Final Report

SURVEY AND ESTABLISHMENT OF A MONITORING SYSTEM FOR DEGRADED FORESTS OF KERALA

A study sponsored under
the Kerala Forestry Project
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KERALA FOREST RESEARCH INSTITUTE
Peechi - 680 653, Kerala, India

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STUDY TEAM

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ABSTRACT

Ecorestoration of degraded forests is of vital importance for Kerala. This task requires assessment of degraded forests, development of methods for their easy identification, identification of strategies for improvement and also means and ways for involving different stake holders.

The Kerala Forest Research Institute, as part of PPF consultancy for the KFD attempted to develop basic information on the status of natural forests in Kerala.

Of a total of 7862 Km^2 of natural forests about 4874 Km^2 (62%) was found to be degraded. Moist deciduous forests were mostly in a degraded state (78%).

The study revealed that crown density alone cannot be taken as criteria for defining and identifying degraded forests. Other parameters like regeneration, recruitment and weed invasion also play an important role. A key for identifying degraded forests integrating these parameters with crown density was developed.

Different causes for forest degradation are analysed separately and their contribution to the degradation of forest was estimated. Unregulated and illegal harvest was found to be a major factor effecting forest degradation.

The present programme of the KFD to tackle forest degradation was evaluated giving special emphasis to the Compensatory Afforestation Programme. The evaluation revealed that a change in concepts and attitudes in forest management is necessary giving due importance to the role of people in caring and sharing benefits from forests.

A three pronged strategy to tackle degradation is proposed which includes two intensities of treatment (high and low) and also improvement in regular management. An amount of Rs. 21673 million is estimated for this programme in the coming ten years.

A monitoring system based on enhancement of ecosystem integrity and also benefits to local people is prepared.

1. INTRODUCTION

1.1. ROLE AND RELEVANCE OF FORESTS IN KERALA

The unique geographical setting with about 48% of the area under undulating hilly terrain, the monsoon climate and the agrobased economy of the people, have made forests a vital resource for the sustainable development of Kerala. By conserving soil and water, they protect the hill slopes from soil erosion and ensures perennial water supply to the rivers and streams which, in turn promote agriculture and other developmental activities. These forests play a major role in regulating the climate. They also supply timber, bamboos, reeds, rattan and many non-wood forest produces including raw materials for rare and valuable medicines which are of economic significance. The fuelwood, fodder, litter, green manure and small timber from these forests are useful to the local people for their day to day subsistence. The rich biodiversity existing in the forests of Kerala makes them unique from a national and global perspective.

1.2. DEPLETION OF FOREST

The immense biotic pressure coupled with unscientific and adhoc resource management adopted in the past have taxed a heavy toll on the otherwise rich forests of Kerala. There has been considerable depletion in the quantity of forest in the state during the last few decades, though the available figures vary considerably. According to a survey conducted by the Kerala Forest Department (Chandrasekharan, 1973) forest loss between 1940-1970 in Kerala was 3,450 km^2. The National Remote Sensing Agency reported that the forest loss in Kerala was of the magnitude of 1,200 km^2 between 1972-1975 and

1980-1982 (NRSA, 1987). As per the records of the Kerala Forest Department legally, Kerala has a forest area of 11,223 Km^2 which includes the Reserved Forest traditionally under the ownership of the State Government and the private forest which were taken over by the Government under the Kerala Forest Vesting and Assignment Act, 1971. Due to encroachments and official diversion of forest land for other purposes, the actual extent of forest has decreased over the past few decades, although these areas have not been legally excluded from the forest area under the possession of the Forest Department. According to another assessment the extent of forest area after deducting areas diverted for non forestry purposes, was 7728 Km^2 (Viswanathan, 1990). NRSA using remote sensing estimated the extend of forest cover as 7614 Km^2 (NRSA, 1987). As per Forest Survey of India the total area under forest cover in Kerala is 10,336 Km^2 (FSI, 1993).

1.3. DEGRADATION OF QUALITY

As in the case of quantity, there has been depletion in the quality of forest in Kerala (Chandrasekharan, 1973; Nair, 1981; Nair, 1984; Karunakaran, 1984; Karunakaran, 1995). A perusal of the Working Plans of various Forest Divisions reveal that substantial area under natural forests are in a degraded state. The condition is same with regard to the forest plantations also as majority of plantations belong to poor site quality classes (Chandrasekharan, 1973; Nair, 1981; Kerala Forest Department, 1996). The Working Plans of various Divisions also highlight this fact. The FSI, based on crown density, has estimated about 81.5% of the forest cover dense forest (crown density >0.4) and 18.5% as open forest (crown density 0.1-0.4 (FSI, 1993). The open forests amounting to 1,915 Km^2 have been categorised as degraded forest.

1.4. THE PROBLEM OF DEFINING DEGRADED FOREST

Forest loss and degradation as an issue started receiving national and global attention only during late 1970's. Well defined criteria for measuring forest loss and degradation are yet to be developed. Conceptual problems involved in defining forests and forest degradation have often resulted in widely varying assessments. Definition of degraded forests, given by Forest Survey of India (FSI), the one currently popular in India, is based on crown density. According to FSI definition, forest areas having crown density below 40% are `open forests' and those above are dense forests. Open forests are taken as degraded forests. Crown density, in general, though a very strong indicator of forest degradation has got serious limitations in categorising degraded areas (Karunakaran, 1995; KFD, 1996; Meher-Homji, 1993). The productivity of many areas which are considered as `dense forest' based on crown density are much below their optimum. Also factors such as poor regeneration, lack of adequate number of saplings and pole crop, reduction in species diversity, etc., do not get accounted when crown density is taken as the only criterion for measuring forest degradation. Again, there are also areas with low crown density which are the climax vegetation of that region and hence cannot be designated as degraded forests.

1.5. CAUSES OF DEGRADATION

A number of factors were attributed to cause forest degradation in the State. A perusal of Forest Working Plans of different Divisions reveal that man-induced factors are the major ones which degrade forests when compared to the natural causes. Factors such as over exploitation, fire, soil erosion, grazing and unscientific resource management were often stated as causes of degradation of forest in the State

(Chandrasekharan, 1973; Nair, 1981; Nair, 1988; Viswanathan, 1990 and Karunakaran, 1992). However, no systematic study has been carried out in Kerala so far to assess the causes of degradation. Location specific information with regard to the causes of degradation and their impact is essential for taking effective measures for prevention and mitigation of forest degradation.

1.6. IMPACT OF FOREST DEGRADATION

Impacts of forest degradation in Kerala are diverse and extensive. While poor regeneration, loss in productivity and cost involved in restoring degraded forests into normal ones are the major tangible impacts; loss of biodiversity, downgradation of forest ecosystem, disturbance in speciation in flora and fauna are some of the intangible effects. The regeneration status of the different forest types get affected seriously due to forest degradation leading to poor crop of selected species. Most of the forest areas in the State are reported to be facing this problem (Kerala Forest Department, 1996). Loss in productivity is another result of forest degradation. The current productivity level of forest in the State is much below its potential (Chandrasekharan, 1973; Nair, 1981; Viswanathan, 1990; Karunakaran, 1992, Kerala Forest Department, 1996). The replacement costs involved in restoring degraded forest into its original status are often quite enormous in terms of money and time. The degradation and fragmentation of natural forests in the State have made many species of flora and fauna rare/endangered/threatened (RET) and the loss in biodiversity due to this is yet to be assessed properly. Degradation leads to downgradation of forest ecosystems, changing the tropical wet evergreen/semi evergreen forest to moist deciduous forest and reed brakes; and moist deciduous forest to dry deciduous forest, bamboo brakes and savannah;

and dry deciduous forest to scrub jungle, thus adversely effecting the quality of the forest. Disturbance to the process of speciation in flora and fauna has a serious impact as the hill forest of Kerala are centres of speciation as evidenced by the high rate of endemism.

The socio-economic impacts of forest degradation are also quite numerous and wide ranging. Lack of moisture conservation in the hills has resulted in unregulated water supply which has often caused in uncontrolled flood during rainy season and drought in summer. Again, degradation of forest has resulted in heavy soil erosion in the hills leading to loss of fertile top soil and siltation of reservoirs. Irregular water supply in the catchment ares of reservoirs have resulted in failure of many hydro electric and irrigation projects in the state from realising their potential. Reduction in productivity in industrial and agricultural sector, employment potential, shortage of wood and wood based products and problems to the life of tribals and other people living in the vicinity of forest, particularly the weaker sections of the society, general degradation of environment and aesthetic appearance, etc. are some of the other serious adverse impacts of degradation having significant socio-economic importance to the people of the Kerala.

1.7. PAST EFFORTS FOR MANAGEMENT OF DEGRADED FORESTS AND THEIR IMPACTS

The Kerala Forest Department during the past has carried out a number of measures in tackling forest degradation. This was carried out as a part of regular forest management activities and also through special schemes. Some of the notable actions taken by the Kerala Forest Department to tackle forest degradation are:

1. Bringing all private forests in the state to government ownership through Vesting and Assignment Act, 1971.

2. Stoppage of clear felling of natural forest for raising plantations (1983).

3. Stoppage of selection felling for timber extraction in natural forest (1987).

4. Measures for consolidation of forest boundaries through construction of cairns and stone walls.

5. Establishment of forest stations (1988).

6. Regular protection and improvement activities as per Forest Working Plan prescriptions and through other schemes.

7. Habitat improvement measures in Wildlife Sanctuaries, National Parks and other protected areas through different state and centrally sponsored schemes.

8. Different Eco-development programmes under Social Forestry.

9. Eco-development activities through Western Ghat Development Programme.

10. Eco-development activities under Nilgiri Biosphere Reserve Programme.

11. Improvement of degraded forest through Compensatory Afforestation and Special Afforestation Schemes.

12. Implementation of Government of India Policies and Acts, such as Wildlife Protection Act, 1972; Forest Conservation Act, 1980 and National Forest Policy, 1988.

However, the magnitude of the factors causing degradation of forest were so enormous that these measures could make only limited impacts in containing forest degradation. Also various financial, technical and institutional factors caused serious constraints in the effective implementation of these programmes and thus prevented in getting the desired objectives.

1.8. SCOPE AND OBJECTIVES OF THE STUDY

Recognising the importance of rejuvenating the degraded natural forests for enhancing their capabilities for providing multifarious bio-physical, ecological and socio-economic functions, the Kerala Forest Department (KFD) has taken up new initiatives to improve the degraded forests under the proposed Kerala Forestry Project. The Department has approached World Bank for financial assistance. For effective investment planning, information based on systematic studies are required with regard to the nature and extent of degraded forests, methods for their identification, the causes of degradation, strategies for improvement are essential. The KFD has awarded a consultancy to the Kerala Forest Research Institute to generate this information. According to this, it has the following specific objectives (see TOR, Appendix I):

(a) To design and undertake a baseline survey of degraded natural forests of Kerala.

(b) To classify the degraded forests in terms of stand parameters relevant to the growth dynamics in Kerala conditions instead of crown density alone.

(c) Prepare detailed maps based on classification and location of degraded forests.

(d) Analyse the determinants of degradation of forests by sampling methods and come out with easily measurable parameters to identify the degraded forests.

(e) Assess the causes of degradation of forests and to suggest strategies and tactics to improve the degraded forests, taking into consideration the various factors involved, past efforts and the options available.

(f) To evaluate the ongoing scheme for compensatory afforestation, one of the current major initiative of the Kerala Forest Department for improving the degraded forests, and to design an appropriate monitoring system.

(g) To present a realistic cost estimate for compensatory afforestation.

2.0. STUDY AREA

The State of Kerala with an area of 38,863 km^2 is situated in the South Western corner of Peninsular India. It lies between 8°18' and 12°48' N latitudes and 74°52' and 77°22' E longitudes.

The climate of Kerala is warm tropical with high rainfall ranging from 2000 to 4500 mm per annum. In certain specialised localities the precipitation even reaches more than 7500 mm. There are also localities especially in the leeward side of the Western Ghats where the rainfall is restricted to a few days and the precipitation goes down to 600 mm. The annual average rainfall is about 3800 mm and the average number of rainy days is about 120. Maximum rainfall is received during south west monsoon and that too in the months of June-July. The south west monsoon is followed by the north east monsoon months are generally December to March, followed by premonsoon showers in April-May. The mean annual temperature of the state is 27°C varying from a minimum of 16° to a maximum of 38° C. The minimum temperature goes down below 0° C on the high hills and the maximum reaches even 45° C at lower elevations. There are 44 rivers which along with their tributaries control the hydrology of the State. The above factors coupled with the peculiar physiographic and edaphic condition have given rise to 12 Agroclimatic zones which have their influences on the flora and fauna of the land.

2.1. PHYSIOGRAPHIC DIVISIONS

Physiographically, Kerala is very peculiar. It is a narrow strip of land of about 600 M length and 100 M width running in the north-south direction. Based on altitude and terrain, this land is divided into three linear strips:

1. Lowland - less than 7.5 m about msl
2. Midland - 7.5 m to 75 m above msl
3. Highland - above 75 m above msl

The Lowland (The Coastal Zone):

The low land lies along the western side adjoining to the coast of Arabian sea forms the plain and are called the coastal zone. It covers an approximate extent of 3921 km^2 (10.09% of the total land area of the State). There are no forests in this zone except for a few patches of mangroves located along the coast. These small patches totalling about 17 km^2 represent the relics of a continuous stretch of 700 km^2 of mangrove forests which are existed along the Kerala coast.

The Midland (The Middle Zone):

The Middle zone is a long stretch of land ascending from 7.5 M to 75 M above msl and is very narrow in width. The total extent is 16227 Km^2 (41.67% of total land area of the State). Only a small extent of natural forest, in discontinuous patches exist in this zone. The natural forest what ever exists were converted to plantations of Rubber, Coconut and Arecanut during the past few decades. Forest plantations of Teak and Eucalyptus cover a small extent.

This land originally supported moist deciduous forests with economically high value timber species. A few patches of virgin forests have been preserved as sacred groves which give clue of the natural vegetation once existed.

The Highland (The Hilly Zone or The High Range Zone):

The hilly zone (above 75 M msl) is composed of undulating hills of varying heights, highest being the Anamudi Peak (2694 M above msl). The hills, dales and plateau support natural forests which are the treasure house of unique plant and animal life. The total extent of the zone is 18707 km^2 (48.15% of the land area of Kerala). Crops of tea, coffee, cardamom, coconut, rubber, pepper etc., have revolutionised the horticultural scenario of this zone and this activity was going on for the past one and a half centuries. In the course of a few decades there was unlimited multiplication of the house holds and the current average land holding size is 0.43 ha. Due to the extremely unplanned development of agriculture in the high lands, the natural forest vegetation has been fragmented in many places thereby loosing the continuity. Thus the forests are at present relegated to the high hill tops, and steeper slopes which are not easily approachable. These forests harbour very high percentage of endemic flora and fauna.

2.2. THE FORESTS

The diverse climatic, physiographic and edaphic conditions have brought about an array of forest types ranging from the temperate hill forests to dry scrub jungles. Various combinations of climatic, edaphic, physical and physiographic features have resulted in the formation of some specialised niches which are the repositories of astounding floral and faunal diversity.

Forest types:

The forests of Kerala exhibit considerable variation in the floristic composition, physiognomy and life forms etc. primarily owing to climatic, edaphic and physiographic variations. The forest growth has been divided into 7 (seven) major types which are subdivided into about 20 subtypes and many further subdivisions depending upon the floristic composition and other minor factors (Chandrasekharan, 1960; Champion & Seth, 1968).

At present the forests occupy mainly the hill tops, steep valleys and plateaux of the Western Ghats. Following are the different forest types found in Kerala.

1. Evergreen and Semi evergreen forests
2. Moist deciduous forests
3. Southern tropical dry deciduous forests
4. Grasslands
5. Montane subtropical and montane temperate forests

The forest patches in general are comparatively of smaller size when compared to those in other parts of India, due to the forest fragmentation taken place during the last four or five decades.

Distribution

The portion of the Western Ghat hills coming within the State of Kerala is broken by a natural gap of 30 km wide at Palakkad and this has played a significant role in isolating a variety of organism on either side of it for a long period of time.

Thick wet evergreen forests occur in the medium elevations of

high hills. These are followed by islands of shola forests surrounded by high elevation grasslands on the crests of the hills. Their crest lines rise to higher altitudes and at places exceeding even 2000 M, where, the precipitation goes as high as 6000-7000 mm. The slopes of the high hills of Brahmagiri and Kottiyoor support good evergreen forests followed by the Wayanad plateau and its western slopes supporting thick moist deciduous forests. The western slopes of Nilgiris, New Amarambalam, Silent Valley and Attappady Valley bear rich evergreen and semi evergreen forests. In the Attappady valley there is an entire spectrum of transition zones from the wet evergreen forests in the South West and North West corners to the dry deciduous xerophytic forests on the eastern slopes which form the leeward side of the Attappady hills. To the South West of the Attappady hills are the evergreen forests of the Lost Valley and the Elival Malai which end at the Kalladikodu hills receiving the highest rainfall of over 6500 mm in the lower elevation. On its northern slope this condition has given rise to a patch of low level evergreen vegetation. In other parts in the lower slopes the vegetation is Muthikulam hills, the hill range abruptly ends as the Palakkad gap where the rainfall goes down leading to moist deciduous forests culminating in moderate type of dry deciduous forests. Some of the forest areas in the hills are almost undisturbed supporting the pristine vegetation.

South of the Palakkad gap starts the long hill chain of the Nelliampathy, Anamalais and Palani hills. The Western slopes contain the moist deciduous, semi evergreen and evergreen forests. The eastern slopes of the Munnar hills support sandal bearing dry deciduous forests of Marayoor. These forests form a continuous belt supporting a congenial habitat for both the plant and animal life of varying kinds.

Between the Periyar plateau and the Munnar hills lies the highly disturbed cardamom lands, which are at varying degrees of destruction due to following of different types cultivations interspersed among the cardamom estates. The clearance of forests in different parts of this stretch has led to the micro climatic change resulting in the gradual deterioration in cardamom yield. This disturbed stretch of land has almost broken the continuity of the forest up to the Periyar plateau.

There is a very good stretch of evergreen, semi evergreen and moist deciduous forests starting from the Periyar plateau. This natural vegetation extends through the Goodrical and Achencoil belts till it reaches the Arienkavu pass separating this stretch from Agasthyamalai hills.

The Shenduruni Valley and the Agasthyamalai hills support some of the rich virgin forests of Travancore. Most of the forests in the Ponmudi hills have been converted into tea and other crops. The moist deciduous, semi evergreen and little bit of evergreen forests situated on the Western slopes in Peppara and Neyyar have been brought under Wildlife Preserves for effective protection from high anthropic pressure.

Extent

There is lot of controversy regarding the extent of forest cover in the State. Different agencies provide different figures (Table 1).

Table 1. Extent of Forests in Kerala

Source	Area under forest (in sq.km.)	Pertaining to the year	% to the geographical area
Resource Survey of forest Dept.	9400	1973	24.10
Revenue Records	10815	1975-79	27.80
Administration Report of the forest Dept.	11220	1992-93	28.87
NRSA	7614	1986	19.59
FSI	10336	1993	26.56
Forest Statistics	9400	1994	24.02

The recorded forest area is 11220 km^2 (1.5% of forest cover of India) of which 10336 km^2 (26.56% of land area of Kerala) have vegetation cover with dense forests (crown density above 40%) occupying 8421 km^2 (82% in the forest area) and open forest (between 10-40% crown density) covering 1915 km^2 (18.5% of forest cover) (FSI, 1993).

The distribution of major forest types in Kerala is given in Table 2.

