in which the names of persons engaged in various works are mentioned, the total amount payable to each noted and the amount paid, recorded. This register should be signed by the SO and the Forest Guard.
- The resolution passed for withdrawal of funds, the actual amount drawn giving the details of cheque number and amount disbursed must tally. It will be the responsibility of the SO to check this tally and record it in his diary.
- The FRO should visit the VSS as often as possible. Whenever he is not in a position to visit any VSS he should at least get the micro-plan, survey sketch, minutes book, muster-roll register, passbook and cheque book through the SO and verify the records. The verification of the record should be mentioned in his tour diary.
- The FRO should indicate, in the following performa in his fund application, the requirement of funds in the different VSSs:

Sl.No.	Name of the Section	Name of the VSS	Amount previously paid to the VSS	Amount for which vouchers received	Further amount required to be released	Remarks (if any)

- The FRO should also maintain a work register in which the details of expenditure should be incorporated every month.
- The DFO will scrutinize the fund application and release the funds, after verifying the utilisation of previous advances. He should explore the possibilities of releasing the funds directly to the Joint Account of the VSS concerned. He may note down the VSS in which more work has been carried out so that they can be visited selectively. This will also give the opportunity to have the list of VSS in which money is deposited and expenditure is not incurred. Such VSSs should be visited on a preferential basis.
- Since some of the FROs are not in a position to visit the VSSs every month, they should at least conduct a meeting of the VSS Presidents in each section. VSS Presidents, along with a minimum of two members of the Managing Committee, the concerned Forest Guard and the SO should be present. All registers maintained in the VSS, including the micro-plan, sanctioned estimates, minutes book, muster-roll, passbook, cheque book, etc, should be reviewed during this meeting. The FRO should enquire from the President and other members whether the amount drawn has been received by them. Minutes of these meetings should be drawn and kept on record, and a copy sent to the DFO for information. Since the FRO may have four to five sections in their ranges, it should not be difficult to conduct one meeting in each section every month.
- Where the number of VSS are large (more than30), the FRO should try to ensure that at least all the VSSs are visited once in a quarter if not once in a month. While drawing up the programme to visit the VSS in every month, they should ensure that the sections where there are more VSSs are definitely visited. Similarly, the VSS in which proper accounts are not forthcoming should be listed out and visited on a priority basis.
- DFO with the FROs, are requested to review the expenditure incurred in the different VSSs every month. During these reviews they should check the record of the FRO about the conduct of various meetings and minutes drawn. All these steps are necessary so as to ensure that there is no misuse of funds. The DFO should check surveyed sketch and field works during their visit.
- Whenever senior officers visit the VSS they should invariably check the minutes book, muster-roll register, chequebook, and passbook, and tally the amounts drawn and disbursed. They should also discuss the work done with the VSS members and involve as many people as possible in this discussion. They should make a mention of such a discussion in their diary. They should also physically check the works executed.

The Conservators of Forests are requested to ensure that in ranges which have a greater number of VSSs, additional inspection parties are formed with the help of other staff available to check the VSS work. The DFO and Flying should be given specific targets indicating the name of the VSS to be visited each month. This should be based on the remoteness of the VSS, their complaints, those VSSs where large areas have been taken up for regeneration, and where more expenditure has

been incurred. The Conservator of Forests should also ensure that a plan is made in such a way that all the VSSs in his circle are visited by the FRO/Sub-DF/DFO and by himself at least once in each quarter so that all VSSs are invariably covered. Whoever visits the VSS should mention his observations in the visitor's book to be maintained in each VSS; the observation should also be reflected in the diary.

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Annexure VII

State-wise/sector-wise base PLP projections for IX Plan Period (1997-98 to 2001-02)

(Rs. in lakh)

Sr. No.	Name of the States/ Union Territories	Forestry and Wasteland Development					
		1997-98	1998-99	1999-2000	2000-2001	2001-2002	Total
	Northern Region						
1	Chandigarh						000
2	New Delhi						0.00
3.	Haryana	330.00	425.00	517.00	615.00	75 1 .00	2638.00
4	Himachal Pradesh	22.22	28.22	35.62	49.16	60. 1 6	195.38
5	Jammu & Kashmir	129.00	149.00	165.00	191.00	214.00	848.00
6	Punjab	386.00	492.00	580.00	716.00	835.00	3009.00
7	Rajasthan	837.84	1739.44	1999.14	2294.82	2583.67	9454.91
	Sub Total (A)	1705.06	2833.66	3296.76	3865.98	4443.83	16145.29
	North Eastern Region						
8	Arunachal Pradesh						0.00
9	Assam	199.34	262.55	345.82	417.54	492.29	1717.54
10	Manipur						0.00
11	Meghalaya						0.00
12	Mizoram	9.97	13.62	16.60	19.71	23.62	83.49
13	Nagaland	82.14	97.75	117.18	131.29	156.53	584.89
14	Tripura	18.00	33.08	42.98	53.44	59.75	207.25
	Sub Total (B)	309.42'	407.00	522.58	621.98	732.19	2593.17
	Eastern Region						
15	Andaman & Nicobar	10.00	10.00	11.00	11.00	12.00	54.00
16	Bihar	1318.27	1664.35	2108.30	2434.83	2900.76	10426.51
17	Orissa	272.00	327.00	398.00	458.00	539.00	1994.00
18	Sikkim						0.00
19	West Bengal						0.00
	Sub Total (C)	1600.27	2001.35	2517.30	2903.83	3451.76	12474.51
	Central Region						
20	Madliya Pradesh	748.00	950.00	1120.00	1336.00	1544.00	5698.00
21	Uttar Pradesh	1290.09	1502.61	1720.51	1936.37	2202.39	8651.97
	Sub Total (D)	2038.09	2452.61	2840.51	3272.37	3746.39	14349.97
	Western Region						
22	D & N Haveli	5.80	6.21	7.32	9.23	11.40	39.96
23	Daman it Din						0.00
24	Goa						0.00
25	Gujarat	119.00	137.00	160.00	185.00	211.00	812.00
26	Maliarashtra	648.59	852.12	1043.58	1320.04	1633.60	5497.93
	Sub Total (E)	773.39	995.33	1210.90	1514.27	1856.00	6349.89
	Southern Region						
27	Andlira Pradesh	1099.00	899.00	1102.00	1642.00	1821.00	6563.00
28	Karnataka	512.75	581.90	795.08	1047.90	1400.42	4338.05
29	Kerala						0.00
30	Pondicheny	27.24	29.96	32.96	36.26	39.88	166.30
31	Tamil Nadu	2438.55	2824.59	3359.52	3898.21	4515.60	17036.47
32	Lakshadweep						0.00
	Sub Total (F)	4077.54	4335.45	5289.56	6624.37	7776.90	28103.82
	Grand Total	10503.77	13025.40	15677.61	18802.80	22007.07	80016.65

Source : NABARD-CPD, Mumbai

Annexure VIII

State-wise/sector-wise base PLP projections for FX Plan Period (1997-98 to 2001-02)

(Rs. in lakh)

Sr. No.	Name of the States/ Union Territories	Plantation and Horticulture					
		1997-98	1998-99	1999-2000	2000-2001	2001-2002	Total
	Northern Region						0.00
1	Chandigarh						0.00
2	New Delhi	40	45.00	50.00	55.00	60.00	250.00
3	Haryana	2506	3277.00	4131.00	4578.00	5141.00	19633.00
4	Himachal Pradesh	820.54	710.69	1003.02	1812.39	2082.71	6429.3^
5	Jamnui & Kashmir*	740	907.00	1058.00	1255.00	1474.00	5434.0(1
6	Punjab	21.81	25.94	30.52	35.96	41.84	156.07
7	Rajasthan	904.42	1847.12	1918.19	2529.41	3246.82	10445.96
	Sub Total (A)	5232.77	6812.75	8190.73	10265.76	12046.37	42348.38
	North Eastern Region						
8	Arunachal Pradesh	1453.86	1576.96	1918.82	2134.84	2616.92	9701.40
9	Assam	2868.59	3493.60	4631.43	5788.95	7181.99	23964.56
10	Manipur	453.93	444.99	434.96	966.59	1181.13	3481.60
11	Meghalaya	360.96	444.18	407.13	484.03	578.07	2274.37
12	Mizoram	162.19	206.28	262.93	337.96	429.21	1398.57
13	Nagaland	257.81	444.18	540.91	651.76	1095.07	2989,73
14	Tripura	301.48	394.85	491.16	603.60	729.57	2520.66
	Sub Total (B)	5858.82	7005.04	8687.34	10967.73	13811.96	46330.89
	Eastern Region						
15	Andaman & Nicobar	21.70	21.70	23.85	23.85	26.25	117.35
16	Bihar	5206.44	6158.85	6906.88	7912.39	9079.16	35263.72
17	Onssa	2502.00	2931.00	3478.00	4040.00	4774.00	17725.00
18	Sikkim	59.91	70.90	81.94	93.56	104.74	411.05
19	West Bengal	50.72	73.43	100.13	125.77	153.70	503.75
	Sub Total (C)	7840.77	9255.88	10590.80	12195.57	14137.85	54020.87
	Central Region						
20	Madhya Pradesh	1932.00	2479.00	3131.00	3910.00	4834.00	16286.00
21	Uttar Pradesh	3123.15	3769.91	4451.81	5166.47	6099.56	22610.90
	Sub Total (D)	5055.15	6248.91	7582.81	9076.47	10933.56	3889690
	Western Region						
22	D & N Haveli	28.50	32.31	38.59	43.46	51.32	194.18
23	Daman & Din	5.20	6.90	7.09	5.56	5.50	30.25
24	Goa	318.48	357.64	453.11	540.64	673.51	2343.38
25	Ciujarat	2187.00	2614.00	3036.00	3515.00	40.29	11392.29
26	Maharashtra	14008.22	18837.21	23477.85	29916.46	37937.06	124176.80
	Sub Total (E)	16547.40	21848.06	'27012.64	34021.12	38707.68	138136.90
	Southern Region						
27	Andhra Pradesh	10515.00	12740.00	13725.00	15934.00	18686.00	71600.00
28	Karnataka	15481.49	17482.91	19772.90	22190.32	24911.15	99838.77
29	Kerala	16033.00	21332.00	27598.00	34785.00	43221.00	142969.00
30	Pondicherry	65.98	72.59	95.43	124.20	157.74	515.94
31	Tamil Nadu	8863.84	10014.20	11299.29	12512.63	13643.31	56333.27
32	Lakshadweep	15.50	18.32	20.16	23.27	26.79	104.04
	Sub Total (F)	50974.81	61660.02	72510.78	85569.42	100645.99	371361.02
	Grand Total	91309.72	112830.66	134575.10	162096.07	190283.41	691094.96

