Measurement of Biodiversity

Chapter · January 2006

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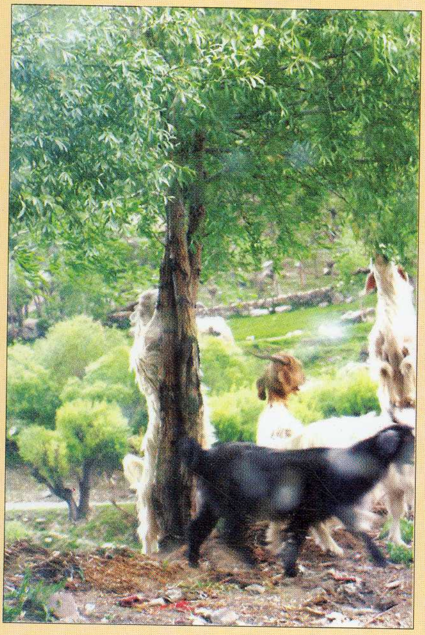
Seminar Proceedings

STATISTICAL ACCOUNTING OF LAND AND FORESTRY RESOURCES

28-29 April, 2006



सत्यमेव जयते

Central Statistical Organisation
Ministry of Statistics & Programme Implementation
Government of India
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Photo : Willows plantation and agriculture land cultivation in Lahaul Valley in Himachal Pradesh;
Photo Courtesy : Madhu Verma

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compiled by

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&

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Preface

The Governments and various policy makers all over the world have increasingly realized the threat to its precious environment due to depletion of natural resources and the growing pace of degradation of the environment. Environmental issues, which have been for a long time part of Indian thought and social processes, are reflected in the Constitution of the Republic of India adopted in 1950. Environment Statistics occupies an important place in the national statistical system. Sound data base on all aspects of environment is a prerequisite for formulation of policies and plans to protect and conserve our environment. The Ministry of Statistics and Programme Implementation, being the nodal agency has been working for the improvement of the environment statistics since 1996.It is also the responsibility of this Ministry for the development of the framework for the preparation of Natural resource Accounting.

This Ministry has been organising workshops /seminars on environment statistics which act as a common platform for academicians and experts sharing their individual experience and knowledge to bring about improvement in environment statistics. The Seminar on 'Statistical Accounting of Land and Forestry Resources' is the sixth in this series and was organised in collaboration with the Indian Institute of Forest Management (IIFM), Bhopal during 28-29 April, 2006.

Forests are one of the most important components of the terrestrial environment system and complete resource base. On the other hand, land as an asset is unlike any other natural resource that may change in quality due to human intervention but effectively cannot be either destroyed or created by man. The Seminar appropriately deliberated upon the various issues in different sessions covering Use and Role of Modern Techniques in Generating Data on Land and Forestry Resources, Environmental Issues in Natural Resources with particular reference to Land and Forestry Resources, Availability of Environmental Data in different organisations and Methodological frameworks for physical and economic accounting of Forest Resources. I am very thankful to Dr. D.K.Bandyopadhyay and his team for organising and giving full logistic support for the Seminar.

I wish to record my special appreciation for the Officers and Staff of the Social Statistics Division of this Ministry headed by Shri K.A.D. Sinha, Additional Director General for organising the Seminar and bringing out the proceeding in this form.

October, 2006

Dr.S.K.Nath
Director General
Central Statistical Organisation
New Delhi

Note from Dr.D.K. Bandyopadhyay, Director, IIFM, Bhopal

Natural Resource Accounting (NRA) is a revaluation of the National Income Accounts of a country, adjusting for the values of natural resources used in various economic activities during the past 'fiscal year' and thus giving 'green effect' to the conventional accounts. Natural resources being a part of the wealth of the nation, initiatives have to be taken to integrate the natural resource accounting along with the System of National Accounts (SNA). The Ministry of Statistics and Programme Implementation (MOS&PI), being the nodal authority to release official statistics, has taken significant steps for improvement of Environment Statistics and also for the development of framework for the preparation of Natural Resource Accounting in India. It is emphasized that the present system of national accounts should continue but at the same time a separate exercise for developing Green GDP should be made based on methodological frameworks being suggested in by various studies commissioned by CSO.

Land is one of the basic components of the environment. It performs major environmental and economic functions which provide an interface between environment and economic development. All these functions to an extent, independent of each other and there is a need to maintain a balance among them so that none of these functions encroach upon the others in a non-sustainable way. In order to arrive at a sustainable development framework, it is necessary to have a clear idea regarding the extent and nature of degradation across the various agro-climatic zones of the country. Important dimensions like trends in land use pattern, trends in uncultivable, fallow and degraded lands, loss of productivity and production due to different types of soil degradation and replacement costs of degradation need to be taken care of while preparing land resource accounts. The annual estimate of degradation arrived through such a process should be subtracted from the agricultural contribution to SDP to arrive at the adjusted SDP for the land sector.

Similarly concern about the phenomena of global warming and declining biodiversity has focused attention on the link between the world's forests and economic growth. The role of India's forests in the national economy and ecology was emphasized in the 1988 National Forest Policy, which focused on ensuring environmental stability, restoring the ecological balance, and preserving the remaining forests. Assertion is further made in New Environment Policy of the Government (2004) on role of ecological services rendered by various ecosystems in the economy of the country. Forests contribute 1.7% to the GDP of the country (MOEF, 1999). Moreover; non-timber forest products provide about 40% of total official forest revenues and 55% of forest-based employment. Nearly 55 million people living in and around forests in India depend upon non-timber forest products as a critical component for their sustenance. But the current production approach for accounting "Forestry and Logging" data only leaves forestry sector far behind in the race of reflecting sectoral contributions in the national product. Thus a typical resource accounting exercise for the forestry sector should take into account the existing system of recording of the stocks and flows, and then try to create linkage with potential accounts.

In this context it is important to mention that the lead taken by the Central Statistical Organization (CSO), Ministry of Statistics and Programme Implementation, Government of India in generating and collating environmental data for past several years. Efforts have been made by them to generate data and create capacities amongst providers and users through their research and training programmes and wider dissemination of their publications. The findings of such projects have been shared with various stakeholders through seminars. The Indian Institute of Forest Management has also been awarded such a pilot study on ‘Natural Resource Accounting for the States of Himachal Pradesh and Madhya Pradesh for Land and Forestry Sector (excluding Mining)’ in 2003 and the researchers have had good learning in the project and the report has been submitted to the CSO.

I am happy that CSO felt confident of our expertise and entrusted the responsibility of conducting the seminar on 'Statistical Accounting for Land and Forestry Resources' during 28-29, April 2006 to the Indian Institute of Forest management, Bhopal. Besides the presenters, efforts have been made by the seminar coordinators to source various experts and practitioners to the programme to draw from the experience of all and get a holistic approach towards the process of Natural Resource Accounting. The proceedings, which is the outcome of the seminar, provides an insight into the current efforts towards methodological frameworks of conducting NRA of land and forest resources. It also provides a list of recommendation which is an extract of thorough churning of presented papers; follow up comments and queries and panel discussions. I am sure the proceedings would help CSO in giving shape to standardized framework for land and forest resource accounting. It would be gratifying if it serves this purpose.

In the end, I wish to put on record my deep gratitude to CSO for first of all giving an opportunity to conduct this seminar to IIFM and their continued involvement for smooth conduct of the seminar. Thanks to all participants for their immense contribution to provide an enriched body of knowledge through their work and expertise. Thanks are also due to the programme coordinators, faculty members and various officials and staff of IIFM for their help in conducting the workshop. Financial support for the workshop provided by the CSO is thankfully acknowledged.

CONTENTS

List of Abbreviations

CFDA	Centre for Development Alternatives
CMDR	Centre for Multi-disciplinary Development Researh
CSO	Central Statistical Organisation
DIP	Digital Image Interpretation
EIA	Environment Impact Assessment
EOS	Earth Observing System
FAO	Food and Agriculture Organisation
FPC	Forest Protection Committee
FRA	Forest Resource Accounting
FSI	Forest Survey of India
GDP	Gross Domestic Product
GIS	Geographic Information System
GPS	Global Positioning Systems
IEG	Institute of Economic Growth
IGIDR	Indira Gandhi Institute for Development Research
IIFM	Indian Institute of Forest Management
IRADe	Integrated Research and Action for Development
ISRO	Indian Space Research Organisation
JFM	Joint Forest Management
LUS	Land Use Statistics
MDPs	Management Development Programmes
MFPs	Minor Forest Products
MOS&PI	Ministry of Statistics & Programme Implementation
MSE	Madras School of Economics
NDP	National Domestic Product
NEHU	North-Eastern Hill University
NGO	Non-Government Organisations
NRA	Natural Resource Accounting
NRSA	National Remote Sensing Agency
NSDP	Net State Domestic Product
NTFP	Non-Timber Forest Product
NWFP	Non-Wood Forest Products
SDP	State Domestic Product
SDSS	Special Support Decision System
SEEA	System of Environmental and Economic Accounting
SERs	State of Environment Reports
SNA	System of National Accounts
TERI	The Energy and Resources Institute
TOF	Trees Outside Forests

Officers and Staffs of CSO Associated with the Seminar

Deputy Director General
SHRI JOGESHWAR DASH

Director
SHRI RAMESH CHAND AGGARWAL

Deputy Director
SHRI SOURAV CHAKRABORTTY

Junior Investigator
SHRI RAJESH KUMAR PANWAR

Chapter - 1

Inaugural Session

Inaugural Session Report

The seminar began with the welcome address by Professor Madhu Verma, Programme Director. She welcomed the Chief Guest of programme, Mr. Vishnu Kumar, Additional Director General, CSO, MOS&PI; Guest of honor of programme Mr. K.A.D.Sinha, Additional Director General, CSO, MOS&PI; Mr. Jogeshwar Dash, Deputy Director General, CSO, MOS&PI, Dr. D.K. Bandyopadhyay, Director, IIFM, officers of CSO, NSSO, various State Directorates of Economics & Statistics, Resource Persons from various organizations, Invitees, Media Persons, Faculty Members and other staff members of IIFM. On behalf of entire IIFM fraternity and on her own behalf, she extended her very hearty welcome to one and all to the beautiful city of hills, gardens and lakes, Bhopal, to the sprawling and fascinating campus of IIFM and to the 6th National Seminar on Statistical Accounting of Land and Forestry Resources, hosted by IIFM in its campus. This was followed by welcome of all the dignitaries on the dais by presentation of bouquets. She then invited all the dignitaries on the dais to kindly come forward and light the lamp so as to mark the beginning of the programme.

Dr. D.K. Bandyopadhyay, Director, IIFM while cordially welcoming all the guest & participants appreciated the noble cause of the seminar i.e. sharing information generated through diverse work of researchers and practitioners for the purpose of environmental conservation. He highlighted that Statistical Accounting of Land and Forestry Resources is a very virgin area and has not been explored much. May be since a decade or so people have started feeling the need and necessity of having such type of accounting process to be in place but this is a road less traveled. He emphasized that in any management systems, accounts play a very important role and the information that gets generated from such accounting process is very much utilized by the financial managers in term of formulating different directives and strategies for any organization. Now same is true in this context because it is the ecosystems which are providing many types of services to many stakeholders and these stakeholders have been using these multiple ecosystem services but still not able to appreciate its value on account of lack of valuation and accounting systems. The forest not only provides the timber, fuel wood and fodder but also provides many types of ecological services. Some of them are tangible in nature and others are intangibles in nature. Even the tangible nature of goods and services provided by the forestry sector are not being accounted properly to reflect true contribution of the sector to GDP. Such entries are very limited in the current account books of the nation.

Dr. D.K.Bandyopadhyay highlighted the importance of the workshop as it provides an opportunity to learn from the people who have been working with some sort of postulation, assumption and hypothesization and developing frameworks to register such contributions. Everyone feels very strongly that only an appropriate NRA accounting system will reflect the true contribution of the sector to the Country's GDP. The forum feels that it is not only 1.1 per cent of the total GDP in Indian context but it is much higher. He mentioned that currently in India, forest and environment sector only gets nine percent of country's total budget allocation which is quite less if we compare the budgetary allocation of China and Brazil. Now we want to put forth this proposal to the policy planners that this allocation should be based on real contribution of the sector.

But to reflect such contribution we require enough information which is also the objective of this seminar. He shared that internationally there are mechanisms of payments for using ecosystem services from forests and land. But one should not fix payments arbitrarily. There are some studies to measure such benefits but the major question is acceptability to the whole scientific community.

He highlighted the recent work done by Prof. Verma of IIFM for the state of Himachal Pradesh which has gone to the policy and decision making process and based on her findings, the government imposed an ecological value tax per hectare of removal of forest. He appreciated CSO's intervention at right time by spear heading this noble cause and conducting such seminar and various projects. He wished the programme a grand success and that two days stay of all participants to be successful, academically and personally.

Dr.K.N.Krishna Kumar, Professor, IIFM and Coordinator of MDPs gave an account of activities of IIFM, Bhopal. Dr.CVRS Vijay Kumar, Associate Professor, IIFM and one of the Programme Directors presented structure of two days deliberations.

Shri Jogeshwar Das, DDG, CSO, MOS&PI mentioned that CSO has been organizing such seminars for the past 10 years, this being 6^{th} seminar in progress. The main purpose of seminar is not only to propagate environmental issues but also to develop a systematic Natural Resource Accounting (NRA). If the deliberations of the seminar succeed, we shall have a system at place and would bring out such accounts and green GDP every year. He highlighted that the current growth rate of the country is mainly based on economic activity. NRA is an attempt to reflect true development which will lead to green GDP. He mentioned that in the process of economic growth, there is depletion of natural resources. The purpose of NRA is to estimate the adjustment to current GDP and come out with green GDP. There is situation like in North-East states where the size of SDP is very small as their major forestry sector's total contribution is not taken into account in estimating SDPs. On the other hand the industrially developed states have high SDP, but they have immense loss of Natural resources and there are discussions as to whether their GDP value should go up or down. All this requires in-depth study. The CSO has sponsored eight projects in India and if we develop methodology then we would be able to develop database on Natural Resources. It may take two - three years to put such mechanism in the system and then we shall be able to compare our estimate with those of other countries of the world. He expected that the inputs from seminar would be very useful in formalising the methodology for NRA.

Shri Vishnu Kumar, ADG, CSO, MOS&PI in his keynote address stressed the need of having well developed framework of NRA to show economic and ecological contributions of forestry and land sectors. He stressed that forestry sector should get compensation for such contribution and people who degrade them should be charged. Forest is an important component to environmental system. They are the ecological system which play multi-dimensional role. They provide not only timber, fuel wood, pulpwood, fodder, fiber & NTFP and support industry and commercial supply but also extend ecological services and maintain the ecological balance to support the mankind. Forest provides livelihoods to millions of people and contributes to health and wealth of urban area. Degraded forest result to poor agriculture, horticulture, and migration of dependent community into urban area. Tropical forests are house of the half of total world wildlife and available biodiversity .The problem of forest degradation has led to destruction of carbon sink effecting global climate. He pointed out that such contributions of forestry sector are not highlighted so far on account of lack of perception for such values amongst stakeholders. Land is basic component of environment and performs various functions. Forest provides services like retention of water, moisture, retention of nutrition, give vegetative cover; maintain ecological property of land, etc. He called upon need for generation of such data. He highlighted the importance of satellite data provided by NRSA which are capable of capturing the intensity of land use category both spatially and temporally. We need to have separate records for agriculture & non-agriculture, degraded land. Some of appropriate modern technologies which can generate data on land and forest resources are GIS, Remote Sensing, EIA, etc. In the end he wished great success to the seminar.

Shri K.A.D.Sinha, ADG, CSO, MOS&PI in his inaugural address mentioned that it has to be appreciated that the Natural Resource Accounting is a complex phenomenon and that a multidisciplinary approach will be required involving Statisticians, Economists, Social Scientists and Environmental Experts alongwith the development of an effective Environment Monitoring Information System. The development of an effective Environment Monitoring Information System will not only provide for a sound data base for NRA but will eventually also result in availability of required data for a more efficient planning, development and management of natural resources and environment. He also stressed that the State DES will also have to be actively associated in filling the data gaps besides the Central Nodal Agencies like Ministry of agriculture, Ministry of Environment & Forests, Ministry of Water Resources and Central water Commission. He also mentioned that the valuation of degradation in the quality of natural resources is an important aspect for consideration in the development of an appropriate methodology and valuation of the same will have to be appropriately provided for in the accounting. The valuation of the physical stock of natural resources is a key area where a lot of thinking will be required to arrive at a consensus. He also mentioned about eight studies on NRA sponsored by the Ministry of Statistics & Programme Implementation. He also expressed the view that the feedback emerging out of deliberations will also help us a good deal in conceptualizing the concept and methodology for NRA. The deliberations will also help in identifying data requirements and data gaps and will also facilitate development of a sound data base besides conceptualizing the issues involved in the measurement and development of appropriate methodology. He extended his best wishes for the success of the seminar.

Shri R.C. Aggarwal, Director, CSO, MOS&PI proposed the vote of thanks. He expressed his sincere thanks to IIFM on behalf of MOS&PI, Govt. of India and especially to Dr. D.K. Bandyopadhyay, Director, IIFM for agreeing to host this Seminar. He expressed his sincere thanks to Dr. R. C Panda, Special Secretary, MOS&PI who showed a lot of interest in the Seminar but couldn't attend the Seminar due to his prior commitments. He extended his gratitude to Shri Vishnu Kumar, Additional Director General (ADG), who has not only spared some time to attend the workshop, despite his busy schedule but also agreed to deliver the keynote address. He had worked in the division which is responsible for estimating the Gross Domestic Product of our country. He stressed that to understand the concept of Natural Resource Accounting it is very essential to have a prior knowledge of conventional system of accounting. Thus he best fits into this position. Sincere thanks were extended to Mr. KAD Sinha, ADG and DDG CSO, MOS&PI, delegates from CSO and special invitees from various department, researchers and academicians from government institutions and NGOs for their active participation in this workshop. He asserted that without their participation and active support it would not have been possible to organize this workshop.

He profusely thanked Dr. Madhu Verma and her team of dedicated faculty members, officers and staff who worked very hard to organize this seminar. He expressed his gratitude to all the contributors of papers who have done strenuous work for preparation of technical papers. He also expressed his thanks to Shri J Dash, Deputy Director General (DDG), for able leadership, constant monitoring and day to day advice for organization of the seminar. He highlighted that it was because of his initiative only that CSO was able to organize two seminars within a gap of 10 month's time. The last seminar was organized in June 2005 on Statistical Accounting of Water resources and its proceeding is already under circulation. He thanked Press and media for their presence and giving coverage to the programme. In the end he thanked all officers and staff of his division for their valuable contribution and also all those who contributed directly or indirectly to this seminar.