Table 2. Distribution of major forest types in Kerala

Forest type	Area (Km^2)	% of total forest area
1. Tropical wet evergreen & Semi evergreen forests	3480	37
2. Tropical moist deciduous forests	4100	44
3. Tropical dry deciduous forests	94	1
4. Montane subtropic, montane temperate forests and grassland	188	2
5. Forest plantation (Man-made forests)	1551	16

Source: Kerala Forest Department records

During the early part of this century these forests coming under all the three zones mentioned above constituted about 50% of the land surface. The agricultural practices followed during these years had eliminated the thick forests of the low and middle lands drastically. Though comparatively less, there was considerable destruction of forests of the high lands not only for raising plantations of coffee, tea, cardamom, etc., but also for setting up house holds by mostly, landless cultivators who had migrated from the low and middle zones. Though the forest area has been reduced considerably they still harbour flora and fauna of incredible diversity. The important regions which contain the astounding biological wealth are mainly the hill tops and slopes with their shola vegetation surrounded by high level grasslands most of which still remain underexplored for their flora, fauna and micro organisms.

3.0. METHODS

3.1. GENERAL APPROACH

Taking into consideration the diverse nature of the forests of Kerala, accomplishing the various tasks required under the project solely based on field survey is an extremely difficult, prohibitively costly, time consuming and labour intensive task, almost impossible within a short time and resources. Because of the highly varied nature of degraded forests in the State, one has to either go for very high sampling intensity or carry out sampling based on effective stratification of areas into more or less homogeneous groups based on appropriate parameters for which the necessary information are not directly available. The chances of human errors that are likely to occur in such intensive field surveys are very high due to difficult terrain conditions and the huge man power required for the task.

On the other hand, considerable amount of secondary information regarding forest degradation is available in Forest Department records such as Working Plans, various survey reports, and department files in the form of reports and maps. Information is also available in other forestry literature and research reports. Besides, considerable amount of knowledge is available among practicing forestry professionals and research scientists. Remote sensing data in the form of satellite imageries can provide up to date information on certain aspects of forest vegetation pertaining to degradation. An integrated approach, involving identification and utilisation of all these secondary data available, to supplement and complement the primary data generated through field survey, was adopted. The detailed methodology followed for individual components of the study are given below:

3.2. SURVEY AND MAPPING OF DEGRADED FORESTS

The aim was to prepare handy maps indicating degraded areas, and their types to facilitate effective policy planning at state level. With this purpose it was decided to prepare a global map of 1:1 million scale (one sheet) and detailed maps of 1:2,50,000 scale (11 sheets) covering the whole of Kerala. These scales are recommended by National Remote Sensing Agency/National Planning Commission for state level planning (NRSA, 1990). For generating the information required for this purpose, the following methods were adopted:

1. The first task was to generate base maps, showing forest areas based on latest available information. This was carried out through visual interpretation of geocoded satellite data of 1:50,000 scale for the year 1995-96 of Indian Remote Sensing Satellite 1B (IRS 1B), procured from National Remote Sensing Agency, Hyderabad. At the time of interpretation, the forest areas were classified into major forest types (Evergreen/semi evergreen, Moist deciduous, Dry deciduous) and different crown density classes (0-0.4; 0.4-0.7; 0.7-1) using photo elements such as tone, colour and texture with the help of a team of interpreters specifically trained for the purpose. This resulted in 82 maps of 1:50,000 scale, corresponding to the Survey of India toposheets covering the whole of Kerala state.

2. To facilitate effective field checking, it was necessary to incorporate information such as important roads, rivers, places and boundaries of administrative units into the interpreted map. These informations were found to be available in Survey of India Toposheets, Working Plan Maps of various divisions and other Forest Department records and base maps were prepared by incorporating these informations. Multiple copies of these composite maps were prepared for further processing.

3. The next step was to generate data required for classifying the forest area in the above base maps into different types of degraded forests (classified based on stand parameters). Three methods were adopted for this purpose.

(a) Data on forest types, their locations, crown density and degradation status were collected from different sources such as Forest Working Plan reports and stock maps of different Forest Divisions, Survey Reports, Forest Department files and other published records.

(b) The project team visited the representative forest areas of different Forest Divisions in the State and gathered first hand information. They also classified the sampled areas into highly degraded, moderately degraded and not degraded based on their observations. For this purpose separate proforma was developed to cover various aspects required for the study (Appendix II).

(c) Knowledge of Forest Officers on forest types and their degradation status were gathered through regional workshops organised at the respective Forest Circles involving Officers at different levels namely, Foresters, Range Forest Officers and Divisional Forest Officers. These meetings were coordinated by the respective Conservators. In these Workshops, the Forest Officers were provided with copies of base maps of locations of their interest and were requested to check the administrative boundaries, forest types and crown density classes. The participants were requested to classify the forest areas known to them as highly degraded, moderately degraded and not degraded taking into consideration the potential and present status of forest vegetation occurring in these areas. The project team interacted with the Officers to elicit relevant

information pertaining to forest degradation and to make necessary input into the maps. This opportunity was also utilised to gather information required in relation to other objectives of the study. The interaction was facilitated through a set of carefully designed questionnaires prepared in consultation with the Forest Department covering aspects such as determinants and causes of degradation, extent and nature of degraded areas, strategies for improvement and views on various measures adopted by Forest Department for improving degraded forests (Appendix III).

4. The different data so gathered in multiple copies of base maps were then utilised for deciding the forest type and degradation status for preparing final maps. In the case of a forest patch having differing information with regard to forest type and degradation status, those information which are similar and obtained from two or more independent data sources were accepted as correct and necessary changes incorporated in the map. While making decisions on type and degradation status required for mapping, information on locality factors such as altitude, rainfall, proximity to habitation etc. were also taken into account.

5. The final maps indicating degraded forest areas falling under the different forest types were prepared in 1:2,50,000 scale and 1:1 million scale by incorporating the required information from the above maps.

In nut shell, the procedure adopted for map preparation is highlighted in the flow chart given below (Fig. 1):

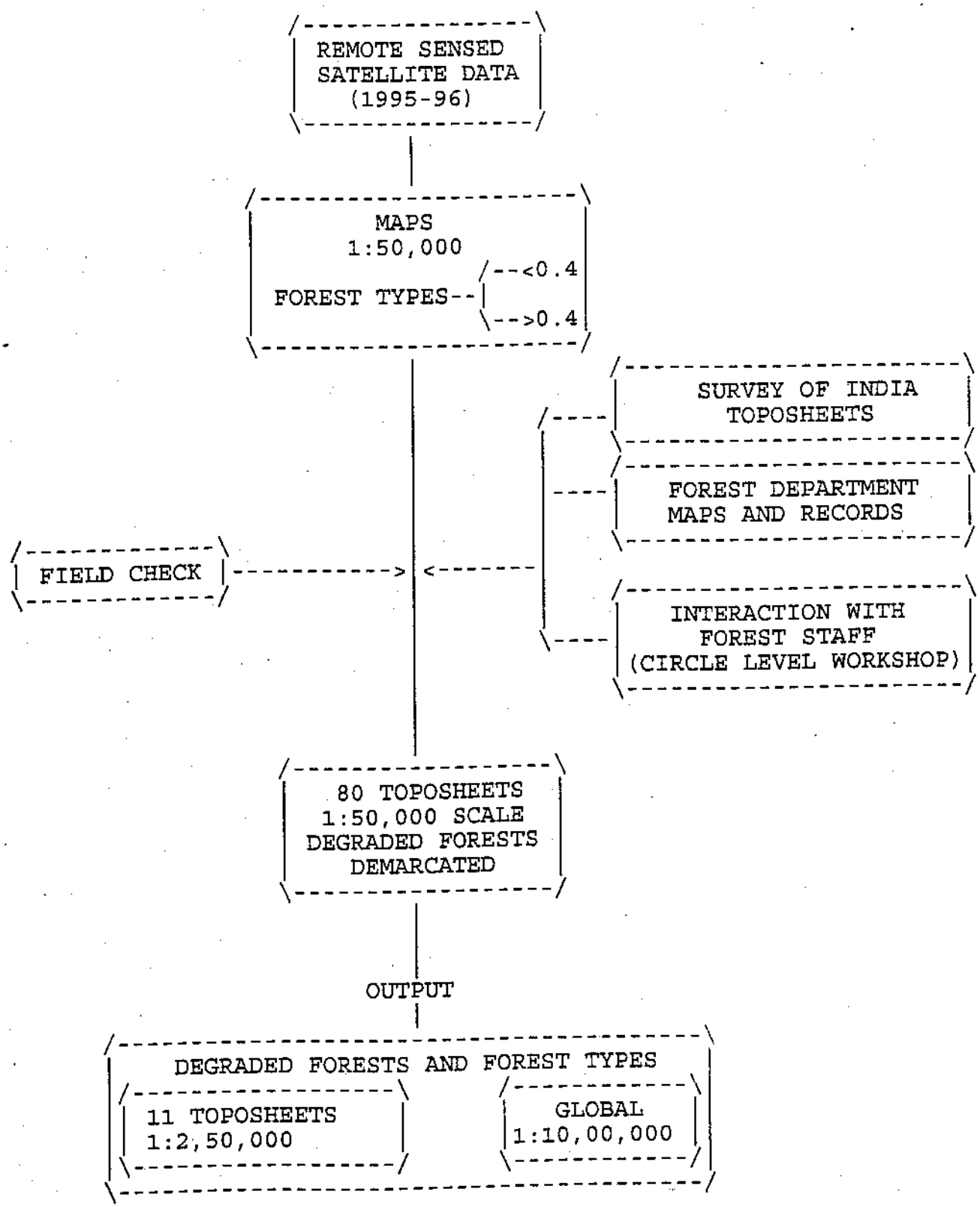


Fig. 1. Flow Chart - Map Preparation

3.3. ASSESSMENT OF EXTENT AND NATURE OF DEGRADED FORESTS

The Extent of degraded forests was arrived at from the base maps and other information gathered during the study. The extent of area was computed from the base maps by gridding them into cells of 0.5 x 0.5 cm size with the help of graph paper. To facilitate easy computation and zonation of areas, the whole data was organised into a computerised spatial database by linking them with cartesian coordinates (X, Y coordinates) representing the whole of Kerala, with the help of a dBase programme. Each forest patch in this database was designated by patch numbers. Information such as forest type, Range and Division to which they belong, altitude, average rainfall, proximity to human habitation, forest continuity etc. were incorporated. The information such as degradation status, forest types etc. received from different sources were incorporated in to this database for making necessary corrections. After effecting the necessary processing required for extracting the desired information, this database was utilised for arriving at area estimates for different categories of degraded forests requiring different treatments. While arriving at the area estimates, taking into consideration the limitations imposed by using map of scale 1:50,000, particularly to the highly fragmented forest areas of Kerala (Forest patches in Kerala are often of small size and this cause problems in computing areas from map of 1:50,000 scale), necessary corrections and approximations were made using the area figures available in Forest Department records, those provided by Forest Officials during Regional Workshops and information gathered through field visits by the project team. The information gathered from multiple data sources using the above methods was utilised for designating a patch as degraded forests or not.

The flow chart below, summarise the procedure adopted for assessment of extent of degraded forest (Fig. 2):

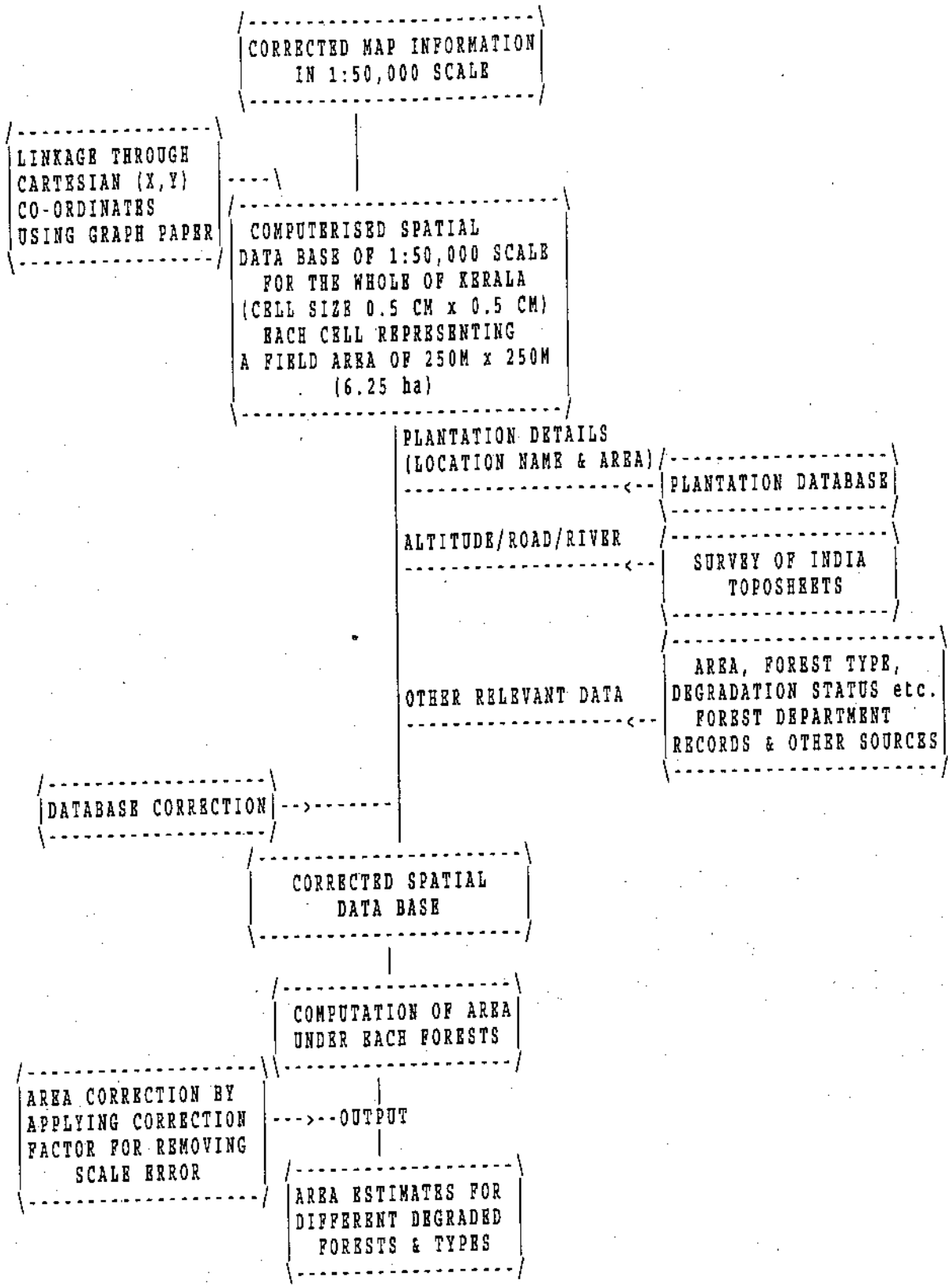


Fig. 2. Flow Chart - Area assessment

3.4. DETERMINANTS OF DEGRADATION

Another task was to identify indicators of degradation and to prepare an identification key which can be used for determining degraded forests. This key has to be applicable to different forest types of Kerala and at the same time simple so that it can be used at the field foresters level. The following method was adopted for this purpose.

Information on various forest types, their characteristics and degradation status gathered as above were utilised in identifying various indicators of degradation. The parameters to identify different degraded forests were arrived at through literature survey, interaction with Forest Officers and through field visits. A prototype identification key was developed by making use of these parameters. It was tested, refined and validated using the sample data gathered from the following data sources:

1. Field enumeration data (growing stock enumeration and regeneration survey in natural forest) available in Working Plans, resource survey reports, research reports and other publications.

2. Data supplied by KFRI scientists and researchers based on their field knowledge in their research plots spread over different parts of Kerala using a Proforma prepared for the purpose (Appendix II).

3. Data gathered from forest staff working in different Forest Divisions through Regional Workshops organised at circle level involving all Field Forest Officers using Questionnaire indicated (Form III - Appendix III).

4. Data gathered through field survey carried out by the team members, during field check of the remotely sensed map in different sample locations of the State using Proforma (Appendix II).

3.5. ASSESSMENT OF CAUSES OF DEGRADATION

As followed in the above cases, the location specific data required for determining the causes of degradation were gathered from the following data sources.

1. Forest Working Plans of various Divisions, survey reports, research publications and Forest Departmental files.

2. Data for different sample locations based on knowledge of Forest Officers gathered through regional workshops using appropriate questionnaire (Form IV - Appendix III).

3. Data supplied by KFRI scientists and researchers based on their field knowledge in their research plots spread over different parts of Kerala using a Proforma prepared for the purpose (Appendix II).

3.6. EVALUATION OF THE COMPENSATORY AFFORESTATION SCHEME

The ongoing scheme for Compensatory Afforestation was evaluated by the following method.

1. Study of the document `Compensatory Afforestation Scheme' prepared by Kerala Forest Department.

2. Collection and compilation of various data on Compensatory Afforestation from Kerala Forest Department records such as locations where Compensatory Afforestation was adopted, different operations carried out and expenditure made.

3. Data gathered through Regional Workshops of forest officers about their views on compensatory afforestation using appropriate questionnaire (Form VII - Appendix III).

4. Informal discussion with Forest Officials involved in Compensatory Afforestation. Discussions with people dependent on forest and living in close proximity to sites where Compensatory Afforestation Programme carried out.

5. Evaluation of sites where Compensatory Afforestation was carried out through field sample survey. Out of the total area of about 20,460 ha. distributed over 14 divisions coming under 3 circles of social Forestry viz. Kozhikkode, Ernakulam and Kollam, 24 plantations belonging to 5 divisions viz., Trivandrum, Idukki, Thrissur, Kannur and Kasargode were selected for field sampling.

3.7. STRATEGIES FOR THE IMPROVEMENT OF DEGRADED FORESTS

To decide the strategies to be adopted for the improvement of degraded forests the following methods were adopted:

1. A study of past management efforts of Kerala Forest Department for improving degraded forest based on available records and literature.

2. Study of location specific data gathered using similar methods as indicated earlier (Data gathered from Forest Department Records, knowledge of Forest Officers).

3. Data gathered through field visits in different degraded forest areas and treatment sites.

4. Study of evaluation results of compensatory afforestation adopted.

3.8. COST ESTIMATES FOR IMPROVING DEGRADED FORESTS

The following method was adopted for preparing cost estimates for improving degraded forests.

1. Collection and systematisation of available cost data on different strategies adopted in the past for improving degraded forests under different plan and non plan schemes.

2. Cost assessment made through field visits carried out in degraded forest areas.

3. Cost assessment provided by the participants attended the Regional Workshops involving all forest officers through appropriate questionnaires (Form IV - Appendix III).

4. Information gathered through discussions with Forest Department Officials.

5. Processing of cost data on Compensatory Afforestation from Forest Department records.

3.9. MONITORING SYSTEM FOR IMPROVING DEGRADED FORESTS

Development of a monitoring system is crucial for ensuring successful implementation of activities for improving degraded forests. For developing this, following method was adopted.

1. A study of monitoring systems followed by the Forest Department for the management of plantations and natural forests.

2. An assessment of changes required in these monitoring systems to make it suitable for the changing needs of forest management through interactions with Forest Department and other stake holders.