*including Sericulture

Source : NABARD-CPD, Mumbai.

Appendix-I
Model - 1

Agro-Forestry Project Profile

A-C Zone : Western Himalayan Region **Tree-Crop Combination : Agrihorticulture**

Situation : Rainfed **Tree : *Prunus persica* (Peach)**

Crops : Maize, Soyabean

Input / Output Analysis

Amount in Rupees

Year	Expenses per Ha				Brenefits per Ha				Net Benefit per Ha.
	Tree	Crop 1*	Crop 2*	Total	Tree	Crop 1*	Crop 2*	Total	
1	10000	600	960	11560	0	1200	1920	3120	-8440
2	5000	570	912	6482	0	1140	1824	2964	-3518
3	5000	540	864	6404	0	1080	1728	2808	-3596
4	7000	480	768	8248	12500	960	1536	14996	6748
5	9000	420	672	10092	15000	840	1344	17184	7092
6	11000	330	528	11858	17500	660	1056	19216	7358
7	11000	240	384	11624	17500	480	768	18748	7124
8	11000	150	240	11390	17500	300	480	18280	6890
9	11000	90	144	11234	17500	180	288	17968	6734
10	11000	-	-	11000	17500	-	-	17500	6500
11	11000	-	-	11000	17500	-	-	17500	6500
12	11000	-	-	11000	17500	-	-	17500	6500
13	11000	-	-	11000	17500	-	-	17500	6500
14	11000	-	-	11000	17500	-	-	17500	6500
15	11000	-	-	11000	17500	-	-	17500	6500
Net Present Value @ 15% DF				**57,144**				**69,183**	**12,039**

Assumptions :

Tree : Prunus Persica

1. No. of trees/ha. = 200
2. Yield of fruit per tree : 4th Yr:: 25 kg., 5th Yr:30 kg., 6th Yr & Onwards: 35 kg.
3. Expenses per tree : Yr 1= Rs.50, Yr 2 & 3 = Rs.25, Yr 4 =Rs.35, Yr 5 = Rs.45, Yr 6 & onwards = Rs.55
4. Sale price of fruit per kg. = Rs.2.50

Crops * : Crop combination of Maize & Soyabean with 0.4 ha area under each crop.

	Maize	Soya Bean
1. Yield per ha.	1000 kg.	800 kg.
2. Sale price per kg.	Rs.3	Rs.6
3. Expenses per ha.	Rs.1500	Rs.2400

Note : 1. There is decline of area under crop from the 2nd year onwards due to shade effect of tree and by the tenth year area under crop becomes nil.

2. investment proposed includes expenses on trees till the fruit bearing year and expenses on crops in the first year

Analysis :

Benefit Cost Ratio

@15% Discount Factor : 1.21

Net Present Value in Rupees @15% Discount Factor : 12,039

IRR : 30%

Investment

Year 1	Rs.11560
Year 2	Rs.5000
Year 3	Rs.5000
Year 4	Rs.7000
Total	**Rs.28560**

Appendix I
Model - 2

Agro-Forestry Project Profile

A-C Zone : Eastern Himalayan Region
Situation : Irrigated

Tree-Crop Combination : Agri-Silviculture
Tree : *Anthocephalus cadamba* (Kadamba)
Crop : Paddy

Input / Output Analysis

Amount in Rupees

Year	Expenses Per Ha.			Benefits per ha			Net Benefit per Ha.
	Tree	Crop	Total	Tree	Crop	Total	
1	12800	4320	17120	0	7200	7200	-9920
2	6400	3456	9856	0	5760	5760	-4096
3	6400	2592	8992	0	4320	4320	-4672
4	6400	1728	8128	0	2880	2880	-5248
5	6400	864	7264	0	1440	1440	-5824
6	6400	0	6400	0	0	0	-6400
7	6400	0	6400	0	0	0	-6400
8	6400	0	6400	160000	0	160000	153600
Net Present Value @ 15% DF			**43,776**			**68,124**	**24,348**

Assumptions :

Tree : Anthocephalus cadamba :
Rotation 8 (1)

1. No. of trees/ha. = 320
2. Income per tree = Rs.500 (in the 8th year)
3. Expenses per tree : Yr 1 =Rs.40; Yr 2 & Onwards =Rs.20

Crops : Paddy

1. Yield per ha. = 1600 Kg.
2. Sale price per kg.= Rs.4.50
3. Expenses per ha. = Rs. 4320

Analysis :

Benefit Cost Ratio at 15% Discount Factor : 1.6

Net Present Value in Rs. at 15% Discount Factor : 24,348

IRR : 31%

Investment

Year1	Rs.17120
Year 2 to 8	Rs.44800
Total	**Rs.61920**

Note : 1. There is decline of area under crop due to shade effect of tree from 2nd year onwards and by the 6th year area under crop becomes nil.
2. Investment proposed includes expenses on trees for eight years and expenses on crop in the first year.

Appendix-I
Model - 3

Agro-Forestry Project Profile

Zone : Lower Gangetic Plains Region
Situation : Irrigated

Tree-Crops Combination : Agri Silviculture
Tree : *Eucalyptus hybrid* (Nilgiri)
Crops : Paddy, Wheat

Input / Output Analysis

Amount in Rupees

Year	Expenses per Ha.				Benefits per Ha.				Net Benefit per Ha.
	Tree	Crop1	Crop 2	Total	Tree	Crop1	Crop 2	Total	
1	62500	5040	3780	71320	0	7200	5600	12800	-58520
2	0	5040	3780	8820	0	7200	5600	12800	3980
3	0	5040	3780	8820	0	7200	5600	12800	3980
4	0	4284	3213	7497	0	6120	4760	10880	3383
5	0	3528	2646	6174	0	5040	3920	8960	2786
6	0	2772	2079	4851	0	3960	3080	7040	2189
7	0	2016	1512	3528	0	2880	2240	5120	1592
8	0	1260	945	2205	0	1800	1400	3200	995
9	0	504	378	882	0	720	560	1280	398
10	0	0	0	0	625000	0	0	625000	625000
Net Present Value @ 15% DF				**86,237**				**200,769**	**114,532**

Assumptions :

Tree : Eucalyptus hybrid : Rotation 10(1)

1. No. of trees/ha. = 1250
2. Income per tree = Rs.500 (in the 10th year)
3. Expenses per tree = Rs.50 (in the 1st year)

Crops :

	Paddy	Wheat
1. Yield per ha.	1600 kg.	1400 kg.
2. Sale price per kg.	Rs.4.50	Rs.4
3. Expenses per ha.	Rs.5040	Rs.3780

Analysis :

Benefit Cost Ratio at 15% Discount Factor: **2.33**

Net Present Value in Rs. at 15% Discount Factor : **114,532**

IRR : **32%**

Investment

Year 1 - **Rs.71320**

Note : 1. There is 15% reduction in area under crops due to shade effect of trees from the fourth year onwards.