Keynote Address by Shri Vishnu Kumar, Addl. Director General, CSO, MOS&PI, Govt. of India at IIFM on 28th April, 2006

Shri. K.A.D.Sinha, Additional Director General, CSO, MOS&PI ,Government of India, Dr. D.K.Bandyopadhyay, Director, IIFM, Shri J.Dash, Dy. Director General, CSO, distinguished participants, Ladies and Gentlemen,

I feel very delighted and honored to address this august gathering on the occasion of 6th Seminar on 'Statistical Accounting for Land and Forestry Resources' hosted by Indian Institute of Forest Management in this very beautiful city of lakes, Bhopal.

As we are aware, forests are one of the most important components of the terrestrial environmental system and an important resource base. They form an ecological system consisting of tree dominated vegetative cover. Forests, however, provide in many ways from local to the global system and play a multi dimensional role. They provide not only timber, fuel wood, pulpwood, fodder and fiber grass and non-wood forest produce & support industrial & commercial activities but also maintain the ecological balance & life-support systems essential for food production, health and all round development of human kind. Forests exercise control over the wealth of adjoining land use systems, provide livelihoods to millions of rural people & contribute towards health and wealth of urban areas. Degraded forests result into impoverished agriculture, horticulture, and in turn trigger migration of dependent communities to urban areas where they end up in low paid, unsecured informal sector. Lack of availability of fodder in such degraded forests also reduces productivity of livestock population and forces their trans-boundary movement. Tropical forests are the repository of more than half of the world's plant & animal species and are the major source of available biodiversity. The concern about forest degradation and depletion therefore, relates to the twin problems of destruction of the carbon sinks affecting the global climate & extinction of species affecting bio-diversity. These issues currently do not get highlighted in the decision making process on account of lack of their appreciation by different stakeholders. .

Land is one of the basic components of the environment and performs three major functions as far as the interface between environment and economic development is concerned: it provides retention of water and moisture as well as retention of soil nutrients to support vegetation cover, maintenance and sustenance of biodiversity and geological properties.

Agriculture and allied activities such as production of food crops, non-food crops and raw materials for industries, production of fuel and fodder for human beings and animals cannot be imagined without land. It also supports the production of mineral resources, sustain forest produce etc.; all of which support and promote economic development.
In the non-agricultural sector, it provides space for housing and settlements in rural and urban areas, as well as for industries, trade and other uses.

The present system of nine-fold classification of land and the corresponding system of data recording followed in India leave quite a number of environmentally significant questions unanswered. Though the remote sensed data published by National Remote

Sensing Agency claims a fair degree of accuracy, it fails to capture the extent and intensity of land degradation within each category, both spatially and temporally. Also this and a host of other estimates pertain to a particular point in time and hence do not reveal much regarding the changes over time. Besides, they are not precise in terms of various types of degradation and also their variation across agro-climatic regions.

Some of the important dimensions that have to be taken care of while resource accounting for the Land sector relates to trends in land use pattern, trends in uncultivable, fallow and degraded lands, loss of productivity and production due to different types of soil degradation and replacement costs of degradation. Due to phenomenal growth in population, ever rising demand for land for both agricultural and non agricultural pursuits has resulted in creation of vast stretches of wastelands, and the decrease in per capita cultivable land besides ecological imbalances but we fail to take account of such factors formally into our accounting system.

Natural resources like forests and land are part of national wealth or stock, however, unlike many other goods and services these resources may not have a ready market. Further their economic use results into deterioration or improvement of their stocks as well as their surrounding environment, in short and long term depending upon the management regime of these assets. To obtain a better understanding of the relationship between the economic activities and environment, it is necessary to take into account the use of land by different economic activities and potentials of forest and land from an ecological point of view.

The current seminar appropriately addresses such issues through its various sessions covering “Use and Role of Modern Techniques in Generating Data on Land and Forestry Resources” which comprises of use of GIS and remote sensing and EIA techniques followed by “Environmental Issues in Natural Resources” with particular reference to plantation, biodiversity, status of forests and impacts of chemicals on land quality. It then tries to take the stock of “Availability of Environmental Data in different organizations” and then discusses ”Methodological frameworks for physical and economic accounting of Forestry and Land Resources”. At the end we intend to discuss the implementable framework needed for such mechanisms during the panel discussion.

I am happy to see such an overwhelming response to the seminar as well as excellent set up provided by IIFM to make it even more interesting and a great learning experience. I wish you all good luck and a very fruitful time during the seminar.

Inaugural Address by Shri K.A.D. Sinha, Additional Director General, Central Statistical Organisation (CSO), MOS&PI, Government of India

Shri Avni Vaish, Principal Secretary, Forests, Government of Madhya Pradesh, Dr. D.K.Bandyopadhyay, Director, Indian Institute of Forest Management (IIFM), Dr. C.V.R.S. Vijaya Kumar, Programme Director, IIFM, Prof. Indira Hiraway, CFDA, Prof. Sudhakar Reddy, IGIDR , Shri Jogeshwar Dash, DDG, CSO, Ministry of Statistics and Programme Implementation, Officers from Central and State Governments, Eminent Statisticians, Economists and Social Scientists from various parts of the country, ladies and gentleman. I am happy to be with you today morning to inaugurate the two days' Seminar on Statistical Accounting of Land and Forestry Resources. This Seminar is intended to provide an opportunity for interaction among the multidisciplinary group of professionals comprising Statisticians, Economists and Social Scientists and to share and concretise our views on Natural Resource Accounting with particular reference to Land and Forestry.

The Central Statistical Organisation, Ministry of Statistics and Programme Implementation, being the nodal agency, is regularly documenting data on environment and related statistics in the form of a compendium of Environment Statistics since 1996. The Compendium provides all environment and related data of interest and relevance to the environment managers and planners at one place. The Central Statistical Organisation, Ministry of Statistics and Programme Implementation is also organising Workshops on environment statistics every year. The basic objective of these Conferences are to review the environment status, availability of data and data gaps and highlight the issues of concern for the environmental management. A total of six workshops have been organised so far. The scope of the workshop organised last year in 2005 and this workshop at Bhopal is basically confined to the Natural Resource Accounting for estimation of Green GDP.

The Natural Resource Accounting assumes particular significance in view of deteriorating environment, depletion in the stock and degradation in the quality of natural resources because of economic and human activity. The Natural Resource Accounting is important not only for a rational planning of finite but vital natural resources and working out of Green GDP, but in the process may also result in development of an Environment Information System. Environment management is a new emerging area to the environment planners and managers. The environment takes into account all the variables (physical, social and cultural) which directly or indirectly influence the existence and development of organisms. Environment is defined as the aggregate of all external conditions/situations influencing the life and further development of living organisms on earth. The three basic factors influencing environment include Air, Water and Land. Rapid industrialisation and accelerated economic growth have been accompanied by the phenomenal environmental degradation and depletion of natural resources. There is growing concern on the deterioration of the environment and need to improve the quality of environment. The protection of environment and conservation of natural resources have emerged key national priorities in India after 1972 Stockhlom Conference on Human Environment.

The Economic Development of a country or region is generally expressed in terms of the growth of its income. Natural Resource Accounting provides for revaluation of the National Income Accounts of a country, adjusted for the values of natural resources used in various economic activities during the past year. Natural Resources get degraded in quality and depleted in stock due to economic and human activity. There is need to understand the extent of such losses or gains and to work out their 'use values', generate accounts of such resource depletion and additions. Sound database on all the aspects of environments is a prerequisite for preparing Green GDP accounts and formulation of various policies and acts to protect and conserve our environment.

At the Rio Summit in 1992 there was an agreement that all the participating Nations would make efforts to expand the existing system of national accounts for integrating environment and social dimensions in the economic accounting framework. Some of the countries have already taken steps in this regard for the preparation of Green GDP. India is also not an exception in this regard for achieving the goal of the preparation of Green GDP. The Ministry of Statistics and Programme Implementation has taken significant steps for improvement of Environment Statistics and also for the development of framework for the preparation of Natural Resource Accounting in India. It is emphasised that the present system of national accounts would continue but at the same time efforts would be made for developing the methodological framework for computing Green GDP.

The Ministry of Statistics and Programme Implementation has awarded eight studies to various research organisations on different sectors in selected states on pilot basis to develop sector wise methodologies for computing Green GDP. These Studies include Mining Sector for the states of West Bengal and Madhya Pradesh (TERI), Air and Water Sector for Andhra Pradesh and Himachal Pradesh(IEG), Land and Forestry Sector for Karnataka (CMDR), Land and Forestry Sector for Madhya Pradesh and Himachal Pradesh (IIFM), Land and Air Sector in West Bengal (Jadav Pur University), Land and Water Sectors in Tamilnadu(MSE), Land and Forestry Sector in Meghalaya(NEHU) and Water Sector in Goa (IRADe). Out of the eight studies, drafts reports of four studies have been prepared and are under examination while the remaining four studies are at various stages of completion. I hope the results of the studies will be available within a reasonable time period and further work to develop standard methodology for computing Green GDP will be taken up.

I am happy that present Seminar has been organised at IIFM, Bhopal which is best suited for the subject of the Seminar. This Ministry has been organising Workshops/Seminars since 1998. The present Seminar is sixth in the series. These Seminars provide a common forum for academicians, experts and administrators for sharing their individual experiences and knowledge to bring about the improvements in the environment statistics. These Seminars have also proved useful in identifying data requirement and data availability and thereby the data gaps and the ways and means to fill up the same.

These two days, Physical Accounting of Land Resources, Physical Accounting of Forestry Resources, Land Pollution Factors and Measurements, Economic Accounting of Land and Forestry Sector and Use of Remote Sensing Technology for collection of data and data-gaps etc. will be discussed. As per the land use statistics, the area under non-agricultural land has increased due to increase in developmental activities e.g. housing, transport system etc. but the net sown area has remained almost constant at 142 million hectares since 1970 despite a lot of pressure of growth in population. It is also estimated that at present about 55 million hectare of the non-forest and non-cultivated land out of a total of 329 million hectare land in the country is degraded. Land degradation or for that matter degradation of any type of natural resource, is a kind of dis-investment of the stock, if more of the natural resource is extracted compared to the quantum replaced. It is a matter of concern that such depreciation is not recorded and incorporated coherently in the national income accounts and consequently results in overestimation of the future earning potential of the resource. In a country like India, where productive land is synonymous with agricultural or pastoral land, the impact of land degradation manifests itself usually through crop yield or declining productivity because of rising input costs. The issue is how to estimate and incorporate the land degradation in natural resource accounts.

The Forests play crucial role in ecology stability, socio-economic well being and development of country. Periodic assessment of forest cover provides a quantative measure of the extent of land area under forest cover along with the density. Comprehensive assessment of the forest resource involves measurement of numerous parameters such as forest cover, tree cover, growing stock, species composition, availability and occurrence of non-wood forest produce and so on. It was only from 2001, the forest cover of the whole country is being assessed digitally at 1:50,000 scale. The estimates of forest area are obtained from three sources namely Ministry of Agriculture, Ministry of Environments & Forests through State Forest Departments and Assessment of forest cover using modern technology of remote sensing. Though more than one-fifth of India's geographic area is recorded as forest area, it is not known with certainty how much forest area actually bears forest cover. The National Forest Policy 1988 aims at having one-third of the country's land area under forest and tree cover. Although the benefits from the forests to the national economy are at presently grossly underestimated with the result that the actual benefits are several times higher than the reported and incorporated in the national income accounts. As per the National Accounts, the share of forestry and logging sector was about 0.9 % of the GDP in 2004-05 as compared to 1.5% in 1993-94. Recognising the need for a realistic valuation of forests benefits and costs, an appropriate accounting framework for integrating Forest Resource Accounts into the National Income accounts is needed. It will provide better understanding of the full range of goods and services supplied by the forests which is essential for the optimal utilisation of forests. The accounts help to understand the interaction between human activity and the environment.

I hope that two days' deliberations at the Seminar will address all statistical and environmental issues relating to Land and Forestry Accounting and come out with specific recommendations. We are looking forward to the deliberations of the workshop with keen interest, particularly in view of pilot studies for development of standard methodology for estimation of green GDP having been sponsored by the Ministry and it will provide us with useful inputs for finalisation of the methodology.

I wish Seminar all success.

Vote of thanks by Shri R.C.Aggarwal, Director, CSO, MOS&PI, Government of India

Dr. D.K.Bandyopadhyay, Director, IIFM, Shri Visnu Kumar, ADG, CSO, ShriVishnu Kumar, ADG, CSO, Shri J.Dash, DDG,CSO, Dr. Madhu Verma, distinguished delegates from central and state governments, resource persons, colleagues and friends.

At the outset, on behalf of Ministry of Statistics & Programme Implementation, Government of India and on my personal behalf , I would like to express my express my sincere thanks to IIFM, particularly Dr. D.K. Bandyopadhyay who has shown keen interest and agreed to host the sixth Seminar on statistical accounting of land and forestry resources at IIFM, Bhopal

I also wish to place my sincere thanks to our special secretary Dr. R.C.Panda who had shown a lot of interest in this seminar but he is unable to attend the seminar due to prior engagements.

We are extremely grateful to Dr. Vishnu Kumar, Addl director General, MOS&PI, CSO who has not only spared some time to attend the seminar despite his busy schedule but also agreed to deliver keynote address. Sir your Division is responsible for estimating the Gross Domestic Product of our country. In order to understand the concept of Natural Resource Accounting it is very essential to have a prior knowledge of conventional system of accounting thus he best fits into this situation.

My thanks are also due to Shri K.A.D Sinha, who has just taken over as Additional director General, MOS&PI, CSO. With in a short time he has taken a command over the subject and inspired all of us.

We are sincerely thankful to all the delegates and participants from Central Ministries/Departments, State Governments, Special Invitees from Research/ Academic Institutions, NGOs for their participation in the Seminar. Without their participation, it would not have been possible us to organize this seminar.

We are extremely grateful to Dr. Madhu Verma and her team of dedicated officers and staff who have done very hard work in the organisation of this seminar. We are also thankful to all the contributors of the papers who have done strenuous work for the preparation of the papers.

Most importantly, I am also grateful to Shri J.Dash , Deputy Director General, MOS&PI, CSO. Because of your able leadership, constant monitoring and day-to-day advise, it has been possible for us to organize the sixth seminar. This is due to his initiative only that we have been able to organize two seminar with in a gap of 10 month's time. The lat seminar was organized in June, 2005, the proceedings of which has already been under circulation.

We are thankful to the press and media persons who play crucial role in proper coverage and spreading right message.

Last but not the least, I am also thankful to officers and staff in my division for their contribution. I am also thankful to all those who have contributed directly or indirectly in this Seminar.

Thank you all once again.

Chapter - 2

Summary of Technical Sessions, Panel Discussion and Recommendations of the Seminar

SUMMARY OF TECHNICAL SESSIONS

Session 1 : Use and Role of Modern Techniques in Generating Data on Land and Forestry Resources

Chairperson : Dr. Vivek Saraf Rapporteur : Mr. A.K. Yadav

Introductory Address: Chairperson

Dr. Vivek Saraf in his introductory remark commented that Natural Resource Management is the top priority in the world today. The resources which were provided by the mother nature are all that we have had in the past and will have in the future. The fast utilisation of the resources and that too at an ever increasing menacing pace is seriously depleting the reserves and emptying our natural resource treasure. The time is not even left to think of the matter as a whole and ponder on issues and take actions to set things right again. Still it is better to start late than never. There are two important issues before us one to plan and control the use of natural resources and second, we have to aim for utilizing the resources to their optimum so that we can extract maximum benefits out of the use.

Regarding the first issue of Planning and Monitoring of utilization of natural resources, it is very important to bear in mind that use or exploitation is done only so that neither the resources get in such a manner over-exploited or exhausted much that it reaches to the point of no return nor that the over exploitation of resources creates any imbalance in the naturally set equations amongst the resource elements.

And second issue is of optimum utilisation of the resources to derive maximum benefits. Land and Forests, are the key themes of discussion during this seminar. The big challenge before us today is to study the stocks or present status of these resources and we have to ensure their use - rather ensure the optimum use. It is essential to consider that either the resources would continue to lie underutilized and unexploited that it would be as much a waste or otherwise we take steps towards efforts to utilize the resources and get maximum returns out of this.

Paper Title : Role and Potential of Geospatial Technology (GIS/GPS/Remote Sensing) in Data Collection, Collation and Preparation of Application Specific Databases in Forestry

Author : Mr.Shakti Prakash,

The speaker highlighted the role of advanced technology in forest inventory in India. Some of important scientific advances in the use of Geo-Spatial technologies are GIS/ GPS/ Remote Sensing which are used for data collection, collation and development of application specific, special decision support systems (SDSS) which help in assisting decision making processes for the implementation in the management of forest resources. Apart from conventional use of aerial photography such as RADAR, LIDAR, Thermography and Optical Sensors are used for data collection. The paper provided an overview of the role and potential of geo-spatial technologies in the management of forestry resources in India.

Discussion :

The participants pointed out that though the paper provide a good overview and potential of geo-spatial technologies but it could have been more useful had there been a case study supporting the theoretical presentation.

Paper Title : Application of Remote Sensing in Forestry Sector

Author : Mr.Lingaraja Sahu

The speaker highlighted the constraints in availability of data. The key data constraints faced these days are restricting the progress in research work to some extent. The underlying research problems associated with the collection of secondary data are: [a] lack of consistent data across districts; [b] lack of data for the districts during a comparable time frame; [c] differences in data between departments, districts and state level; [d] data may not be available for some districts (for instance if new districts are carved from existing districts). Though many people try to circumvent these issues with the help of data from various sources despite its inconsistency, still the applications of science and technology cannot be ignored which has its own path. The argument was supported by a case study on Dudhwa National Park where in the speaker made an attempt to identify loss of Forest and Grassland due to flood .He had used three techniques for the study viz., Image Restoration Technique, Image Enhancement Technique & Information Extraction technique. He compared three year data to observe the change (1991, 1996, and 2001) .The study found that (Siltation & Flooding) are the two key factors behind the loss of forests and grassland which can be addressed by aligning river-banks with the stones of riverbed. The method is advantageous as it [i] increases the infiltration power of river, reducing flooding capacity; [ii] stops the lateral growth of river (reducing erosion activities inside the park); [iii] reduces insitu production and deposition of silt from the immediate surrounding, which is a major threat to Terai grassland; [iv] facilitates the construction of roads along the river sides, which in turn would reduce the siltation from the adjacent areas; stone pitching also works as a hurdle to soil eroding agents. The author assessed the impact of land use and land cover changes with the help of remote sensing technology without relying on the inconsistent secondary data, it used digital image interpretation (DIP) to identify the changes in the course of rivers, areas of inundation and loss of grassland due to various natural phenomena. This led to the analysis of the geomorphic terrain conditions and extraction of necessary conclusions to restore the remaining grassland, which is under serious threat from siltation by various mountain rivers.