3. Development of monitoring system incorporating items, methods, who, when and why monitoring, is carried out.

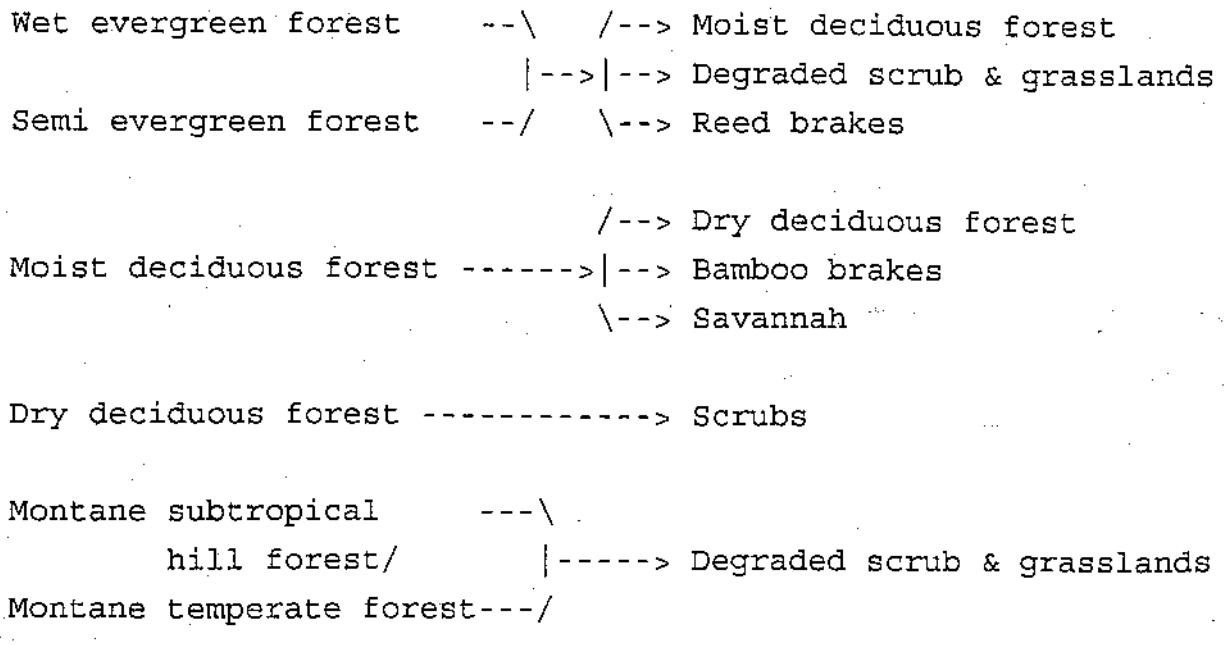
4.0. RESULTS AND DISCUSSIONS

4.1. DATA SOURCES

It was found that there is substantial amount of secondary data which can be made use of for the various aspects of the study. The major data sources identified and utilised in the study are given in Appendix V. These data has helped in reducing the quantum of primary field data collection required for the study.

4.2. SURVEY AND MAPPING

It was found that, over the last few decades, the forest of Kerala has suffered degradation in the direction indicated below changing the forest composition drastically.



4.2.1. MAPS

Two sets of maps prepared are appended, (1) A map in 1:1 million scale showing a global picture of the forest of Kerala and their degradation status, (2) A detailed map in 1:2,50,000 scale (11 sheets for the whole of Kerala) which contain the following information:

Forest types

Distribution of major forest types categorised into dense and degraded as below.

(a) Evergreen/Semi evergreen forests (Dense)
(b) Evergreen/Semi evergreen forests (Degraded)
(c) Moist deciduous forest (Dense)
(d) Moist deciduous forest (Degraded)
(e) Dry deciduous forest (Dense)
(f) Dry deciduous forest (Degraded)
(g) Montane sub tropical/temperate forest (Dense)
(h) Montane sub tropical/temperate forest (Degraded)
(i) Grasslands
(j) Forest Plantations

Boundaries of Forest Divisions

The administrative boundaries (as per the latest information available) of different Territorial Forest Divisions and Protected Areas (Wild Life Sanctuaries/National Parks/ Biological Parks). Division Head Quarters are also indicated in the map.

Major Roads, Rivers, Reservoirs

The major roads, rivers and reservoirs are incorporated in to the maps.

Names of Reserve Forests

The names of major Reserve Forests, within the limits of scale of the map are provided. This will give a clue for identifying degraded forest areas in the state.

Taking into consideration the difficulties in segregating forest areas into different in subtypes in a map of 1:2,50,000 scale (in a map of this scale an area of $1cm^2$ represents a field area of 6.25 Km^2) only major forest types are provided. There were also difficulties in demarcating evergreen/semi evergreen areas and so they have been combined. Though there were degraded areas in grass lands, again, because of difficulties in demarcation no attempt was made to classify grasslands into degraded and non degraded ones. In this study, since attempt was to concentrate on natural forest, degradation status of plantations is not provided. As a general case, by and large, there were degraded forest areas along the fringes of human habitations but because of limitations of map scale they merge with the major category indicated in the map. This was also the case with forest patches of smaller size of different categories, particularly of size less than 100 ha.

4.2.2. EXTENT AND NATURE OF DEGRADED FORESTS

The total area under different categories of forest as brought out by the study are given below (Table 3):

Table 3. Status of degraded natural forest in Kerala

Sl. No.	Forest type	Area in Km^2 Not degraded	Degraded	Total
1.	Tropical wet evergreen/ Semi evergreen forest	1908.84 (55)*	1571.16 (45)*	3480.00 (100)
2.	Tropical moist deciduous forest	902.00 (22)*	3198.00 (78)*	4100.00 (100)
3.	Tropical dry deciduous forest	33.84 (36)*	60.16 (64)*	94.00 (100)
4.	Montane subtropical/ wet temperate forest (including Grassland)	142.88 (76)*	45.12 (24)*	188.00 (100)
Total		2987.56 (38)*	4874.44 (62)*	7862.00 (100)

* Percentage of total area under the type

Crown density as defined by Forest Survey of India, is the main criteria currently used for identifying degraded forests. At present, the areas having crown density 10-40% are considered as (open forest) degraded. However, the study has found that, determination of degradation status of forest solely based on crown density will be misleading, particularly in the conditions prevailing in Kerala. The following tables highlights this fact (Table 4, 5 & 6).

Table 4. Status of natural forest under different crown density class.

Crown density	Degradation status		
	Degraded	Not degraded	Total
Low (10-40%)	1315.82	326.26	1642.08
Medium (40-70%)	2291.30	490.69	2781.99
High (Above 70%)	1267.32	2170.61	3437.93
Total	4874.44	2987.56	7862.00

Table 5. Percentage distribution of degraded natural forests of Kerala under each crown density classes.

Crown density	Degradation status		
	Degraded	Not degraded	Total
Low (10-40%)	80.13	19.87	100
Medium (40-70%)	82.36	17.64	100
High (Above 70%)	36.86	63.14	100
Total	62.00	38.00	100

Table 6. Percentage distribution of natural forest over three crown density classes.

Crown density	Degradation status		
	Degraded	Not degraded	Total
Low (10-40%)	26.99	10.92	20.88
Medium (40-70%)	47.00	16.42	35.39
High (Above 70%)	25.99	72.65	43.73
Total	100.00	100.00	100.00

The following table highlights the relationship between forest degradation and proximity of forest areas to human habitation (Table 7).

Table 7. Status of natural forest in relation to Proximity to human habitation

Sl. No.	Forest type	Area of degraded forest in Km^2		
		Near human habitation (<5 km)	Away from human habitation (>5 km)	Total
1.	Tropical wet evergreen/ Semi evergreen forest	1194.08 (78)*	377.08 (22)*	1571.16 (100)
2.	Tropical moist deciduous forest	2622.36 (82)*	575.64 (18)*	3198.00 (100)
3.	Tropical dry deciduous forest	41.51 (69)*	18.65 (31)*	60.16 (100)
4.	Montane subtropical/ wet temperate forest (including Grassland)	28.42 (63)*	16.70 (37)*	45.12 (100)
Total		3886.37 (79.7)*	988.07 (20.3)*	4874.44 (100)

* Percentage of total under this type

The above tables (Table 3, 4, 5, 6 & 7) highlights the following points which are very significant in the management of degraded natural forests of Kerala.

1. 62% of the total natural forests are degraded and require treatment.

2. In natural forest areas of low crown density (10-40%), only 80.13% are degraded. The rest of the area are not degraded and are of climax vegetation of that particular area. At present all the forest having crown density 10-40% (open forest) are considered as degraded.

3. 82.36% of the natural forest of medium crown density (40-70%), and 36.86% of high crown density (Above 70%) are degraded.

4. Among the degraded forests 47% belongs to medium crown density class (40-70%), 26.99% belongs to low crown density (10-40%) and 25.99% belongs to high crown density (>70%).

5. 79.7% of the degraded natural forest lie in proximity to human habitation (within 5 Km radius) and biotic pressure induced by man is the major cause of degradation. So crucial aspects in the management of degraded forest lie in reducing the biotic pressure.

4.3. DETERMINANTS OF DEGRADATION OF FORESTS

4.3.1. INDICATORS OF DEGRADATION

The following were identified as major parameters of forest degradation in the State. These parameters were seen to occur individually or in combination in a degraded forest.

Table 8. Major parameters determining forest degradation in Kerala.

Parameters	Category	
	Degraded	Not Degraded
1. Proximity to habitation	<5 km	>5 km
2. Continuity of forest patches	Discontinuous	Continuous
3. Forest patch size	<100 ha	>100 ha
4. Crown density	<0.4	>0.4
5. Formation of gulley	High	Low
6. Established seedlings	Low <40%	High >40%
7. Established pole crop	Low <40%	High >40%
8. Presence of indicator plant species (this include Eupatorium, Lantana, Tall grass (Lemon grass, Citronella, Pennisetum panicum, Mikania micarantha)	High (covering more than 60% of the area)	Low (covering less than 40% of the area)

These parameters are strong indicators of degradation of a forest as discussed below:

1. Proximity to habitation: Most of the degraded forest were found to occur in the fringes of human habitation. It was observed that almost 79.7% of degraded forest occur in the fringes.

2. Continuity of forest patches: The forest patches which are isolated were found to be highly degraded due to human pressure. Discontinuity often results in lack of natural regeneration as well as habitat suitability for wildlife.

3. Patch size: Patch size was found to determine the degradation status. Forest patches which are of smaller size were found to have suffered from poor regeneration, depletion in number of species. These patches were also found to be less suitable for wildlife habitation.

4. Crown density: Crown density in combination with other parameters were found to decide the degradation status in most of the cases. Areas which are of less than 0.4 crown density were degraded except in cases where such forests are climax vegetation.

5. Formation of gulley: Gulley formation was another indicator of degradation. In areas were soil erosion is a major problem there were large number of gullies. These were prevalent in areas adjoining river basins and steep slopes of hill areas.

6. Established seedlings: The regeneration status was found to determine the sustainability of the forest. In some cases although there was profuse regeneration, it was observed that there was problems in the establishment of seedlings.

Hence established seedlings was found to be a good indicator of degradation. However, this vary considerably from forest type to forest type. An area having less than 40% of the normal number of established seedlings (>60 cm height) expected in the respective type of forest can be considered as degraded.

7. Established pole crop: In deciding the continued sustenance of the forest, recruitment of seedlings and saplings to higher size class is important though the number vary from type to type. Forest with less than 40% of the normal density of established pole crop (>2 M height) for that forest type can be considered as degraded.

8. Presence of indicator plant species: The following major indicator species were found to be a good indicator of degradation. The species are Eupatorium, Lantana, Tall grass (Lemon grass, *Citronella*, *Pennisetum panicum* and *Mikania micarantha*. In a locality where the presence of these indicator species cover more than 60% of the ground cover can be considered as degraded.

4.3.2. IDENTIFICATION KEY FOR DETERMINING DEGRADED FORESTS

The parameters for preparing the identification key was chosen from a large number of parameters (Proforma I - Appendix III). The basic philosophy adopted while preparing the identification key was that it should be representative for different types of forests in Kerala and at the same time simple enough so that it can be used by a Field Forester or Forest Guard who may not have much technical expertise.

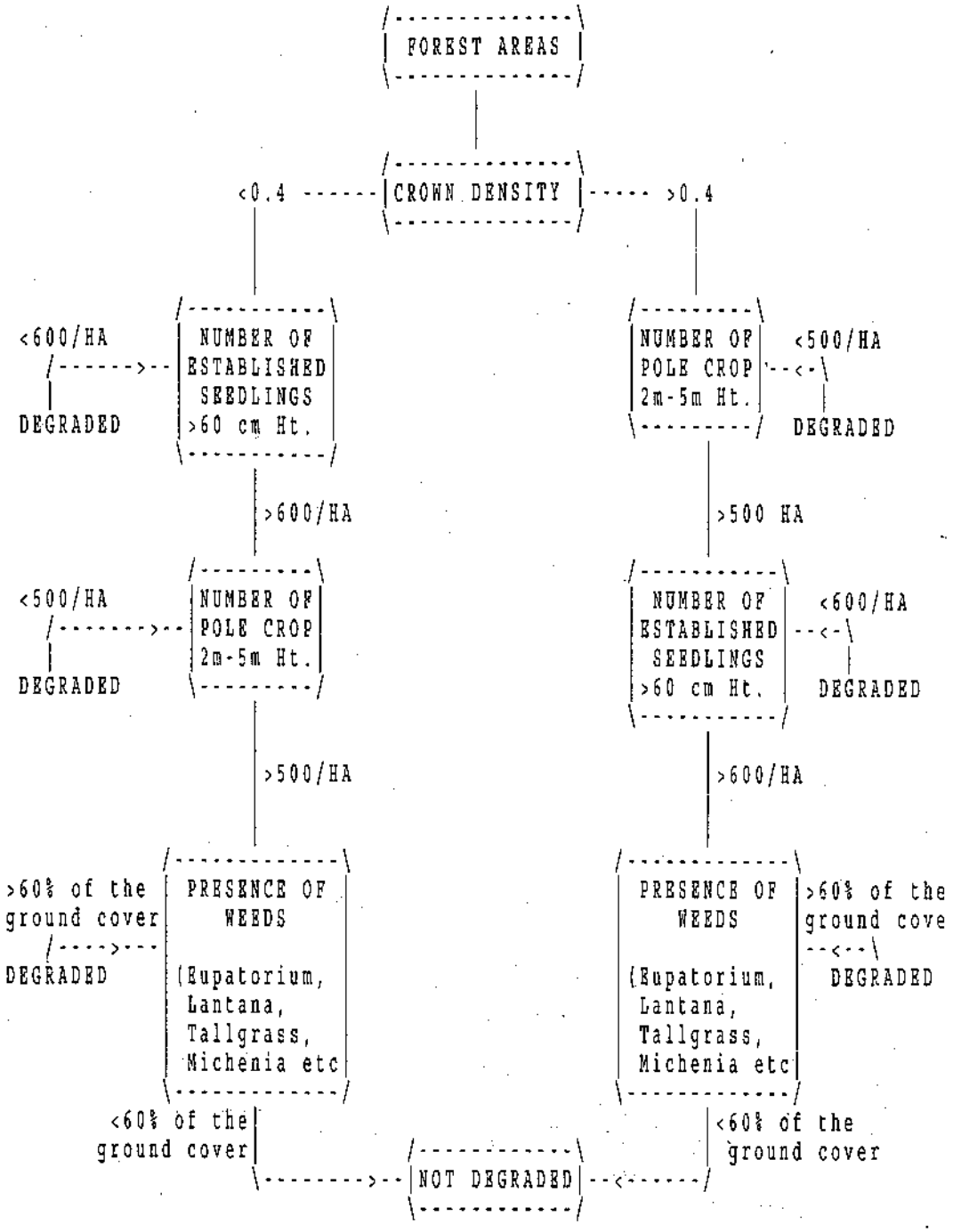


Fig. 3. Key for determining degraded natural forests in Kerala

4.4. CAUSES OF DEGRADATION

In the order of priorities, the following factors were found to be responsible for degradation of forest in Kerala during the last five decades.

1. Unregulated and illegal harvesting of forest produces by man and cattle (timber, fuelwood, fodder, green manure, litter and other nonwood forest produce).

2. Over exploitation/unscientific exploitation of resources. (Unscientific harvesting of bamboo, reeds, rattans, medicinal plants and other non-wood forest produce).

3. Diversion of forest land for non forestry purposes (encroachment, conversion of natural forest into plantations and other land uses).

4. Damage due to harmful effects of management operations (such as Selection felling, Selective felling, Alignment of roads and Construction of dams).

5. Fire

6. Invasion of weeds

7. Soil erosion

8. Poor regeneration

Unregulated and illegal harvesting of forest produces by man and cattle:

Considerable extent of area were effected due to unregulated and illegal harvesting of various forest resources (timber, small wood, fuel wood, green manure, litter and other non-wood forest produce).

Among the various factors, unregulated and illegal harvesting of forest produces by man and his cattle were found to have caused maximum damage. This include illicit felling of trees for timber and small wood, collection of fuel wood, fodder through unsystematic over grazing, green manure through lopping of branches, litter collection through sweeping the forest floor and unregulated and illegal collection of other different non wood forest produces. Effect of illicit felling was more prevalent in areas, particularly the vested forests, which were under private ownership in the past. Though appeared to be of minor concern, felling of trees for small timber and fire wood were found to occur in large extent of area. The damage caused due to cattle grazing was also substantial, though cattle grazing was not legally allowed in most of the forest areas in the State. The graziers often put fire for promoting growth of grass. Illegal collection of rattan, bamboos and reeds, ivory, sandal and other non wood forest produces were also found to contribute degradation. These factors have resulted in increased occurrence of fire, soil erosion and poor regeneration of many valuable species.

Over exploitation/unscientific exploitation of resources:

Under the disguise of permitted harvesting (by Forest Department), there were substantial over exploitation/unscientific exploitation of different forest

produce. This include timber, bamboo, reeds, rattan and different other non-wood forest produce. Previously large quantity of timber was extracted in the name of selection felling without looking into the silvicultural requirement. Even now, the timber extractions taking place in the name of collection of dead and wind fallen trees are not as per prescriptions. Unscientific logging practices followed have caused damages not only to the residual crop but also made the land prone for soil erosion. Though there were clear guidelines for harvesting of bamboos and reeds, these quidelines were not followed properly. The extraction procedures were unscientific leading to considerable amount of wastage and damage to the residual crop. Often to facilitate easy extraction, labourers set fire to the forest causing serious damage. This was also the case with collection of rattans, medicinal plants and other non-wood forest produce.

Diversion of forest land for non forestry purposes:

Substantial forest area are found to be diverted for non forestry purposes. Encroachment by settlers was one of the major item in this. While 1940's, 1950's and early 1960's the people were encouraged to clear forest, settle in the forest and raise agricultural crops aimed at enhancing food production. However, later on this has developed into a serious humanitarian problem of containing large number of land hungry people, who encroached into the forest land causing serious damage to the forest. In the past, the government were forced to regularise these encroachments on humanitarian and political grounds. In the suburbs of various river valley hydal projects, the damage caused by the settlers, who came as labourers for construction of dams was severe. These settlers often indulge/become instrumental in the hands of miscreants involved in illegal activities. Another factor which lead to the damage

of forest was unscientific large scale conversion of natural forests into monoculture plantations. In the names of enhancing productivity, economic value of the forest and supply of industrial raw material to industries, large extent of good natural forests were converted into plantations of teak, eucalyptus and other species. The extent of poor and failed plantations seen today in the State is a standing testimony of poor site selection and faulty management practices adopted. As these plantations were not of immediate use to the local people who were living in the vicinities of these forests, the pressure on adjoining natural forests for their needs such as fuel wood, fodder and other non-wood forest produce increased, leading to degradation of these forests.

Damage due to harmful effects of management operations:

Some of the management operations adopted in the past were also found to have caused degradation of the forest. The prevalent practice of selection felling was found to cause more damage to the forest than the benefit of the timber extracted as well as the opening generated for subsequent regeneration and growth of the forest, ultimately leading to the stoppage of this practice. This was also the case with clear felling. Similarly, faulty alignment of forest roads, particularly those made by contractors for timber extraction were found to have resulted in extensive soil erosion in many areas.