2. Investment proposed includes expenses on trees and crops in the first year

Appendix-I
Model - 4

Agro-Forestry Project Profile

A-C Zone : Lower Gangetic Plains Region

Situation : Rainfed

Tree-Crop Combination : Agrisilviculture
Tree : *Acacia auriculiformis*(Australian Babool)
Crop : Jute

Input / Output Analysis

Amount in Rupees

Year	Expenses Per Ha.			Benefits Per Ha.			Net Benefits per Ha
	Tree	Crop	Total	Tree	Crop	Total	
1	3000	4095	7095	0	5850	5850	-1245
2	1500	4095	5595	0	5850	5850	255
3	1500	4095	5595	0	5850	5850	255
4	1500	3686	5186	0	5265	5265	80
5	1500	3276	4776	0	4680	4680	-96
6	1500	2867	4367	0	4095	4095	-272
7	1500	2457	3957	0	3510	3510	-447
8	1500	2048	3548	0	2925	2925	-623
9	1500	1638	3138	0	2340	2340	-798
10	1500	1229	2729	0	1755	1755	-974
11	1500	819	2319	0	1170	1170	-1149
12	1500	410	1910	0	585	585	-1325
13	1500	0	1500	0	0	0	-1500
14	1500	0	1500	0	0	0	-1500
15	1500	0	1500	60000	0	60000	58500
Net Present Value @ 15% DF			**27,016**			**31,574**	**4,558**

Assumptions :

Tree : Acacia auriculiformis : Rotation 15(1)

1. No. of trees/ha. = 60
2. Income/tree = Rs.1000
3. Expenses / ha.: Yr 1=Rs. 3000, Yr 2 & onwards= Rs.1500

Crop : Jute

1. Yield per ha.	1300 kg.
2. Sale Price per kg.	Rs.4.50
3. Expenses per ha.	Rs.4095

Analysis :

Benefit Cost Ratio at 15% Discount Factor: 1.17

Net Present Value in Rs. at 15% Discount Factor : 4,558

IRR : 29%

Investment

Yr.1	Rs.7095
Yr.2 to 15	Rs.21000
Total	**Rs.28095**

Note : 1. There is 10% reduction in area under crops due to shade effect of tree from the fourth year onwards.
2. Investment proposed includes expenses on trees for 15 years and expenses on crop in the first year

Appendix-I
Model - 5

Agro-Forestry Project Profile

A-C Zone : Middle Gangetic Plains Region
Situation : Rainfed

Tree-Crops Combination : Agri-Silviculture
Tree : *Dalbergia sissoo* (Sheesham)
Crop : Seasamum

Input / Output Analysis

Amount in Rupees

Year	Expenses Per Ha.			Benefits per Ha.			Net Benefit per Ha
	Tree	Crop	Total	Tree	Crop	Total	
1	7000	2000	9000	0	4000	4000	-5000
2	0	2000	2000	0	4000	4000	2000
3	0	2000	2000	0	4000	4000	2000
4	0	1800	1800	0	3600	3600	1800
5	0	1600	1600	0	3200	3200	1600
6	0	1400	1400	0	2800	2800	1400
7	0	1200	1200	0	2400	2400	1200
8	0	1000	1000	0	2000	2000	1000
9	0	800	800	0	1600	1600	800
10	0	600	600	0	1200	1200	600
11	0	400	400	0	800	800	400
12	0	200	200	0	400	400	200
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0
20	0	0	0	112000	0	112000	112000
Net Present Value @ 15% DF			**14,360**			**16,547**	**2,186**

Assumptions :

Tree : Dalbergia Sisoo : Rotation 20 (1)

1. No. of trees/ha. =280
2. Income per tree = Rs.400
3. Expenses per tree =Rs.25 (in the first year)

Crop : Seasamum

1. Yield per ha. = 200 kg.
2. Sale price per kg.= Rs.20
3. Expenses per ha. = Rs.2000

Analysis :

Benefit Cost Ratio at 15% Discount Factor : 1.15

Net Present Value in Rs. at 15% Discount Factor : 2,186

IRR: 35%

Investment :

Year 1 - **Rs.9000**

Note : 1. There is 10% reduction in area under crops due to shade effect of tree from the fourth year onwards.
2. Investment proposed includes expenses on trees and crop in the first year.

Appendix-I
Model - 6

Agro-Forestry Project Profile

A-C Zone : Middle Gangetic Plains Region
Situation : Non arable land

Tree-grass Combination: Silvipasture
Tree : Bamboo
Grass: *Dichanthium annulatum*(Marvel grass)

Input / Output Analysis

Amount in Rupees

Year	Expenses Per Ha.			Benefits Per Ha.			Net Benefit per Ha.
	Tree	Grass	Total	Tree	Grass	Total	
1	10000	4000	14000	0	5000	5000	-9000
2	0	2000	2000	0	5000	5000	3000
3	0	2000	2000	0	5000	5000	3000
4	0	2000	2000	0	5000	5000	3000
5	0	2000	2000	25000	5000	30000	28000
6	10000	2000	12000	0	5000	5000	-7000
7	0	2000	2000	0	5000	5000	3000
8	0	2000	2000	0	5000	5000	3000
9	0	2000	2000	0	5000	5000	3000
10	0	2000	2000	25000	5000	30000	28000
Net Present Value at 15% Discount Factor			**24,796**			**43,703**	**18,907**

Assumptions :

Tree : Bamboo

1. No. of trees/ha. = 250
2. Income per tree: Rs.100 (in the 5th & 10th year.)
3. Expenses per ha. = Rs.10000 in the 1st and 6th year

Grass : Dichanthium annulatum

1. Yield per ha. = 20000 kg.
2. Sale price per kg.= Re.0.25
3. Expenses per ha. = Yr.1 = Rs.4000, Yr.2 & onwards = Rs.2000

Note : Investment includes expenses on trees and grass in the first year.

Analysis :

Benefit Cost Ratio at 15% Discount Factor : 1.76
Net Present Value in Rs. at 15% Discount Factor : 18,907
IRR : 55%

Investment

Year 1 **Rs.14000**

Appendix-I
Model - 7

Agro-Forestry Project Profile

A-C Zone : Upper Gangetic Plains Region
Situation : Irrigated

Tree-Crop Combination: Agrisilviculture
Tree : *Populus deltoides*
Crops : Paddy, Wheat

Input / Output Analysis

Amount in Rupees

Year	Expenses Per Ha.				Benefits Per Ha.				Net Benefit per Ha.
	Tree	Crop 1	Crop 2	Total	Tree	Crop 1	Crop 2	Total	
1	22000	4320	3360	29680	0	7200	5600	12800	-16880
2	12000	4104	3192	19296	0	6840	5320	12160	-7136
3	12000	3888	3024	18912	0	6480	5040	11520	-7392
4	12000	3672	2856	18528	0	6120	4760	10880	-7648
5	12000	3456	2688	18144	0	5760	4480	10240	-7904
6	12000	3240	2520	17760	0	5400	4200	9600	-8160
7	0	3240	2520	5760	600000	5400	4200	609600	603840
Net Present Value at 15% Discount Factor				**82,292**				**272,533**	**190,241**

Assumptions :

Tree : Populus deltoides : Rotation 7(1)

1. No. of trees/ha. = 500
2. Income per tree : Rs.1200 (in the 7th yr.)
3. Expenses per ha. : Yr.1 = 22000 , Yr.2 & onwards = Rs.12000

Analysis :

Benefit Cost Ratio at 15% Discount Factor : 3.31

Net Present Value in Rs. at 15% Discount Factor : 190,241

IRR : 68%

Crops :

	Rice	Wheat
1. Yield per ha.	1600 kg.	1400 kg.
2. Sale price per kg.	Rs.4.50	Rs.4.00
3. Expenses per ha.	Rs.4320	Rs.3360

Investment

Year 1	Rs.29680
Year 2 to 6	Rs.60000
Total	**Rs.89680**

Note : 1. There is reduction in area under crop from 2nd to 7th year due shade effect of tree
2. Investment includes expenses on trees for 6 years and expenses on crop in the first year.

Appendix-I
Model - 8

Agro-Forestry Project Profile

A-C Zone : Trans Gangetic Plains Region
Situation : Rainfed

Tree-Crop Combination : Agrisilviculture
Tree : *Acacia nilotica*
Crops : Bajra, Guar

Input / Output Analysis

Amount in Rupees

Year	Expenses Per Ha.				Benefits Per Ha.				Net Benefit per Ha.
	Tree	Crop 1	Crop 2	Total	Tree	Crop 1	Crop 2	Total	
1	8000	1500	750	10250	0	3000	1500	4500	-5750
2	0	1425	713	2138	0	2850	1425	4275	2138
3	0	1350	675	2025	0	2700	1350	4050	2025
4	0	1275	638	1913	0	2550	1275	3825	1913
5	0	1200	600	1800	0	2400	1200	3600	1800
6	0	1125	563	1688	0	2250	1125	3375	1688
7	0	1050	525	1575	0	2100	1050	3150	1575
8	0	975	488	1463	0	1950	975	2925	1463
9	0	900	450	1350	0	1800	900	2700	1350
10	0	825	413	1238	0	1650	825	2475	1238
11	0	750	375	1125	0	1500	750	2250	1125
12	0	675	338	1013	0	1350	675	2025	1013
13	0	600	300	900	0	1200	600	1800	900
14	0	525	263	788	0	1050	525	1575	788
15	0	450	225	675	0	900	450	1350	675
16	0	375	188	563	0	750	375	1125	563
17	0	300	150	450	0	600	300	900	450
18	0	225	113	338	0	450	225	675	338
19	0	150	75	225	0	300	150	450	225
20	0	75	38	113	400000	150	75	400225	400113
Net Present Value at 15% Discount Factor				**17,262**				**45,051**	**27,789**

Assumptions :

Tree : Acacia nilotica : Rotation 20(1)

1. No. of trees/ha. = 400
2. Income per tree = Rs.1000 (in 20th year)
3. Expenses per tree = Rs. 20

Crops :

	Bajra	Guar
1. Yield per ha.	1000 kg.	1000 kg.
2. Sale Price per kg.	Rs.3	Rs.1.50
3. Expenses per ha.	Rs.1500	Rs.750

Analysis :

Benefit Cost Ratio at 15% Discount Factor : 2.61
Net Present Value in Rs. at 15% Discount Factor : 27,789
IRR : 38%

Investment

Year 1 **Rs.10250**

Note : 1. There is 5% reduction in area under crop from 2nd year onwards due to shade effect of tree.
2. Investment proposed includes expenses on trees and crops in the first year.