Discussion:

The participants mentioned that though Mr. Sahu attempted to quantify various forest resources that had depleted over the years, it would have been of great interest if such resources are valued and the value is deducted from GDP and such relationship would have been highlighted. Another participant pointed out that the accuracy rate of information obtained from remote sensing is 87 – 88% . The GIS and GPS technology are tools to estimate the forest cover mainly but lacks in providing data regarding species density, types of species. Though higher type of resolution can identify the species, it is difficult to identify age distribution.

Paper Title : Physical Accounting of Forest Resources

Author : D.Pandey, S.Dasgupta, Prakash Lakhchaura

The paper provided an overview of status of forest in our country. The speaker intervened that FSI not only has data related to Forest Cover and some inventory but also have data on species identification, density etc. He highlighted the importance of Physical accounting of the forest resources which is essential for policy and planning purposes. Accurate assessment of various parameters of forests including forest cover by density and type, growing stock by species and diameter class, annual increment, volume and extent of NTFP & medicinal plants are essential for conservation, valuation and sustainable development of the resources. Scientific forest management in India for the last 150 years has yielded considerable data on the forest resources of the country but still there are gaps in the database which are significant. The high diversity of forest types in the country and the vastness and spread of the forest resource are primarily responsible for this gap. As a result, the value of forest resources and its contribution in the country's GDP is poorly understood and grossly undervalued.

Forest survey of India generates two kinds of information. One is spatial information such as forest cover by type and density, information on fire etc. and the other is non-spatial information such as growing stock/volume of wood inside and outside forests. Both spatial and non-spatial information are based on latest technologies and are regularly updated. The information is extensively used for effective planning at National and State level. The paper stressed the need for harmonization among data collection agencies, need for unified database on forestry sector, reliability of data collected, updating of reliable data on periodic basis and identification of a nodal agency on forestry database, to act as a link between different agencies. On the whole, he attempted to delineate the parameters for the proper physical accounting of India's forest resources, the present status of assessment and the manner by which the assessment can be improved.

Discussion:

It was pointed out that the paper well highlighted the fact that forestry sectors contribution to GDP is grossly underestimated. One truck of timber is recorded but other 15-20 trucks of timber go out un-recorded and the same is the case of many MFPs. Another participant mentioned that forest statistics can be collected from various forest departments but the available data is limited and accuracy level is near 25%. Further MFP data is available at the state level and not at the district level. Another participant stressed the need for a nodal agency to collate and assimilate the data from various sources for the purpose of users as simultaneous efforts using different methodologies adopted by many agencies lead to different outcomes and create confusion amongst users.

Response:

In response to above queries and suggestions, Mr. Dasgupta commented that ICFRE Dehradun has been given a project to assess the quantity of recorded and non-recorded forest products including MFP. The work has been done but the report is still awaited. Further ICFRE has also started inventory of herbs and shrubs. Similarly assessment of quantity of un-recorded gum, tendu patta and other MFPs can be taken care of but the methodology is an important factor in this regard. Due to decreasing manpower and increasing work by government of India, it is getting very difficult for FSI to perform multifarious tasks.

The Chairperson Dr. Vivek Saraf summarized the discussion in the end by highlighting the importance of geo-spatial technology and tools for collection of data for land and forest resources. He also cautioned about ground reality of such data instead of taking it as it is. Finally he emphazised the role of such estimates in the National Accounting and Valuation of land and forest resources.

Session 2 : Environmental Issues in Natural Resources with particular reference to Land and Forest Resources Use

Chairperson : Dr. J.B.Lal Rapporteur : Mr. Lingaraja Sahu

Introductory Address: Chairperson

Talking about the doctrines of forest management, he focused about some of the sustainable practices or management practices ranging from sustained yield to integrated natural resources management. As the concept of sustainability changes from one geographical area to the other, he mentioned that it is very important to acquire various aspects of knowledge and put them with right kind of combination. But in the recent foray, it has been observed that the human value system is completely lacking. He also opined that the participatory knowledge is the conglomeration of indigenous and scientific knowledge and hence indigenous practices and knowledge cannot be underestimated, as this can play an important role in shaping the sustainability issues in the context of integrated natural resources management.

Discussing about the major goals of natural resources management, he opined that the same can be described under three heads: [1] stability of physical environment; [2] productivity of physical environment; [3] equity in social environment. He also emphasized about the monitoring of critical biodiversity in the natural system in order to maintain an eco-balance, which is not only important to the existence of that particular species but also for the sustenance of other species dependent on it. In the similar context he also said that less importance has been given on grass land despite its high ecological values. He has also given a great emphasis on "land use weighted by energy density" system for decision making criteria for the management of natural resources.

After his introductory note he invited presenters for sharing their research and experience with the participants.

Paper Title : Use of Agrochemicals in India

Author : Dr. Renu Bhardwaj

The speaker has brought upon the issues related to the increase in food production with the help of three independent variable multiple regression models. Even though, the area under food grain has not increased, in the mean time the production has increased. This may be because of the increase in irrigation by 2.35 times, pesticide by 20.37 times and fertilizer by 122 times. She also mentioned that on one hand, the use of bio-pesticides has increased from 1956 to 2004, on the other hand the use of pesticide has gone down after an increase from 1956 to 1990 (approximated from the bar diagram). Discussing about the results she mentioned that the fertilizer has shown a linear correlation and pesticide has shown a linear relation to some extent and then reverted back i.e. shows a non-correlation with the effective yield. She also said that irrigation has a better impact than the fertilizer and furthermore, fertilizer has a better impact than the pesticide as concluded from the multiple regression models. Fertilizer, irrigation and pesticide and better farm technology can increase the yield by manifolds.

Discussion:

The participants found the linear relationship of fertilizer and pesticide to the yield interesting and mentioned that integrated management of agriculture with promotion towards organic farming should be stressed.

Paper Title : The Position of Forest in Orissa – A Critical Analysis

Authors : Dr. K.C. Pani and Shri B.N. Mohanty

He presented an overview of the forests in Orissa state with the help of secondary data, importance of forests in state's economy and existing system for forest accounting, and suggested for improvement in accounting network etc. along with the inter and intra departments coordination for effective management of natural resources. He raised concern about the decrease in contribution of forestry sector to NSDP (overall picture), despite an increase in the forest area (as reported by FSI). He suggested a detailed investigation in to the matter. As per the various G.O.I reports, forest area under forest department is almost 45%, whereas, the forest area under revenue department is almost 55% but no proper coordination seems to be existent between these departments. He argued for a better cooperation with the establishment of a separate cell to monitor and coordinate various works related to better management practices in the forestry sector. He stressed the need for inter departmental cooperation for natural resources management of the state. He further stated that for forestry resources assessment upto block level, emphasis should be given to the preparation of a concrete master plan to convert non-forest land to thick forest land and enough budgetary support should be provided to conserve and regenerate the degraded forest land.

Paper Title : Status of Forest and Land resources in Jharkhand

Author : Shri Pravin Kumar Gupta

He made a general presentation on land and forest resources of the state of Jharkhand. He mentioned that the Ministry of Environment & Forests, Govt. of India launched a Scheme during the 10th Five year Plan for assisting the State Government/UTs to bring out State of Environment Reports (S.E.Rs) on triennial basis. The State of Environment Reports provides an over view of prevailing Bio-Physical and Socio-Economic Conditions in a particular area. This gives an opportunity to assess how human activities affect the environmental conditions and their implications on human health and economic well being?

He talked about an organization 'India' a non-profit research development and consultancy organization established in 1983 under the Societies Registration Act. It fosters the new relationship in the people, technology and environment interactions needed to attain the goal of sustainable development. The ESRs deal with the green issues, the term used to describe the issues related to agriculture, deforestation, land conversions & destruction of pristine areas; blue issues which describe the forms of water related issues, i.e. ground and surface, marine and costal water etc. and the brown Issues to describe the issues related to industrialization, urbanization, transport energy and other pollution related issues. Further the Jharkhand State Pollution Control Board was constituted after the separation of the Jharkhand State from Bihar on 9.9.2001 under the Prevention and Control of Water pollution Act, 1974. Soon after declaration on 15.12.2001, the board started implementing environmental legislation within the territorial jurisdiction of the State. The paper concluded with the comments on lack of coordination between statistics department and forest department.

Session 3 : Availability of Environmental Data in different Organisations

Chairperson : Mr. S. Dasgupta, Rapporteur: Mr. Alind Shrivastava

Introductory Address: Chairperson

The session began with introductory remark of the Chairperson who highlighted the diversity of benefits of watershed management, conservation of natural and heritage sites and land and forest resource accounts. He then invited the speakers to share their work with the participants

Paper Title : Watershed Management Data Base in MP

Author : Ms. Ritu Bharadwaj

The basic rationale of the paper was to provide overview of Rajiv Gandhi Watershed Mission of the state of M.P. including different approaches like Demographic, Integrated watershed development programme and participatory approach of watershed management and Community led campaign for water harvesting in the villages called Pani Roko Abhiyan. Watershed management provides livelihood security to the people in rainfed / dryland areas by improving their resource base, improving agriculture production and incomes, contributes to ecological security and thereby food security by focusing on poor regions and poor people and reduces impact of drought. The speaker also shared the concurrent evaluation process of the mission in addition to mid term & end term evaluation, identification of gaps in implementation, feed back & handholding support to PIA assessment of corrective measures. She highlighted the innovation in planning process adopted under the program, water budgeting , maintenance of Water Resource Registers and indicators of monitoring system.

Discussion:

The Methodology and data set provided by the paper was appreciated for its comprehensive approach.

Paper Title : Baghs And Bagiyas In The City Of Bhopal

Author : Dr. Meera I. Dass

The speaker highlighted the importance of man made environment as part of the larger environment and man made environment verses natural environment. Complex concepts of this relationship can be seen at Sanchi in the visual depiction. The ancient literature is full of festivals in honour of Forests, Mountains, Rivers etc.Nature was eulogized in hymns, systematized in rituals and symbolized in art forms. It was man's relationship with the sacred and the divine. It was the very centre of one's being, existence.

Construction of Mosques and Gardens was considered meritorious in Islam. Mughal gardens are well known and admired for their exceptional beauty such as Shalimar gardens. Other Islamic rulers emulated them and made gardens too. A tradition of building gardens for merit came up in Bhopal where the entire city was bordered with gardens. She shared information about the architecture and gardens of Bhopal and their significance in Bhopal's lifestyle. Concepts of the entire city as a garden (72 baghs) was depicted .Some survive in altered form. None survives in the original form. Old maps and surviving names point towards the location of these former gardens The monument, building and garden which once considered being glory of Bhopal city have detoriated with passage of time. This monument, structures & gardens have to be conserved such that the tradition and culture of Bhopal city continues to exist.

Discussion:

The participants appreciated the variety of natural and man-made heritage sites of the city and supported the need for generating information and data base for their conservation as the presentation was also a prologue to the next day morning educational tour to these sites. Participants showed their keen interest on learning while visiting sites.

Paper Title : Land resources accounting – Methodology and Data Issues

Author : Dr.Haripriya Gundimeda

The speaker first presented the characteristic of Land resources in the SNA. Land is an asset, which unlike any other natural resource cannot be created or destroyed by man, neither can it be imported/exported. But there can only be implications due to degradation of land. The 1993 SNA includes only land areas over which ownership has been established and that can be put to economic use. Within the SNA, recreational land is one of the exhaustive categories of land, e.g., land which is used for both agriculture and recreation is treated as one or the other, depending on whether its value as agricultural land exceeds that of its value as recreational land and vice versa.

She further explained the status of land resources in the SEEA. The economic view of land is only part of the picture. Explicitly SEEA includes all land on the grounds that it might one day provide use benefits even if it does not today. Land and surface water assets are sub-divided into five categories: land underlying buildings and structures; agricultural land and associated surface water; wooded land and associated surface water; major water bodies and other land. The categories are determined by use – for example, recreational land has a dual use, it can legitimately be allocated to two headings. In order to have a categorization where the sum is that of the total available land area, recreational land can be shown as an "of which" item under the relevant headings.

She further threw light on flows relevant to environmental accounting like transfers to economic assets (e.g. if land is transferred from a wild or waste state to one in which ownership may be established and entering the system boundary), changes in quantity due to (changes in) economic use are regarded as the appearance or disappearance of additional amounts of assets, e.g. change from cultivated land-to-land underlying buildings resulting in an increase or decrease in the value of land; changes in quality as a result of environmental degradation, e.g. erosion, nutrient loss; changes in status, changes due to political and catastrophic events, e.g. due to abnormal flooding or earthquakes, changes in classification, e.g., changes in land use for a particular parcel of land. Changes during the beginning and the end of a period that are the result of price changes of land over time and that are recorded in the revaluation accounts.

She then talked about uses of comprehensive system of land accounting which provides complete picture of land cover and land use for a nation and allows deriving trends and indicators of change. It aids the integration of diverse data source on land cover and land use as well as other data e.g. on population, economic activity, water balances, species or fertilizer use, promotes standardization and classifications of land cover, land use and causes of changes in land cover and land use.

In case of accounting for forest resources there is need to construct physical accounts by opening Stock, accounting for depletion or addition and then close the accounts, e.g. for physical account of carbon & timber we need to have opening stocks (stock of timber and carbon present at the beginning of the accounting period) , which includes area accounts and volume accounts of timber. Further we need to have value account for timber, value account for carbon and integrated forest account.

Discussion:

A query was raised regarding type of land utilization and various environmental services from land sector which have been taken into consideration while constructing account for land resources,

Responses:

Land is shown under the non produce account of the integrated system of accounting. The methodology has been prepared and certain assumptions are made to make the methodology functional as a number of problems is faced while constructing land resource accounts. The changes in stock of land and forest are adjusted with state domestic product .But while making adjustments we also need to account changes in the stocks due to other reasons say earthquake which is on account of an environmental activity and not in economic activity. We put such changes under different head structures i.e. other volume changes and other accumulations. Other volume changes are not under control thus it is not deducted from GDP.

The session was concluded by closing remarks of the Chairperson. He highlighted the usefulness of all three papers presented in terms of their methodological framework addressing diversity of resources

Session 4 : Methodological frameworks for Physical and Economic Accounting of Forestry Resources

Chairperson : Dr. Sudhakar Reddy, Rapporteur: Mr. A.K. Yadav
Introductory Address: Chairperson

The session was chaired by Dr. Sudhakar Reddy, Indira Gandhi Institute for Development Research (IGIDR), Mumbai.
Dr. Sudhakar Reddy in his opening remarks emphasized the importance of preparing Natural Resource Accounts such that we have greater control on the sustainable use of natural resources. He advocated that Government should set up some social institutions that will work towards the advocacy of conservation of natural resources. He remarked that an accounting methodology that would capture all the goods and services provided by environment sector, is not currently available to all concerned for its ready and easy use. He then invited various resource persons to make their presentations.

Paper Title : Methodological Frameworks for Physical and Economic Accounting of Forestry-The Case of Mangroves in Gujarat

Author : Indira Hirway & Subhrangsu Goswami

The speaker at the outset highlighted the importance and characteristic of Mangrove Forest which is a salt resistant forest ecosystem growing in the inter-tidal zone on sea coasts. They grow into thick forests, creating almost a wall on the coast .They grow only in suitable environment, where there are mud flats, water flows and suitable temperatures. She then emphasized on economic & ecological importance of mangroves. They not only provide fuelwood (also charcoal), fodder and timber, but also one of the most productive eco systems in the world, they support and provide breeding ground for a large variety of marine lives and ecosystems. Amongst the commercial uses cosmetics, medicine and a variety of other products like alcohol, gum, honey etc and wood products are provided by them. They protect the agriculture against saline water, strong winds, coastal property, life and provide livelihood to many. They also help in stabilization of sediments, regulate flooding and temperatures, carbon sequestration and other ecological functions.

The paper mainly talked about the unique ecosystem of mangroves, and the goods and services they provide at various levels, from community to global scale and there is an urgent need to capture these values at various levels. She stressed that mangroves are natural capital, which have a potential of contributing significantly to the development of the coastal region in multiple ways. There is a need to explore this possibility of development, which promotes both the economy and the ecology. She explained carbon sequestration value of mangroves. The major policy implication is that any policy or project that affects mangroves adversely needs to be weighed systematically against the environmental costs of loss of mangroves and systematic efforts should be made to regenerate mangroves on Gujarat Coast.

Discussion:

A query as to why only carbon sequestration value was considered, when there are other ecological values relate to mangrove forest, was made by the participants.

Response:

The value of carbon sequestration was taken because the data were available for that. There were other ecological functions which have been utilized from the mangroves but the data regarding the same was not available.

Paper Title : An Impact Study On Forest Resource Accounting Through Participatory Mode In West Bengal

Author : Prof. M.M. Adhikari & Dr.Kausik Pradhan

The presentation began with highlighting importance of participatory approach in development issues. The participatory development involving the people has been recognized and perceived as an integral process for the success of all development schemes, especially for the large unfenced, sprawling forest resources surrounded often by the impoverished rural people. The speaker then gave a brief introduction to the Joint Forest Management or Participatory Forest Management which entails the involvement of local people in management of forests. Government of West Bengal realized the need for a paradigm shift from traditional custodial forest management to participatory approach with the local people and issued an order in 1987 for bestowing 25% share of the revenue earned through sale of the regenerated crop. Then Government published an enabling resolution in 1989 recognizing the need of the people's participation in forest management and detailing the modes, procedures and rules for sharing arrangement. This approach changed power relationship between the forest department and community people with a bottom up concept.

Realizing that active participation and involvement of the local people are vital for regeneration, maintenance and protection of the Sal and other hardwood forests and plantations in the district of Bankura and other parts of West Bengal have been taken care under JFM. The present study envisaged the physical resource accounting in some forest fringes through participatory way of statistical accounting. The paper discussed the concept, field methods and impact of participatory vegetation monitoring under the aegis of the sustainable ecology management. The paper concluded that the people are working successfully with the forest department and they had built a sense of belongingness within themselves. The communities decide about the process of felling the trees and helping the forest department regarding the regeneration of the economically beneficial species in their forest fringes. Thus communities being aware about the harmful and beneficial species of their forests, accordingly harvest the species and also take the help from the NGO to build their capacity regarding the income generating approach from their forest resources.