Role of fire:

Fire was the next serious cause which has played a role in degrading the forest. Forest fire, apart from causing damage to the existing crop, very often wiped most of the regeneration and also exposed the forest areas for soil erosion. Occurrence of fire in forest areas by and large are caused by miscreants

or occurred by accident because of negligence of people entering in to the forest. Incidence of forest fire due to natural forces was found to be insignificant in Kerala, indicating that the extent of forest fire seen today is the effect of many other factors as mentioned above.

Invasion of weeds:

Invasion of weeds often occur as a result of degradation of forest. It also leads to further degradation of the existing forests. These weeds suppress regeneration of different species and tree growth causing substantial degradation of forests. Currently large chunk of forest areas were found to be invaded by weeds such as Eupatorium, Lantana, tall grass and Mikanea. The occurrence of weeds such as Lantana, Eupatorium and tall grass during summer act as fuel for forest fire. However, invasion of weeds was found to be an effect of degradation of forest rather than a cause, as the extent of area suffered exclusively due to the occurrence of weeds was only very limited. In general, a healthy forests do not promote the growth of weeds.

Soil erosion:

Substantial forest area were found to be prone for serious soil erosion. These includes river and stream banks and denuded areas in steep slopes. Continuous fire, excessive cattle grazing and denudation of forest due to various other factors mentioned above have all cumulatively caused in increasing the areas prone for soil erosion. However, even in this case, soil erosion, in Kerala, by and large was found to be an effect of degradation of forests rather than a cause, as the extent of soil erosion in a good forest is substantially low.

Poor regeneration:

As in the case of many other factors poor regeneration is not only a cause for degradation but also the effect of degradation of forest. However, on an overall assessment, as in the case of fire, soil erosion and invasion of weeds, it was found that poor regeneration potential of the site, as a cause for degradation was confined only to a very small portion, though poor regeneration as an ultimate effect of degradation has occurred in the whole degraded forests in the State. This was evident from the Forest Working Plans, the opinions of the Forest Officers attended the workshop and the data gathered through field visits. Given adequate protection from other causes of degradation, forest were found to recoupe very fast. Some of the forest areas where these causes were properly checked, as seen in Sanctuaries, National Parks and other well managed locations provide typical examples to the regeneration potential of the forests.

The extent of degraded forests affected by different factors causing forest degradation are given in table 9.

Table 9. The extent of degraded forest affected by different causes of degradation in Kerala (percentage to the total degraded area in bracket).

Causes	Extent per Km^2
1. Unregulated and illegal harvesting of forest produces	3575.46 (73.35)
2. Fire	3119.64 (64.0)
3. Invasion of weeds	2973.41 (61.0)
4. Over exploitation/unscientific exploitation of resources	2729.69 (56.0)
5. Diversion of forest land for non forestry purposes (including the residual forest area affected)	2242.24 (46.0)
6. Soil erosion	1852.29 (38.0)
7. Damage due to harmful effects of management operations	1364.84 (28.0)
8. Poor regeneration	731.17* (15.0)

* Poor regeneration as an effect of degradation occur in all the degraded forests in Kerala. In this case, the extent given is of those areas where regeneration is a cause of degradation.

In this, occurrence of fire, invasion of weeds, soil erosion and poor regeneration occur as a result of degradation due to various other factors mentioned above and hence can be checked substantially by preventing/mitigating incidence of these factors.

4.5. EVALUATION OF COMPENSATORY AFFORESTATION

The total area in which Compensatory Afforestation was implemented was about 20278 ha. The total expenditure made comes to Rs. 128.9 million. The extent of single area tackled varies from 4 ha. to 380 ha. The average expenditure incurred during the last three years per ha. was Rs. 6357/-. The expenditure made in individual locations as available from Forest Department records comes to Rs. 900/- per ha. to about Rs. 30,000/- per ha. The regeneration techniques used was essentially planting though the different operations carried out have helped in promoting natural regeneration. The number of species planted, as seen from records varies from two to more than twenty.

The list of the plantations selected for the field survey is given in Appendix VI. Information on various aspects were gathered using a proforma (Appendix IV).

The Tables 10 to 14 give the results of the evaluation of Compensatory Afforestation scheme implemented in the five Divisions studied. The major findings are discussed below.

Table 10. Thiruvananthapuram Division

Sites covered	.....	6
Total area covered	.....	177.4
Forest type	.....	Moist Deciduous
Crown density	.....	<0.4
Standing crop	.....	*Terminalia paniculata* *Albizzia odoratissima* *Dillenia pentagyna* *Pterocarpus marsupium* *Careya arborea* *Bambusa bambos* *Terminalia bellerica* *Artocarpus hirsutus*
Species planted	.....	*Tectona grandis* *Emblica officinalis* *Albizzia odoratissima* *Artocarpus hirsutus* *Terminalia arjuna* *Terminalia paniculata* *Vateria indica* *Swietenia macrophylla* *Dalbergia latifolia* *Adenanthera pavonina*
Spacing	.....	Not consistent
Survival	.....	Average 70 percent (Poor (40%) at one s Edavam I).
Soil and water conservation	.....	Gulley plugging only

Table 11. Idukki Division

Site covered	.....	(Keerimudi)
Area	.....	200 ha.
Forest type	.....	Evergreen but at preser dominated by moist deciduou species over grassland (80(elevation)
Crown density	.....	0.4 - 0.7
Standing crop	.....	*Terminalia paniculata* *Dillenia pentagyna* *Emblica officinalis* *Macaranga peltata* *Pterocarpus marsupium*
Species planted	.....	*Terminalia paniculata* *Artocarpus heterophyllus* *Emblica officinalis* *Pterocarpus marsupium* *Cassia fistula*
Spacing	.....	2 x 2m
Survival	.....	80 percent
Soil and water conservation	.....	Nil

Table 12. Thrissur Division

Sites covered	.....	6
Total area covered	.....	501.50
Forest type	.....	Moist Deciduous
Crown density	.....	< 0.4
Standing	.....	*Terminalia paniculata* *Terminalia tomentosa* *Bridelia retusa* *Albizzia odoratisima* *Xylia xylocarpa* *Tectona grandis* *Strychnos nux-vomica* *Grewia tiliaefolia* *Pterocarpus marsupium* *Lagerstroemia microcarpa* *Bambusa bamboos*
Species planted	.....	*Emblica officinalis* *Artocarpus heterophyllus* *Cassia fistula* *Terminalia bellerica* *Terminalia tomentosa* *Terminalia arjuna* *Tectona grandis* *Swietenia mahagony* *Anacardium occidentale*
Spacing	.....	2 x 2m
Survival	.....	Average 70 percent except in one (60 percent due to excessive weed growth

Table 13. Kannur Division

Sites Covered	.....	3
Total area covered	.....	238.88
Forest type	.....	Moist Deciduous
Crown density	.....	0.4 - 0.7
Standing crop	.....	*Xylia xylocarpa*
		Terminalia tomentosa
		Emblica officinalis
		Pterocarpus marsupium
		Terminalia paniculata
		Dillenia pentagyna
		Lagerstroemia microcarpa
		Swietenia mahagoney
		Garcinia gummi-gutta
		Terminalia bellirica
		Hydnocarpus laurifolius
		Ficus hispida
		Gmelina arborea
		Grewia tiliaefolia
		Mangifera indica
		Bridelia retusa
Species planted	.....	*Acrocarpus fraxinifolius*
		Terminalia tomentosa
		Casuarina equisetifolia
		Butea monosperma
Spacing	.....	2 x 2m
Survival	.....	90 percent
Soil and water conservation	.....	Gulley plugging

Table 14. Kasaragode

Sites covered	.....	11
Total area	.....	1712 ha.
Forest type	.....	10 moist deciduous
		1 semievergreen
Crown density	.....	0.4 - 0.7
Standing crop	.....	*Terminalia tomentosa*
		Terminalia paniculata
		Pterocarpus marsupium
		Grewia tilliaefolia
		Xylia xylocarpa
		Ficus sp.
		Meliusa tomentosa
		Artocarpus hirsutus
		Emblica officinalis
		Mangifera indica
		Butea parviflora
		Lagerstroemia reginae
		Holigarna arnotiana
		Adina cordifolia
		Cinnamomum malabathrum
		Syzigium cuminii
		Felicium decipiens
		Ficus callosa
		Hopea parviflora
		Lagerstroemia microcarpa
		Dillenia pentagyna
Species planted	.....	*Terminalia tomentosa*
		Terminalia bellirica
		Dendrocalamus strictus
		Acrocarpus fraxinifolius
		Emblica officinalis

Swietena microphyllay
Tectona grandis
Pterocarpus marsupium
Grevellie robusta
Gmelina arborea
Bambusa bambos

Spacing ..... 2 x 2m (at one site no specific spacing)

Survival ..... Above 80 percent

Soil and water conservation ..... Gulley plugging

4.5.1. SUITABILITY OF SITE OF THE PROGRAMME

The general feature of the sites were Compensatory Afforestation was carried out were summarised in Table 15.

Table 15. General features of sites tackled (percent to area/sites)

	Feature	High	Medium	Low
1.	Soil depth*	9	60	31
2.	Rockiness	13	57	30
3.	Erosion proneness	13	48	39
4.	Gulleys	26	74	--
5.	Crown density**	--	56	44
6.	No. of trees per/ha***	--	52	48
7.	Basal area****	--	41	59
8.	Natural regeneration	39	52	9
9.	Weed invasion	43	48	9
10.	Resource use	9	17	74
11.	Grazing	0	40	60
12.	Fire incidence	13	26	61
13.	Lopping	0	22	78
14.	Green manure collection	4	35	61
15.	Encroachment	--	9	91
16.	Influence of settlements	--	9	91

* Soil depth ... High >60cm; Medium 30-60cm; Low <30cm

** Crown density ... High <0.7; Medium 0.4-0.7; Low <0.4

*** No. of trees ha^{-1} (above 10 cm gbh) ... High >1000; Medium 600-1000; Low <600

**** Basal area ... High >50 m^2/ha; Medium 25-50 m^2 ha^{-1}; Low <25m^2 ha^{-1}

Soil depth

The depth of the soil cover was high in 9 percent, medium in 60 percent and 31 percent low. The sites in Kasaragode, Kannur and Idukki have soils of medium depth while majority in Thrissur and Pathanamthitta are shallow. Nearness to settlements and less crown density are the reasons for low depth of soil. Otherwise, the soil cover and its quality does not pose a threat to the scheme.

Rockiness

Of the sites visited for evaluation, 13 percent had high rockiness, 57 percent medium and 30 percent low rockiness. The exposure by rocks is low in Kasaragode and Kannur, Medium to high in Thrissur and Idukki and medium in Pathanamthitta and Thiruvananthapuram.

Erosion proneness

High soil erosion proneness was observed in 3 percent, medium in 48 percent and low in 39 percent of the sites. This was low to medium in Kasaragode and Kannur and medium to high in Thrissur, Idukki, Pathanamthitta and Thiruvananthapuram.

Gulleys

Most of the sites showed the presence of gulleys indicating excessive and uncontrolled movement of water (74 percent medium).

Crown density:

According to crown density 56 percent of the sites had crown density between 0-4-0.7 and 44 low density of <0.4. This shows that crown density alone need not be an indicator of degradation. Although according to crown density 56 per cent of sites belong to the class 0.4--0.7 stand parameters (Number of trees per ha., basal area and regeneration status etc.) indicated that these areas are degraded. For eg. in Palar RF of Kasaragode the crown density was above 0.4 but the number of stems and regeneration was very low. The same is the case with Keerithodu site at Idukki.

Number of trees per ha.

This indicator showed that 52 percent of the sites had medium number and 48 percent below normal. Higher number of trees were present in Kasaragode and Kannur while the tree cover was very low in other Divisions.

Basal area

According to basal area 49 percent had medium levels of basal area while 51 percent had low. As in the case with the number of trees per ha the basal area was high in Kasaragode and Kannur and low in other Divisions. It was very poor in Thiruvananthapuram sites.

Natural regeneration

Natural regeneration is an important indicator of degradation. Natural regeneration was high in 39 percent of the sites, medium in 52 percent and low only 9 percent of the sites. Most

of the sites in Kasaragode had high levels of regeneration while it was low to medium in other divisions. Enhancement of natural growth through other means avoiding planting can be a success in selected sites.

Weed invasion

Weed invasion, an important indicator of degradation, was high 43 percent, medium in 48 and low only 9 percent of the sites. Low weed invasion was observed only at Kasaragode. Induction of changes in the microclimate especially light and protection from regular fire can help in reducing this menace.

Resource use

One of the factors of forest degradation is resource use by people. Such an impact was high only in 9 percent of the sites, medium in 17 percent and low in 74 percent of the sites covered under the evaluation. Resource use was high only in Thiruvananthapuram Division. In future, sites can be selected on the basis of intensity of resource use so that peoples' participation and commitment to restoration can be utilised effectively.

Grazing

The impact of grazing was medium in 40 percent and low in 60 percent of the sites. The impact of grazing is most felt in Thrissur and Thiruvananthapuram. It was not high anywhere indicating .pa the management of cattle by stall feeding rather than grazing in forests.

Fire incidence

Fire is yet another factor for degrading natural forests. Fire incidence was found high in 13 percent, medium in 26 percent and low in 61 percent of the sites. Fire plays a crucial role in the forest sustainability mainly in Thrissur, Idukki and Thiruvananthapuram. The main reasons are settlement intensity near the forests and also NTFP collection habits of the local people.

Lopping of trees/branches

This phenomenon was medium in 22 percent and low in 78 percent of the sites. Use of forests for firewood was high in Thrissur, Idukki, and Thiruvananthapuram and low in Kasaragode and Kannur.

Green manure collection

4 percent of the sites had high levels of green manure collection 35 percent medium and 61 percent low. The intensity of green manure collection did not have a geographical pattern and must be related to the nearness of settlements and their landuse needs.

Encroachment threat

The level of encroachment threat was medium in 9 percent and low in 91 percent of the sites indicating the stabilization of landuse in the State.

Influence of settlements

The influence of settlements was low in most sites as they were away from the sites and only necessary items are derived from the forests for implementing the programme.

Taking into account all these characteristics and overall suitability for the programme was assessed. This exercise revealed that 65 percent of the sites were highly suitable while 35 percent were more or less suitable for implementing the programme.

4.5.2. IMPLEMENTATION

Species planted: On an average, about 20 different species (Table 16) have been tried over the State.

Table 16. Species planted

1. *Terminalia tomentosa*	2. *Sweitenia mahagony*
3. *Terminalia bellirica*	4. *Gmelia arboria*
5. *Dalberigia latifolia*	6. *Artocarpus hirsutus*
7. *Adenanthera pavonina*	8. *Artocarpus heterophyllus*
9. *Tectona grandis*	10. *Albizzia odoratissima*
11. *Legerstroemia microcarpa*	12. *Acrocarpus fraxinifolius*
13. *Tamarindus indica*	14. *Bambusa bambos*
15. *Casuarina equisetifolia*	16. *Grevelia robusta*
17. *Dendrocalamus strictus*	18. *Cassia fistula*
19. *Pterocarpus marsupium*	20. *Grewia tiliifolia*
21. *Anacardium occidentale*	22. *Meliusa tomentosa*
23. *Dillenia pentagyna*	24. *Emblica officinalis.*
25. *Vateria indica*	

The species selection has been dictated by previous knowledge, seed availability and familiarity with the technology of raising and planting them. As most sites except one in Ranipuram in Kanjangad and Keerimudi in Idukki were of the Moist Deciduous forest type the species choice did not fail. But in relation to evergreen forest rehabilitation, more investigations are required to identify promising species and their regeneration technology.

Soil and water conservation: Only gulley plugging was done at most sites. Staggered trenches, bunding and terracing were not attempted. For gulley plugging, by and large, locally available material were used. There is scope using vegetative methods to reduce the cost.

Plantation success: Over 80 percent of the sites showed good growth of seedlings planted (1-2 years). Except in Ranipuram of Kanjangad and one plantation in Thrissur which was a failed cashew site the growth of plants during the first two years is good. Continuous monitoring of the sites over a period of 5 years is required to truly assess the success of the programme. More over, problems were observed in distinguishing planted/ naturally regenerated seedlings as proper recording was not carried out with regard to the residual growth, spacing adopted and planting design followed.

Regeneration of other species: The over all care accorded to the sites improved the natural regeneration in 39 percent of the sites. In 52 percent the impact was below average and in 9 percent of the sites there was no impact. These sites were in Kasaragode, Kannur and Idukki. Other areas recorded an increase in natural regeneration due to the activities carried out under the programme.

Weakness and threats

Bio-physical threats: Fire, grazing and weed invasion in combination were the major threat which affected the programme negatively in 44 percent of the sites. Weed invasion alone hampered 26 percent of the sites. In five percent of the sites failure can be attributed to wrong choice of species while in another five percent it was over head shade. The problem of overhead shade can be avoided by avoiding planting in well stocked sites.

In most of the sites except Parakkad in Koderimala of Kannur, spacing was maintained at 2500 trees per ha uniformly. At this site varying spacing was attempted on the basis of the stand density of the trees already growing. This approach of avoiding blanket regimes can be attempted at other sites in future.

The information gathered from various sources indicted that there was no systematic assessment of causes of degradation and planning for appropriate strategies at site level before embarking on planting activities. Also there was no provision for making local deviations required from the scheme in the operations needed for effecting improvement of degraded sites.

Social threats: In all sites the programme was operated as a Departmental one. Local people were involved in the programme only as labourers. The absence of real participation and well defined rights over the benefits to be accrued in future is a major negative feature. As local people have no stakes at present over the usufructs there interest in the long-term sustainability of the wealth being created is weak.

Management

The following weaknesses were also observed with regard to the implementation and management of Compensatory Afforestation.

1. Prioritisation of degraded sites: Correct information with regard to the extent of forest areas and their degradation status was not available at reserve/range/division/state level at the time of implementation of the programme. It was observed that there are considerable variation in extent and nature of forest of different forest reserves. Proper surveying and demarcation of boundaries were not carried in the past. The information available with different forest department records were only assessment and there were variations in these estimates. By and large, classification of forest area based on crown density was chosen in planning Compensatory Afforestation which was found to be highly misleading. Consequently there was some difficulty in prioritising the areas taken up for Compensatory Afforestation.

2. Though it was mandatory in the scheme to prepare treatment maps, a perusal of Forest Department records, revealed that no proper map was prepared in most of the sites. This was the case with plantation journals also. Though, preliminary operations for planting were recommended one year before, very often, it was observed that site evaluation particularly with regard to the actual causes of degradation were not made adequately. This often lead to giving preference for artificial regeneration based on planting operations in many locations where emphasis on other measures such as fire protection and attention to reduce various biotic pressures would have been much more efficient.

3. As proper treatment maps and journals recording various operations carried out were not available, there were difficulties with regard to monitoring the effectiveness of different operations carried out.

4. The Forest Officers who have attended the Workshop, as well as those consulted during different stages of the study were unanimous in their opinion, that very often, operations carried out in the field were tailored to suite the sample estimate provided in the scheme rather than the requirement of the site. Consequently it was not possible to attend to important operations such as soil conservation, weed control and motivation and involvement of local people.

4.5.3. CONCLUSIONS

1. The compensatory afforestation programme concentrated mainly on afforestation with indigenous (need not be local) species.

2. The sites chosen belong to degraded areas and are suitable for such operation. Though, in record, the area to be chosen were of crown density below 0.4 the Officers have deviated from this norm and selected degraded sites belonging to other crown density classes.

3. The species choice was restricted to a few moist deciduous species and that too of timber use.

4. Only regular operations were carried out and most sites were located predominantly away from settlements.

5. The planting programme is a success as recorded in 80 percent of the sites. Differential spacing, Shade management, enhancement of natural regeneration through other means were not attempted anywhere.

6. Peoples participation was conspicuously absent.

7. More attention for survey and demarcation of existing forest areas and assessment of degraded areas at reserve/range/ division levels can help in priortisation of areas taken up for treatment.