Appendix-I
Model - 9

Agro-Forestry Project Profile

A-C Zone : Eastern Plateau and Hill Region
Situation : Irrigated

Tree-Crops Combination : Agrisilviculture
Tree : *Gamelina arborea*
Crops : Paddy, Linseed

Input / Output Analysis

Amount in Rupees

Year	Expenses per Ha				Brenefits per Ha				Net Benefit per Ha.
	Tree	Crop 1	Crop 2	Total	Tree	Crop 1	Crop 2	Total	
1	20000	5040	6825	31865	0	7200	6600	13800	-18065
2	0	4788	6484	11272	0	6840	6270	13110	1838
3	0	4536	6143	10679	0	6480	5940	12420	1742
4	0	4284	5801	10085	0	6120	5610	11730	1645
5	0	4032	5460	9492	0	5760	5280	11040	1548
6	0	3780	5119	8899	0	5400	4950	10350	1451
7	0	3528	4778	8306	0	5040	4620	9660	1355
8	0	3276	4436	7712	0	4680	4290	8970	1258
9	0	3024	4095	7119	0	4320	3960	8280	1161
10	0	2772	3754	6526	0	3960	3630	7590	1064
11	0	2520	3413	5933	0	3600	3300	6900	968
12	0	2268	3071	5339	320000	3240	2970	326210	320871
Net Present Value at 15% Discount Factor				**69139**				**119,997**	**50,858**

Assumptions :

Tree : Gamelina arborea : Rotation 12(1)

1. No. of trees/ha. = 400,
2. Income per tree = Rs.800
3. Expenses per ha. = Rs.20000 (in the 1st year)

Crops :

	Paddy	Linseed
1. Yield per ha.	1600 kg.	1200 kg.
2. Sale price per kg.	Rs.4.50	Rs.5.5
3. Expenses per ha.	Rs.5040	Rs.6825

Analysis :

Benefit Cost Ratio at 15% Discount Factor : 1.74

Net Present Value in Rs. at 15% Discount Factor : 50,858

IRR : 33%

Investment

Year 1 **Rs.31865**

Note : 1. There is 5% reduction in area under crop from 2nd year onwards due to shade effect of tree.

2. Investment proposed includes expenses on trees and crops in the first year.

Appendix-I
Model - 10

Agro-Forestry Project Profile

A-C Zone : Eastern Plateau & Hill Regions
Situation : Non-arable land

Tree-Crops Combination : Silvipasture
Tree : *Hardwickia binata* (Anjan)
Grass : *Pennisetum pedicellatum* (Dinanath Grass)

Input / Output Analysis

Amount in Rupees

Year	Expenses Per Ha			Benefits Per Ha			Net Benefit Per Ha
	Tree	Grass	Total	Tree	Grass	Total	
1	24000	5000	29000	0	13500	13500	-15500
2	2000	5000	7000	0	13500	13500	6500
3	2000	5000	7000	0	13500	13500	6500
4	2000	5000	7000	0	13500	13500	6500
5	2000	5000	7000	0	13500	13500	6500
6	2000	5000	7000	0	13500	13500	6500
7	2000	5000	7000	0	13500	13500	6500
8	2000	5000	7000	0	13500	13500	6500
9	2000	5000	7000	0	13500	13500	6500
10	2000	5000	7000	0	13500	13500	6500
11	2000	5000	7000	0	13500	13500	6500
12	2000	5000	7000	0	13500	13500	6500
13	2000	5000	7000	0	13500	13500	6500
14	2000	5000	7000	0	13500	13500	6500
15	2000	5000	7000	400000	13500	413500	406500
Net Present Value @15% DF			**60,062**			**128,097**	**68,035**

Assumptions :

Tree : Hardwickia binata : Rotation 15(1)

1. No. of trees/ha. = 400
2. Income per tree : Rs.1000 (in the 15th year)
3. Expenses per ha. : Yr. 1 =Rs.24000, Yr 2 & onwards=Rs.2000

Grass : Pennisetum pedicellatum

1. Yield per ha.= 90000 kg.
2. Sale price per kg.= Re.0.15
3. Expenses per ha.= Rs.5000

Analysis :

Benefit Cost Ratio at 15% Discount Factor:	**2.13**
Net Present Value in Rs. at 15% Discount Factor :	**68,035**
IRR :	**47%**

Investment

Year 1	Rs.29000
Year 2 to 15	Rs.28000
Total	**Rs.57000**

Note : Investment proposed includes expenses on trees for 15 years and expenses on grass in the first year.

Appendix-I
Model - 11

Agro-Forestry Project Profile

A-C Zone : Central Plateau & Hill Regions
Situation : Rainfed

Tree-Crops Combination : Agrihorticulture
Tree : *Emblica officinalis* (Awala)
Crop 1 : Groundnut
Crop 2 : Gram (Rabi)

Input / Output Analysis

Amount in Rupees

Year	Expenses per Ha				Brenefits per Ha				Net Benefit per Ha.
	Tree	Crop 1	Crop 2	Total	Tree	Crop 1	Crop 2	Total	
1	12000	5000	5500	22500	0	6400	7000	13400	-9100
2	8000	5000	5500	18500	0	6400	7000	13400	-5100
3	8000	5000	5500	18500	0	6400	7000	13400	-5100
4	8000	5000	5500	18500	12800	6400	7000	26200	7700
5	8000	5000	5500	18500	16000	6400	7000	29400	10900
6	8000	5000	5500	18500	19200	6400	7000	32600	14100
7	8000	5000	5500	18500	16000	6400	7000	29400	10900
8	8000	5000	5500	18500	12800	6400	7000	26200	7700
Net Present Value @ 15% DF				**86,494**				**93,903**	**7,410**

Assumptions :

Tree : Emblica officinalis

1. No. of trees/ha. = 200
2. Yield per tree : Yr. 4 = 8 kg., Yr 5=10 kg., Yr.6=12 kg., Yr 7=10 kg., Yr 8=8 kg.
3. Sale price per kg. = Rs.8
4. Expenses per ha. : Yr 1 = Rs.12000, Yr 2 & onwards = Rs.8000

Crop :

	Groundnut	Gram
1. Yield per ha.	800 kg.	1000 kg.
2. Sale price per kg.	Rs.8	Rs.7
3. Expenses per ha.	Rs.5000	Rs.5500

Analysis :

Benefit Cost Ratio at 15% DF	**1.09**
Net Present Value in Rs. at 15% DF:	**7,410**
IRR :	**27%**

Investment

Year 1	Rs.22500
Year 2 to 4	Rs.24000
Total	**Rs46500**

Note : Investment proposed includes expenses on trees for 4 years and expenses on crops in the first year.

Appendix-I
Model - 12

Agro-Forestry Project Profile

A-C Zone : Western Plateau & Hill Regions
Situation : Rainfed (Non arable)

Tree-Crop Combination : Silvipasture
Tree : *Albizia amara*
Grass : *Cenchrus ciliaris*

Input / Output Analysis

Amount in Rupees

Year	Expenses Per Ha			Benefits Per Ha			Net Benefit Per Ha
	Tree	Grass	Total	Tree	Grass	Total	
1	13750	10000	23750	0	1500	1500	-22250
2	6875	1500	8375	6875	7000	13875	5500
3	6875	1500	8375	6875	10000	16875	8500
4	6875	1500	8375	6875	14000	20875	12500
5	6875	1500	8375	6875	14000	20875	12500
6	6875	1500	8375	6875	14000	20875	12500
7	6875	1500	8375	6875	14000	20875	12500
8	6875	1500	8375	6875	14000	20875	12500
9	6875	1500	8375	6875	14000	20875	12500
10	6875	1500	8375	6875	14000	20875	12500
11	6875	1500	8375	6875	14000	20875	12500
12	6875	1500	8375	6875	14000	20875	12500
13	6875	1500	8375	6875	14000	20875	12500
14	6875	1500	8375	6875	14000	20875	12500
15	6875	1500	8375	6875	14000	20875	12500
16	6875	1500	8375	76875	14000	90875	82500
Net Present Value @15% DF			**62,341**			**97,293**	**34,952**

Assumptions :

Tree : Albizia amara

1. No. of trees/ha. = 275
2. Income from wood = Rs.70000 (in the 16th year)
3. Fodder income per tree per year = Rs.25
4. Expenses per ha.: Yr 1 = Rs.13750, Yr 2 & onwards Rs.6875

Grass : Cenchrus ciliaris

1. Yield per ha.= Yr.1 = 1500 kg., Yr.2 = 7000 kg., Yr.3 = 10000 kg., Yr.4 & onwards = 14000 kg.
2. Sale price per kg.= Rs.1
3. Expenses = Rs.10000 in the first year and Rs.1500 from 2nd year onwards.