Paper Title : A Study on the Contribution of Different Plantation Schemes on Rural Life – A Case Study of West Bengal

Author : Dr. Ranjit Chakrabarty & Mr. N. Bhattacharya

The speaker began his presentation by presenting the status of forest in India where massive degradation of the forest has threatened the environment, which has been now been realized by all. The thought and social processes concerning the environment issues are reflected in the Constitution of the Republic of India adopted since 1950. He then spoke on legal status of forest. The Directive Principles of State policy are an integral and significant element in the constitution of India, contain provisions, which reflect the commitment of the state to protect the environment with regard to forests and wildlife. The Directive Principles of State policy enjoins upon the citizens of India the special responsibility to protect and improve the environment. The roots of the growing trends towards popular participation in our conservation and national resource development programme lie in this constitutional requirement. In 1970s the foundation of the present day institutional framework for the environmental programmes in India was sown with the establishment of the National committee of environmental Planning and Coordination immediately after the historic Stockholm Conference on environment held in 1972. The committee gradually transformed into the Department of Environment in 1980 and five years later to a full fledged Ministry of Environment and Forests (MOEF) of the Government of India (GOI). The state governments also have their own Departments of Environment to implement the policies and programmes in the environment and forests sectors. A case study of social forestry and their role in lives of rural people was presented. Though social forestry crops take a long time to mature in comparison to other agricultural crops produced by the rural people, but social forestry system helps the government to earn the revenue by utilizing unused government lands as it is controlled by the community. It also helps the government to promote the rural development and to prevent land and forest deterioration. Crops of social forestry need community mechanism for their protection and distribution of benefits and absorption of cost.

Paper Title	**:**	**Proposed Methodological Framework and Data Issues for Physical Accounting of Forestry Resources: Learning from the States of Madhya Pradesh and Himanchal Pradesh**
Author	**:**	**Madhu Verma, C.V.R.S.Vijaya Kumar, B.R.Phukan, Akhilesh Yadav & Atanu Rakshit**

The speaker presented the recent work that she and her team have done for CSO to develop a methodology and framework for asset and flow accounts for the land resources and forest assets. The contribution of forestry sector to the GNP i.e. the value of forest reflected in the System of National Accounts (SNA) represents less than 10 % of the real value. In 2000-01,the contribution of Forestry and Logging sector to India's Gross Domestic Product (GDP) at factor cost at 1993-94 prices was Rs.12,816 crore, which was 1.7 % of India's total GDP. Thus on account of this q*uid pro quo* approach the budget allocation to forestry sector is miniscule against the National Forest Policy of GOI wherein it aims at having one third of its geographic area(2/3rd in hilly and mountainous regions) under forest and tree cover which is currently 757,009 sq. kms.(23.03% of geographical area); forest cover - 675,538 sq. kms.((20.55%).This adversely affects the management of forests in the country.

She then presented land sector status and accounting process based on review of SEEA framework and methodology developed under the project. Presentation as made on land cover and land use breakdown, changes in land cover by categories of change, land use stock changes, both physical and monetary and degradation and depletion account again both physical and monetary.

The speaker informed that the following accounts have been developed for the forest Sector like

- Physical asset accounts- Volume and Area
- Physical asset accounts- Commercial working
- Monetary asset accounts- Volume and Area
- Flow accounts- Goods and Services
- Degradation and Depletion account- Physical and Monetary
- Expenditure for forestry management & protection
- Accounting matrix for ecological services/amenities

The asset accounts record stocks & changes in stocks of natural resources over time. Forest asset account typically includes balance account for forest land & stocks of standing timber, both in Physical and Monetary terms. The asset accounts- commercial working are developed for land available for wood supply. Area accounts use extent of total forest area of the state. The flow accounts for forest goods & services includes both cultivated and natural forests and attempt to include all forest goods and services both marketed and non-marketed in flow accounts. The expenditure for forestry management & operations doesn't add any new information to the national accounts but reorganizes expenditures in the conventional SNA that are closely related to the protection & management of forest.

The deforestation, depletion & forest degradation accounts based on the depletion cost (SEEA 2003) more consistent with economic depreciation i.e. the change in asset value from one period to the next relies on good data linking the physical status of a forest and the services it provides. She then presented the data that has been colleted and fed into various accounts so mentioned. The policy inputs that can be inferred to from the tables were also shared.

Discussion:

The participants wanted to know whether the FAO framework has been used for understanding depletion and deforestation. Another participant wanted to know whether input/output tables of 1998, 2003, 2004 have been used in the study. The participants wanted to know the process of construction of various tables presented in the paper.

Response:

The author informed that the international definitions have been followed for various terms as they were given to use SEEA framework for accounting of land and forestry resources. Further the report which is currently under submission to CSO contains all probable step that have been used. On its finalization the report can be accessed from CSO and methodology could be understood to construct natural resource accounts.

The Chairperson Dr. Sudhakar Reddy summarized the discussion in the end and recommended that soon we should have standardized framework for physical and economic accounting of forestry and land resources in a simple format.

Session 5 : Methodological frameworks for Physical and Economic Accounting of Land Resources

Chairperson : Dr. Sudhakar Reddy, Rapporteur: Mr. Lingaraja Sahu

Introductory Address: Chairperson

Dr. Sudhakar Reddy in his opening remark emphasized that though we are discussing physical and economic accounting of forest and land resources in two separate sessions but in practice we need to integrate the two sectors. In fact forest is the sub set of larger set of land resources. Any change in one sector triggers of changes in the other since they are inextricably linked to each other. He then invited various resource persons to make their presentations.

Paper Title : Environmental Impact of Subsidies: Case of Agriculture

Author : Rita Pandey

The major focus of the paper was on environmental stresses and indicators that have to be identified and collated to design policies. Agricultural impact on environment could come from the types of crops used, conditions etc. Yield may response to the relief of agricultural stresses. Hence, there is a need to understand the impact of various agricultural stresses rather than mere addition to the yield. One way to evaluate the effects of subsidies is to measure the demand for inputs, careful study of the stresses that may be caused because of the level of inputs and its impact on the health and welfare of human being. We need to study the impact of predominant production practices. She also focused on lack of consistent data on environmental aspect from various sources and reliability of data.

The paper, provided an analytical framework to identify the environmental impact of subsidies to agricultural inputs and analyse its implications for the sustainability of agriculture. To deal with this topic it focused on fertilizer, irrigation and power, subsidies to these inputs are given in different forms and sizes. A number of studies have attempted to measure the magnitude of these subsidies. Depending on the definition of subsidy used, the magnitudes of subsidy have varied. However, there exists one commonality between the policy implications of these studies. All the studies bring out that in addition to straining budgets, subsidies to these inputs distort their prices and thereby affect levels of their use, which have wide ranging implications for the environment and the economy. Here, the speaker brought out the environmental implications of the subsidy induced demand of these inputs in agriculture. The paper recommended assessment of data periodically by union government, more research studies to debate on the quality of data. The speaker at the end showed concern as to what extent the subsidy is admissible and above what limit, the subsidy is inducing negative impact on environment. The data on such aspects need to be collected from field as different agencies do not have adequate or consistent information on environmental impacts of various subsidies.

Discussion:

The participants commented that though the study does not provide a methodological framework to generate the environmental stress data due to time constraints, it is a good idea to develop an environmental quality curve so that we get an indication of negative impact of various inputs on agricultural yields. Another participant commented that though two main points have been highlighted in the presentation namely negative impact of excess use of agricultural input on the environment and policy towards subsidy, there should have been more details of impact of policy of subsidy, on increase in the agricultural output.

Response:

The assumption in the study was conceptualized by the fact that subsidy induces consumption of agricultural inputs. The government has been providing subsidies for in-organic fertilizers but no subsidy is given towards organic farming which is a treatment for checking in-flow of heavy nutrients towards lakes, rivers and other water bodies.

Paper Title	**:**	**Towards a Framework of Land Resources Data Collection for Planning for Sustainable Growth**
Author	**:**	**Vishnu Kumar and Aloke Kar**

The speaker introduced the type of Land resources by status of legal control into three type as (i) privately owned land (ii) revenue land (iii)forest land .The paper then gave an account of land use practices in India. Out of the total geographical area of 328 m ha., privately owned agricultural land is 50%, land under forest is 23%, common property resources are15% and rest 10% to 12% are revenue land. He shared the current sets of data available on land resources like Land Use Statistics (LUS), Forestry Statistics and Land Holding Statistics .He emphasized that the LUS is the most comprehensive supply-side data. On the use side, land holding data and LUS confined to use of private land. The major limitations of Land Holding Data are that the number of operational holdings suffers from over-enumeration. He highlighted the significance of existing datasets but stressed that we need to collect village-level data on availability of different categories of land from the land records and data on their ownership, possession and use for consumption and livelihood by households through enquiry method . Further we need to provide data on ownership, operation, leasing and use of private property land resources; on availability and accessibility to CPR, particularly revenue and forest land in the village and shall have to provide data on dependence, utilisation on the CPR for each category of households, including landless labourers' household and those not pursuing any agricultural activity for its wider use for analysis and policy inputs.

Paper Title	**:**	**Physical and Economical Accounting of land resources**
Author	**:**	**Dr Indira Hirway**

The speaker at the very beginning emphasized that the land is one of the basic components of environment. It performs three major functions as far as the interface between environment and economic development is concerned:

1. Land performs environmental functions, such as, retention of water and moisture as well as retention of soil nutrients to support vegetation cover, maintenance of geological properties of land etc. for sustenance of environment, bio diversity etc.

2. Land performs economic functions related to agriculture and allied activities such as, production of food crops, non-food crops and raw materials for industries, production of fuel and fodder for human beings and animals, production of mineral resources, sustaining forest produce – all of which support and promote economic development, and

3. Land also has other economic functions in the non-agriculture sector. It provides space for housing and settlements in rural and urban areas, as well as for industries, trade and other non-agricultural uses.

Loss of soil and moisture of land under non-agricultural use need not be treated as land degradation. She shared her exercise of quickly valuing the cost of land degradation of the changes in the land put to wasteful use during the 1980s and 1990s, and to estimate its value using the right price; the changes in the cultivated area (net sown area) during the 1980s and 1990s, and estimate its value using the right price: examining the land degradation in general during the period, and estimate its monetary value.

All the three exercises mentioned above define land degradation as the process of loss of current or potential biological or economic productivity of land. This may take place due to climatic variations and human activities. This broadly includes the process of soil erosion by wind and water, soil salinity and alkalinity, water logging, long-term loss of vegetation, and deterioration in various other physical, chemical and biological or economic properties of land. Land degradation, however, is a wider concept and it includes soil degradation as well as degradation of water, vegetation, landscape and micro climatic components of an ecosystem. She emphasised that the major problems with these data are that they are not time series data, they do not give comparable estimates of wasteland in the 1980s and 1990s (except for the land utilization statistics of the government of Gujarat, which are not fully satisfactory). As a result, we couldnot estimate the value of land degradation in the 1980s and 1990s. At the end she mentioned that as we do not have data on the wasteland separately for agricultural land and other land uses. We cannot estimate the impact of degradation of agricultural land on other areas.

Discussion:

The paper provided link to various presentations and difficulties currently faced for constructing land resource accounts. The participants supported generation of additional data and provisioning of framework for statistical accounting of land resources.

Paper Title : Environmental Status Report of Madhya Pradesh

Author : Mr. Lokenndra Thakkar

The speaker shared the details of the state of environment report of Madhya Pradesh. He highlighted the environmental stresses in the state. He also raised question about the use of these reports in the policy and decision making process. Sharing of data is again a problem and collecting and collating of data has been a tiring exercise at the state level and hence the generation of these statistical data has to be brought down to district level with adequate graphical diagrams and pictures to explain things more lucidly and vividly with a focus to add more and more participation in data generation and its use. He then gave the overview on functions of EPCO and the status of environmental data in MP.

Discussion:

The participants emphasized on the necessity of developing systematic data bases on various environmental resources not only by state but also by specific departments and institutions. Such coordination and exchange of data shall help giving right signals regarding status of environment for its consideration in the decision making and policy formulation process.

Paper Title : An Overview of Land Pollution in India

Author : Dr. J.K. Saha and Dr N. Panwar

The speaker raised environmental concerns due to land pollution in India. He mentioned that the Engineering sector reduces waste water by 42 % and holds the first rank in India. He said that the use of waste water could be made with precaution as some of the studies have revealed that some of the plant species do not react to the change in the quality of water. Organic Carbon is a most important component of soil and hence, more focus has to be given to increase its concentration. He promoted use of compost. Waste water treatment are needed to reduce the environmental impact on ground water. For regeneration of forest areas, Industrial waste water can be used in arid zones. Degraded lands can effectively be rejuvenated by tree plantation and in fact forest can play an important role in minimizing pollution. Industrial & municipal wastewater have the potential to be used for tree plantation in arid zone and municipal solid waste composts with high amount of heavy metals are prohibited for use in agriculture. Such MSW composts can be used to reclaim degraded land through tree plantation.

Discussion:

The participants emphasized the need of detailed soil quality data for the use of appropriate technologies.

The session concluded with vote of thanks from Dr. Sudhakar Reddy for presentation of high quality papers. He reiterated the need for constructing standardized formats for collection and accounting of land resources in India. With this the individual paper presentation ended. This created an appropriate ground for putting forward thread-bare discussion on preparedness of various departments for statistical accounting of forest and land resources with a panel of experts comprising of practitioners, academicians and data users in the next session.

SUMMARY OF PANEL DISCUSSION

Preparedness of various Departments for Statistical Accounting of Forest and Land Resources

The panel discussion was chaired by Mohd. Hashim, Principal Chief Conservator of Forests, Govt. of M.P. The panelist were Mr. Avni Vaish, IAS, Principal Secretary Forests, Govt. of MP, Bhopal, Dr. A Subba Rao, Director, Indian Institute of Social Sciences(IISS), Bhopal, Dr.Indira Hiraway, Director and Professor, Centre for Development Alternatives (CDA), Ahmedabad, Shri J. Dash, DDG, CSO, GOI & Dr. JB Lal, IFS(Ret).The session was moderated by Dr. Madhu Verma .

Panel discussion began with introductory note of Dr. Madhu Verma who highlighted that the immense data currently generated by various agencies need to be maintained in an organized manner for its rightful use and analysis by user of various agencies. Further the existent data gaps should be filled up such that correct information goes into decision making process. She shared the efforts made by CSO and by various institutions in developing methodologies for Statistical Accounting of Forest and Land Resources for incorporating both tangible and intangible benefits and costs associated with forest and land ecosystems. She mentioned that this exercise should not end in project mode. Thus at this stage it is very essential to understand the preparedness of various Departments for Statistical Accounting of Forest and Land Resources. It is necessary to know whether the existing system in terms of manpower and time shall be able to carry forward the work of NRA or some additional resources and capacity building shall be needed for the purpose. She then requested Mr. Hashim to kindly chair the session and commence proceedings. Mr Hasim invited Mr. Lingaraj Sahu and Mr. Akhilsh Kumar Yadav. to present an overview of two days proceedings of the seminar such that panelist get informed about various efforts in the direction of environmental accounting and then accordingly discuss various issues.

The chairperson stressed the importance of availability of data for judicious and sound decision making process and then invited viewpoints of experts and comments from other participants. The views put forward by the experts and related discussion was as follows:

Dr. J.B.Lal: We are aware that economic valuation of intangible and tangible benefits is very important. We also know that use of plastic is harmful for environment but we still use it. Being aware is one thing and being sensitive is another thing. This happens as we are not able to visualize value of damage it causes to us. Thus appreciation and understanding of economic valuation is very important. But at the same time many difficulties arise for economic valuations like (i) lack of framework for Natural Resource Accounting; (ii) long gestation period of forest. even if we are going to harvest tree in minimum period of 20 year, then also it’s a long period, (iii) it is very difficult to differentiate between capital stock and incremental stock. It is difficult in case of timber but it is more difficult in case NTFP on account of lack of its valuation in most cases. Further externality in forestry sector is very high as compared to other sector. Thus it becomes essential to generate data regarding various services from forest and other natural resources for appropriate use of such resources.

Dr. A Subba Rao: Tools like GIS and GPS provide us with broad figures like degraded land. For land erosion due to air, wind, water we have state level data, but still district level data or regional level data are missing. So we have to use latest statistical tools and sampling methods to generate ground level data.

Jogeshwar Dash: So far as CSO is concerned, we are not only targeting forest & land sector data but our goal is to eventually go for Green GDP and where we have to make adjustment with all type of natural resources including air, water, mineral, land and forest. Green GDP in India as well as in many other developing countries is not in advanced stage. We are making the attempt. Role of CSO is to act as facilitator to generate green accounts.

For each sector methodology has to be developed and our consultants have been doing this job. For developing methodology, we have not assigned the task to any government departments but eight projects to specialized institutes. These institutes have their subject specialist. Out of eight projects, four project reports of the first cohort have been submitted and we are waiting for final view from the experts. We believe the proposed methodology and generated datasets of each of report to particular subject area will address wide range of issues and will be disseminated for larger use. Special mention of two projects done by Dr. Madhu Verma and her team at IIFM and Dr. Haripriya and her team at MSE was made.

In a particular project, the data for statistical accounting is generated using a methodology based on pilot study for small area or taking state as a whole but when we go for the whole country we must have appropriate methodology suiting to all types of issues and which should be available not only once but on regular basis. Further data should have credibility, so that it could become part of CSO's major publication which is known as Environmental Statistics published for last 10 years. Currently it does not contain everything that we require for appropriate decision making. We have made an attempt through recent projects to generate such information.

Dr Hiraway: I would like to put forward my point from data user side. I would like to share my experience. We did environmental accounting for Gujarat and did methodology study of valuation of mangrove of Gujarat. We found that data are scattered, and of poor quality. You get data from multiple sources but the quality of data is many a time inconsistent as the agencies do not collude. Example of study on mangrove forest, many organizations are generating data like the FSI, Forest Department, ourselves and other state institute.We all are doing same exercise but we do not coordinate with each other. Another such institute is state level institute Gujarat Ecological Commission. Other institute of all India level like CSO, Eco-development board, central ground water etc. do work individually and do not coordinate. Problem is faced while accessing data for pollution. It is not available or produced even under Right to Information Act. Information on EIA, pollution of land is not unavailable. We don’t get groundwater extraction data and data on pollution by industry. Industries do not provide such data. .

Similarly data on common land from forest department and land records do not match, so you face problems when you intend to use it. Another problem is that one has to access data from two/three sources as one does not get complete data in required format from one source. In addition, the data is costly. For example if we require the data of rainfall of particular region it may cost Rs. One lakh. Data available through satellite imagery is very costly. Nominal charge everyone can pay but if they charge cost based price then it is much expensive. Further the political commitment to environment is very low. Study of environment is important when all the states are trying to achieve high economic growth. Environment seems to be low priority sector area.

Lastly CSO approach is positive indication in this regard and its the nodal agency in collating/generating data & developing methodology. I would like to give some suggestions to CSO. First it should coordinate with other departments. The directorate of Economics and Statistics in state level should also improve its working so that their expertise can be used for quality data. So far as NRA methods are concerned, we should depend not only on one model or framework rather on many methods like input output or satellite account. We need such data which could be used for social promotion, environmental consciousness, and for policy formulation.