8. Preparation and maintenance of journals containing periodic site evaluation reports (including those areas lying in the influence one of the degraded forest patch), treatment plans and maps, will help in proper monitoring of afforestation programme.

9. Operational flexibility is required in the implementation of the programme as these requirement vary considerably from site to site.

4.6. Constraints faced by the Forest Department in improving degraded forests

The following constraints were found to be faced by The Forest Department Officials in planning and implementation of the activities related to improvement of degraded forests. They are classified broadly into three, Technical, Financial and Socio-political.

4.6.1. Technical constraints:

(a) Lack of standardised procedure to identify degraded forests

As indicated earlier, the criterian based on crown density to identify degraded forests in Kerala was of limited use. The varied forest types, their characteristics, different causes of degradation and the changes they were forcing on these forest types, were found to be quite diverse. A tropical forest, as seen in Kerala, should have the following five basic characteristics viz:

1. Vertical composition of species typical to the type
2. Horizontal composition of species typical to the type
3. Satisfactory regeneration of the various species in different stages.
4. A typical ground flora
5. A mature forest floor

Simple and appropriate method which at the same time, can be universaly applied to the different types of forests, taking into consideration the integral components for identifying degraded forests was not available to the Field Forest Officers. This has often caused problems in deciding the extent of degraded forests and assessing the intensity of degradation in different forest areas. This has adversely affected proper policy planning and their effective implementation.

(b) Information on actual extent of area under degradation: In spite of all the past efforts, the forests of Kerala are not yet properly surveyed. The boundaries of the reserve/ vested forest are not clearly available and still there is lot of dispute. As a corollary to this, information with regard to the area under degradation is also not available which are very essential for planning and implementation of improvement activities.

(c) Lack of proper maps of appropriate scales showing the location, nature and extent of degraded forests suitable for policy planning, operational planning etc.

No standard maps were available to the Forest Officers which can clearly show the degraded forest, their extent, nature and the location. Such maps of 1:1 million and 1:2,50,000 scale are necessary for policy planning at state level. 1:50,000 maps are required for planning at forest divisions, 1:25,000 at forest range level and 1:5,000 to 1:2,000 at site levels for operational planning. Lack of availability of these maps have been causing problems in locating degraded forest areas for effective treatment, planning and implementation of improvement activities and their proper evaluation and monitoring.

(d) Lack of information with regard to the factors causing degradation and their impacts based on Scientific studies.

Information with regard to the actual causes of degradation based on systematic assessment was not available. As found out in this study, these causes vary considerably from place to place. Lack of such information has often resulted in poor presentation of the issues involved to the policy planners and administrators. As discussed in the previous chapters the consequence of degradation of forest are far reaching and its impact on the sustanance of life system alarming. Clear cut idea about the intensity of different causes of degradation at different levels - site, forest range, forest division, forest circle and the State is a must for devising appropriate strategies required different levels. This in turn are essential not only for efficient utilisation of available funds for successful implementation of improvement activities but also for highlighting the seriousness of the problem to the administrators and politicians who may not have the necessary technical background.

(e) Lack of appropriate techniques to counter degradation based on systematic Scientific studies

Informations were found to be lacking with regard to the appropriate techniques to be adopted to counter degradation. Very often, the factors causing degradation vary from place to place and hence require site specific treatments. Lack of appropriate techniques required for tackling forest degradation - Silvicultural and Socio-economic approaches - often resulted in wastage of considerable amount of scarce resources. This was one of

the main reason for not achieving the desired success in most of the ambitious programms and schemes taken up by Forest Department in the past in improving degraded forests, typical examples being, mixed seeding, heterogenous plantations and compensatory afforestation.

4.6.2. Financial and Institutional constraints:

(a) Lack of funds

Though degradation of forest is a matter of national concern, the outlay for addressing this gigantic problem is often meagre. For example, under the Compensatory Afforestation Scheme while the budget estimated for improvement of degraded forest in an area of about 57180 ha., is Rs. 1365.435 million, so far only Rs. 143.8 million was made available. The extent of area to be tackled as per our findings is 487444 ha., which is almost 8.5 times than that is envisaged to be improved under Compensatory Afforestation Scheme. If the same amount is projected proportionally to the whole area, the total requirement will come to 11640.33 million rupees. It should be remembered that the total investment in the entire forestry sector during the period from 1985-94 is only 3416.041 million (KFD, 1994). To avoid further degradation of forest, ecorestoration schemes have to be implemented within the shortest period possible.

(b) Rigidity in fund utilisation

The operation connected with ecorestoration are seasonal and the operating staff should be in a position to utilise the allocated funds during that period without any

avoidable restrictions. The study has identified a number of problems in this regard. The following table (Table 17) on the allocation and expenditure made during 1990-94 under different plan and non plan schemes in the forestry sector in Kerala will highlight the extent of limitations.

Table 17. Allotment and expenditure under different plan and non plan schemes during 1990-1994

Year	Allotment (Rs. in lakhs)	Expenditure (Rs. in lakhs)
1990-91	4501.68	3440.937
1991-92	4910.38	4383.063
1992-93	5668.27	6035.726
1993-94	6058.95	5864.486

Forest Statistics, Govt. of Kerala, 1994

The delay in sanction of estimates, existing schedule of rates, letter of credit system for release of funds prevalent etc., were the major bottleneck for timely utilisation of funds. These problems are discussed briefly.

To execute the operation estimate sanction is a pre-requisite. The delegated powers, especially at divisional level require an upward revision. The nature of work actually required for ecorestoration may vary for different situation and the officers were of the view that there should be sufficient freedom at divisional level to take independent decision in this regard. Probably the superior officers can issue appropriate guidelines in using such powers.

The existing schedule of rates requires modification taking into consideration the variations of the task involved as well as the site specific issues involved. The officers were of the view that there should be sufficient flexibility in schedule of rate with appropriate control measures in to tackle this problem.

(c) Lack of infrastructure

The problem of lack of infrastructure was also raised by many officers as one of the constraint. This may require attention at the appropriate levels.

(d) Lack of functional freedom (including transfer of officers and staff)

Improvement of degraded forests require thorough knowledge of local issues such as site conditions and the people involved. Frequent transfer officers involved often deprive this knowledge. The officers were by and large unanimous that there should be sufficient functional freedom and a transfer policy taking into consideration the demands of the job.

(e) Lack of adequate incentive and motivation to the staff on duty

The degradation of forest involve considerable amount of efforts on the part of officers not only on technical aspects of afforestation but also on the art of tackling the social issues. Only a highly motivated staff can tackle this problem. Appropriate incentive and other measures to motivate the staff are required for this purpose.

(f) Training to the staff

The Forest Department staff particularly those involved at the operational level in improving degraded forest need to be trained on various aspects of the problem involved. This include technical aspects such as regeneration methods and soil and water conservation as well as extension methods of interacting with local people.

(g) Information system

There is scarcity of timely availability of information at various levels of Forest Department officials with regard to different issues connected with the tackling of forest degradation. Consistant efforts are needed to generate and distribute the necessary information on the basis of need at appropriate time. The officers attended the Workshops highlighted the difficulties paused in this regard.

4.6.3. Socio-political constraints

(a) Lack of communication with local people

At present, the participation and involvement of local people in the protection and management of forests is quite low. There is lot of communication gap exist between local officers and the people. The officers attended the Workshops highlighted the difficulties arising out of the situation.

(b) Interference of politicians

The forest officers attended the Workshops raised the problem of interference of local politicians in day to day activities as one of the constraints. An appropriate strategy may be thought of to prevent harmful interference.

(c) Lack of cooperation from local public

This was also raised as one of the constraints. Creating awareness, developing appropriate stake holder relationship at local level is required to tackle this issue.

4.7. Strategies for improving degraded forests and cost estimates

4.7.1. Strategies

The problems facing the Forest Department are summarised in nut shell to suggest the strategies identified.

1. **Protection from illegal harvesting/removal of different forest resources:**

   At present, an extent of 3575 Km^2 (73%) of the degraded forest are effected by this problem. Also, an extent of 2242 Km^2 (46%) suffers from biotic pressure resulting out of the diversion of natural forest for other purposes made in the past. About 80% of the degraded forest lie in proximity to human habitation (with in 5 Km. distance). Ensuring protection from removal of forest produce through illegal activities is one of the important requirement to prevent/mitigate forest degradation. An appropriate strategy is required in this regard.

2. **Fire protection:**

   About 3120 Km^2 (64%) of forest area are effected by forest fire and considerable amount of forest loss. It is necessary to adopt appropriate strategy to prevent forest fire.

3. **Control of weeds:**

   About 2973 Km^2 (61%) of the degraded forest is invaded by weeds. This is effecting regeneration and growth of useful species. Mechanisms to eradicate this menace is necessary.

4. **Regulated harvesting of non-wood forest produce:**

At present, 2730 Km^2 (56%) suffers from unscientific/over exploitation of resources, particularly non timber resources such as bamboo, reeds, rattan and different plants of medicinal value. Often, harvesting procedures adopted cause serious damage to the existing crops resulting in heavy loss of wealth. Over grazing also cause a serious problem. Appropriate measures are required to control this.

5. **Soil and moisture retension:**

Soil erosion and moisture depletion is one of the major problem in degraded forests. There is an extent of 1852 Km^2 (38%) which requires soil and water conservation measures. The impact of soil erosion is wide ranging.

6. **Improved utilisation of available forest resources:**

Shortage of resource supply has often lead to over exploitation of existing resources. This is the case with most of the timber and non timber forest produce exist in Kerala. However, one can seen that there is considerable amount of wastage in the use of these resources. According to a study, wastage of timber during harvesting, processing and utilisation comes to about 30%. This was the case with various non timber produce also. Hence, measures for improved utilisation of available resources assumes significance.

7. **Improvement of productivity of the forest:**

Almost all the degraded forest in the State are effected by poor regeneration. Strategies to control this are essential

for improvement. Also it is necessary to upgrade the quality of degraded forest to help the forest to provide its various functions. There is also a need to generate substantial amount of resources in the degraded forests near habitations, to meet the requirements of the local people.

With the increased aspirations of the people, there is more demand for better economic, ecological and social benefits from the forest. With the continued depletion of forest, the demand on the existing resource has become more and more. An appropriate strategy to cope with this situation is required.

However, an analysis made from sample data gathered from different sources revealed that only 5% of the total degraded forest require high intensity treatment. 10% requires moderate treatments and rest of the 85% of the area requires general protection measures involving low intensity treatments.

The following broad technical, institutional and socio-economic measures were identified during the study for improving degraded forests.

Technical measures:

1. Promotion of regeneration through artificial means:

Here, the main emphasis is for planting. This is required to be adopted in areas where regeneration is essentially a cause of degradation. It is also required in areas where regeneration by natural means take more time. As substantial areas are under poor regeneration due to various reasons which requires more time for control, artificial regeneration assumes significance. Artificial regeneration is also required for the upgradation of the forest to meet

the new challenge imposed by scarcity of the resource and increasing aspiration of the people.

2. **Generation of alternative resources in buffer zones through appropriate interface forestry and agroforestry activities:**

To augment the resource shortage there is a need for generation of alternative resources in human habitations lying in close proximity to forest areas. This has to go simultaneously with the improvement activities with in the forest areas.

3. **Regulated harvesting of existing forest resources:**

To ensure efficient utilisation of existing resources it should be ensured that the harvest procedure followed in all timber as well as non timber resources should not adversely affect the existing crop. On the contrary it should help in improving the quality of existing forests.

4. **Efficient use of available forest resources to produce value added products so as to generate income and employment to the people.**

Institutional measures:

1. **Survey and mapping:**

This include survey and demarcation of existing reserve forests, consolidation of forest boundaries, preparation of maps in appropriate scale, suitable for operational planning.

2. **Decentralisation of administrative machinery:**

Decentralisation of administrative machinery of the Forest Department to provide functional autonomy and freedom at different levels for speedy implementation of various strategies for improvement of degraded forests.

3. **Infrastructure development and modernisation:**

Infrastructure development and modernisation in the forestry sector to enable efficient implementation of various activities to remove the causes of degradation and to promote various strategies to improve the degraded forests.

The study has found that at present, the motivation of the staff particularly at the Rangers level and below is not adequate enough to take up massive operations for improving degraded forests. To boost the morale of the staff the adoption of following measures is recommended.

(a) Better service conditions to the staff.

(b) Better residential facilities for staff living in the remote areas.

(c) Allowances for the staff working in remote areas to provide quality education to the children.

(d) Judicious transfer policies taking into consideration the needs of the job.

(e) Rewards for doing good job and punishment for dereliction of responsibilities.

4. **Training:**

To take up appropriate strategies for improving degraded forests, it will be useful to provide the departmental staff training on areas such as forest extension, improved regeneration techniques and soil and water conservation works.

5. **Protection:**

Enforcement of measures to prevent illegal activities.

Socio-economic:

Most of the degraded forest areas lie in the fringes of human habitations and the major reason for forest degradation is the increased pressure on the scarce resources. Success of activities for improving degraded forest in these areas depends largely on how best these measures can reduce the pressure on the resources - land and forest - from these local people. Hence, involvement of local people is a must in such cases. However, a study of the past management efforts of the forest department reveal that adequate attention is yet to be paid in this direction. The local people can be involved in the following areas.

(1) Protection of forest from biotic pressures - fire, grazing, illicit harvesting, encroachment etc.

(2) Sustainable management of existing forest resources through judicious harvesting practices.

(3) Generation of alternate resources in the land occupied by the people.

(4) Reduction in consumption of existing forest resources through adoption of consumption alternatives.

(6) Promotion of private initiative in the form of capital and labour for sustainable use of available resources.

(7) Judicious implementation of a combination of different strategies taking into consideration the overall cost and benefits involved.

This is expected to help in not only in diverting the people involved in illegal activities but also in reducing the operational cost involved in improvement measures substantially. More over, in the long run it will also help in developing proper stake holder relationship in the forest for their continued support of sustainable management of these forests.

To get adequate support and involvement from the local people, considerable amount of effort is necessary to create awareness and goodwill. No readymade approach is available in this regard and considerable amount of experimentation based on trial and error is required.

An evaluation of Compensatory Afforestation as well as other schemes of Kerala Forest Department has revealed some weaknesses in the existing system. They are,

1. The degraded forests in Kerala lying in different zones, namely, (a) those in close proximity to human habitation, (b) those lying in National Parks, Sanctuaries and other Protected Areas and (c) those in other natural forests, are tackled by different wing of the Department, viz. Social Forestry wing through different Social Forestry Programme,

Wildlife wing through different habitat improvement activities and Territorial wing of the Department through regular protection and management measures. Because of the interlinkage which exist in the causes of degradation, to ensure effectiveness, greater coordination between the different wings of the Forest Department will be helpful in the successful implementation of these programmes.

As most of the degraded forest lie in close proximity to human habitation, improvement of degraded forest has to be taken up with the involvement and support of local people. There is a necessity to generate alternative resources in the buffer zones, especially through agro-forestry activities and there is also need for adoption of consumption alternatives. To achieve this, close coordination between Forest Department with its other sister departments of Government of Kerala such as Rural Development Department, Agriculture Department, and Tribal Welfare Department is required. They may also have to work in unison with local bodies.

2. By and large, so far, the activities for improvement of degraded forest were confined to planting and very often the normal functions of protection of the area and promotion of natural regeneration tend to get neglected. In many cases sufficient allocation of funds were not made for these purposes. Attention in this regard will be helpful in reducing the cost involved in improvement of degraded forest.

3. The past efforts for improvement of degraded forests reveal that in most cases, post planting care is neglected. To avoid failure it is essential to pay attention for continued

improvement activities in the areas where treatment operations have been initiated.

4. Most often improvement activities start with planting. Adequate time is not available for activities such as prioritisation of areas to be taken up for improvement, survey and demarcation, site evaluation, preparation of treatment plans, preliminary soil and water conservation and creation of awareness among local public to get their support, which are very vital for successful implementation of the programme. It was felt that planting and other associated operations be carried out only after attending these preliminary task. With these objective, it is suggested that the field planting be carried out in the third year after making necessary preparation. In addition, the areas planted requires protection and maintenance on a continuous basis so as to prevent the operation of different causative factors.

5. The treatment of degraded forests has to be carried out in a phased manner. However, to avoid further degradation of the remaining areas there is need for some preventive measures. Adequate measures for this including necessary budget allocation is required for this purpose.

6. The existing technical know how to carry out the different task mentioned above are very limited. Lot of research efforts are required to generate this. Often, this has to be carried out through trial and error methods.

4.7.2. Cost estimates for improving degraded forests

Based on the sample data gathered it was found that out of the total area of degraded forest only 5% requires high intensity

operations, 10% requires moderate intensity operations and the rest of the area (85%) require low intensity operations.

The estimate of cost required for improving degraded forests is given in table 18 and table 19. Taking into consideration the cost escalation and the fluctuations that might occur, in consultation with the Forest Department, a 10% annual escalation in cost is provided. As suggested during the discussion the cost estimate is prepared for a period of ten years. However, cost for Establishment, other Infrastructure development and Research are not included in this estimate. For casual labour a market rate of Rs. 100/- is provided in the budget.

Table 18. Average Cost estimate per ha. for improving degraded forests

Year	High intensity operations	Medium intensity operations	Low intensity operations
1	7,800.00	5,100.00	3,000.00
2	6,700.00	6,600.00	3,250.00
3	14,800.00	9,900.00	3,550.00
4	10,000.00	7,800.00	3,800.00
5	10,500.00	8,300.00	3,900.00
6	7,500.00	8,900.00	4,100.00
7	7,500.00	7,200.00	4,700.00
8	7,500.00	5,000.00	4,400.00
9	8,000.00	4,200.00	4,200.00
10	4,900.00	4,500.00	4,450.00
Total per ha.	85,200.00	67,500.00	39,350.00

Table 19. Overall costs for improving degraded forests in Kerala for ten years

Category	Area in ha.	Per ha. cost	Total
High intensity operations	24,375	85,200.00	207,67,50,000
Medium intensity operations	48,750	67,500.00	329,06,25,000
Low intensity operations	4,14,375	39,350.00	1630,56,56,250
Total	4,87,500	44,457.50	2167,30,31,250
Grand total for 10 years (exclusive of infra structure requirement)			Rs. 2167,30,31,250 (21673.03 million)

Taking into consideration the need for reducing the biotic pressure, to carry out various measures related to this an amount of Rs. 5000/- per ha. over a period of ten years is ear marked as credibility fund which may be considered as the opportunity cost given to the local people. Provision for watcher-cum-extension worker for every 25 ha of degraded area is also provided for the entire 10 year period. The total outlay for this comes to Rs. 21673.03 million for the improvement of degraded forests in the State.

4.8. Monitoring System for improving degraded forests

For years, the future of the world's forest has been a major concern among scientists and foresters, but has of late become a matter of public concern. The important issues of concern related to tropical forest have been reduction in forest area and quality, environmental degradation of forest areas, loss of biodiversity, loss of cultural aspect and knowledge, loss of livelihood and climate change. More and more people realise that there is a need for Sustainable Forest Management (SFM). The task of a system to evaluate sustainability of forest management will therefore be to assess the following two conditions:

1. Ecosystem integrity is maintained or enhanced.
2. Well-being of the people is maintained or enhanced.

The perspective

The forest managers relies on afforestation as a source of enhancing wood production while other interest groups demand on the sustainability of different functions of the forest ecosystem. In the changed scenario, the goals of sustainable forest management including afforestation programmes are most likely to include the following:

* to ensure a non declining trend in wood production
* to ensure that the quality of soil, water and vegetation are maintained or enhanced.
* to promote appropriate environmental, social and economic benefits to the community.

Progress towards these goals are measurable. To achieve these goals all parties in the programme should be accountable

through shared values and regulations. In many cases well defined self regulations may be most appropriate.