Analysis :

Benefit Cost Ratio at 15% Discount Factor: 1.56

Net Present Value in Rs. at 15% Discount Factor : 34,952

IRR : 43%

Investment

Year 1 **Rs.23750**

Note : Investment proposed includes expenses on trees and grass in the first year.

Appendix-I
Model - 13

Agro-Forestry Project Profile

A-C Zone : Southern Plateau & Hill Regions **Tree-Crop Combination : Agrisilviculture**

Situation : Irrigated **Tree : *Ceiba pentendra***

Crop : Groundnut

Input / Output Analysis

Amount in Rupees

Year	Expenses Per Ha			Benefits Per Ha			Net Benefit Per Ha
	Tree	Crop	Total	Tree	Crop	Total	
1	24000	5000	29000	0	6400	6400	-22600
2	12000	5000	17000	0	6400	6400	-10600
3	12000	5000	17000	0	6400	6400	-10600
4	12000	5000	17000	0	6080	6080	-10920
5	12000	5000	17000	0	5760	5760	-11240
6	12000	5000	17000	50000	5440	55440	38440
7	12000	5000	17000	50000	5120	55120	38120
8	12000	5000	17000	50000	4800	54800	37800
9	12000	5000	17000	50000	4480	54480	37480
10	12000	5000	17000	50000	4160	54160	37160
11	12000	5000	17000	50000	3840	53840	36840
12	12000	5000	17000	50000	3520	53520	36520
13	12000	5000	17000	50000	3200	53200	36200
14	12000	5000	17000	50000	2880	52880	35880
15	12000	5000	17000	50000	2560	52560	35560
Net Present Value @15% DF			**109,840**			**156,586**	**46,746**

Assumptions :

Tree : Ceiba pentendra

1. No. of trees/ha. = 275
2. Income per tree = Rs.50000 (from 5th yr onwards)
3. Expenses per ha.: Yr 1 = Rs.24000, Yr 2 & onwards Rs.12000

Crop : Groundnut :

1. Yield per ha. = 800 kg.
2. Sale price per kg. = Rs.8
3. Expenses per ha. = Rs.5000

Analysis :

Benefit Cost Ratio at 15% Discount Factor: **1.43**

Net Present Value in Rs. at 15% Discount Factor : **46,746**

IRR : **28%**

Investment

Year 1	Rs.29000
Year 2 to 6	Rs.60000
Total	**Rs.89000**

Note : 1.There is 5% reduction in area under crop due to shade effect of tree from 4th year onwards

2. Investment proposed includes expenses on trees for 6 years and expenses on crop in the first year.

Appendix-I
Model : 14

Agro-Forestry Project Profile

A- C Zone : Southern Plateau and Hill Region
Situation:Rainfed

Tree-Crop combination : Agrisilviculture
Tree : *Tamarindus indica* (Imli)
Crop : Chilli

Input / Output Analysis

Amount in Rupees

Year	Expenses Per Ha			Benefits Per Ha			Net Benefit Per Ha
	Trees	Crop	Total	Trees	Crop	Total	
1	7000	1260	8260	0	1800	1800	-6460
2	4000	1260	5260	0	1800	1800	-3460
3	4000	1260	5260	0	1800	1800	-3460
4	4000	1260	5260	0	1800	1800	-3460
5	4000	1134	5134	0	1620	1620	-3514
6	4000	1008	5008	0	1440	1440	-3568
7	4000	882	4882	0	1260	1260	-3622
8	4000	756	4756	0	1080	1080	-3676
9	4000	630	4630	0	900	900	-3730
10	4000	504	4504	200000	720	200720	196216
Net Present Value @15% DF			**28,163**			**57,264**	**29,101**

Assumptions:

Tree: Tamarindus Indica: Rotation 10 Years

1. No of trees/ha.=100
2. Yield per tree=200 kg
3. Sale price of fruit per kg.=Rs 10
4. Expenses per tree=Yr 1=Rs70
   Yr 2 & onwards =Rs 40

Crop : Chilli

1. Yield per ha = 300 kg.
2. Sale price per kg.= Rs. 6
3. Expenses per ha =Rs.1260

Analysis:

Benefit Cost Ratio @ 15% DF = 2.03
Net Present Value @ 15% DF = Rs 29101
IRR = 32%

Investment:

Year 1	=	Rs	8260
Year 2 to 10	=	Rs	36000
Total	=	**Rs**	**44260**

Note: There is 10% reduction in area under crop due to shade effect of trees from 4th year onwards. Investment proposed includes expenses on trees for 10 years and expenses on crop for one year.

Appendix-I
Model : 15

Agro-Forestry Project Profile

A-C Zone: West Coast & Ghat Region
Situation: Irrigated

Tree-Crop combination: Agrisilviculture
Tree: *Casurina equisetifolia*
Crop: Paddy

Input / Output Analysis

Amount in Rupees

Year	Expenses Per Ha			Benefits Per Ha			Net Benefit Per Ha
	Trees	Crop	Total	Trees	Crop	Total	
1	62500	4320	66820	0	7200	7200	-59620
2	5000	4320	9320	0	7200	7200	-2120
3	5000	4320	9320	0	7200	7200	-2120
4	5000	3888	8888	0	6480	6480	-2408
5	5000	3456	8456	0	5760	5760	-2696
6	5000	3024	8024	0	5040	5040	-2984
7	5000	2592	7592	250000	4320	254320	246728
Net Present Value @15% DF			**86,889**			**120,795**	**33,907**

Assumptions:

Tree: Casurina equisetifolia: Rotation 7Years

1. No of trees per ha.=2500
2. Income per ha =Rs 250000 (in the 7th Yr)
3. Expenses :Yr 1=Rs25/tree, Yr 2 & onwards= Rs.5000

Analysis:

Benefit Cost Ratio @ 15% DF = 1.39
Net Present Value @ 15% DF = Rs 33906
IRR = 25%

Crop : Paddy

1. Yield per ha.= 1600 kg.
2. Sale price per kg. = Rs 4.50
3. Expenses per ha= Rs 4320

Investment:

Year 1	=	Rs 66820
Year 2 to 7	=	Rs 30000
Total	=	**Rs. 96820**

Note: There is 10% reduction in area under crop due to shade effect of trees from 4th year onwards. Investment proposed includes expenses on trees for 7 years and expenses on crop for one year.

Appendix-I
Model 16

Agro-Forestry Project Profile

A-C Zone : West Coast & Ghat Region
Situation : Irrigated

Tree-Crop Combination : Agrihorticulture
Tree : *Cocos nucifera* (Coconut)
Crop 1 : Elephant Foot
Crop 2 : Ginger

Input/ Output Analysis

Amount in Rupees

Year	Expenses per Ha				Brenefits per Ha				Net Benefit per Ha.
	Tree	Crop 1	Crop 2	Total	Tree	Crop 1	Crop 2	Total	
1	9600	7000	4200	20800	0	0	6000	6000	-14800
2	4800	3000	4200	12000	0	0	6000	6000	-6000
3	4800	3000	4200	12000	0	0	6000	6000	-6000
4	4800	4000	4200	13000	0	25000	6000	31000	18000
5	4800	7000	4200	16000	20000	0	6000	26000	10000
6	4800	3000	4200	12000	20000	0	6000	26000	14000
7	4800	3000	4200	12000	20000	0	6000	26000	14000
8	4800	4000	4200	13000	20000	25000	6000	51000	38000
Net Present Value @15% DF				**64,387**				**82,037**	**17,650**

Assumptions :
Tree : Cocos nucifera (Coconut)
1. No. of trees/ha. = 160
2. Yield per ha : 10000 nuts (from 5th year onwards)
3. Sale price per nut = Rs.2
4.Expenses per tree : Yr 1 = Rs.60,
Yr 2 & onwards = Rs.30

Analysis :
Benefit Cost Ratio at 15% Discount Factor: 1.27
Net Present Value in Rs. at 15% Discount Factor : 17,650
IRR : 32%

Crop :0.5 ha. Each crop

	Elephant Foot	Ginger
1. Yield per ha.	25000 kg.every 4 years	2000 kg.
2. Sale price per kg.	Rs.2	Rs.6
3. Expenses per ha.	Rs17000 for 4 years	Rs.8400

Investment

Year 1	Rs.20800
Year 2 :	Rs.7800
Year 3 :	Rs.7800
Year 4 :	Rs.8800
Year 5 :	Rs.4800
Total	**Rs.50000**

Note : Investment proposed includes expenses on trees for 5 years and expenses on first crop for four years and second crop for the first year.