Avni Vaish: We need to understand where we stand so far as NRA is concerned. I thought that accounting of forest resources is used at policy level. Two years ago while planning budget, we thought that we were taking care of ecological services contribution of forests and that MP should get additional resources for forestry sector contribution to GDP of state. But we are yet to get compensation. May be we could not put our case well, so I shall look forward for the study of IIFM. I would put a question -why only forest resources and not other all natural resources are taken into account. We need to consider both forestry and non forestry sectors in totality.

That's important area we need to look at FRA. Data is important for budget allocation, policy, planning process. It is also important to know what forestry sector is contributing. If we can correlate data of rainfall, groundwater, soil productivity, forest impact on economic & ecological cycles, it will provide meaningful information. There is very little attention on water management through forest and I would ask IIFM to conduct some study. Hydrological area is extremely weak area. I have asked IIFM to help to get some methodology, which will help in our working plan. It will help in resource mobilization based on hydrological study in policy making.

Mohd. Hashim:

I would like to highlight main points of discussion that :

- Forest Accounting is poorly reflected in GDP. For planning and management of sector in holistic manner, we need to do NRA on regular basis. It shall be useful in making our case for getting requisite funds we need for sustainable management of the sector.
- Public awareness is poor for intangible services of forest.
- Forest are capable of cleaning air ,soil, carbon sequestration, water recharge, and tangible benefit like grazing, removal of NTFP, which should also be accounted in our records.

The session ended with vote of thanks by Dr. Madhu Verma. to all dignitaries on the dais for a very fruitful discussion and memorable culmination of the seminar.

RECOMMENDATIONS OF THE SEMINAR

DATA ORGANIZATION

Land Sector

Data to be generated by different agencies and collated by a centralized agency for its wider use. Data to be generated following SEEA framework on the following.

1. Landuse and landuse changes from one use to another.
2. Impact of various economic activities on land uses
3. Depletion and degradation account of land.
4. Land cover and land use breakdown
5. Changes in land cover by categories of change
6. Landuse stock changes
7. Physical and monetary degradation and depletion land resource accounts.

Forest Sector

1. Species- wise, density wise, age wise, timber and non-timber wise Volume and area of forest
2. Stock and flow volumes and values of forest
3. Degradation and depletion estimates of forest
4. Expenditure on forestry management and protection
5. Physical and monetary values of stock and flows values of forest under JFM
6. Separate data for total and mangrove forest
7. Making exercise of forest resource accounting, a component of Working Plan Preparation of the forest department.

Future Research

1. Developing methodology for carrying out physical and monetary account of land and forestry resources at the district level or at the division level (for forestry sector).
2. Valuation study of specific type of forest
3. Valuation of land use changes
4. Valuing the ecosystem service from forest and generating market for such services.

Capacity Building

1. Use of modern techniques for generating data, its collation and preparation of specific data bases.
2. Use of methodology to generate stock and flow values of forest resources.
3. Preparation of Natural Resource Accounts by field level personnel
4. Regular organization of training programmes by CSO with experts of NRA

Chapter - 3

Summary of Valedictory Session

Summary of Valedictory Session

The valedictory session of seminar began with the welcome address by Dr.D.K. Bandyopadhyay, Director, IIFM. He welcomed all guests on the dais and expressed his happiness that the time of 36 hours, which were spent on the issues of accounting seem to have been very fruitfully utilised. He agreed that finalizing methodology for NRA was a very difficult task but in last two days many people who are working directly in this area expressed their opinion and shared their work. He was confident that all the presentations and discussions shall be prepared in the form of proceedings along with the recommendations by IIFM and shall be sent to CSO for fine tuning of the framework. He welcomed Shri Avani Vaish and introduced him as one of the very dynamic administrators of the state. He acknowledged very candidly that his presence in the valedictory session itself showed his concern and commitment towards the system of natural resource accounting. The Director also welcomed Shri Mohd. Hashim ,PCCF, Government of MP who is heading the forest department in the state like MP. He hoped that after fruitful technical sessions and very thought provoking panel discussion everyone would be going back enriched professionally.

Dr K.C.Pani, Asst Director, Directorate of Economics and Statistic, Orissa, one of the participant of the programme expressed his sincere feelings and gratitude to all the organizers of the workshop. He expressed that such seminars provide a good opportunity to share work which may go a long way in setting the objective ahead of us in national concern . Dr.K.A.D.Sinha, ADG, CSO expressed his happiness for very useful discussion and number of quality papers presented at the seminar. In particular, he mentioned about two excellent papers, one presented by IIFM and another by MSE on methodological details of NRA. These would be very helpful in calculating the green GDP. He complimented IIFM for doing an excellent job of coordination. He highlighted that they have had all necessary expertise and thus deserve full credit, in particular Dr. Madhu Verma and the team for the successful organization of seminar. He opined that feedback emerging out of deliberations will help CSO in conceptualizing the methodologies for NRA covering all the sectors. A lot of brainstorming though still be required to finalize them. Further considerable efforts will be required for gathering the required data which is presently not available but he felt confident that with expertise available at CSO and with other organization like IIFM and MSE in the field will surely be able to sort out these problems soon. He suggested that F.S.I though has also developed a good M.I.S for forest, but needs additional capacity building to cater the need of additional data requirement, which will be clear by finalizing the methodology by these two institutes. He stressed active involvement of state DES as well as central nodal organizations such as Ministry of Agriculture, Ministry of Environment and Forest for sustained formulation of NRA. He shared that accounting of degradation of natural resources is one step in NRA and valuation for the same is another important component which should be provided in the NRA framework. The valuation of physical stock is another vital area where a lot of thinking is required. He supported that NRA is a complicated subject and needs a multidisciplinary approach. In the end he thanked IIFM for its excellent organization of seminar.

The seminar further proceeded by address of Shri Mohd. Hashim,PCCF,Govt of M.P., who highlighted that forests are very important for the existence of human civilization and their livelihoods thus the contribution of forest accounting will be useful for the purpose of public awareness besides achieving others objectives. Stories from earlier days tell the importance of forest. But in the industrialization age because of extensive use of the use of timber, and other forest produce, the forest are shrinking and in other countries also forest are shrinking. Every year thousand of hectares of forest are cleared for the cultivation of Soya. He showed his concern as to how natural resources and forests are used for consumption of modern people, without realising that our survival and existence is in danger for e.g. rise in temperature due to extensive deforestation is creating hazard. He proposed that the information from NRA should be used for planning, awareness building amongst people and for making a case for preservation of forest.

Shri Avni Vaish, Principal Secretary, Forest, Govt of MP appreciated the work of Dr Madhu Verma. He stressed that the work which has been done by her and IIFM is in long term shall lay the foundation of giving forest and the forestry sector their due recognition of their contribution to the economy. Not much groundwork has been done for the same. He highlighted the work of Dr Verma who estimated M.P. opportunity cost of conserving such large area of the state under forest. He shared that the state has degraded forest land but no fund is available to rejuvenate that land. Had there been a mechanism for compensation for forest conservation, situation would have been much comfortable for us. Thus we are stuck in double bind. About 10 lakh hectares of degraded forest available but we cannot do anything. Because of this reason we have asked the central government for special package of compensation but the recognition is yet to come. He mentioned that he had been in environmental sector for a long time in various capacities and at various levels nationally and internationally and has been impressed by the fact that environmental figures play an important role in policy making. But on account on non existing correlation between policy and environment impact, not much could be achieved. Perhaps the environmental services rendered by forest are not recognized because of their intangible form, place factor, geographical location.The effect of forest is seen somewhere else than their original location like soil effects, water supplies etc. This type of correlation has to be worked out for wise decision making process.

In the end Dr CVRS Vijay Kumar, the seminar coordinator in his vote of thanks expressed his gratitude to CSO in showing confidence in IIFM and giving an opportunity to conduct the 6th National seminar on “Statistical Accounting of Land and Forestry Resources” at IIFM, Bhopal. He thanked Shri. Vishnu Kumar , Adl. Director General, CSO, MOS&PI for participating in the workshop out of his busy schedule and agreeing to be the Chief Guest of the programme and Shri KAD Sinha, Adl. Director General, CSO, MoS&PI for agreeing to be the Guest of honor of the inaugural programme; Shri Avni Vaish, Principal Secretary, Forests, Govt. of MP for accepting IIFM invitation and gracing the valedictory function and showing his seriousness on the issues. Shri Mohd. Hasim for his presence and valuable thoughts, Shri Jogeshwar Dash, CSO and Shri R. C Agarwal, CSO for their continuous support in many ways to make the event smooth and successful; the Chairpersons of various sessions for chairing the sessions and delivering key note address; Mr. Lingaraj Sahu, Mr. Akhilesh Yadav and Mr. Alind Shrivastava, rappourters of various sessions; all the Central and State Departments for sending their officers to this seminar; the media and press persons for the coverage of the programe; Prof. Bandyopadhyay, Director, IIFM for his constant support, Dr. K.N. Krishnakumar, Chairperson- MDP, Col. Ramesh Singh, Administrative Officers, various Assistants Managers, all others staff members of IIFM for successful completion of seminar. The valedictory session ended with final thank of Dr.Madhu Verma to one and all for their immense support and she assured that any future event if requested from CSO, shall be conducted with same enthusiasm at IIFM.

Annexures

ANNEXURE – I

Seminar on Statistical Accounting of Land & Forestry Resources, 28-29, April 2006

Programme Schedule

Date and Time	Programme
	Friday April 28, 2006
9.30 – 10.00 a.m	**Registration: Room No. 119**
10.00 – 11.00 a.m.	**Inaugural Session** **Introduction** : Dr. Madhu Verma, Programme Director, IIFM, Bhopal **Lighting of Lamp and Presentation of Bouquets** **Welcome** : Dr. D.K.Bandyopadhyay, Director, IIFM **IIFM Activities**:Dr. KN Krishna Kumar, Chairperson-MDP, IIFM Guest of Honour **Overview of the Programme :** Dr. CVRS Vijay Kumar, Programme Director, IIFM Bhopal **Key Note Address by :** Dr. Vishnu Kumar, Additional Director General, CSO, MOSPI, Goverment of India- Guest of Honour **Inaugural Address**: Shri K.A.D. Sinha, Additional Director General, CSO, MOS&PI, Government of India - Chief Guest **Vote of thanks**:Shri R.C.Aggarwal, Director, CSO, MOS&PI, Govt. of India **Overview of the Programme** :Dr. C.V.R.S.Vijaya Kumar, Programme Director, IIFM, Bhopal Rapporteur: Mr. Alind Shrivastava
11.00 – 11.30 a.m.	**High Tea**
11.30 – 1.00 p.m.	**Technical session – I** **Use and Role of Modern Techniques in Generating Data on Land and Forestry Resources** Chair: Dr. Vivek Saraf Director, Systems, National Centre for Human Settlement and Environment. Rapporteur: Mr. A.K. Yadav 1. Role and Potential of Geospatial Technology (GIS/GPS/Remote Sensing) in Data Collection, Collation and Preparation of Application Specific Databases in Forestry -Mr.Shakti Prakash, NISTADS, Pusa, New Delhi 2. Application of Remote Sensing in Forestry Sector -Mr.Lingaraja Sahu, TERI, New Delhi 3. Physical Accounting of Forest Resources – D.Pandey, S.Dasgupta,

	Prakash Lakhchaura, Foest Survey of India, Dehradun
1.00 – 2.00 p.m.	**Lunch**
2.00 – 3.30 p.m.	**Technical session – II** **Environmental Issues in Natural Resources with particular reference to Land and Forestry Resources** Chair: : Dr. JB Lal (IFS) Retd. Visiting Professor, China, Natural Resource Economics Rapporteur: Mr. Lingaraja Sahu 1. Use of Agrochemicals in India -Dr. Renu Bhardwaj, Mr. A.K.Thukral, & Ms.Rajni Bala 2. The Position of Forest in Orissa – A Critical Analysis- Dr. KC Pani, Assistant Director & Shri B.N. Mohanty, Assistant Director, Directorate of Economics and Statistics, Orissa. 3. Status of forest and land resources in Jharkhand – Pravin Kr. Gupta.
3.30 – 3.45 p.m.	**Tea**
3.45 – 5.00 p.m.	**Technical Session – III** **Availability of Environmental Data in different organisations** Chair: Mr. Saibal Dasgupta, Joint Director (TFI) FSI, Dehradun Rapporteur: Mr. Alind Shrivastava (i) Watershed Management Data Base in Madhya Pradesh – Ms. Ritu Bhardwaj,Task Manager, Rajiv Gandhi Mission for Watershed Management, Bhopal (ii) Conservation of Natural & Heritage sites – Need for information and Data base – Dr.(Mrs.) Meera I Dass (iii) Land Resource Accounting - – Methodology and Data Issue – Dr. Haripriya Gundimeda
5.30 – 7.30 p.m.	**Visit to Bharat Bhawan , Boating in Upper Lake and Walk at the Promenade**
7.30p.m. onwards	**Welcome Dinner at the Rooftop, Lakeview Ranjeet, near Upper lake**
	Saturday April 29, 2006
6.30 – 8.30 a.m.	**Heritage walk in Old Bhopal City (Kamla Park, Hamam, Sheetal Das Ki Bhagia, Mata ke Mandir, Sadar Manzil, Gohar Mahal – Lead by Dr. Meera Dass**
10.00 – 11.30 a.m	**Technical Session – IV** **Methodological frameworks for physical and economic accounting of Forest Resources** Chair: Prof. B. Sudhakar Reddy, Indira Gandhi Institute for Development Research (IGIDR), Mumbai Rapporteur: Mr. A.K. Yadav

	1. Valuation of Mangroves of Gujarat – Dr. Indira Hiraway 2. An Impact Study on Forest Resource Accounting Through Participatory Mode in West Bengal - Prof. M.MAdhikari, & Dr.Kausik Pradhan, B.C.K.Viswavidyalaya, W.B. 3. A study on the contribution of Different Plantation schemes on Rural Life – A case Study - Dr. Ranjit Chakrabarty & Ms. N. Bhattacharya 4. Proposed Methodological Framework and Data Issues for Physical Accounting of Forestry Resources: Learning from the States of Madhya Pradesh and Himachal Pradesh - Dr. Madhu Verma, Dr.C.V.R.S.Vijaya Kumar, Dr.B.R.Phukan, Mr.Akhilesh Yadav & Mr.Atanu Rakshit
11.30 – 11.45 a.m.	**Tea**
11.45 – 1.00 p.m.	**Technical session – V** **Methodological frameworks for physical and economic accounting of Land Resources** Chair: Prof. B.Sudhakar Reddy, Indira Gandhi Institute for Development Research (IGIDR), Mumbai **Rapporteur: Mr. Lingaraja Sahu** 1. Environmental Impact of Subsidies: Case of Agriculture – Dr. Rita Pandey 2. Towards a framework of Land Resources data collection for planning for sustainable growth – Dr.Vishnu Kumar and Aloke kar 3. Physical and Economic Accounting of Land Resources: A case of State of Gujarat – Dr. Indira Hiraway 4. An overview of Land Pollution in India – Shri. J.K. Saha Scientist, Indian Institute of Soil Science, Bhopal
1.00 – 2.00 p.m.	**Lunch**
2.00 – 3.15 p.m.	**Panel Discussion: Preparedness of various Departments for Statistical Accounting of Forest and Land Resources** **Chair** : Mohd. Hashim, PCCF, Govt. of M.P., **Panelist:** Mr. Avni Vaish, IAS, Principal Secretary Forests, Govt. of MP, Bhopal, Dr. A Subba Rao, Director, IISS, Dr.Indira Hiraway, Director and Professor, CDA, Ahmedabad, Shri J. Dash, DDG, CSO, GOI & Dr. JB Lal, IFS(Ret). **Moderator :** Dr. Madhu Verma **Overview of the Proceedings**:Mr. Lingaraj Sahu **Rapporteurs :** Mr. Lingaraja Sahu & Mr. A.K. Yadav
3.15-3.30	**High Tea**
3.15 – 4.00 p.m.	**Chair** :Dr. D.K. Bandyopadhyay, Director, IIFM

	Observation by : Dr. KAD Sinha, ADG, CSO, MOSPI, Govt. of India, Dr. Vishnu Kumar, ADG, CSO, MOSPI, Govt. of India **Address by :** Mohd. Hasim, , PCCF, Govt. of M.P. Bhopal - Guest of Honour **Valedictory Address**: Mr. Avni Vaish, Principal Secretary, Forests, Govt. of MP- Chief Guest **Vote of thanks :**Dr. C.V.R.S.Vijaya Kumar, IIFM, Bhopal
4.00 p.m.	**Visit to National Museum of Man/Manuabhan Ke Tekri, Ride on rope way, ride on marine drive of Bhopal.**
8.30	**Dinner at the Guest House**

Date and Time	**Programme**
	Sunday April 30, 2006
8.00 a.m. to 6.00 p.m.	Optional tour to Sanchi, Bhimbaithika, Bhojpur

Seminar Coordinators

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ANNEXURE - II

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Annexure III

A. List of Resource Persons and Articles

1. Vivek Saraf, Director, System National Centre for Human Settlement & Environment,Bhopal : Tools for generating data regarding forest and land resources

2. Shakti Prakash , Consultant , Leopton Software Research Pvt Ltd, New Delhi: Role and potential of geospatial technologies(GIS/GPS/ Remote Sensing) in data collection, collation & preparation of application specific spatial databases in forestry

3. Lingaraja Sahu, Research Scholar, Centre for Economic & Social Studies (CESS) Nizamiah Observatory, Hyderabd : Application of remote sensing in forest resource assessment -A case study in and around Dudhwa National Park

4. S. Dasgupta, Joint Director, Forest Survey of India Dehradun : Physical Accounting of Forest Resources.

5. Renu Bhardwaj, Reader, Deptt. Of Botanical & Env. Sci. G.N.D.U Amritsar : Use of Agrochemicals in India

6. K. C. Pani & Sri B. N. Mohanty, Assistant Directors, Directorate of Economics and Statistics, Orissa : The position of forest in Orissa – a critical analysis.

7. M. M. Adhikary , Professor of Agricultural Extension & Former Dean, Faculty of Agriculture, Bidhan Chandra Krishi Viswa Vidyalaya, Mohanpur, Nadia : An Impact study on forest resource accounting through participatory mode in West Bengal

8. R. Chakrabarty , Professor & Dean, Business Management, Deptt. Of Business, Calcutta University,Calcutta : A Study 0n the Contribution of Different Plantation Schemes on Rural Life – A Case Study of West Bengal

9. Madhu Verma, Professor, Forest Resource Economics & Management & C.V.R.S.Vijayakumar, Associate Professor,, Quantitative Techniques & Computer Applications, Indian Institute of Forest Management , Bhopal : Proposed Methodological Framework and Data Issues for Physical Accounting of Forestry Resources: Learning from the States of Madhya Pradesh and Himachal Pradesh

10. Rita Pandey, Professor , NIPFP, New Delhi : Environmental Impact of Subsidies: Case of Agriculture

11. Indira Hirway , Director & Professor of Economics, Centre for Development Alternatives,Ahmedabad : Physical and Economic Accounting of land resources- a Case of State of Gujarat

12. J.B. Lal, IFS (Retd.), Visiting Professor, NFU, China, : Environmental Issues in the Management of Land Resources

13. Shri Pravin Kumar Gupta, Deputy Director (Ag), Directorate of Staitistics & Evaluation , Jharkhand : Land and Forest Resource Accounting in Jharkhand.