Forest managers face two kinds of pressures. The first is to convince the public that the management has addressed all values in the forest. These would include biodiversity conservation, climatic and hydrological regulations, economic viability and community benefits. The second is to ensure with in a regional planning exercise that production forests, protected areas, plantations and private lands contribute towards some agreed goals.

Hence the key expectations from the indicators selected for monitoring the forestry programme are that they:

* are meaningful to the public, i.e. that let us tell the story of what we are doing in an understandable way.
* address all key issues, including ecological, environmental and socio-economic in a balanced way.
* build a common vision and approach across tenures and forest types.

The monitoring plan:

The monitoring plan prepared for the scheme takes into consideration the paradigm shift experienced at present in the management of natural resources, especially forests. The scheme (Table 20) is built in such a way that one can identify the items, indicators, methods, where, when, who, and why this task should be carried out. The major items include identifying site suitability, monitoring the physical implementation of the programme, impact of the programme on 1. ecosystem and 2. communities. The plan is self explanatory and needs fine tuning at the level of forest management units

(field). The individual schedules prepared for units may contain indicators and appropriate for the scale of operation. Thus the monitoring plan provides a broad framework on the basis of which specific plans can be constructed, tested and implemented.

PS: We have learned the hard way that trying to undertake forestry in isolation with stakeholders and communities invariably pays the wrong kind of dividends.

Table 20. Monitoring work plan for compensatory afforestation

Items	Indicator	Methods	Where	When	Who	Why
Site suitability						
Soil	Slope, Soil depth, Erosion proneness/ Landslides, Gulley formation Organic matter layer	Clinometer, Pits, Visual, Visual Visual Visual	Field -- -- --	Before operations	Forest Department Staff	To ensure proper selection of site for afforestation
Water	Moisture storage, Lean flow (Streams)	Gravimentric, staff guage	Field -- --	Before operations	Researcher + Forest Department Staff	
Vegetation	Species richness, (indicator species) Crown density Regeneration Weed growth	Qudrat Survey, Visual, Qudrat survey, Qudrat survey	Field -- -- --		Researcher + Forest Department Staff	
Afforestation						
Species choice	Species suitable to the site	Species site matching Species already growing+ Scientific support + Literature consultancy	Field	Before nursery raising	Forest Department Staff and Scientists	To ensure proper planting operations

ms	Indicator	Methods	Where	When	Who	Why
ursery operations	Seed source, Mother beds, Containers, Medium, Fertiliser, Irrigations	Records Visual Visual Visual Visual Visual	Field -- -- -- -- --	During nursery raising	Forest Department Staff, Scientific support	
	Age of outplanted seedling	Visual		Before planting	Scientific support	To ensure proper planting operations
Planting	Spacing	On the basis of measurement of residual growth	Field	While planting	Forest Department Stff+Scientists	
	Pitting	Soil depth compasion	--	While Planting	Forest Department Staff	
	Planting	Time of out planting	--	While Planting	Forest Department Staff	
Soil and water conservation	Slope, No. of gulleys, Erosion Proneness	Measurements of slope Gulley width length Staggered trenches pits	-- -- --	Before planting	Forest Department Staff, Soil conservation Department	To ensure successful implimentation of the afforestation
Social operation	People's perceptions i. Selection of species ii. Protectin and maintenance iii. Sharing of benefits iv. Duties & responsibilities	Participatory Rural Appraisal (PRA)	Community sites	Before operation During operation	Forest Department Staff, Community NGO, Panchayat	

Items	Indicator	Methods	Where	When	Who	Why
Impact of afforestation						
Ecosystem function is maintained	1. Soil erosion is minimised	Visual	Field	Once in a year	Forest Department Staff	Ecosystem integrity is enhanced
	2. Gulleys are plugged	Visual+records	Field	Twice in a year	Forest Department Staff+Scientists	
	3. Soil water holding capacity is increased	Gravimetry	Field	Twice a year	Forest Department Staff+scientists	
	4. Lean flow is increased	Staff guage	Field	Continuous after monsoon	Forest Department Staff+Community	
	5. Vegetation status improves, Species richness increases, Crown density increases, Regeneration of desirable species. Weed gowth is less	Qudrat survey Qudrat survey Visual Survival and growth of species planted	Field	Twice a year	Forest Department staff and scientists	

Items	Indicator	Methods	Where	When	Who	Why
Impact on communities		Meetings (Periodicity) Attendance Participation of women, NGOs and local bodies. Formation of Protection Committiees, Delegation of power, Empowerement	Communities	Once in three months	Forest Department Staff, NGOs, Panchayat	
Community has a voice in management	1. Participation					
	1. Sharing of incentives and benefits	Employment, Non Timber Forest Produces (NTFP), Other non marketed benefits				Well being of the communities ensured
Stakeholders participate in forest management	2. Duties and responsibilities	Controled grazing Tending of plant growth Prevention of fire Increase in environmental awareness				
Change in structure and function of the committies	1. Immigration	Survey	Communities	During operation	Researcher+ Forest Department Staff	
	2. Increase in income	Survey	Communities	During operation	Researcher+ Forest Department Staff	
	3. Conflicts	PRA	Communities	During operation	Researcher+ Forest Department Staff & NGOs	

5.0. CONCLUSIONS

1. The total degraded natural forest in Kerala comes to 4874.44 Km^2 (62% of natural forest).
2. About 80% (3886.37 Km^2) of the degraded forest lie in proximity to human habitation (within 5 Km radius).
3. Crown density cannot be considered as a sole criteria for identifying degraded forest in Kerala.
4. An identification key, based on parameters such as number of established seedling, pole crop and extent of weed growth is found suitable for classifying forests into degraded and non-degraded.
5. Peoples' participation in planning, management and use of the system has to be developed for efficient of Compensatory Afforestation. This alone can provide sustainability to the programme. The crucial element of participation of local communities was absent in the present programme.
6. For rehabilitation of degraded forest, more emphasis need to be given for methods like enhancement of regeneration, fire protection and grazing regulation. Also efforts are necessary to reduce biotic pressures. This can be done only by developing a stakeholder relationship.
7. Total cost estimate for improvement of degraded forests for a period of ten years comes to Rs. 21673 million.

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7.0. ACKNOWLEDGEMENTS

This consultancy was awarded by the Kerala Forest Department as a part of preparatory study for the forth coming Kerala Forestry Project funded by World Bank. The authors acknowledge Kerala Forest Department and World Bank for providing this opportunity.

A number of people helped in this venture. The guidance, help, suggestions and inspiration provided by them are deeply acknowledged without assigning any responsibility for the failures and shortcomings.

1. Shri. T.K. Raghavan Nair, Principal Chief Conservator of Forest.
2. Shri. P.N. Surendran, Retired Principal Chief Conservator of Forest.
3. Shri. Sasidharan Nair, Chief Conservator of Forests.
4. Shri. K. Balachandran Thampi, Chief Conservator of Forests.
5. Shri. T.M. Manoharan, Chief Conservator of Forests.
6. Mr. Chris Keel and Mr. Norman Jones of World Bank.
7. Shri. C.K. Karunakaran, Retired Chief Conservator of Forests.
8. Dr. S. Chand Basha, Retired Principal Chief Conservator of Forest and former Director, KFRI.
9. Shri. Vinodkumar Uniyal, Conservator of Forests.
10. Shri. K.P. Ouseph, Conservator of Forests.
11. Dr. S. Sathish Chandran Nair, Director INTACH, Regional Centre., Trivandrum.
12. Shri. Subramanyam and Shri. Balakrishna Pillai, Assistant Conservators of Forests, World Bank Projects.
13. All the Officials of Forest Department who have shared their knowledge and provided valuable help.
14. The Project Staff (of about 30 persons) of various categories who have worked sincerely to achieve the various objectives of the study.
15. All members of KFRI, who have contributed in various ways.

Appendix I

CONSULTANCY FOR SURVEY AND ESTABLISHMENT OF MONITORING SYSTEM FOR DEGRADED FORESTS IN KERALA - TOR

Objectives:

To assess the extent and nature of degraded forests, design and undertake base line surveys to arrive at a global estimate of degraded forests in Kerala and design a monitoring system for the Compensatory Afforestation Scheme currently implemented by KFD.

Responsibilities:

1. Design and undertake a baseline survey of degraded forests.
2. Classify degraded forests in terms of stand parameters relevant to the growth dynamics in Kerala conditions instead of crown density alone.
3. Prepare detailed maps based on classification and location of degraded forests.
4. Analyse the determinants of degradation of forests by applying sampling methods.
5. Assess causes for degradation of forests and suggest strategies to improve the forests.
6. Evaluate the Scheme for Compensatory Afforestation and design appropriate monitoring system applying sample methods to assess the impact of the scheme including, physical and cost aspects.

Methodology:

Detailed survey with inventory of forest areas, interaction with local people, discussions with KFD and other stake holders. Compilation and systematisation of available cost data.

Output:

Prepare a report and detailed map presenting the status of degraded forests, develop a monitoring system for assessing the impact of Compensatory Afforestation Scheme.

Duration:

6 months starting from January 1996 to 2nd half of 1996.

Consultancy:

Local consultant/Research Institute

Appendix II

/--------------------\
|Project: KFRI 251/96|
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Survey and Establishment of a Monitoring System for Degraded Forests in Kerala

Guide lines and proformae for gathering base line data from sample locations for field survey

I Inventory method:

1. Identify degraded forest areas in each forest divisions - from map and through local enquiry. Indicate in the map the presence of degraded forests, if any, not included in low crown density areas (that is 0.4 or 0.4-0.7).

2. Classify the forests into classes based on degree of degradation not degraded, slightly degraded, moderately degraded and highly degraded.

3. Divide them further into (a) altitude zones, (below 500, 500-1000, above 1000m) (b) major forest types, (Evergreen / Semi evergreen / Moist deciduous / Dry deciduous / Subtropical hill forest / Montane temperate forest / Grassland / Plantations). Further stratify the forests into valleys, middle of slope and top of hills and also based on proximity to human habitations (Close / Moderately close / Interior)

4. Number of sample location to be covered. Take samples in such a way so that on an average for every 1000 ha. of forest belonging to one class there will be at least 1 sample. Also, in each class there will be at least 3 samples in the whole of Kerala. One patch of forests indicated in the map is the sampling unit.

5. To save time data can be collected based on visual observation. However maximum care need to be taken to avoid subjectivity and personal bias. One sample location represent the whole forest patch in that area. (The estimated time required to gather data from one sample location is approximately 10 minutes).

6. Mark the sample locations in the map.

7. Collect data on sample locations using proforma I.

II Procedure for Computation of average stocking per ha. of the forest patch samples:

1. Choose an area representing the forest selected for sampling.

2. Take a circular plot of 10 M radius and collect data through actual counting. Ten, one metre steps can be used as radius for laying the circular plots.

3. For conversion into ha. the data obtained can be multiplied by a factor 100/3 (approximate).

4. Sufficient number of plots in a sample patch can be made to get average information for a patches.

5. Examine whether the estimation made through visual observation tally with counting.

III Procedure for field check:

Tick mark each vegetation types personally checked in the field. After completing the field check in a division based on local enquiry and personal observation, tabulate range wise details of extend (area) of degraded forests in the given proforma (Proforma II). Also provide details regarding persons/agencies consulted and the problem encountered.

IV Considerations while selecting sample locations:

It will be useful if we select sample locations having unique characteristics.

V Clues for collecting information on Division and Range boundaries:

In most of the cases, the boundaries are roads, rivers, ridges or other natural features. In cases where boundaries are artificial it may be specified in the Proforma II and the map.

Project: KFRI 251/96

Survey and establishment of a Monitoring System for Degraded Forests in Kerala

(PROFORMA FOR GATHERING BASE LINE DATA FROM SAMPLE LOCATIONS)
(Proforma 1)

1. Name of Division :

2. Name of Range:

3. Name of Forest Station/Section (if known):

4. Name of Location (Name of reserve):

   Lat./Long. (approx) :

   (Also indicate in map)

5. Toposheet Number in which the sample location is located:

6. Serial Number of the location:
   (as indicated for each toposheet)

7. Area of the sampled patch:

   Below 5 ha / 5-10 ha / 10-15 ha / 15-25 ha / 25-50 ha / 50-100 ha / Above 100 ha

8. Degradation status:

   Heavy / Moderate / Not degraded

9. Proximity to habitations:

   Close / Moderately close / Interior

10. Vegetation/Forest type:

    Evergreen / Semi evergreen / Moist deciduous / Dry deciduous / Scrub / Subtropical hill forest / Montane temperate forests / Grassland / Plantations (specify species / Others (specify)

11. Altitude:

    Below 500 M / 500-1000 M / Above 1000 M

12. Configuration:

    Valley / Middle of slope / Top of hill

13. Slope:

    Level / Moderate / Steep / Very steep / Precipitous

14. Aspect:

    South / South west / West / West north / North / North east / East / East south

15. Closeness to roads:

    Below 100M / 100-500M / 500-1000M / 1000M-5KM / Above 5KM

16. Closeness to water course:

    Below 100M / 100-200M / 200-500M / 500M-1KM / 1KM-5KM / Above 5KM

17. Number of dry months:

    Below 2 months / 2-4 months / 4-6 months / 6-9 months / Above 9 months

18. Rainfall:

    Low (Below 200cm) / Medium (200-400cm) / High (Above 400cm)

19. Maximum height of Top canopy trees:

    Below 10 M / 10-20 M / 20-30 M / Above 30 M

20. Number of strata present:

    One / Two / Three / Four

21. Canopy density (Based on ground observation):

    0-40% / 40-70% / 70-100%

22. Number of trees per ha. having height:

    (a) Greater than 2M (inclusive of those greater than 10 M):

        Below 500 / 501-1000 / 1001-1500 / 1501-2000 / Above 2000

(b) Greater than 10M (inclusive of those greater than 20M and 30M):

Below 200 / 201-400 / 401-600 / 601-800 / 801-1000 / Above 1000

(c) Greater than 20M (inclusive of those greater than 30M):

Below 50 / 51-100 / 101-200 / Above 200

(d) Greater than 30 M:

Below 25 / 26-50 / 51-100 / Above 100

23. Major tree species present in descending order of abundance (Local name or Botanical name)

(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)
(10)

24. Major plant indicators present and unique to the forest locations (Trees, Shrubs, Herbs, Climbers and Other types)

Please indicate the Presence by 'P' and Rank those present based on order of importance (R)

	P	R
(1) Eupatorium (Communist pacha) (Shrub)		
(2) Lantana (Kongini) (Shrub)		
(3) Trema orientalis (Amathali) (Small tree)		
(4) Tall grass (Lemon grass/Citronella)		
(5) Emblica officinalis (Nelli) (Tree)		
(6) Dillenia pentagyna (Kodapunna) (Tree)		

(7) Careya arborea (Pezhu) (Tree)

(8) Macaranga sp. (Vatta) (Tree)

(9) Ochlandra travancorica (Eeta, Reed)

(10) Wrightia tinctoria (Thondappala, Kambippala) (Small tree)

(11) Anogeissus latifolia (Mazhukanjiram) (Tree)

(12) Bambusa arundinaceae (Mula)

(13) Mikania micrantha (Mikania) (Climber)

(14) Helecteris isora (Idampiri) (Shrub)

(15) Parthenium hysterophorus (Parthinium) (Shrub)

(16) Cassia fistula (Konna) (Tree)

(17) Sterculia sp. (Tree)

(18) Any other plant indicators present: (This can include bamboo and reed species not included in the lists, canes or other species of local importance).

25. Health status of trees: (Poor / Moderately good / Good) (Incidence of hollowness/decay, Bark, Exposed root etc.)

26. Animal species unique to the forest patch sampled (This can include large mammals, small mammals, arboreals, birds, reptiles, amphibians, fishes, insects): Local / Zoological names

(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)
(10)

27. Soil status:

(1) Soil fertility:

(a) Presence of Organic matter (humus):

Low / Medium / High

(b) Soil fertility status:

Low / Medium / High

(2) Soil depth:

Shallow / Medium / Deep

(3) Soil erosion status:

High / Moderate / Not significant

(4) Exposed rock % per ha:

Below 25% / 25-50% / 50-75% / 75-100%

28. Regeneration status: (This should be assessed in terms of number and diversity of plants above height)

Poor / Moderate / Good / Very good

II For each causes of degradation based on their degree of intensity indicate their rating as Not significant (N), Low (L), Medium (M) and High (H). Also in column R mark the number corresponding to the ranks (say 1,2,3,.....) provided based on the relative order of occurrence of different causes.

	I	R
(1) Poor regeneration		
(2) Lack of normality of forest (irregular age gradation)		
(3) Fire		
(4) Cattle grazing		
(5) Soil erosion		
(6) Fuel wood collection		
(7) Due to damages while MFP collection		
(8) Unregulated harvesting (unrestricted collection of reed/bamboo etc.)		
(9) Lopping for green manure/fodder		
(10) Illicit removal of trees		
(11) Quarrying in and around		
(12) Damage due to harmful effects of management operations such as Selection felling, Selective felling, Alignment of roads, Construction of dams etc. (specify)		
(13) Any others: (Specify)		

III Past efforts for management of these forest:

In column I, for each management strategy adopted, indicate N/L/M/H depending as degree of stress given as not significant low, medium, high respectively. Similarly, in column R, indicate the ranks provided to each strategy based on order of priorities. (say 1, 2, 3,.....).

	I	R
1. Promotion of regeneration through artificial means		
2. Protection from illegal harvesting		
3. Fire protection		
4. Generation of alternate resources in buffer zones (interface forestry/agro-forestry activities)		
5. Regulated grazing		
6. Soil/water conservation		
7. Regulated harvesting of non-wood products		
8. Diversion of man power involved in illegal activities through alternate employment generation		
9. Protection from pests and diseases		
10. Improved utilisation of available resources (MFP collection / medicinal plants / collection of reeds and bamboos)		
11. Creation of awareness among local public to get their support and involvements in in improving degraded forests		
12. Wildlife conservation measures		
13. Any others specify		

IV Approximate Cost/ha incurred for these strategies during the last 5 years (arrived based on personal assessment of investigators).

Below Rs.100 / 100-200 / 200-500 / 500-1000 / 1000-1500 / 1500-2000 / 2000-4000 / 4000-6000 / 6000-10000 / Above 10000

Strategies:	Cost/ha (1994-1995)	Cost/ha (1993-1994)	Cost/ha (1992-1993)	Cost/ha (1991-1992)	Cost/ha (1990-1991)
1. Promotion of regeneration through artificial means:					
2. Protection from illegal harvesting:					
3. Fire protection:					
4. Generation of alternate resources in buffer zones (interface forestry/agro-forestry activities)					
5. Regulated grazing:					
6. Soil/water conservation:					
7. Regulated harvesting of non-wood products:					
8. Diversion of man power involved in illegal activities through alternate employment generation:					
9. Improved utilisation of available resources (MFP collection / medicinal plants / collection of reeds and bamboos):					
10. Creation of awareness among local public to get their support and involvements in in improving degraded forests:					
11. Wildlife conservation measures:					
12. Protection from pests and diseases					
13. Any others (specify):					

V Changes (in the forest area sampled) during the last 5 years qualitative assessment based on personal judgment (indicate in %. positive changes can be denoted by ` + ' before the percentage and negative changes with ` - ':

1 Vegetation:

(a) Stocking (Trees above 1 M:)

(b) Stocking (Trees below 1 M):

(c) Number of tree species:

(d) Canopy density

(e) Economic utilisation potential of forest

2 Abundance of wildlife population:
Animal species unique to the forest patch sampled (This can include large mammals, small mammals, arboreals, birds, reptiles, amphibians, fishes, insects): Local / Zoological names

(a) Major species:

(i)

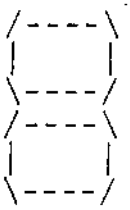
(ii)

(iii)

(iv)

(v)

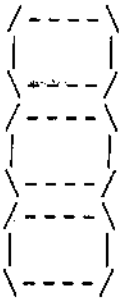
(b) Overall density



(c) Overall species diversity

3. Soil status

(i) Soil fertility

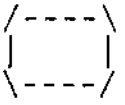


(ii) Soil erosion

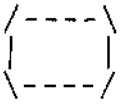
(iii) Exposed rock

4 Incidence of fire damaging the forests

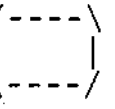
5 Incidence of excessive fuelwood collection



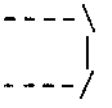
6 Incidence of uncontrolled cattle grazing



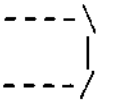
7 Incidence of unregulated MFP collection



8 Incidence of excessive lopping for green manure and fodder

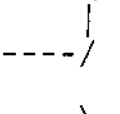


9 Incidence of unregulated harvesting of bamboo, reeds, rattans (specify)

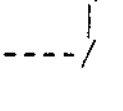


10 Incidence of illegal removal of trees

11 Incidence of pests and diseases



12 Incidence of quarrying harmful to the forest



13 Incidence of harmful management operations (selection felling, clear felling, selective felling, conversion of natural forests to plantations and vice versa, alignment of roads, construction of dams etc.)