Appendix-I
Model : 17

Agro-Forestry Project Profile

A-C Zone : West Coast & Ghat Region **Tree-Crop combination: Agrisilviculture**
Situation : Rainfed **Tree: *Tectona grandis* (Teak)**
Crop : Sweet Potato

Input / Output Analysis

Amount in Rupees

Year	Expenses Per Ha			Benefits Per Ha			Net Benefit Per Ha
	Tree	Crop	Total	Tree	Crop	Total	
1	38000	18000	56000	0	30000	30000	-26000
2	11875	18000	29875	0	30000	30000	125
3	11875	18000	29875	0	30000	30000	125
4	11875	18000	29875	0	30000	30000	125
5	11875	18000	29875	0	30000	30000	125
6	11875	18000	29875	0	30000	30000	125
7	11875	18000	29875	0	30000	30000	125
8	11875	18000	29875	0	30000	30000	125
9	11875	18000	29875	0	30000	30000	125
10	11875	18000	29875	0	30000	30000	125
11	11875	18000	29875	0	30000	30000	125
12	11875	18000	29875	0	30000	30000	125
13	11875	18000	29875	0	30000	30000	125
14	11875	18000	29875	0	30000	30000	125
15	11875	18000	29875	0	30000	30000	125
16	11875	18000	29875	0	30000	30000	125
17	11875	18000	29875	0	30000	30000	125
18	11875	18000	29875	0	30000	30000	125
19	11875	18000	29875	0	30000	30000	125
20	11875	18000	29875	3800000	30000	3830000	3800125
Net Present Value @15% DF			**209,715**			**419,961**	**210,246**

Assumptions :

Tree: Tectona grandis : Rotation 20 Years

1. No of trees per ha.= 475
2. Income per ha. = Rs.3800000 (in the 20th year)
3. Expenses per tree=Yr 1=Rs80, Yr 2 & & onwards =Rs 25

Crop : Sweet Potato

1. Yield per ha=10000 kg.
2. Sale price per kg. = Rs 3
3. Expenses per ha =Rs.18000

Analysis :

Benefit Cost Ratio @ 15% DF = 2.00
Net Present Value @ 15% DF = 210,246
IRR = 30%

Investment:

Year 1	=	Rs 56000
Year 2 to 20	=	Rs 225625
Total	=	**Rs. 281625**

Note : Investment proposed includes expenses on trees for 20 years and expenses on crop for the first year.

Appendix-I
Model - 18

Agro-Forestry Project Profile

A-C Zone : Gujarat Plains and Hill Region
Situation : Rainfed

Tree-CropsCombination : Agrisilviculture
Tree : *Dalbergia Sissoo* (Sheesham)
Crop : Castor

Input / Output Analysis

Amount in Rupees

Year	Expenses Per Ha			Benefits Per Ha			Net Benefit Per Ha
	Tree	Crop	Total	Tree	Crop	Total	
1	7000	240	7240	0	2000	2000	-5240
2	0	240	240	0	2000	2000	1760
3	0	240	240	0	2000	2000	1760
4	0	216	216	0	1800	1800	1584
5	0	192	192	0	1600	1600	1408
6	0	168	168	0	1400	1400	1232
7	0	144	144	0	1200	1200	1056
8	0	120	120	0	1000	1000	880
9	0	96	96	0	800	800	704
10	0	72	72	0	600	600	528
11	0	48	48	0	400	400	352
12	0	24	24	0	200	200	176
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0
20	0	0	0	112000	0	112000	112000
Net Present Value @ 15% DF			**7,080**			**15,117**	**8,037**

Assumptions :

Tree : Dalbergia Sisoo : Rotation 20 (1)

1.No. of trees/ha =280

2. Income per tree = Rs.400

3. Expenses per tree =Rs.25(in the first year)

Crop : Castor

1. Yield per ha.= 250 kg.
2. Sale price per kg. = Rs.8
3. Expenses per ha. = Rs.240

Analysis :

Benefit Cost Ratio at 15% Discount Factor : 2.14

Net Present Value in Rs. at 15% Discount Factor : 8,037

IRR : 30%

Investment :

Year 1 - **Rs.7240**

Note : 1. There is 10% reduction in area under crops due to shade effectof tree from the fourth year onwards.

2. Investment proposed includes expenses on trees and crop in the first year.

Appendix-I
Model : 19

Agro-Forestry Project Profile

A-C Zone: Western Dry Region
Situation: Rainfed

Tree-Crop combination: Agrisilviculture
Tree : *Prosopis cineraria* (Raj Teak)
Crop : Pearl millet (Bajra)

Input / Output Analysis

Amount in Rupees

Year	Expenses Per Ha			Benefits Per Ha			Net Benefit Per Ha
	Tree	Crop	Total	Tree	Crop	Total	
1	10800	1500	12300	0	3000	3000	-9300
2	3600	1425	5025	0	2850	2850	-2175
3	3600	1350	4950	0	2700	2700	-2250
4	3600	1275	4875	0	2550	2550	-2325
5	3600	1200	4800	0	2400	2400	-2400
6	3600	1125	4725	17850	2250	20100	15375
7	3600	1050	4650	17850	2100	19950	15300
8	3600	975	4575	17850	1950	19800	15225
9	3600	900	4500	17850	1800	19650	15150
10	3600	825	4425	17850	1650	19500	15075
11	3600	750	4350	17850	1500	19350	15000
12	3600	675	4275	17850	1350	19200	14925
13	3600	600	4200	17850	1200	19050	14850
14	3600	525	4125	17850	1050	18900	14775
15	3600	450	4050	17850	900	18750	14700
16	3600	375	3975	17850	750	18600	14625
17	3600	300	3900	17850	600	18450	14550
18	3600	225	3825	17850	450	18300	14475
19	3600	150	3750	17850	300	18150	14400
20	3600	75	3675	417850	150	418000	414325
Net Present Value @15% DF			**14,732**			**242,700**	**227,968**

Assumptions:

Tree: Prosopis cineraria (Raj Teak)

1. No of Trees = 170
2. Income per ha = Rs 17850 (6th Yr onwards from fruits and green leaves) & additional Rs.400000 in the 20th Yr. from fuelwood.
3. Expenses per ha.:Yr 1 = Rs.10800, Yr 2 & onwards = Rs.3600

Crop : Pearl millet

1. Yield per ha=1000kg
2. Sale price per kg. = Rs 3
3. Expenses per ha= Rs. 1500

Analysis:

Benefit Cost Ratio @ 15% DF = 16.5
Net Present Value @ 15% DF = 227,968
IRR = 36%

Investment:

Year 1	Rs 12300
Year 2 to 6	Rs 18000
Total	**Rs 30300**

Note: 1. There is 5% reduction in area under crop from 2nd year onwards due to shade effect of tree.
2. Investment proposed includes expenses on trees for 6 years and crop in the first year.

Appendix-I
Model - 20

Agro-Forestry Project Profile

A-C Zone : Western Dry Region
Situation : Non arable wasteland

Tree-crop Combination : Silvipasture
Shrub : *Ziziphus nummularia*
Grass : *Cenchrus ciliaris*

Input / Output Analysis

Amount in Rupees

Year	Expenses Per Ha			Benefits Per Ha			Net Benefit Per Ha
	Shrub	Grass	Total	Shrub	Grass	Total	
1	16000	10000	26000	0	1500	1500	-24500
2	2000	1500	3500	0	7000	7000	3500
3	2000	1500	3500	0	10000	10000	6500
4	2000	1500	3500	2000	14000	16000	12500
5	2000	1500	3500	2000	14000	16000	12500
6	2000	1500	3500	2000	14000	16000	12500
7	2000	1500	3500	2000	14000	16000	12500
8	2000	1500	3500	2000	14000	16000	12500
9	2000	1500	3500	2000	14000	16000	12500
10	2000	1500	3500	2000	14000	16000	12500
Net Present Value @ 15% DF			**37,131**			**56,941**	**19,810**

Assumptions :

Tree : Ziziphus nummularia

1. No. of shrubs/ha. =400
2. Yield of fruits per bush = 3 kg. (4th Yr.onwards)
   Yield of leaves per bush = 2 kg.(4th Yr. Onwards)
3. Sale price = Re 1 /kg.
4. Expenses per shrub = Rs.40 (in the first year) and Rs.2000 from 2nd year onwards.

Grass : Cenchrus ciliaris

1. Yield per ha.= Yr.1 = 1500 kg., Yr.2 = 7000 kg., Yr.3 = 10000 kg., Yr.4 & onwards = 14000 kg.
2. Sale price per kg.= Rs.1
3. Expenses = Rs.10000 in the first year and Rs.1500 from 2nd year onwards.

Analysis :

Benefit Cost Ratio at 15% Discount Factor : **1.53**

Net Present Value in Rs. at 15% Discount Factor : **19,810**

IRR : **33%**

Investment :

Year 1	Rs. 26000
Year 2 to 4	Rs. 6000
Total	**Rs. 32000**

Note : Investment proposed includes expenses on shrubs for 4 years and grass in the first year.