B. List of Resource Persons and Power Point Presentations (Full articles not received)

1. Ritu Bharadwaj, Task Manager, Rajiv Gandhi Mission for Watershed Management, Bhopal : Rajiv Gandhi Watershed Mission in M.P. and Perspective Plan of Watershed Development Projects

2. Meera Ishwar Dass, Coordinator, INTACH, Arera Colony, Bhopal : Baghs and Bagiyas in the city of Bhopal-

3. Haripriya Gundimeda, Associate Professor, Madras School of Economics, Chennai : Land resources accounting – Methodology and Data Issue

4. Indira Hirway , Director & Professor of Economics, Centre for Development Alternatives,Ahmedabad : Methodological Frameworks for Physical and Economic Accounting of Forestry-The Case of Mangroves in Gujarat

5. Vishnu Kumar, Addl. Director General, CSO, MOSPI, Govt. of India New Delhi : Towards a Framework of Land Resources Data Collection for Planning for Sustainable Growth.

6. J.K. Saha Senior Scientist, Indian Institute of Soil Science, Bhopal : An overview of land pollution in India

Annexure - IV

Papers presented in the Seminar

ANNEXURE - IV

Tools For Generating Data
Regarding Forest And Land Resources

Dr. V. Saraf, Director systems, NCHSE, Bhopal

Natural Resource management is the top priority in the world today. The resources those were provided by the Mother Nature are all that we had and will have. The fast utilization of the resources and that too at an ever increasing menacing pace is seriously depleting the reserves and emptying the treasure trove. The time is not left even to think of the matter as a whole and ponder on issues such as the actions to set things right again. Still it is better to start late than never.

There are two important issues before us – one, to plan an control the use of natural resources and secondly, we have to aim for utilizing the resources to their optimum so that we extract maximum possible benefits out of the use.

Regarding the first issue of Planning and Monitoring of utilization of natural resources it is very important to be borne in mind that use or exploitation is done only so that neither the resources get so over exploited or exhausted so much that it reaches to the point of no return nor this that the over exploitation of resources creates any imbalance in the naturally set equations amongst the resource elements.

And second issue is of optimum utilisation of the resources to derive maximum benefits. Land and Forests, are the key themes of discussion during this seminar. The big challenge before us today is to study the stocks or present status of these resources and we have to ensure their use - rather ensure the optimum use. It is essential to consider that either the resources would continue to lie underutilized, unexploited that it would be as much a waste or otherwise we take steps towards efforts to utilize the resources and get maximum returns out of this. What would it take to achieve optimum utilization of Land and Forests, and to plan and monitor the use of these resources – OBVIOUSLY DATA.

There are multiples of studies and models, we see all around, that are produced after some theoretical or mathematical or even field based exercises. Many of these are good and useful too. Whatever the efforts till date, there is an urgent need to devise the methods for the following:

- working out relevant set of data items required for such stock taking, planning, monitoring etc.
- classification of data as per their characteristics and utility in analytical exercises
- working out procedures for data collection and other data synthesis
- identification of suitable tools for this purpose
- classification of data also as per the source and thereby listing of sources, media of such information, etc.

Coming back to point that the data is required for taking up any useful exercise, what is commonly felt is - The data is not available readily. The data generation process involve various methods. What we see is - Either the systems are not up to date. Many agencies are still engaged in age old traditional methods of detailed surveys. They follow long duplicated efforts of computations. The mapping is done with tracing or hand drawing.

Let us for a moment talk about Maps. Maps as such are a highly useful medium of working with data. The plain maps itself are quite full of information. Added with other details the maps become a strong tool for decision making. The times have come that every thing, every thing that relates with the space or area, be mapped. The information which one cannot understand in words or figures, are much easily expressed and understood in form of graphics. The maps are nothing but these far more true representation of facts as these also speak-up of the location or position of the entity. Once the information or facts are put on maps, the future course becomes far more easy for the end users – be it analysis, decision making or whatever.

Where we are benefiting most today being in a country like India is that we are getting astounding support from our veteran agencies.

- The mapping done by Survey of India drafting every part of the country is no small resource. Their maps – commonly known as Top sheets, are the starting point for many of us today in any exercise. Moving a step forward, the Survey of India is also digitizing the Top sheets and they are working on releasing the same in public domain, where every one will be free to use the digital form of maps. There are some constraints though for security reasons which even include restrictions in digitization by any random agencies. But then this does not bar one from digitization individual's requirements. Sale and other distribution are of course prohibited. These maps are available at the scales of 1:50,000, and also on 1:25,000 for some areas. The maps were created in 1969, but now the Survey of India is also releasing fresh versions including the latest information.

- Our country leads in Space Programs being utilized most productively that is for mapping. We get latest, even for past, the remote sensed information on resources – water, forests, land, etc. etc.. The information is available for different time periods, at different scales, for multiple usages and what not. The Department of Space's agency National Remote Sensing Agency commonly known as NRSA which provides data through their NDC the NRSA data centre, offers the facility to buy data on orders on quite reasonable charges as compared to other countries. What counts more here is the quality which is more dependable in Indian remote sensed products. The products apart from print media are also available in digital form, which is far more cheap and more usable. The thematic information that one gets from remote sensing is largely applicable in such works as we are going to discuss here today.

- The remote sensing images undergoing hyper spectral data processing yield numerous information. Talking about land and land cover one finds the hyper spectral processing quite handy and useful. Land cover basically describes the physical state of the earth's surface and the immediate surface in terms of natural

environment such as vegetation which includes Forest, and also soils and other details. The land cover features can be classified using the data acquired from different spatial, spectral and temporal resolutions. When these images are used for mapping using high spectral resolution, it helps classification of discrimination of vegetation species, soil types, and other finer details, segregated.
Recently for the global land use and land cover for vegetation mapping, following the geosphere biosphere programme scheme, a classification was done which included upto 17 categories of classification of land cover. The exercise used the MODIS data sets. MODIS is the Moderate Resolution Imaging Spectro-Radiometer mounted over the Earth Observing System EOS-AM1 and EOS-AM2.

In India similar exercise initiated by ISRO and NRSA using ReourceSat data Spatial Accounting of landuse and lancover at national level was carried out using IRS AwiFS (Advanced Wide Field Sensor) data sets.

- Why talk about the big works. Our smallest agents the Patwaris also carry an exact detail map with them. That means even the smallest land parcel of our every village is mapped. What we have to consider is to digitize it - which many states have already accomplished. For any local level micro planning it is recommended to include the revenue or cadastral maps, where digitization helps.
- AISLUS All India Soil and Land Use Survey, New Delhi has also produced maps on Land Use and Soils. There are maps available on Soil Erosion Intensity also – a vital input for checking of erosion through interventions like plantation, etc.

The most important tool that we have when we talk about maps is the Computer. The computer has become all the more important through the advent of GIS. The GIS that is Geographic Information System is a tool which makes the mapping far more easy, efficient and it offers so many useful features which one otherwise cannot achieve with any amount of manual efforts. The GIS is a handy tool for creation of maps, manipulation of information (manipulation for updating or correction sake), reproduction – as all maps we see published are computer printed, and when we talk about the advanced usage – the superimposition, the merging of maps, querying of information for analysis. The GIS is also commonly called as the Decision Support System. It is being used as not only an assisting tool but also as a dependable system for many planning, evaluation and monitoring exercises. It is useful for us to know that the GIS packages are more user-friendly now and also economic so much that one individual can own a copy on Home PC. There are several GIS packages in the market such as ArcInfo, MapInfo, AutoCAD Map, GeoMedia, etc.

It is a highly useful feature that GISs allow to incorporate manually created maps(after digitization), Toposheets, other maps, remote sensed maps, etc. on one platform. GIS also enables alteration of scales – which is very very important for map integration or superimposition.

The Forest department itself, in many states has taken up rigorous mapping of their Resources and further on to digital form of mapping for many useful applications. IIFM itself has a highly sophisticated GIS lab with highly capable and knowledgeable experts on panel. The forest resource mapping is well augmented with the help of combination techniques where the Forest resource maps based on surveys can be merged with other products say remote sensed scenes, other produced maps, to enhance value and utility of the information. That is what is desired to be achieved.

The objectives we must keep before us for carrying out the information generation and also somewhere for deliberations during seminar would be:

- ensure - foremost work should be to digitize the maps
- include every other useful map in digital form on the exercise
- combine the maps or superimpose as many related themes as possible
- conclude with tools like GIS the decision about the status, results, etc. whatever is desired.

The other useful tools for the data generation which I hope would be discussed or referred by experts talking in the seminar, are as follows:

- Electronic Total Station – ETS for gathering information contours and slopes through survey but directly recording digitally
- Geo Position System – GPS for registering the Geo-coordinates with help of Satellite system and also for slopes and contouring

These tools are extremely helpful for accurate data recording, save lot of time and ready the data for immediate processing without data entry which is cumbersome job

What we shall have to bear in mind is:

- to resort to modern means of data collection and generation for achieving better results
- combine as many relevant themes as possible so that many aspects are duly considered – we do not know how the information interact with each other
- combine pre-prepared maps preferably already digitized by other agencies so that time is saved of recreating
- keep track of web based releases or even other electronically published maps
- use GIS which is the only solution tool or rather the converging point for all the information processing paths

Role And Potential Of Geospatial Technolgies(Gis/Gps/ Remote Sensing) In Data Collection , Collation & Preparation Of Application Specific Spatial Databases In Forestry

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There have been recent important scientific advances in the use of geospatial technologies (GIS/GPS/ remote sensing) that have produced mature techniques ready for data collection. collation and development of application specific spatial decision support systems (SDSS) to assist in decision making processes for the implementation in the management of forest resources. Along with the traditional reliance on aerial photography, other systems such as radar, lidar, thermography and optical sensors, offer forest practitioners cost-effective methods of spatial data collection in integration with GIS/GPS. Data and information collected and collated can be used to answer typical operational questions such the location, condition and extent of the actual forest resources. This paper intends to overview the role and potential of geospatial technologies(GIS/GPS/ Remote Sensing) in data collection , collation & preparation of application specific spatial databases in forestry sectors along with brief discussion of the same in forestry sector of India.

1. INTRODUCTION

Today, satellite remote sensing has made it possible to collect a wide range of data on natural resources in a reliable and systematic manner. What is more, earth resource satellites can give information in advance on the scale and pattern of resources to resource managers, thus enabling them to take timely action and measure the cost effectiveness of their interventions objectively. It is necessary to develop and integrate remote sensing with GIS/ GPS, so as to make these tools an effective operational system to support planning and decision-making. Data & information about the availability and status of natural resources will no doubt increase considerably with the availability of satellite imagery. This, however, is only the first step, since data & information on resource availability alone is not adequate to plan for sustainable development of natural resources. There has to be an integration of such information with economic and social data. Applications of geospatial technologies (GIS/GPS/Remote sensing) have been greatly increased by utilizing modern computer systems and use friendly. Many forestry and natural resource managers are using remotely sensed and GPS data widely to provide input to new GIS databases, to update existing databases and for monitoring land-use/land-cover changes of various types. GIS data can often be valuable in the analysis of remotely sensed data, enabling significant improvements in the classification accuracies achieved.

2. GEOSPATIAL TECHNOLOGIES (GIS/GPS/REMOTE SENSING) IN FORESTRY DATA COLLECTION, COLLATION AND DEVEOPMENT OF APPLICATION SPECIFIC SPATIAL DECISION SUPPRT SYSTEMS (SDSS):

Major geospatial technologies currently in application across the world for collecting, collating and preparing forestry management/governance specific spatial decision support systems are as follows:

a) Remote sensing Technologies:

i)Satellite (passive) Remote Sensing Systems

ii)Radar (active) Remote Sensing Systems

iii) Airborne Laser Scanning (ALS) / Lidar Remote Sensing

iv) Hyperspectral Remote Sensing

v) Aerial Photography

vi) Aerial Videography

b) Geographic Information Systems (GIS)

c) Global Positioning Systems (GPSs)

2.1. SATELLITE BASED REMOTE SENSING APPLICATIONS IN FORESTRY:

Remote sensing technologies can detect, identify, classify, evaluate and measure various forest characteristics in two ways: qualitatively and quantitatively. Qualitatively, remote sensing can classify forest cover types to: coniferous and deciduous forest, mangrove forest, swamp forest, forest plantations, etc. Quantitative analysis can measure or estimate forest parameters (e.g., dbh, height, basal area, number of trees per unite area, timber volume and woody biomass), floristic composition, life forms, and structure. Table 1 gives a brief overview of application opportunities for forest management.

Table 1: Overview of remote sensing application opportunities for forest management

Type/sub-type	Application	Scale/Resolu	Frequency	Cost	Limitation
Aerial photography					
- Panchromatic	+++	++	++	--	--
- True Color	+++	++	++	---	--
- Color Infrared	+++	++	++	---	--
- B&W	++	++	++	---	--

Infrared					
Scanning: Air					
- MSS	+++	++	++	-	--
- Hyperspectral	+++	++	++	--	--
Scanning: Space	++	+	+	-	-
Radar: Air	++	++	++	--	--
Radar: Space	+	+	+	-	--(current satellits)
Lidar/laser: Air	+	++	++	--	--
Videography: Air	+	++	++	--	--

2.2. RADAR BASED REMOTE SENSING SYSTEMS APPLICATIONS IN FORESTRY:

Within the applications of radar based remote sensing in forests, There are many factors to take into consideration. Mapping terrain is performed by a side-looking setup of the radar to highlight the differences in topography. Sometimes different forest types have differing geometric structures, canopy surface roughness and moisture levels. These parameters result in contrasting backscatter. Backscatter is important in radar imaging because backscatter increases approximately equally with increasing biomass. Relatively smooth surfaces produce little backscatter compared to the rougher canopy of unharmed forests. To end up with an effective image for burn delineation, one should wait for several months after the fire. This is to allow the burnt areas to dry out and leaves and small twigs to drop from the trees which results in a greater contrast in backscatter, leaving the burnt areas to look darker than the unaffected areas. Within forest management, remote sensing contributes to fire-fighting efforts, spreading areas, speed and success of re-growth and damage assessment. Forest management also uses remote sensing data to estimate future urban spread and population growth Major applications are as follows depending on the spatial and spectral resolution (air or space and number of spectral bands):

2.2. a. Qualitative Mapping Applications:

- Forest cover types
- Forest species level mapping
- Mapping flooded forest
- Detecting deforestation and forest degradation
- Monitoring logging activities
- Detecting forest roads
- Mapping burned forest

2.2. b. Quantitative Measurements and Estimation Applications:

- Forest cover area measurement
- Tree height estimation
- Crown cover estimation
- DBH estimation
- Number of trees per unit area (density)
- Age estimation
- Timber volume estimation
- Basal area estimation
- Biomass estimation

2.3. AIRBORNE LASER SCANNING (ALS) / LIDAR REMOTE SENSING APPLICATIONS IN FORESTRY:

Airborne Laser Scanning (ALS) also referred to as Light Detection and Ranging (LiDAR), is a remote sensing technology which enables large areas to be surveyed cost effectively using a fixed or rotory wing platform. The ALS instrument emits a stream of discrete points, up to 70,000 every second, which are reflected from objects the aircraft flies over. Post Processing of the data provides co-ordinates with height accuracies ranging from 0.1 meters to 0.5 meters and horizontal accuracies ranging from 0.3 meters to 1.5 meters, depending on flying height, GPS geometry. Points reflected from the ground are separated from those above the ground. A closely spaced array of co-ordinated points can be obtained if required with point spacing ranging from 0.2 to 4.0 meters. It has the unique advantage of providing three-dimensional data through direct and indirect retrievals with unprecedented accuracy. It has enormous potential for forest ecological research, because it directly measures the physical attributes of vegetation canopy structure that are highly correlated with the basic plant community measurements. This technology is new and is restricted to only few countries of the world and has not yet properly reached to many countries including India. In India, this technique could be utilized to address various aspects of forest ecosystem management, not possible earlier with the data available from aerial photographs, optical and radar satellites or even by ground measurements. Forest management strategy in India should be based on reliable, lidar-derived database on forest structure and its productive potentials Because of its ability pass between tree branches to record both ground and non ground features, ALS is particularly suited to forestry applications. Applications include the acquisition of data to compute average tree heights, the use of terrain data to plan the location of roads to be used in timber harvesting and the determination of drainage locations for the design of retention corridors. Its major applications on forestry sector are:

- Tree height estimation.
- Forest cover types determination.
- Forest trees species differentiation.
- Crown cover or canopy density estimation.
- Forest stands volume estimation.
- Forest stands woody biomass estimation.
- Forest trees water stress detection.

- Forest trees nutrient deficiency

2.4. HYPERSPECTRAL REMOTE SENSING APPICATIONS IN FORESTRY :

All objects reflect, absorb, or emit electromagnetic radiation based on their composition. A hyperspectral sensor, using reflected solar radiation (0.4 micrometers - 2.5 micrometers wavelength range), captures the unique spectra, or 'spectral signature', of an object, which can then be used to identify and quantify the material(s) of which it is composed. For vegetated targets it has the effect of measuring the status of the target. Typically, the analysis of a hyperspectral scene involves the decomposition of each pixel in the image into its constituents, where these are represented by spectra of relatively pure material, which are themselves extracted from the scene. The identity of these constituents is determined by comparison with 'library' spectra of known materials measured in the field or in the laboratory.

Hyperspectral data enables the identification of terrestrial features with greater accuracy and the capability of developing unique image products not possible using the current generation of space borne sensors. Typically, the analysis of a hyperspectral scene involves the decomposition of each pixel in the image into its constituents, where these are represented by spectra of relatively pure material, which are themselves extracted from the scene. The identity of these constituents is determined by comparison with 'library' spectra of known materials measured in the field or in the laboratory. Hyperspectral data enables the identification of terrestrial features with greater accuracy and the capability of developing unique image products not possible using the current generation of space borne sensors. A space borne hyperspectral sensor is an enabling tool to be used to monitor both static and dynamic targets at high spectral and spatial resolution. There is currently no commercial space borne hyperspectral sensors in orbit, although some are planned.