14 Change in forests in any other aspects (specify)

i

ii

15 Overall health status of the forest

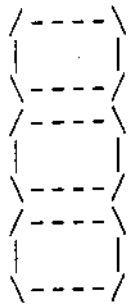
VI Future strategies for improvement:

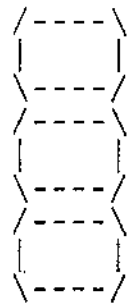
(Gradation based on degree of importance (I) and relative order of preference (R))

In column below I mark N, L, M and H for each strategies, based on their degree of importance as, not required, low medium and high. Similarly, in column below R mark the number corresponding to the ranks provided based on the relative order of priorities (say 1, 2, 3, ...).

	Not significant (N) / Low (L) / Medium (M) / High (H)	Relative order of preference
	I	R
1. Promotion of regeneration through artificial means:		
2. Protection from illegal harvesting:		
3. Fire protection:		
4. Generation of alternate resources in buffer zones (interface forestry/agro-forestry activities)		
5. Regulated grazing:		
6. Soil/water conservation:		
7. Regulated harvesting of non-wood products:		
8. Diversion of man power involved in illegal activities through alternate employment generation:		
9. Improved utilisation of available resources (MFP collection / medicinal plants / collection of reeds and bamboos):		
10. Creation of awareness among local public to get their support and involvements in in improving degraded forests:		

11. Wildlife conservation measures:





12. Protection from pests and diseases

13. Any others specify:

VII Cost/ha anticipated during the next five years for different strategies (component wise) for improvement of these forest:
Below Rs.100 / 100-200 / 200-500 / 500-1000 / 1000-1500 / 1500-2000 / 2000-4000 / 4000-6000 / 6000-10000 / Above 10000

Strategies:	Cost/ha (I year)	Cost/ha (II year)	Cost/ha (III year)	Cost/ha (IV year)	Cost/ha (V year)
1. Promotion of regeneration through artificial means (includes all planting and maintanance cost)					
2. Protection from illegal harvesting:					
3. Fire protection:					
4. Generation of alternate resources in buffer zones (interface forestry/agro-forestry activities)					
5. Regulated grazing:					
6. Soil/water conservation:					
7. Regulated harvesting of non-wood products:					
8. Diversion of man power involved in illegal activities through alternate employment generation:					
9. Improved utilisation of available resources (MFP collection / medicinal plants / collection of reeds and bamboos):					
10. Creation of awareness among local public to get their support and involvements in in improving degraded forests:					
11. Wildlife conservation measures:					

. Protection from pests and diseases

. Any others (specify):

Signature, Name & Address of the person giving the information

Project: KFRI 251/96

Survey and establishment of a Monitoring System for Degraded Forests in Kerala
Proforma for field data collection (Area under different types of forests)
(Proforma II)

1. Details of degraded forest in a division (to be guestimated based on knowledge acquired during the field trip to each forest division for field check. (For this, discussion with local forest officers, voluntary agencies and other local people will be useful).

Name of Range	Forest type	Area of degraded forests in ha.			
		Not degraded	Degraded Low	Degraded Medium	Degraded High
(1)	a Evergreen				
	b Semi evergreen				
	c Moist deciduous				
	d Grassland				
	e Plantations				
	Others				
	f				
	g				
	Total				
(2)	a Evergreen				
	b Semi evergreen				
	c Moist deciduous				
	d Grassland				
	e Plantations				
	Others				
	f				
	g				
	Total				

3)	a Evergreen	
	b Semi evergreen	
	c Moist deciduous	
	d Grassland	
	e Plantations	
	Others	
	f	
	g	
	Total	
4)	a Evergreen	
	b Semi evergreen	
	c Moist deciduous	
	d Grassland	
	e Plantations	
	Others	
	f	
	g	
	Total	
	Grand Total	

. Details of persons/agencies discussed during the survey

(a) Forest department officials

(Name and Designation)

1.
2.
3.
4.

(b) Local people/tribals

1.
2.
3.

(c) Voluntary agencies/others

1.
2.
3.

3. Problems encountered during field survey

4. Details regarding Division and Range boundary
(This should also be indicated in the map)

Name & Signature
of Investigator

Appendix III

Survey and establishment of a Monitoring System for Degraded Forests of Kerala

Workshop of Forest Department Officials

Total time: 3 hours 30 minutes
(09:00 AM TO 01:00 PM with
30 minutes tea break)

Programme of activities:		Time
1. Filling up of Form I	: To get input from participants with regard to locations (forest circle/division/range names) which they are familiar.	10 minutes
2. Map checking (Guidelines for map checking) (Form II)	: Checking the maps and classifying the forest patches into highly degraded, moderately degraded and not degraded.	40 minutes
4. Filling up of Form III	: To provide information on `determinants of degradation'.	20 minutes
5. Filling up of Form IV	: To provide information on `causes of degradation'.	30 minutes
6. Filling up of Form V	: To provide information on `strategies for improvement'.	60 minutes
7. Filling up of Form VI	: To provide information on `forest type wise area guestimates under different categories of degradation'.	10 minutes
8. Filling up of Form VII	: To provide information on `compensatory afforestation'.	20 minutes
9. Filling up of Form VIII	: To provide your suggestions for improving the map/form.	10 minutes

FORM I

Project: KFRI 251/96
Group No:

Survey and establishment of a Monitoring System for Degraded Forests of Kerala

Workshop of Forest Department Officials

This workshop is organised to get your input for the establishment of a monitoring system for degraded forests of Kerala. As a preliminary to this, we have mapped the forest cover of Kerala, using remote sensing, in 1:50,000 scale and classified them into major forest types, and three crown density classes high, medium and low. We have also marked the forest division and range boundaries using information available from forest department records. We would like to utilise your knowledge and experience about the different forest areas of Kerala in identifying degraded forests of Kerala. Your field expertise will also be required in identifying the parameters to be selected for deciding the indicators and causes of degradation and strategies for improvement of the degraded forest. For this you will have to choose one sample location each, which you are quite familiar in three degrees of degradation viz., highly degraded, moderately degraded and not degraded belonging to two major forest types of your area. We would also like to have your views on the compensatory afforestation programme being implemented to improve the degraded forests. Please fill up this form so that we can provide you the maps of area of your choice.

Name:

Designation:

Address:

Name of a forest circle/division/range which you are most familiar based on your experience during the last five years. Those who have implemented compensatory afforestation programme may kindly select the same area.

Forest circle/Division/Range

FORM II

| Project: KFRI 251/96 |

Survey and establishment of a Monitoring System for Degraded Forests of Kerala

Guideline for Map checking and Providing information from Sample locations on forest degradation

Map checking can be carried out by the group under the leadership of Range Officer. He will be assisted by supporting staff and local people who have knowledge of the area. The Divisional Forest Officer can supervise this task for the ranges under his division and the Conservator can coordinate this for the whole circle.

For a group of participants who can provide information pertaining to a forest range, a set of maps pertaining to that range will be provided. The maps are prepared toposheet wise (1:50,000 scale) by mapping forest areas using remotely sensed data for the period 1995-1996. The forest areas are classified based on major forest types and three crown density classes Low density (0.0-0.4), Medium density (0.4-0.7) and High density (0.7-1.0). The major features such as roads, rivers, place names are taken from Survey of India toposheets and Forest Division and Range boundaries from Kerala Forest Department records. There are likely to be errors in these maps and we require your input in checking the maps based on your field expertise.

Examine the map and make necessary correction if any, with regard to forest type, crown density, location name, division/range boundary etc.

Based on your field knowledge, look for forest patches which are highly degraded and indicate them as "HD" and those patches which are less degraded (moderately degraded) as "LD". The remaining forest patches will be treated as "not degraded". While classifying the patches, in case you feel that there are portions which belongs to different categories of degradation, please indicate boundary features if any, to facilitate the division of the area.

5. **The Conservator, Divisional Forest Officers, Range Forest Officers, Retired Forest Officials (invited)** who are participating in the workshop can identify six sample locations each in the **circle/division/range** of which they are familiar and provide information in form III (on indicators of degradation), and in form IV (on causes of degradation). They may also provide in separate forms on strategies for improving degraded forests (form V), area guestimates for different types of degraded forests in their respective circle/division/range (Form VI). Those who have implemented compensatory afforestation may provide their views on this in Form VII. In Form VIII, all the participants are requested to provide their comments/suggestions with regard to the forms/maps used in the workshop.

While filling the forms though it is desirable to provide information on all items indicated in the form, you may skip those items for which you are not in a position to give the information. You may also make guesses and assumptions based on your field knowledge.

6. **Procedure for identifying sample locations:** In a map, look for areas belonging to two major forest types in your circle/division/range. From each forest type, again look for areas, highly degraded, moderately degraded and not degraded. Select one sample location each, which is familiar to you, for these degradation classes in both the forest types. These sample locations need to be shown in the map by a circle and each location has to be numbered as highly degraded-forest type I (Location No. 1), forest type II (Location No. 2); moderately degraded-forest type I (Location No. 3), forest type II (Location No. 4); not degraded-forest type I (Location No. 5), forest type II (Location No. 6). These sample locations are required for providing site specific information pertaining to, indicators of degradation in Form III, and causes of degradation in Form IV.

FORM III

Project: KFRI 251/96
Group No:

Survey and establishment of a Monitoring System for Degraded Forests of Kerala

(FORM FOR GATHERING BASE LINE DATA FROM SAMPLE LOCATIONS TO IDENTIFY INDICATORS OF DEGRADATION IN DIFFERENT TYPES OF FORESTS)

Workshop of Forest Department Officials

In this form, you are requested to provide information for the six sample locations (in two major forest types and three degradation levels) which are familiar to you in your Forest Circle/Division/Range.

1. Basic information about the sample locations (for items four to eight you may use the code numbers corresponding to the values while filling the form). In the column, major forest type you may write the forest type of the area you have selected.

Forest type 1:

Forest type 2:

Items	Name & type of sample Location					
	Highly degraded		Moderately degraded		Not degraded	
	Forest type 1	Forest type 2	Forest type 1	Forest type 2	Forest type 1	Forest type 2
	Location 1	Location 2	Location 3	Location 4	Location 5	Location 6
1. Toposheet number of the map corresponding to the sample locations (this can be noted from right hand top corner of the map given to you)						
2. Name of Forest circle/division/range						
3. Name of the location/forest reserve from which sample location is selected						
4. Size (area) of the sample location selected 10-25ha / 25-50ha / 50-100ha / 100-200ha (1) (2) (3) (4)						
5. Proximity of the sample location to human habitations/accessibility Close / Moderately close / Interior (Below 500 M) (500-5 KM) (Above 5 KM) (1) (2) (3)						
6. Canopy density (based on ground observation) Low / Medium / High (0-40%) (40-70%) (70-100%) (1) (2) (3)						
7. Maximum height of top canopy trees Below 10M / 10-20M / 20-30M / Above 30M (1) (2) (3) (4)						
8. Number of vertical strata present One / Two / Three / Four (1) (2) (3) (4)						

2. Coverage of vegetation in the sample locations (100% coverage means fully packed)

Low	/ Medium	/ High
0-40%	40-70%	70-100%
(1)	(2)	(3)

You may use the code given while filling the form. In case you have information in terms of percentage coverage or number per ha. you may give that information also. In column pertaining to location you may also give the location names you have selected in the serial order as indicated in item 3 of basic information about sample location (i.e. of page 2).

Items	Name & type of sample Location					
	Highly degraded		Moderately degraded		Not degraded	
	Location 1	Location 2	Location 3	Location 4	Location 5	Location 6
Location Name ----->						
1. Coverage of ground level vegetation (below 1M height) Low / Medium / High 0-40% 40-70% 70-100%						
2. Coverage of saplings (1M-2M height) Low / Medium / High 0-40% 40-70% 70-100%						
3. Coverage of pole crop (2M-5M height) Low / Medium / High 0-40% 40-70% 70-100%						
4. Coverage of small trees (5M-10M height) Low / Medium / High 0-40% 40-70% 70-100%						
5. Coverage of medium sized trees (10M-20M height) Low / Medium / High 0-40% 40-70% 70-100%						
6. Coverage of tall trees (Above 20M height) Low / Medium / High 0-40% 40-70% 70-100%						

3. Presence of plant indicator species of degradation. Depending up on the percentage cover present, indicate values N (Below 10%), L (10-20%), M (20-40%) and H (Above 40%).

In column pertaining to location you may also give the location names as given in page 3, you have selected in the serial order as indicated in item 3 of basic information about sample location (i.e. of page 2).

Species	Name & type of sample Location					
	Highly degraded		Moderately degraded		Not degraded	
	Location 1	Location 2	Location 3	Location 4	Location 5	Location 6
Location name ---->						
Eupatorium (Communist pacha) (Shrub)						
Lantana (Kongini) (Shrub)						
Tall grass (Lemon grass/*Citronella/pennisetum/panicum*)						
Careya arborea (Pezhu) (Tree)						
Macaranga sp. (Vatta) (Tree)						
Mikania micrantha (Mikania) (Climber)						

FORM IV

Project: KFRI 251/96
Group No:

Survey and establishment of a Monitoring System for Degraded Forests of Kerala

(FORM FOR GATHERING BASE LINE DATA TO IDENTIFY THE CAUSES OF DEGRADATION AND CONSTRAINTS IN IMPROVING THE DEGRADED FORESTS)

Workshop of Forest Department Officials

This form has got three parts. In Part I, you may provide information with regard to causes of degradation and constraints for improvement pertaining to sample locations of degraded forests identified earlier. In Part II, you may provide general informations on causes of degradation and constraints for improvement pertaining to forest circle/division/range. In part III, you are requested to provide your views on several aspects regarding, causes of degradation and constraints in improving degraded forests. In this form, we will deal only degraded forests and so let us concentrate locations 1, 2, 3, 4 which you have chosen.

Part I

(Data for sample locations pertaining to degraded forests in Forest Circle/Division/Range

In the sample locations you have identified, you are required to rate the causes of degradation and constraints for improvement degraded forests based on their degree of intensity as, Not significant (for <10% damage) (N), Low (10-20% damage) (L), Medium (20-40% damage) (M) and High (Above 40% damage) (H).

Causes	Name & type of sample Location			
	Highly degraded		Moderately degraded	
	Location 1	Location 2	Location 3	Location 4
Location name---->				
Fire				
Soil erosion				
Cattle grazing				
Fuelwood collection				
Illicit removal of trees				
Unregulated harvesting (unrestricted collection of reed/bamboo etc.)				
Damage due to harmful effects of management operations such as Selection felling, Selective felling, Alignment of roads, Construction of dams etc. (specify)				
Due to damages while NWFP collection				
Lopping for green manure/fodder				
Poor regeneration				
Any others				

2. Constraints in improving degraded forests (This information is collected with the intention of identifying the major institutional and other constraints in improving the forests. The identity of persons providing the information will not be revealed).

Indicate N, L, M and H for, Not significant (for <10% damage), Low (10-20% damage), Medium (20-40% damage) and High (Above 40% damage) respectively.

Constraints	Name & type of sample Location			
	Highly degraded		Moderately degraded	
	Location 1	Location 2	Location 3	Location 4
Location name---->				
(1) Lack of infrastructure (shortage of trained personnels / man power)				
(2) Lack of funds				
(3) Timely availability of funds				
(4) Administrative barriers in efficient utilisation of funds				
(5) Lack of cooperation from local public				
(6) Lack of functional freedom				
(7) Lack of support from higher officials				
(8) Lack of support from lower staff				
(9) Lack of adequate, timely information				
(10) Lack of technical know how				
(11) Negligence by the staff on duty				
(12) Lack of adequate motivation/incentive to the staff on duty				
(13) Suspicion between Forest staff and local public due to lack of proper communication				
Any others				
(14)				
(15)				

Part II

(General information pertaining to the forest circle/division/range)

Among the potential causes listed, please indicate the major causes of degradation in your forest circle/division/range. Based on their order of intensity indicate in column I, indicate N, L, M and H for, Not significant (for <10% damage), Low (10-20% damage), Medium (20-40% damage) and High (Above 40% damage) respectively.

Name of Forest Circle/Division/Range:.....

Causes	I
Fire	
Soil erosion	
Cattle grazing	
Fuel wood collection	
Illicit removal of trees	
Unregulated harvesting (unrestricted collection of reed/bamboo etc.)	
Damage due to harmful effects of management operations such as Selection felling, Selective felling, Alignment of roads, Construction of dams etc. (specify)	
Due to damages while MFP collection	
Lopping for green manure/fodder	
Poor regeneration	
Any others:	

Among the following potential constraints listed, please indicate the major constraints in improving the degraded forests in your **forest circle/division/range**. Based on their order of intensity indicate N, L, M and H for, Not significant (for <10% damage), Low (10-20% damage), Medium (20-40% damage) and High (Above 40% damage) respectively.

Constraints	I
(1) Lack of infrastructure (shortage of trained personnels / man power)	
(2) Lack of funds	
(3) Timely availability of funds	
(4) Administrative barriers in efficient utilisation of funds	
(5) Lack of cooperation from local public	
(6) Lack of functional freedom	
(7) Lack of support from higher officials	
(8) Lack of support from lower staff	
(9) Lack of adequate, timely information	
(10) Lack of technical know how	
(11) Negligence by the staff on duty	
(12) Lack of adequate motivation/incentive to the staff on duty	
(13) Suspicion between Forest staff and local public due to lack of proper communication	
Any others:	

Part III

Give briefly your views on the following (you are requested to give your views freely as it is necessary to suggest appropriate strategies for improving degraded forests. Here identity of the person will not be disclosed).

1. What are the major constraint which you feel important in controlling the degradation of forests?

2. Are you satisfied with the work which you are doing for improving the degraded forests? If no, give your suggestions for improvement.

3. Do you have any incentive for doing a good job? If ye what are they? If no, what are the incentives which y would like to have?

4. Do you feel that the current transfer policy of the Kerala Forest Department is adversely effecting your efforts in improving the degraded forests? If yes, how? and give suggestions for improvement.

5. Do you feel that your current technical expertise is sufficient in improving the degraded forests? If not sufficient, what type of training you would visualise for equipping yourself in tackling forest degradation? What type of training you visualise for your subordinate staff which will help them to help you better?

6. Can you suggest any change in the approach of your superior officers towards you which will help in your work for improving degraded forests?

7. What type of functional freedom you envisage, which will help you to function more effectively in your effort in improving degraded forests?

8. Do you think it necessary to interact more with the local people in improving degraded forests? If you feel that the current communication is sufficient, please state what are the methods by which you communicate at present with local people? If you feel that more interaction is necessary what are the ways in which you would like to communicate with the local people?