Appendix-I
Model : 21

Agro-Forestry Project Profile

A-C Zone: The Islands Region
Situation : Rainfed

Tree-Crop combination:
Agrisilviculture
Tree: *Cocos nucifera* (Coconut)
Crop : Paddy

Input / Output Analysis

Amount in Rupees

Year	Expenses Per Ha			Benefits Per Ha			Net Benefit Per Ha
	Tree	Crop	Total	Tree	Crop	Total	
1	9600	4320	13920	0	7200	7200	-6720
2	4800	4320	9120	0	7200	7200	-1920
3	4800	4320	9120	0	7200	7200	-1920
4	4800	3888	8688	0	6480	6480	-2208
5	4800	3456	8256	20000	5760	25760	17504
6	4800	3024	7824	20000	5040	25040	17216
Net Present Value @15% DF			**37,452**			**43,777**	**6,325**

Assumptions:

Tree: Cocos nucifera (Coconut)

1. No of trees = 160
2. Income per ha =Rs 20000 (from 5th Yr onwards)
3. Expenses per tree :Yr.1 = Rs.60, Yr 2 & onwards =Rs.30

Analysis:

Benefit Cost Ratio @ 15% DF = 1.17
Net Present Value @ 15% DF = Rs 6325
IRR = 31%

Crop : Paddy

1. Yield per ha=1600Kg
2. Sale price per kg. = Rs 4.50

Expenses per ha.= Rs 4320

Investment:

Year 1 = Rs 13920
Year 2 to 5 = Rs 19200
Total = **Rs. 33120**

Note: There is 10% reduction in area under crop due to shade effect of trees from 4th year onwards. Investment proposed includes expenses on trees for 5 years and expenses on crop for one year.

Appendix-I
Model 22

Agro-Forestry Project Profile

A-C Zone : Multi Purpose Tree Species (MPTS) for Problematic Soils & Polluted Habitats
Situation : Saline soils

Tree: *Prosopis juliflora*

Input / Output Analysis

Amount in Rupees

Years	Expenses Per Ha.	Benefits per Ha.	Net Benefit per Ha.
1	9000	0	-9000
2	3000	0	-3000
3	3000	0	-3000
4	3000	0	-3000
5	3000	0	-3000
6	3000	0	-3000
7	3000	0	-3000
8	3000	0	-3000
9	3000	0	-3000
10	3000	150000	147,000
Net Present Value at 15% DF	**20274**	**37,078**	**16,804**

Assumptions :

Tree : Prosopis juliflora

1. No. of trees/ha. = 600,
2. Income per tree = Rs.250
3. Expenses per tree = Yr.1 = Rs.15, year 2 to year 10 = Rs.5

Analysis :

Benefit Cost Ratio at 15% DF : 1.83

Net Present Value in Rs. at 15% DF : 16,804

IRR = 26%

Investment

Year 1	Rs. 20000
Year 2 to Year 10	Rs. 27000
Total	**Rs.47000**

Note : Investment includes expenses on trees for ten years

Appendix-I
Model 23

Agro-Forestry Project Profile

A-C Zone : Multi Purpose Tree Species (MPTS) for Problematic Soils & Polluted Habitats
Situation : Acid soils

Tree: *Gamelina arborea*

Input / Output Analysis

Amount in Rupees

Year	Expenses Per Ha.	Benefits per Ha.	Net Benefit per Ha.
1	20000	0	-20000
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	0	320000	320,000
Net Present Value at 15% DF	**17391**	**59,810**	**42,419**

Assumptions :

Tree : Gamelina arborea : Rotation 12(1)

1. No. of trees/ha. = 400,
2. Income per tree = Rs.800
3. Expenses per tree = Rs.50 (in the first year)

Analysis :

Benefit Cost Ratio at 15% DF :	**3.44**
Net Present Value in Rs. at 15% DF :	**42,419**
IRR =	**29%**

Investment

Year 1	**Rs. 20000**

Note : Investment includes expenses on trees for the first year

Appendix-I
Model - 24

Agro-Forestry Project Profile

A-C Zone : Multi Purpose Tree Species (MPTS) for Problematic Soils & Polluted Habitats

Tree : *Populus deltoids*

Situation : Bio drainage

Input / Output Analysis

Amount in Rupees

Year	Expenses Per Ha.	Benefits per Ha.	Net Benefit per Ha.
1	22000	0	-22000
2	12000	0	-12000
3	12000	0	-12000
4	12000	0	-12000
5	12000	0	-12000
6	12000	0	-12000
7	0	600000	600000
Net Present Value at 15% DF	**54,109**	**225,562**	**171453**

Assumptions :

Tree : Populus deltoides : Rotation 7(1)

1. No. of trees/ha. = 500
2. Income per tree: Rs.1200 (in the 7th yr.)
3. Expenses per ha. : Yr.1 = Rs.22000, Yr.2 & onwards =Rs.12000

Analysis

Benefit Cost Ratio at 15% DF : **4.17**

Net Present Value at 15% DF : **171,453**

IRR : **56%**

Investment

Year 1 to 6 **Rs.82000**

Note : Investment includes expenses on trees for 6 years

Appendix II

RIDF-V: Terms and Conditions

Part A - Projects to be implemented by the State Government Departments

1. Activities: The activities presently prioritised include:
   - i) Medium and Minor Irrigation (Major Irrigation on a selective basis)
   - ii) Soil conservation/watershed management
   - iii) Flood protection/drainage
   - iv) Rural roads/bridges (priority to provide connectivity to unconnected villages)
   - v) Rural market yards/godowns/integrated market yards
   - vi) Integrated cold chains
   - vii) Fish jetties.

2.	Phasing: (period of completion)	Maximum of three years i.e., upto 31 March 2002
3.	Quantum of Loan:	The loan would be restricted to the balance cost of the project subject to ceiling of 90% of the latest estimated cost.
4.	Type of Projects:	Priority would be given to the ongoing projects. In case of new projects, only short duration projects which could be completed in 1-2 years would be considered.
5.	Cut Off Date:	Expenditure incurred on or after 1 April 1999 only would be eligible for reimbursement.
6.	Rate of Interest:	12% p.a. payable every quarter.
7.	Repayment Period:	Each drawal would be treated as a separate loan and would be repayable in 7 years including 2 years grace period i.e., each drawal would be required to be repaid in five equal annual instalments commencing from 36th month.
8.	Nodal Department:	Finance Department (FD) of the State Government would continue to be the nodal department for documentation, drawal of fund etc. FD, if it so desires, may authorise a specified senior official of the implementing department(s) only for submission of drawal applications to NABARD.
9.	Mode of Funding:	NABARD would release the sanctioned amount on a reimbursement basis. However, if the State Government desires, NABARD may consider releasing upto 10% of the sanctioned amount in advance for purchase of material, equipment etc., to be adjusted proportionately from out of the eligible amount in reimbursement claims received subsequently.

10.	Security:	The loan under RIDF-V would be released against mandate to be executed by the State Government and registered with RBI authorising the latter to debit the government's account and pass on the amount to NABARD in case of default in payment of interest and/or repayment of principal by the State Government. However, if the State Government has already executed the mandate in respect of its borrowings under earlier trancehs covering all borrowings under RIDF, executing a fresh mandate may not be necessary.

Part B : Projects to be Implemented by PRIs/SHGs/NGOs

1.	Activities	The nature of the projects in individual cases may vary from State to State and PRI to PRI but would normally fall within one of the following broad categories. i) Rural link roads/Culverts/Small bridges ii) Community irrigation including Bandharas iii) Primary School Building including additions iv) Drinking Water Supply v) Watershed Development Works vi) Drainage Works vii) Premises for Primary Health Services viii) Village haats ix) Cold storage, godowns, seed farms etc.
2.	Phasing Quantum of loan, type of projects, Cut off date, Rate of interest and Re-payment period:	Same as at items 2 to 7 of Part A.
3.	Security:	i) Where the State Govt. borrows the fund on behalf a PRI/SHG/NGO and the latter becomes only and executing agency, same as at item 10 of Part A. ii) Where (a) the State Government desires that selected PRI/SHG/NGO should, in addition to executing the project, be also a borrower and (b) the concerned PRISHG/NGO, has enabling powers to borrow under the Statute/Rules/Regulations/ Byelaws etc., the loan under RIDF-V would be released on execution of a default guarantee by the State Government in favour of NABARD, accompanied by a mandate broadly on the line of one referred to at item 10 of Part A.

		iii) Where NABARD is satisfied that 9a) the projects to be financed are likely to generate adequate income for GP/SHG/NGO to enable it to meet the obligations of payment of interest and repayment of principal on time without risk of default; (b) GH/SHG/NGO is otherwise financially, managerially and organisationally capable of managing the project; and (c) the GP/SHG/NGO has specific power to borrow and create charge on its assets/income in favour of lender in terms of the Statute/Rules/Regulations/Byelaws etc. NABARD may in specific cases, waive the requirement of security as at (i) or (ii) above in favour of another alternate arrangement. iv) Where NABARD is satisfied about the financial strength and sound methods of operation of a PR finance corporation of a State finances to the PRIs could also be routed through them or arrangement of co-financing with them could be worked out.
4.	Selection of PRIs/ GPs/SHGs/NGOs:	Selection will be made on the basis of norms evolved by NABARD.
5.	Sanctioning Committee:	The loans in respect of projects to be implemented by the PRIs/SHGs/NGOs would generally be sanctioned by the Project Sanctioning Committee at the State/District Level with membership drawn from NABARD, RBI, lead Bank, State Government departments and experts from the field of Rural Development and Panchayats/SHG. The constitution of the Committee would be decided by NABARD. However, loans to GPs/SHGs/NGOs under item 3 (iii) and 3 (iv) above would be sanctioned by Project Sanctioning Committee at the Head Office of NABARD.
6.	Nodal Department:	For loans to be sanctioned under items e (i) and (ii) above, as in the past, Finance Department would be the Nodal Department for acceptance of terms and conditions, documentation, payment of interest and repayment of principal etc.
7.	Returns:	PRI/SHG/NGO concerned shall furnish to NABARD a quarterly statement of progress (physical and financial) in the prescribed proforma within 10 days from the close of the quarter.
8.	Review of Progress:	The progress will be reviewed PRI/SHG/NGO-wise at the State/Divisional/District level by a Committee headed by the principal Secretary, Finance/Rural Development/Panchayat Raj Institution. The level of review will be decided in consultation with the State Government.