2.4.1. Comparative Advantages of Hyperspectral Imaging:

There are always be applications for airborne hyperspectral sensors, e.g., where there is need for very high spatial resolutions (1-4 m), or for short-term time-critical events that may not coincide with orbital parameters. However, space borne hyperspectral sensors offer certain advantages over airborne hyperspectral sensors and conventional multi-spectral satellites:

1. Hyperspectral data can be acquired anywhere globally at low cost to the end user.
2. A space borne sensor has a well defined sun-synchronous orbit, ensuring consistent illumination characteristics.
3. Space borne hyperspectral sensors provide year round temporal data.

Space borne hyperspectral data provide unique capabilities to discern physical and chemical properties of Earth surface features not possible using current broad-band multi-spectral satellites. . The quality of forest information products currently generated by today's remote sensing technology could be improved dramatically by the use of space borne hyperspectral sensors. Forest chemistry can be derived for use in monitoring forest health, precision forestry and environmental monitoring and assessment. The various forestry application areas and different levels of hyperspectral remote sensing are illustrated in Figure 1.

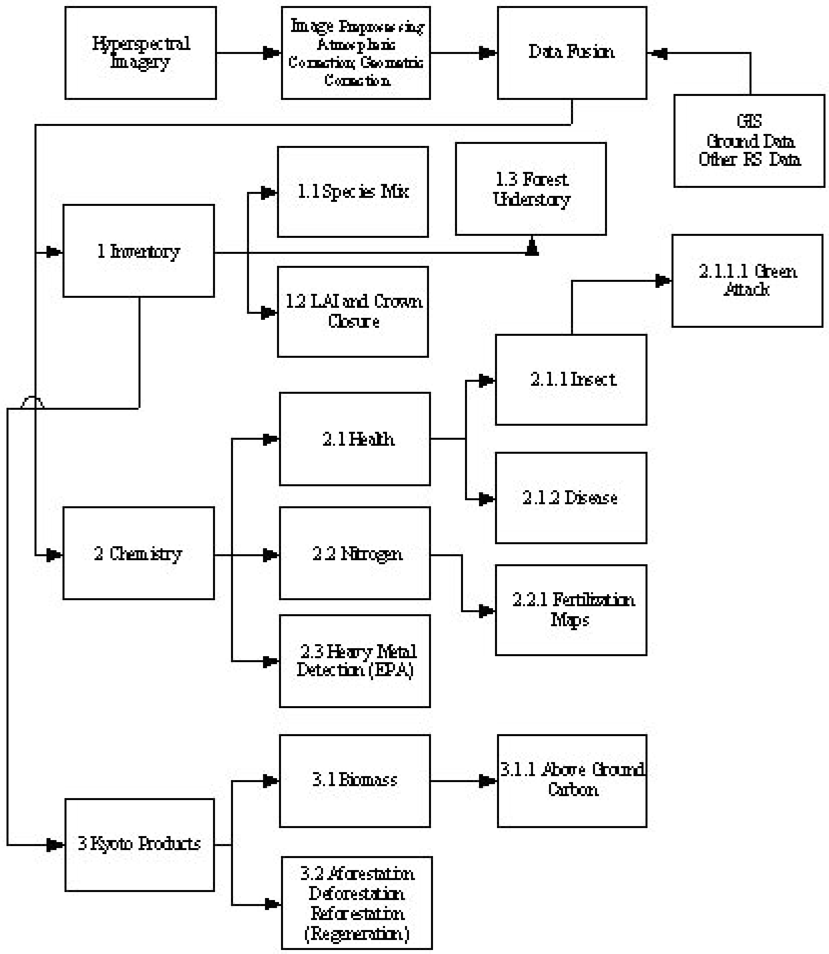

Figure 1: forestry application areas and different levels of hyperspectral remote sensing

The main application areas are:

- Forest inventory,
- Forest chemistry, and
- Kyoto products.
- Initial inventory and assessment of forest resources and their condition
- Updating of existing information
- Forest area and type mapping
- Stand delineation and associated parameters (tree height, stand density, volume)
- Mapping of silvicultural activities (clear cuts, afforestation areas)
- Mapping of Forest damage (storm damage, fire damage, insect calamities)

2.5. AERIAL PHOTOGRAPHY APPLICATIONS IN FORESTRY:

Aerial photographs are the major source of remote sensing data used in forestry, but their consistency in quality has been variable. Image contrast, spectral sensitivity, and spatial resolution are considered important factors when defining parameters for forestry aerial photography.

2.5. a. Qualitative Mapping:

- Forest cover types
- Identify individual species
- Species composition
- Forest fire detection
- Forest fire hazard
- Detecting forest trees health (vigor and stress)
- forest trees diseases and insects infestation
- forest trees under air, soil and water pollution
- Assessment of wind damage and other sever climatic condition
- Detecting deforestation and forest degradation
- Forest monitoring:
- some of the above
- logging activities
- reforestation and afforestation
- Timber harvesting planning
- Forest roads planning
- Forest inventory
- Forest management
- Assessing slope failure and soil erosion
- Assessing and managing forest recreation resources
- Assessing and managing wildlife habitat

2.5. b. Quantitative Measurements and Estimation:

- Forest cover area measurement
- Number of trees
- Tree height measurement
- Crown cover measurement

- Crown closure measurement
- Crown diameter measurement
- DBH estimation
- Age estimation
- Site estimation
- Timber volume estimation
- Thinning volume estimation
- Basal area estimation
- Annual Growth estimation
- Basal area growth estimation
- Biomass estimation
- Stand size
- Dead, declined trees

2.6. AERIAL VIDEOGRAPHY APPLICATIONS IN FORESTRY:

Aerial videographic imagery, with frame location identified using global positioning system receivers, has been demonstrated to be an efficient and cost effective method for gathering ground-truth data for satellite image interpretation and post-classification accuracy assessment. Both the usefulness and effectiveness of air-video image interpretation can be enhanced by integrating video imagery with other spatial databases in GIS softwares. A series of programs, shell scripts are written to facilitate this process. The user interface allows control of video tape recorders, and the real-time display of the flight position on a workstation monitor. Queries of coverages and multi-spectral imagery may be performed. The operator's interpretation of the video image and data from the spatial queries are recorded for further analysis. The air-video interpretation system is used for the development of refined land-cover maps. A number of other applications are being developed. Though video imagery is a rich source of information, it is much more useful when combined with other spatial data-sets. The data logging, reporting, and error checking process can be improved and simplified by incorporating the interpretation of video imagery into a GIS environment. Major applications of aerial viedography in forestry are as follows:

- Forest cover types determination.
- Forest trees species differentiation.
- Crown cover or canopy density estimation.
- Detecting forest trees health (vigor and stress)
- forest trees diseases and insects infestation
- Mapping forest trees spatial distribution

3. GEOGRAPHIC INFORMATION SYSTEM (GIS) APPLICATIONS IN FORESTRY:

GIS nowadays makes a major contribution to various aspects of forest management. Forestry has been responsible for a significant growth in the use of GIS. He claims that the earliest inspiration for using GIS in forestry was the capability to update forest inventory on a regular basis and reduced cost. As management goals for forestry are becoming more diverse, so the importance of GIS technology increases. For the relatively new, multi-disciplinary concept of community forestry, GIS offers great potential as a means of integrating socio-cultural information with biophysical data. All forest managers need accurate and timely information to make wise decisions on resource management. There is often a direct relationship between the quality of information and cost of collection, handling and storage. GIS and related technologies offers substantial advantages by allowing high quality and timely output of information at low cost, compared to other methods. Forestry organizations can become more efficient and productive by using the analytical capabilities of GIS, which were previously not available. Forest managers use various types of spatial information for planning and policy making, research and decision making. Data and information required for forest management can be collected in various ways. However, in community forest management, data & information on socio-economic and cultural issues would be required in the data set, in addition to the standard data types Major applications of GIS in forestry sector are as follows:

- Forest health monitoring: includes insect pest monitoring
- Resource inventory: includes resource assessment and inventory
- Forest fire and emergencies: includes pre-planning and post fire assessment
- Forest conservation and biodiversity: focused on conservation
- Forest road access and harvest scheduling: road network and harvesting
- Forest ecosystem management and rehabilitation: ecology and ecosystem applications
- Wildlife habitat: wildlife habitat conservation and planning
- Water wetlands and watersheds: conservation of soil and watersheds, and wetlands
- Recreation and community-based eco-tourism
- Strategic planning: strategic planning purpose
- Participatory planning: planning with involvement of local communities

Main spatial data requirements in forest resource management, in general and in community forestry, in particular are given in table2:

Table 2 : Spatial Data Requirements for forest resource management

Information Category	Purpose
Administrative boundaries • cadastral boundaries, forest administration boundaries, timber concession boundaries • compartments and sub-compartments	General administration, management and planning
Terrain features • elevation, slope, aspect • digital terrain model (DTM), • triangulated irregular network (TIN) • hill shade, drainage	Planning of timber harvesting (e.g., road construction), site assessment (e.g., susceptibility to wind throw)
Infrastructure • roads, tracks, etc	Planning and management of forest

• power lines, pipelines etc • building and other structures	operations, monitoring and evaluation Maintenance of forest roads and culverts
Soil and understorey vegetation	Site assessment and silvicultural treatment
Forest stand characteristics • species composition, age • yield class, stand density	Planning and management of forest operations (e.g., thinning, harvesting)
Management activities • planned and actual silvicultural treatment (thinning harvesting, etc) • damage control (e.g., insect, disease, fire, wind and encroachment)	Monitoring
Spatial Data Requirements for Community forestry	
Socio-economic information • demographics • employment • infrastructure, livelihood needs	Determine local community (and stakeholder) interest in forest management
Cultural beliefs, tenure and other rights • cultural heritage • historical sites	Traditional rights, eco-tourism potential, conservation of heritage sites

Review of GIS applications shows there is high potential for use of GIS in a wide variety of applications, from conventional management focused issues, (e.g., timber stocks, conservation and resource inventory) to modern concerns, such as community-based ecotourism and participatory planning. Some observations from the literature are that:

- GIS is frequently used in various aspects of forest management in industrialized nations but use of GIS in developing countries has increased in recent years. The declining cost of computer hardware and GIS software, user friendliness of GIS software and increasing awareness, are factors in this trend.
- The spatial information required for community-based forest management is much broader than in 'conventional' government-based management.
- The integration of GIS with participatory research methods is increasing, especially in developing countries. Such integration is important in the case of community-based forest management where local knowledge regarding resource management is essential if management aims are to be achieved.
- To establish a community-based GIS requires a well-organized plan that includes tasks such as identifying priorities of different stakeholders, management of

institutional as well as technological issues, and providing relevant training to community facilitators and GIS operators.

- A standard PC (even a laptop computer) can be used with Desktop GIS software for a community-forestry GIS project. There is scope for use of freeware available on the Internet by resource-poor community organizations.
- Various constraints have been found in using GIS in forestry, e.g., lack of access to services and advice for information technology, requirement for technical skills in collecting data and maintenance of databases, lack of availability of suitable data (format and structure) for particular projects. Most of these are more pronounced in developing countries and among resource poor community organizations.

4. GLOBAL POSITIONING SYSTEMS (GPS) APPLICATIONS IN FORESTRY :

The Navigation Satellite Timing and Ranging Global Positioning System (NAVSTAR GPS), simply known as GPS is a satellite-based radio-navigation system that is capable of providing extremely accurate 24-hour, 3-dimensional (latitude, longitude, and elevation) location data). GPS currently uses a collection of 24 satellites positioned in orbit to allow a person who has the equipment to automatically have their position triangulated to determine their location .GPS now comes in instruments that can be hand-held, and can be connected to a PC to allow automatic downloading of data. Some examples of applications of GPS in forestry are: recording forest inventory and research plot centres; mapping forest boundaries and timber sales; characterization of forest stands; response to forest fire; maintenance of access roads. In the case of community-based forest management, GPS has been used to locate both bio-physical and socio-cultural information It assists in the management of forests. As the size and physical terrain of forests make it difficult to survey, GPS makes it easier, faster and more accurate to create land surveys (within 1% of land survey accuracies using DGPS). Also, GPS allows for measurement of timber of interest to forestry companies and conservation groups. Forest fire management is enhanced by the power of Differential Global Positioning Systems (DGPS). For example, a helicopter with DGPS gear can fly along the perimeter of a fire and download an accurate map of the fire's size. This provides useful information to destroy the fire in the right places with the right number of firefighters..

4.1. Advantages and limitations of GPS use in forestry

GPS is generally less expensive, and more accurate and reliable than conventional methods for many forest navigation applications .For some forestry applications (e.g., inventory field sampling, resonance survey, and identification and positioning of forest recreation point features), the positioning accuracy, even with uncorrected GIS is usually considered sufficient. The satellite service is free and anyone with a GPS receiver can receive the signals and locate position. The system supports unlimited users simultaneously. The use of GPS has some limitations:

- GPS receivers give a location reading, which is subject to errors, some of which are under our control and others not.

- To obtain a GPS position reading, we need to occupy the point. If we cannot get to a point because of danger from wildlife or steep terrain we cannot obtain the GPS reading.
- GPS needs a clear view of the sky. Areas that are covered with a thick forest canopy cannot receive GPS signals.
- Elevation readings from receivers are not very accurate except from very expensive GPS units.

5. MAJOR APPLICATIONS OF GEOSPATIAL TECHNOLOGIES IN FORESTRY IN INDIA:

5.1. Satellite Image Data Based Forest Cover Mapping Of The Country:

Forest Survey of India (FSI) assess the forest cover of the country on a two-year cycle using satellite data. The main objective is presentation of the information on forest resources of the country at state and district level and to prepare forest cover maps on 1:50,000 scale. First assessment of forest cover of the country was made in 1987 and thereafter eight more assessments have been made. Districtwise information on forest cover has been made available from the third assessment (i.e. from 1991) onward. Till the fourth assessment interpretation of data for the entire country had been done visually. During fifth and sixth assessment interpretation of data for Madhya Pradesh and Maharashtra which comprises 28% forest cover of the country had been done digitally and for rest of the States/UTs, it had been done visually. In seventh assessment interpretation has been done digitally for thirteen states namely; Andhra Pradesh, Arunachal Pradesh, Assam, Delhi (UT), Himachal Pradesh, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura, which comprises 63% of the forest cover of the country. By eighth assessment the entire country was covered by digital assessment. Figure 2 shows the FSI methodology of forest cover mapping based geospatial technologies:

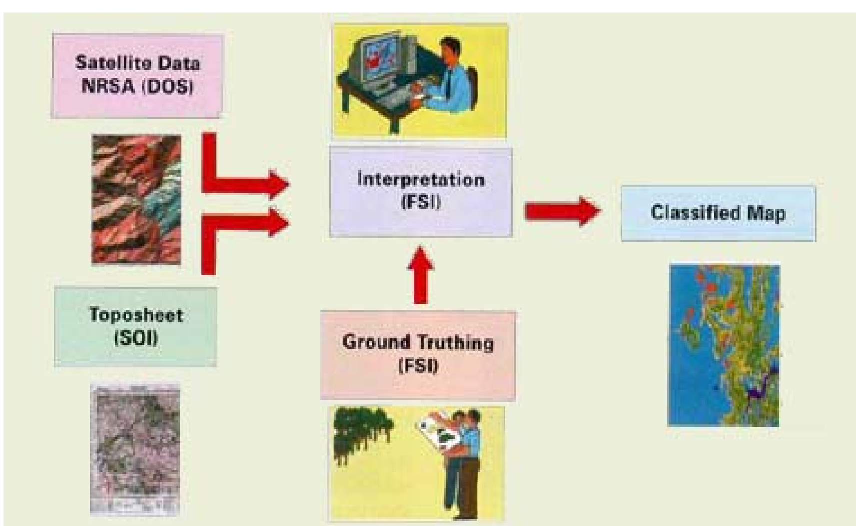

Fig 2. Schematic Presentation of the Methodology of Forest Cover Mapping

The first assessment in 1987 was done visually on 1:1 million scale. Thereafter, upto 1999 the assessment was done on 1:250,000 scale. On this scale, the country was covered by 363 toposheets of SOI. To enrich the information on forest cover and to make it more useful, assessment on 1:50,000 scale is desirable and has been taken up since the 2001 assessment for the forest cover assessment to be done on 1:50,000 scale, the quantum of work increase manifold as the country is covered by 5,200 sheets on this scale. However, the application of DIP reduces the time taken in interpretation significantly. DIP technique offers a more objective assessment of forest cover at a larger scale and better cartographic presentation, thus overcoming the limitations of visual interpretation to a large extent. In case of fragmented forest, the area of forest cover decreases as the openings which were not clearly discernible on the smaller scale are picked up on the larger scale. Conversely, the scattered small patches of forests/plantations, not discernible at smaller scale, are included in the assessment on larger scale thus adding to forest cover. The forest cover is broadly classified in 4 classes, namely very dense forest, moderately dense forest, open forest and mangrove. The classification of the cover into dense and open forests is based on internationally adopted norms of classification. It has not been possible to further segregate the dense forest into more classes owing to enormity of work of ground validation and limitations of methodology. Mangroves have been separately classified because of their characteristic tone and texture and unique ecological functions. The other classes include scrub and non-forest. These classes are defined in table 3

Table 3 : Forest Cover Classes	
Very Dense Forest	All lands with canopy density over 70 percent.
Moderately Dense Forest	All lands with canopy density between 40 percent and 70 percent.
Open Forest	All lands with canopy density between 10 to 40 percent.
Mangrove	Salt tolerant forest ecosystem found mainly in tropical and sub-tropical inter-tidal regions.
Scrub	All lands with poor tree growth mainly of small or stunted trees having canopy density less than 10 percent.
Non-Forest	Any area not included in the above classes

5.1.1. Limitations Encountered In Geospatial Technologies Based Forest Cover Mapping:

There are certain cartographic and technological limitations in the assessment of forest cover

- Since the resolution of sensor LISS-III is 23.5 m the plantations along road, canal and railway line of a width less than the resolution are not recorded
- Considerable details on ground may be obscured in areas having clouds and shadows. It is difficult to interpret such areas without the help of collateral data

- The reflectance of young plantations with small crown and low chlorophyll content is not recorded by satellite sensors
- Gregarious occurrence of bushy vegetations and agricultural crops like lantana, tea and coffee poses problems in delineation of forests as their reflectance is similar to that of the forest
- Recorded forest areas cannot be delineated if their boundaries are unavailable
- Species composition is not identifiable with the images (of above mentioned resolution) used

5.2. INVENTORY OF FOREST/TREE RESOURCES:

An accurate assessment of forest and tree resources in the country is essential for formulating sound strategy for forestry sector. Precise data and latest information on forest cover and volume of growing stock of forests/trees and trends of changes therein are basic ingredients for policy and planning purposes. FSI has been conducting field inventory for estimating the growing stock (volume) and other parameters of the forests by laying out systematic sample plots since PISFR project began in 1965. So far about 80% of the country’s forest areas have been inventoried including some areas more than once and about 140 reports have been published. However, under Xth Five Year Plan during 2002-2007, FSI is conducting field inventory of forest resources inside and outside forest including vegetation survey and estimation of soil carbon in forest.