9. Are you aware of the concept of Joint Forest Management/Participatory Forest Management? If yes, please indicate your view in one or two sentences. Do you think JFM will help in improving the degraded forests or it can lead to more destruction? Why?

10. What is your opinion about "private investments" in improving degraded forests?/enhancing productivity of degraded forests? If yes, please indicate in one or two sentences. Do you think they will help in improving the degraded forests or will they lead to more destructions? Why?

FORM V

Project: KFRI 251/96
Group No:

Survey and establishment of a Monitoring System for Degraded Forests of Kerala

(FORM FOR GATHERING INFORMATION REQUIRED FOR DECIDING THE STRATEGIES FOR IMPROVING THE DEGRADED FORESTS)

Workshop of Forest Department Officials

A list of potential strategies have been identified for improving degraded forests. In this form you are requested to provide your views on the effectiveness of these strategies based on your experience under various schemes implemented by the Kerala Forest Department in the past aimed at improving degraded forests.

1. Please read this list and make additions, if any:

Strategies
Promotion of regeneration through artificial means:
Protection from illegal harvesting:
Fire protection:
Generation of alternate resources in buffer zones (interface forestry/agroforestry) to reduce pressure on natural forests
Regulated grazing:
Soil/water conservation:
Regulated harvesting of non-wood products:
Diversion of man power involved in illegal activities through alternate employment generation:
Improved utilisation of non wood forest produces:
Creation of awareness among local public to get their support and involvement in improving degraded forests:
Wildlife conservation measures:
Any others (specify):

2. The Kerala Forest Department has implemented various schemes in the past to improve the degraded forests. Which are the schemes implemented in you circle/division/range during the last 5 years? In the first box, You may tick mark the schemes implemented in your circle / division / range. In the second box, you may indicate your opinion about the success of these programmes in improving the degraded forests by tick marking appropriate item.

	1	2
1. Reforestation of degraded forests (Social Forestry)		Poor/Average/Good
2. Regeneration of denuded forests (Social Forestry)		Poor/Average/Good
3. Tribal sub plan (Social Forestry)		Poor/Average/Good
4. Eco Development Programme (Social Forestry)		Poor/Average/Goo
5. Special Component Plan (Social Forestry)		Poor/Average/Goo
6. Heterogenous mixed seedings		Poor/Average/Goo
7. World Food Programme		Poor/Average/Goo
8. Rural Landless Employment Generation Programme		Poor/Average/Goo
9. Western Ghat Development Programme		Poor/Average/Goo
10. Operation Water Spread		Poor/Average/Goo
11. Project Rosewood		Poor/Average/Goo
12. Nilgiri Biosphere Reserve Programme		Poor/Average/Goo
13. Compensatory afforestation		Poor/Average/Goo

14. Kallar Watershed Development

15. Attappady-Bommiampady eco-development schemes

16. Silvan Valley Furn Sanctuary

17. Project Tiger

18. Project Elephant

19. Conservation of Lion tailed Monkey

20. Various Wildlife Sanctuary/ National Park/ Other protected area management Programmes

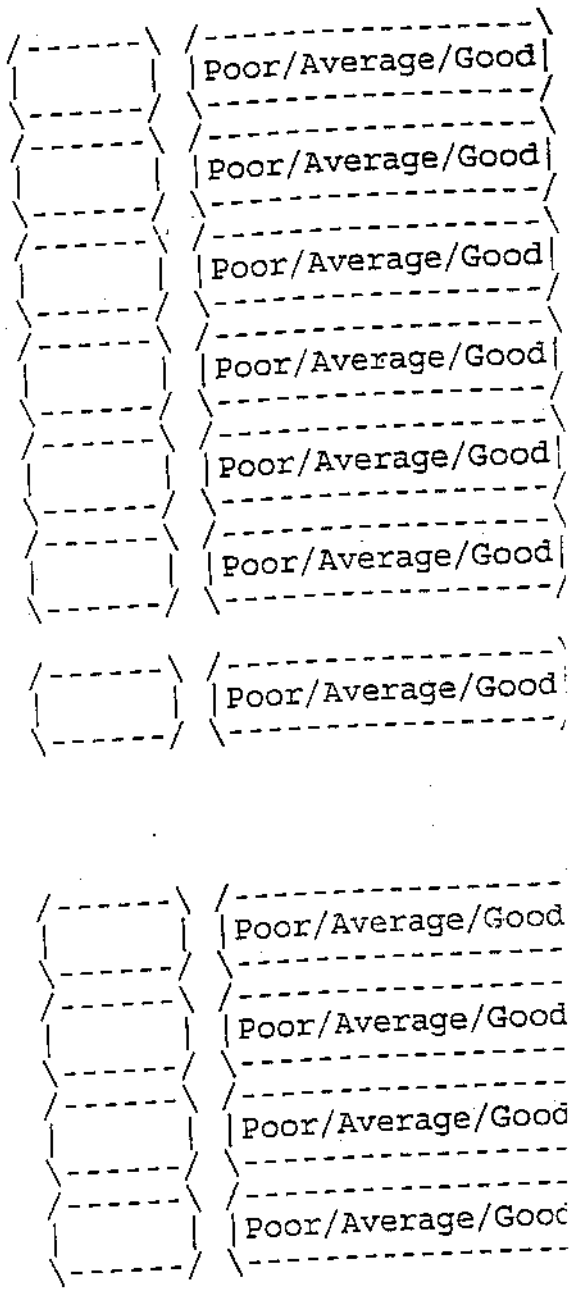
Any others (specify):

21.

22.

23.

24.



3. For one location of your choice, please indicate whether the strategies identified have been tried in the last 5 years, with your assessment of approximate expenditure/ha. that might have incurred for each strategy. This is to assess how much importance has been given for each strategy individually / collectively during the past.

In column S, for each management strategy identified, indicate N, L, M, H depending on degree of stress given in the past, as not significant low, medium, high respectively. And in column I, indicate your assessment of approximate total cost (give code numbers) that might have been incurred per ha for different strategies identified.

Cost categories:

Below Rs.500 (1) / 500-1000 (2) / 1000-1500 (3) / 1500-2000 (4) / 2000-4000 (5) / 4000-6000 (6) / 6000-10000 (7) / 10000-15000 (8)

Name of Location:

Strategies	First Year		Second Year		Third Year		Fourth Year		Fifth Year	
	S	I	S	I	S	I	S	I	S	I
Promotion of regeneration through artificial means										
Protection from illegal harvesting										
Fire protection										
Generation of alternate resources in buifer zones (interface forestry/agroforestry) to reduce pressure on natural forests										
Regulated grazing										
Soil/Water conservation										
Regulated harvesting of non wood products										
Diversion of man power involved in illegal activities through alternate employment generation										
Improved utilisation of non wood forest produces										
Creation of awareness among local public to get their support and involvements in improving degraded forests										
Wildlife conservation measures										
Any others (specify)										
Overall expenditure/ha (here, it is required to provide your assessment about the approximate cost incurred and is not the added up total).										

4. Your assessment based on personal judgment about the changes occurred in the forest area you have selected in 3 and its adjoining sites during the last 5 years you have sampled in %. Improvement can be denoted by ` + % ' and degradation can be denoted by ` - % '. **This is to assess the effectiveness of the different strategies tried in the past.**

Location name:

Parameters	Assessment of change in % (approximate)
1 Vegetation (stocking):	
2 Incidence of fire damaging the forests	
3 Incidence of excessive fuelwood collection	
4 Incidence of uncontrolled cattle grazing	
5 Incidence of unregulated collection of non wood forest produces	
6 Incidence of excessive lopping for green manure and fodder	
7 Incidence of unregulated harvesting of bamboo, reeds, rattans (specify)	
8 Incidence of illegal removal of trees	
9 Change in forests in any other aspects such as 1. Socio economic conditions of the local people depending on forests 2. Impacts on site adjoining to the location sampled (specify) i ii	

Your general views with regard to improvement/degradation with reasons.

5. Your views on future strategies to be adopted for improving degraded forests for the coming 5 years including investment required/ha for each strategy individually and collectively.

In column S, for each management strategy identified, indicate N/L/M/H depending on degree of stress required as not significant low, medium, high respectively. And in column I, indicate your assessment of approximate investment required/ha for different strategies identified during the coming 5 years.

Investment categories:

Below Rs.500 / 500-1000 / 1000-1500 / 1500-2000 / 2000-4000 / 4000-6000 / 6000-10000 / 10000-15000
(1) (2) (3) (4) (5) (6) (7) (8)

Name of location:

Strategies	First Year		Second Year		Third Year		Fourth Year		Fifth Year	
	S	I	S	I	S	I	S	I	S	I
Promotion of regeneration through artificial means										
Protection from illegal harvesting										
Fire protection										
Generation of alternate resources in buffer zones (interface forestry/agroforestry) to reduce pressure on natural forests										
Regulated grazing										
Soil/Water conservation										
Regulated harvesting of non wood products										
Diversion of man power involved in illegal activities through alternate employment generation										
Improved utilisation of non wood forest produces										
Creation of awareness among local public to get their support and involvements in improving degraded forests										
Wildlife conservation measures										
Any others (specify)										
Overall investment/ha (here, it is required to provide your assessment about the approximate amount required and is not the added up total).										

6. Your views on future strategies to be adopted for improving degraded forests for the coming 5 years including investment required/ha for each strategy individually and collectively in your **circle/division/range**.

In column S, for each management strategy identified, indicate N/L/M/H depending on degree of stress required as not significant low, medium, high respectively. And in column I, indicate your assessment of approximate investment required/ha for different strategies identified during the coming 5 years.

Investment categories:

Below Rs.500 / 500-1000 / 1000-1500 / 1500-2000 / 2000-4000 / 4000-6000 / 6000-10000 / 10000-15000
(1) (2) (3) (4) (5) (6) (7) (8)

Strategies	First Year		Second Year		Third Year		Fourth Year		Fifth Year	
	S	I	S	I	S	I	S	I	S	I
Promotion of regeneration through artificial means										
Protection from illegal harvesting										
Fire protection										
Generation of alternate resources in buffer zones (interface forestry/agroforestry) to reduce pressure on natural forests										
Regulated grazing										
Soil/Water conservation										
Regulated harvesting of non wood products										
Diversion of man power involved in illegal activities through alternate employment generation										
Improved utilisation of non wood forest produces										
Creation of awareness among local public to get their support and involvements in improving degraded forests										
Wildlife conservation measures										
Any others (specify)										
Overall investment/ha (here, it is required to provide your assessment about the approximate amount required and is not the added up total).										

7. Institutional/Other measures required for improvement of degraded forests (please give your views):

a. Infrastructure development and modernisation in the forestry sector to enable efficient implementation of various activities to remove the causes of degradation and to promote various strategies to improve the degraded forests.

b. Decentralisation of administrative machinery to provide functional autonomy and freedom for speedy and efficient implementation of various strategies for improvement of degraded forests.

c. Participatory forest management/Joint forest management to ensure involvement of people, especially the local population who depend forests for their day to day subsistence.

d. Private initiative to bring capital investment and professionalism in resource management activities connected with the improvement of degraded forests.

e. Integrated data capture, storage, processing and information retrieval using automated methods to ensure timely availability of information needed for quick and judicious decision making required in improving degraded forests.

f. Judicious implementation of a combination of different strategies taking into consideration the overall cost and benefits involved.

g. Any others:

FORM VI

Project: KFRI 251/96
Group No:

Survey and establishment of a Monitoring System for Degraded Forests of Kerala

Workshop of Forest Department Officials

FORM FOR DATA COLLECTION REGARDING AREA UNDER DEGRADED FORESTS

1. Details of degraded forest in a division/range (to be guestimated based on field knowledge. (To be provided by Divisional Forest Officer/Range Forest Officer)

Name of Division/ Range	Forest type	Forest area in ha. or in %			
		Not degraded	Moderately degraded	Highly degraded	Total
	a Evergreen/ Semi evergreen				
	b Moist deciduous				
	c Grassland				
	d Plantations				
	Others				
	e				
	f				
	Total ha.				
	Total %				

FORM VII

Project: KFRI 251/96
Group No:

Survey and establishment of a Monitoring System for Degraded Forests of Kerala

(FORM FOR COMPENSATORY AFFORESTATION)

Workshop of Forest Department Officials

1. How you have identified the site for Compensatory Afforestation? What were the criteria used? Was crown density a criteria? When you have identified the site for Compensatory Afforestation?

2. What were your goals in taking up Compensatory Afforestation activities in your site?

3. What are the methods/factors you have adopted for Compensatory Afforestation?

4. Was planting/artificial regeneration an activity you have tried in site? If so, when you have initiated the activities?

5. What were the species tried? Are they commonly seen in the planting site/adjoining forests? What was the reason for selecting these species?

6. What was the type of planting stock used?

   Seedling/wildling/cutting

7. What are the other operations you have carried out in your site?

8. How much investment you made/ha? (rough)

9. How many more years of work it requires to complete the activity of Compensatory Afforestation in your site? What are the problems you have faced in Compensatory Afforestation?

10. How do you rate your attempt? Success/failure? / Are you happy with the performance of the Compensatory Afforestation of your site?

a. Very good/good/poor/very poor

b. Improvement/degradation in vegetation

c. Improvement/degradation in wildlife (fauna)

d. Improvement/degradation in socio-economic condition of people

e. Improvement/degradation in off-site condition

FORM VIII

Project: KFRI 251/96
Group No:

Survey and establishment of a Monitoring System for Degraded Forests of Kerala

Workshop of Forest Officials

Your comments / suggestions for improving the Map / Form for data collection:

Map:

Form:

Name:
Designation:

Signature of
the participant

xxxxi

Appendix IV

EVALUATION OF COMPENSATORY AFFORESTATION

(Proforma for field data collection)

I GENERAL INFORMATION

1. Division	Territorial: Social Forestry
2. Range	
3. Locality	
4. Forest type	Evergreen; Semi evergreen; Moist deciduous
5. Area (ha)	
6. Slope	Steep; Medium; Flat-undulating
7. Elevation	
8. Soil depth	High; Medium; Low
9. Rockiness	High; Medium; Low
10. Erosion proneness	High; Medium; Low
11. Settlements	High; Few; Nil
12. Resource use	High; Medium; Low
13. Grazing	High; Medium; Low
14. Fire incidence	High; Medium; Low
15. Lopping	High; Medium; Low
16. Green manure	High; Medium; Low
17. Streams	Many; Few; Nil
18. Gulleys	Many; Few; Nil
19. Foot paths	Many; Few; Nil
20. Encroachments	Many; Few; Nil

II STANDING CROP

1. Number of trees/ha.	
2. Crown density	<0.4 0.4-0.7 >0.7
3. Major species	
4. Girth of 20 trees	
5. Regeneration status	High; Medium; Low
6. Weed invasion	High; Medium; Low

7. Suitability of the are for compensatory afforestation

Suitable; Partially suitable; Not suitable

III WORK DONE

Silviculture

1. Preplanting operation
2. Species planted
3. Survival
4. Spacing Depth of pit
5. Tending operations
6. Protection Fire/Grazing/Felling
7. Number of watchers
8. Soil conservation for planting

Soil and water conservation

1. Gulley plugging - Number of gulleys
2. Trenching - Number of trenches ha^{-1} size
3. Bunding -
4. Other operations

IV IMPACT

1. Change in structure
2. Change in regeneration
3. Change in Soil build up
4. Shift of degradation to other areas

V WEAKNESSES/THREATS

1. Fire
2. Grazing
3. Felling
4. Foraging
5. Species choice
6. Seed availability
7. Nursery technology
8. Spacing
9. Planting techniques
10. Shade
11. Weed/overgrowth

VI FINANCE (Rs.)

1st year expenses

1. Nursery
2. Planting
3. Aftercare
4. Soil and water conservation
5. Total per ha.

2nd year expenses

1. Casuality replacement
2. Aftercare
3. Total per ha^{-1}

VII EVALUATION/COMMENTS

1. Convenor
2. People
3. Range Officer
4. DFO
5. Evaluator

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33. Viswanathan T.P., 1951, Working Plan for Malayattoor Division (Muvattupuzha Part) (1951-1952 to 1966-1967).
34. Kurian Akkara, 1974, Working Plan for Malayattoor Division (1974-1975 to 1984-1985).
35. Ramesan R., 1990, Management Plan for Chinnar WLS (1990-1991 to 1999-2000).
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39. Ramesan R., 1990, Management Plan for Thattekkad Bird Sanctuary (1990-1991 to 1999-2000).

40. John C.M., 1955, Working Plan for Kottayam Division (1955-1956 to 1969-1970).
41. Karunakaran C.K., 1970, Working Plan for Kottayan Division (1970-1971 to 1984-1985).
42. Abraham P.A., 1984, 3rd Working Plan for Kottayam Forest Division (1984-1994), KFD, 195 p.
43. Narayana Pillai K., 1958, Working Plan for Ranni Division (1958-1959 to 1972-1973).
44. Menon M.N., 1947, Working Plan for Konni Division (1947-1948 to 1961-1962).
45. Kesavan Pillai N., 1966, Working Plan for Konni Division (1966 to 1980).
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59. Surendranathan Asari P.K., 1977, Industry Oriented Management Plan for reeds (1977-78 to 1991-92).

Survey Reports/Other Forest Department records:

60. Chandrasekharan C., 1973, Resource Survey of Kerala, A Quantitative Assessment, Kerala Forest Department, Trivandrum.
61. Administration Reports - Kerala Forest Department (different years).
62. Forest Statistics - Kerala Forest Department (different years).
63. Data on Compensatory Afforestation such as list of afforestation sites, extent, expenditure, operations carried out and species planated from Forest Department files.
64. Various past and ongoing plan and non plan schemes of Forest Department for improving degraded forests.
65. **KFRI Research Reports on various aspects related to the study** - This include databases on plantations, reports on regeneration and ecological studies, taxonomical surveys of differnet plant species, wildlife census reports and habitat studies of different fauna.

Publications:

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70. Karunakaran C.K., 1995, Keralathile Vanangal Noottandukaliloote-2 (Malayalam), State Institute of Languages, Kerala, Trivandrum, 172 p.
71. Viswanathan T.P., 1990, Forest Management in Kerala-Problems and Remedies (Malayalam), State Institute of Languages, Kerala, Trivandrum, 152 p.
72. Various articles and other publications on forest degradation in Kerala published in different journals, books, popular magazines etc.

73. Survey of India toposheets of 1:50,000 and 1:2,50,000 scales of Kerala
74. Satellite imageries of 1:50,000 scale, LISS 1 of Indian Remote Sensing Satellite IRS 1B for the period 1995-96, for the whole of Kerala.
75. Various Working Plan maps of different forest divisions in Kerala.
76. Information provided by Forest Officers participtaed in the regional workshops (11 workshops to cover Forest Circles of different, Territorial, Social Forestry, Wildlife and Working Plan were organised in which Forest Officers of different categories, Foresters, Rangers, DFOs, Conservators participated) in the form of multiple copies of maps and questionnaires on various aspects.
77. Field data gathered by the project team through intensive sampling of different forest divisions of Kerala.

Appendix VI

List of sites visited for evaluation of Compensatory Afforestation Scheme:

1. Thiruvananthapuram Division

Kallala I 1996, Kallala II 1996, Anchumoorthimudu 1996, Elanjiam 1996, Edavam I 1996, Edavam II, 1996

2. Idukki - Keerimudi 1995

3. Thrissur

Pothinthadam 1995, Mannathippara 1995, Thrissur 1996, Mullakkara 1994, Therthamkuzhi 1995

4. Kannur

Thalassery 1996, Kokkarpoil 1996, Koderimala 1995

5. Kasargode

Katikaji 1995, Pthikkara 1995, Kinanur, 1995, Nerodi 1995, Chamakochi 1995, Ranipuram 1996, Palar, 1996, Kallada 1996, Chappakkal 1996