Implementation of JFM Component

The programme will be implemented at the State level by the State Forest Department and it will be the nodal agency. At the district level, Divisional Forest Officers and Forest Range Officers will be implementing the VSS projects.

Duties and Responsibilities of VSS

The General Body of the VSS shall meet once in six months to review the action taken in pursuance of the approved JFM Plan and functioning of the Managing Committee. The Forest Range Officer shall be the Convenor of the General Body. The members of the VSS individually and collectively shall:

a) Ensure protection of forest against encroachment, grazing, fires and thefts of forest produce;

b) Also be responsible to carry out development of forests in accordance with the approved JFM Plan;

c) Make other villagers aware of the importance of forests;

d) Help the forest officers in carrying out forestry development/eco-development work in accordance with the JFM Plan.

The member of VSS shall have the powers to:

a) Apprehend the forest offenders and hand them over to the authorities concerned to take action under the provisions of the relevant Forest Act and Rules;

b) All such cases where forest offenders have been handed over to the concerned forest officials, the concerned forest authority will be responsible to report back the action taken by them to the Management Committee of the concerned VSS.

Functions and Responsibilities of Forest Department

a) The actions taken for implementation of the concept of JFM shall be reviewed by District Forest Committee as constituted in terms of GO MS No.182 EFES&T (For.II) Dept. dated 24.8.1993.

b) The Forest Department shall be responsible to provide assistance to VSS in selection/demarcation of the forest areas to be put under JFM and in preparation of JFM micro-plan, approving of the budget micro-plan and getting the budget approved;

c) Forest Department shall be responsible to transfer the skills of sound silvicultural treatment and soil conservation practices to the members of VSS and to guide JFM micro-plan implementation.

d) The officials of Forest Department shall assist the members of VSS in apprehending forest offenders wherever necessary.

Role of NGOs

NGOs can play an active role in facilitating JFM implementation in the following aspects:

(i) Support role to Forest Department and other NGOs.

a) Organising orientation programme like exposure trips for Forest Department personnel and NGO representatives to on-going experiences in JFM.

b) Training – co-ordinating training for Forest Department, NGOs and members of VSS. Providing resource persons in training camps organised by Forest Department.

c) Communication – preparation of communication packages regarding JFM to be made available to Forest Dept., NGOs and VSS enabling in setting up a live information system between Forest Dept. and VSS.

d) Sharing documentation or orientation training programmes, experience in community organisations for forest management.

(ii) Village level activities

a) Dissemination of information regarding government programmes.

b) Encouraging community to organise into a VSS.

c) Liaison with government together with and on behalf of the community for approval of VSS so as to get access to lands and facilitating implementation of JFM.

d) Supporting people's initiatives in protecting forest land.

e) Arranging funds to VSS for implementing JFM plan from the resources other than the Forest Department.

f) Organising training programmes/camps for members of VSS so as to facilitate afforestation activities, strengthen the capacities of Management Committee members of VSS, organise women's camps for their active participation and articulation in the VSS, identify capacity in building of VSS members with potential to strengthen people's involvement.

g) Intervening and strengthening community capacity to enable democratic functioning of VSS, to encourage women's involvement, to deal with conflicts and actively participate in implementing JFM Plan.

h) Encouraging VSS members to take up nursery raising, peripheral plantation, fodder cultivation, bio-gas plants and other non-conventional energy resources so as to reduce their dependence on forest lands.

i) Documenting field experience to focus on emerging issues.

(iii) Research and net work with Forest Department and NGOs on institutional, economical and ecological aspects of JFM.

At the instance of the Government of Andhra Pradesh, JFM has been included as one of the components for RIDS funding. For JFM activities the fund is made

available broadly under the same terms and conditions as far other RIDF components. The stipulations are as follows:

Rate of Interest : 11½ per cent.
Repayment period: 7 years with two years grace period under which only interest will be paid on quarterly basis.

Aims and Objectives of JFM/VSS

i) Treatment of degraded forest areas on the basis of watershed as per the needs of the land to check soil erosion, improving profile water regime, restore green cover so as to increase the productivity of degraded forests and provide ecological balance.

ii) To create employment to rural people especially landless scheduled caste, scheduled tribes and backward class women.

iii) To empower the rural people by social and economic development.

iv) To provide a share in usufructs of the forests to the people involved in JFM and maintain sustainability in employment generation.

v) To develop thrift habits and self-help among the groups.

vi) To involve NGOs in training the VSS groups and the forest staff.

Project Components

The treatment practices will include:

a) Rehabilitation of degraded forest lands with viable root stock by nurturing natural regeneration. This involve the following:

b) Coppicing by cutting high stumps by regular felling to no more than 15 cms from the ground level

c) Removal of unwanted thorny and miscellaneous growth

d) Multiple shoot cutting to obtain no more than 3 shoots per stump

e) Thinning in natural teak areas at regular intervals

f) Second coppice cutting followed by single is to be done after two years of the first coppice cutting

g) Soil and moisture conservation works.

Benefits and Justification

The viability of the VSS supported forestry project is assessed by estimating the economic rate of return on the investment made. The various activities proposed for rehabilitation of the degraded forest lands include nurturing natural regeneration with viable root stock, soil and moisture conservation and support activities. As the forest activities have a large labour component, the cost thereon has been valued with a shadow price less than market wage rate, the conversion factor being 0.8 reflecting the opportunity cost of labour adequately. Year to year

(from 4th year) maintenance/harvesting @ Rs.300/ha also involves mainly labour operations and as such these costs are converted into economic cost with the same factor. The species to be planted is purported to meet the demands for fodder, fuel wood, small timber etc., of the participatory VSS members. Output having commercial value will be marketed (teak, minor forest produce etc.,) either through government outlets or other appropriate channels. Apart from valuing them at local market rates, weightage of additional 50% benefits are given to the benefit stream keeping into consideration the desirable impact on environmental protection, control of soil erosion, recycling of water and control of humidity, carbon sequestration and oxygen generation, increased bio-diversity etc., are stated to be added advantages of forest development. The quantification of such benefits and pricing methodology being difficult, a reasonable weightage of 50% as premium appears to be in order. It is also to be noted that by reckoning 15 year period, the benefits from small timber and teak wood have been under estimated necessitating better valuation while working out economic rate of return.

Initial cost of site preparation, plantation, soil and moisture conservation measures etc., require large employment of human labour. The non-recurring employment generated is arrived at by reckoning 80% of such costs and dividing the same with the average daily wage rate of Rs.50/-. The yearly maintenance operations and harvesting require human labour. The recurring employment every year is assessed by considering the entire maintenance cost and dividing the same by the daily wage rate.

Economics of JFM Projects in Andhra Pradesh

Economic Analysis

The viability of VSS supported forestry project is assessed by estimating the economic rate of return on the investment made. The various activities proposed for rehabilitation of the forest lands include nurturing natural regeneration with viable root stock, soil and moisture conservation and support activities. As the first two activities have large labour component, the cost thereon has been valued with a shadow price less than market wage rate, the conversion factor being 0.8 reflecting the opportunity cost of labour adequately year to year (from 4th year) maintenance, harvesting @ Rs.300/ha also involves mainly labour operations and as such these costs are converted into economic cost with the same factor. The species to be planted is purported to meet the demands for fodder, firewood, small timber etc., of the participatory VSS members. Output having commercial value will be marketed (teak, minor forest produce etc.) either through government outlet or other appropriate channels. Apart from valuing them at local market rates, weightage of additional 50 per cent benefits are given to the benefit stream keeping into consideration the desirable impact on environmental protection. Control of soil erosion, recycling of water and control of humidity, carbon sequestration and oxygen generation, increased bio-diversity etc., are stated to be added advantage of forest development. The quantification of such benefits and pricing methodology, being difficult, a reasonable weightage of 50 per cent as premium appears to be in order.

It is also to be noted that by reckoning 15 year period, the benefits from small timber and teakwood have been under estimated necessitating better valuation while working out economic rate of return.

Employment

Initial cost of site preparation, plantation, soil and moisture conservation measures etc., require employment of human labour. The non-recurring employment generated is arrived at by reckoning 80 per cent of such costs and dividing the same with average daily wage rate of Rs.50. The yearly maintenance operations and harvesting require human labour. The recurring employment every year is assessed by considering the entire maintenance cost and dividing the same by the daily wage rate.

Addition to Domestic Product

Contribution to gross domestic product has been arrived at by estimating net benefits at market prices (gross benefit during 5-15 year period less maintenance cost) and net domestic product has been valued at 95 per cent of the GDP addition.

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