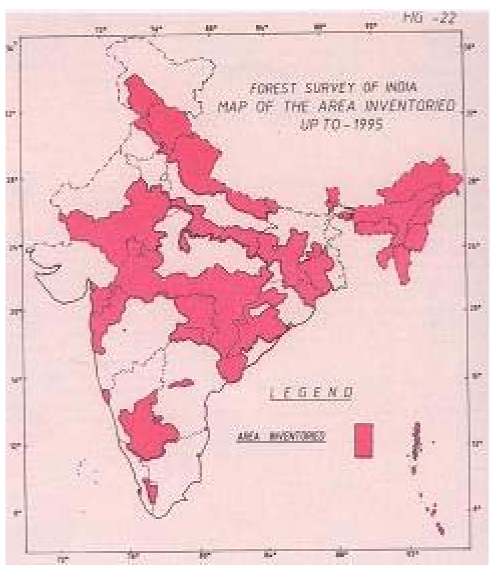

Figure 3 : Map depicting inventoried forest area

5.2.1. FSI METHODOLOGY:

A methodology has been developed for a comprehensive assessment of forest resources inside and outside forest areas at national level by stratifying the country into physiographic zones and to take a sample of 10 percent districts for detailed inventory during a cycle of two years. This information, thus generated, will form a part of the biennial State of Forest Report. These estimates will be further improved in the subsequent reports as another set of 10 percent districts are sampled and surveyed, and so on. Together with forest inventory, assessment of herbs & shrubs (vegetation survey) is being carried out. In addition, assessment of regeneration status, biodiversity indices and soil carbon in forest areas are being carried out.

5.2.1.a. Methodology

i) Forest Inventory :

The country is stratified into 14 physiographic zones as depicted in the figure above according to tree species composition and other physiographic and ecological parameters. In strata, districts are considered first sampling units and grids of size 1 ¼* x 1 ¼* as secondary sampling units. Ten percent of districts are being inventoried every year.

(a) 1:50,000 scale Survey of India toposheet is divided into 36 grids of 2 ½* x 2 ½*, further each are divided into 4 sub-grids of 1 ¼* x 1 ¼* forming the basic sampling units. Two of these sub-grids are randomly selected and corresponding sub-grids in all the 2 ½* x 2 ½* grids are selected to form the sample. The intersection of diagonals of such sub-grids is marked as center of plot on the map. At the center of selected subgrid a plot of 0.1 ha area is laid out in each such grid and data are collected from the plots falling in forest area only.

(b) For collecting data on soil, forest floor (humus & litter carbon), sub-plots of 1x 1m are laid at each corner within the 0.1 ha plot.

(c) The data regarding herbs and shrubs (including regeneration) are collected from four square plots of 1m x 1m and 3m x 3m respectively. These plots are laid out at 30 meters from the centre of 0.1 ha plot in all four directions along diagonals in non-hilly area and along trails in hilly areas.

Data is collected from randomly selected sample plots. The data on checking is entered in the computer and after rectification it is sent to headquarter for processing. Processing will be carried out for different parameters such as area estimation, stand and stock tables, standard error estimation etc.

ii) Trees Outside Forests [TOF(Rural)] :

Extensive tree wealth exists outside continuous forested areas in every country. Termed as “Trees Outside Forests (TOF)”, these are in the form of small woodlots and block plantations, trees along linear features, such as roads, canals bunds, etc. and scattered trees on farmlands, homesteads, community lands and urban areas. Inventory of trees outside forest areas is of great importance in planning as this, together with the forest inventory, provides a complete picture of wood/forest resources. FSI has been carrying out TOF assessments since early 1990s. However, an accurate estimate at the national level at a specific time frame was given for the first time in State of Forest Report 2001

5.3. AERIAL PHOTOGRAPHY BASED THEMATIC MAPPING :

Preparation of thematic maps based on interpretation of aerial photographs is an important activity of FSI. Aerial photographs procured from Survey of India (S.O.I) are interpreted using stereoscopes. After intensive ground verification corrections are incorporated in the interpreted aerial photographs. These photographs are sent to the SOI for transference of the interpreted details on base maps on 1:50,000 scale and for preparation of thematic maps. Thematic maps depict forest types, major species composition, crown density of forest cover and other land uses. They depict as many as 48 forest types and 14 other categories of land uses. Thematic map are one of the best forest type map available in FSI. These maps are used by various State Forest Departments for updating stock maps, working plan preparations, management of forest resources and land use planning. These are also indented by Railways, Engineering, Educational, Mining and other establishments for their general planning and programme execution. The total geographic area of the country is covered by 5,200 SOI map sheets on 1:50,000 scale. Of these about 3,400 sheets bear forest cover. Each year about 5,200 aerial photographs corresponding to 260 SOI sheets on 1:50,000 scale were interpreted for generation of thematic maps. About 75% of the forested area of the country has been covered by thematic mapping. The activity of thematic mapping work has been scaled down to 50 sheets per year

6. CONCLUSIONS

It quite evident from the brief discussion of geospatial technologies based data collection, collation and preparation of application specific spatial decision support systems that that geospatial technologies can help foresters and community-based organizations, e.g., forest user communities and issue-based working groups to meet the challenges of integrating biophysical, socio-economic and cultural data and information for sustainable forest management. GIS/GPS can help address the disparate information needs of forest management and also to promote enthusiasm among community members to be actively involved in data gathering and developing GIS applications. There is a need to develop application specific spatial decision support systems (SDSS) to assist in efficient and sustainable forest management. The role and potential of geospatial technologies will be more pronounced with ongoing & upcoming technological advances in several remote sensing techniques [(Satellite (passive) Remote Sensing Systems , Radar (active) Remote Sensing Systems , airborne laser scanning (als) / lidar remote sensing, hyperspectral remote sensing, aerial photography , aerial videography) along with integration with Geographic Information Systems (GIS) and Global Positioning Systems (GPSs)] . Application specific spatial decision support systems will assist more efficiently in several forestry management related decision processes due to the availability of high relosution satellite data (QUICKBIRD, IKONOS etc) and hyperspectral remote sensing data. The presentation (on computer) of remote sensed spatial data seems to attract people, who are encouraged by seeing the output of their work presented in graphical forms. In the planning and decision making processes directed towards sustainable management of forest resources it is essential that a wide range types of data and information is available to concerned ones at several levels of decision making processes. .

Application Of Remote Sensing In Forest Resource Assessment -A Case Study In And Around Dudhwa Natioanal Park

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Abstract

Albeit, reliable and comparable region-wise data is one of the prerequisites for any kind of analysis, but some of the key data constraints faced these days are restricting the unprecedented progress in research work to some extent. The underlying research problems associated with the collection of secondary data are: [a] lack of consistent data across districts; [b] lack of data for the districts during a comparable time frame; [c] differences in data between departments, districts and state level; [d] data may not be available for some districts (for instance if new districts are carved from existing districts). This research paper with the help of its case study at Dudhwa National Park has made an attempt to avoid such gaps in data inconsistency and data discrepancy using remote sensing technology, where a decision-making is dynamic and pragmatic. Though many people try to circumvent these issues with the help of data from various sources despite of its inconsistency, but still the applications of science and technology cannot be ignored at its own path.

This paper explores empirically the impact of land use and land cover changes with the help of remote sensing technology without relying on the inconsistent secondary data. The present study used digital image interpretation (DIP) to identify the changes in the course of rivers, areas of inundation and loss of grassland due to various natural phenomena. This later led to the analysis of the geomorphic terrain conditions and extraction of necessary conclusions to restore the remaining grassland, which is under serious threat from siltation by various mountain rivers.

Key words

Remote sensing, DIP, imagery, spatial data, temporal change detection, inundation, siltation, mangrove, water logging.

Application of Remote Sensing in bridging data gaps

Although remotely sensed data will rarely, if ever, completely supplant other sources of data in social science research, there are numerous ways that they can assist in answering research questions that are fundamental to the social sciences. One important contribution is the synoptic view from space that only remote sensing can provide. Remote sensing imagery can provide snapshots of phenomena over large areas, thus broadening the scope of social science inquiry. Examples include basin-scale analyses of deforestation, or scenes from space that pick up archaeological artifacts that are not visible on the ground or to the naked eye (Sever 1998). The ability of remote sensing to pick up and then represent parts of the non-visible spectrum in visible colors (red, green and blue) uncovers aspects of the natural and built environment that were previously opaque to social scientists. Another advantage of the synoptic view is that scientists can "custom design" the spatial boundaries of their research. Political scientists, economists and others are often restricted to the use of national-level data sets. Remote sensing allows scientists to observe, and perhaps to understand certain processes that transcend national boundaries, such as cross-border social networks or patterns of trade and interaction (Blumberg and Jacobson 1997). As cross-border flows increase in the age of globalization, remote sensing may represent an important means of tracking these flows, whether they be flows of raw materials, water resources, or other natural resources. Furthermore, data collected using a common algorithm can provide valuable, consistent and objective cross-country comparisons that would not be available through data collected by national agencies (Sutton and Costanza 2002). Remotely sensed data may provide a cost-effective method to reduce, but not replace, expensive ground data collection. In many parts of the world, spatial data on roads or infrastructure, farm sizes, industrial activities, or any number of other variables visible from space are either not available or difficult to obtain. In other instances, an area may simply be inaccessible for reasons of political turmoil or armed conflict. In these cases, remote sensed data, utilized independently or entered into a geographic information system (GIS), may provide an alternative source of data. Another example would be land uses by individual farmers. Farm level surveys can be employed to determine the amount of land farmed and the proportions in different land-use classes (e.g., Marquette 1998), but this may be costly and potentially less accurate than overlaying farm property boundaries onto remote sensing images (e.g., McCracken *et al.* 1999). Social scientists are often interested in how context affects human behavior (Rindfuss and Stern1998). Important contextual variables for an analysis of what crop small holders are likely to grow might include the following: the world price for a commodity, the farm gate price, the distance to major markets, what other farmers are growing, and the soil type and quality. Remote sensing can provide important information on biophysical parameters such as slope, aspect, soil types, water bodies and vegetation cover, and, in some cases, infrastructure parameters such as roads, pipelines, or power lines, that can impact people's decision-making or livelihood options.

Data derived from remote sensing can provide dependent variables for numerous studies of human impacts on the environment. Although such studies are often focused on land-use and land-cover change (deforestation, agricultural expansion, urban sprawl, etc.), remote sensing can also provide valuable data on other human impacts such as air and water pollution (point source and non-point source), ozone depletion, coral bleaching, and land degradation, among others. These variables are particularly important for human dimensions of environmental change research, and can be associated with a variety of independent variables such as government policies, technologies, and economic and demographic factors.

Remote sensing may provide additional measures of certain phenomena, which would allow social scientists to cross-check or complement their own data sources derived from field surveys, censuses or administrative records (Rindfuss and Stern 1998). Censuses, for instance, generally rely on household measurement of population. Identification of houses or new settlements from space can facilitate more accurate censuses. Measures of urban extent may be more accurately generated by remote sensing than by more traditional measures, such as official “city limits” based on administrative boundaries. Administrative records may provide parcel-level information that can be cross-checked against remote sensing images. The time series capabilities of remote sensing mean that these data can also be readily updated. These data may also be more consistent and freer from the kinds of bias that may are inherently part of data collected through survey instruments (Blumberg and Jacobson 1997). Because many remote sensing scientists are trained in the natural sciences, social scientists, who become experienced in remote sensing image interpretation can bring valuable insights to bear on the spatial patterns they see on the ground. Examples may include spectral differences in land use types that are associated with different forms of land tenure, or socially important distinctions in types of land use that may be masked by one land cover classification such as “forested” (e.g., oil palm plantation versus natural palms) (Rindfuss and Stern 1998).

Forest resource assessment

Forest being the major biological investment on the Earth’s crust and variable contributions and influences reaching all other sub-kingdoms, its management has an all-pervasive ramification. The present century is introducing a dynamic change and unprecedented progress in the various spectrum of science at a pace never encountered by civilizations in the past. Yet, our capabilities to comprehend these changes and realize their efficiency to sort some of the crucial problems invariably lack far behind. Flowing with the above-mentioned context, the role of remote sensing as an additional tool for forest management cannot be overlooked. The Satellite based remote sensing is a sustainable global information system because it has the immense potential to meet the growing needs and demands of the present and future. The synoptic coverage, which provides capability for integration of real time information on regional and local scales, is a unique characteristic of this technology. Its versatility lies in its perennial and inherent ability to conceptualize situations to give clear perceptions for defining short and long-term objectives within a cost effective and time bound programme.

Therefore, it would be appropriate to view the applications of remote sensing for issues of forest management as a contribution to the present information system, not just as an ancillary tool to extract information but also to make effective management plans with various analysis like forest cover change over a period of time, corridor identification, species level identification, forest canopy and occurrence of various vegetation classes in different altitude, slope and aspect of the terrain etc. The loss of forests increases soil erosion, river siltation, and deposition, affecting navigation, fisheries, wildlife habitat, and drinking water supplies, as well as farming productivity and self-sufficiency.

Sensitive estuarine environments are protected by mangrove forest, which is cut or lost to urban growth, aquaculture, or damaged by pollutants or siltation. Monitoring the health of this forest is a step towards protecting the coastlines from erosion and degradation, and nearby inland areas from flooding. The loss of forests also affects the genetic diversity of species on Earth, which controls our intrinsic ability to adapt to changing conditions and environment. Rainforests account for approximately one half of the plant and animal species on Earth, and destroying large sections will only serve to reduce the gene and species pool. The rate and extent of deforestation, as well as monitoring regeneration, are the key parameters measured by remote sensing methods.

Remote sensing brings together a multitude of tools to better analyze the scope and scale of the deforestation problem. Multitemporal data provides for change detection analyses. Images of earlier years are compared to recent scenes, to tangibly measure the differences in the sizes and extents of the clearcuts or loss of forest. Data from a variety of sources are used to provide complementary information. Radar, merged with optical data, can be used to efficiently monitor the status of existing clearcuts or emergence of new ones, and even assess regeneration condition. In countries where cutting is controlled and regulated, remote sensing serves as a monitoring tool to ensure companies are following cut guidelines and specifications.

High-resolution data provide a detailed view of forest depletion, while radar can provide a view that may otherwise be obscured by clouds. All remote sensing devices, however, provide a view of often remote and inaccessible areas, where damage to forests may be continuing unnoticed. Repetitive coverage of satellite gives consistent data of any particular region over a period of time, no matter how the terrain condition behave, which enables various research and scientific community to better understand the environment for sustainable development of natural resources.

Background

The Dudhwa National Park is situated in the Nighashan Tehsil of Lakhimpur-Kheri district in the northern state of Uttar Pradesh between 28^0 18' N to 28^0 42' N and 80^0 28' E to 80^0 57' E, it is a part Ddudhwa Tiger Reserve. First time Post-indiependent period, a wildlife sanctuary was created at Sonaripur in an area of 15.7 Sq. Km. with a view to protect Swamp deer. In 1968 this was extended to 212 Sq. Km. and renamed as Dudhwa Sanctuary. Subsequently in 1977, 490 Sq. Km. additional areas were included in this sanctuary and its status was increased to Natioanl Park. Finally it got Tiger Reserve status in 1987-88. Dudhwa National Park along with Kishanpur Wildlife Sanctuary forms the area for Dudhwa Tiger Reserve, which came in to being 1987-88 with a total area of 884 Sq. Km. Of two park. The Kishanpur Wildlife Sanctuary is partly situated in Lakhimpur-Kheri and Shajahanpur district of Uttar Pradesh. Dudhwa National Park and Kishanpur Wildlife Sanctuary are apart from each other by a minimum distance of 40 km. by road.

Dudhwa is now called as last Terai, since it holds remains of the dense forest that once existed along the foothills of the Himalayas. Here species threatened continued to thrive. It is also one of the best spots on earth to watch birds. The area comprising of the forests, once the playground of big hunters, full of jheels, marshylands and grasslands, which has been slowly converted to paddy and sugarcane fields. This was once the part of the most extensive swamp deer ranges called *barasinghas.* Before independence Dudhwa was untanned land of marshes, grasslands and dense forests, menacing malarial mosquitos plague and oppresive famines were associated with the region. The habitat is nurtured by the Sharada river and its tributaries. The Mohana arm to the north flanks the park and whereas Suheli river forms the Suthern boundary. The park covers an area of 498.29 km and the topography is almost flat, with insignificant undulating terrain demarcating its extreme northern and southern boundary. An unusual absence of surface stones and rocks typify the soil texture. The forests soaks in 1600 mm of rain annually and because it is well vegetated, groundwater level is high along most of the forested terai landscape.

Objectives

As collection of repetitive timely data and comparison of old data with the recent one of any particular season and region is not only a tough task to get but also prone to many type of errors due to change in methodologies in various dynamic sectors like forestry, water resources, climate change etc. Hence, remote sensing as a technique is emerging as a scientific solution to the above ambiguity in data mismatching and gaps. In continuation to the above discussion, a case study in and around Dudhwa National Park has made an attempt to bridge some of those gaps, while proving its applicability towards forest resources assessment and management with its objectives focused on 6 major headings: [a] River Pattern Analysis-which includes demarcation of change and/or shift in river during 1991, 1996 and 2002; [b] Land use and Land cover assessment from 1991,1996 and 2002 satellite imageries; [c] Temporal Change Detection Analysis of various season data (Satellite data of 1991,1996 and 2002) giving emphasis on Dense Forest, Grass and Marshy Land; [d] Encroachment and/or replacement of Forests, Grass and Marshy Land by Agriculture and Fallow Land; [e] Loss of Forests and Grass Land due to flooding or siltation by various rivers like the Mohana, Suheli river and the Sharada river; [f] Loss of Marshy Land by other Land cover and Land use practices.

Study Area

The study area constitutes a part of Terai Arc Landscape and covers an area 3099 Sq. Kms. The average elevation of the area is about 163mts, having a variation not more than 50 mts from the Mohana river in the north to the Suheli river in the south. It spreads along pillibhit and Lakhimpur districts of Uttar Pradesh. The study area for the analysis is more or less like an ellipse, diagonally extending from 28^0 42’ 57’’ & 80^0 16’ 17’’ (max. Lat/Lon) to 28^0 4’ 33’’ & 80^0 58’ 31’’ (min. Lat/Lon). The Sharada Sagar is located at North-West corner, whereas meeting point of the Kauriala iver and Girwa river demarcates the South-Eastern Corner. In the northern side we have international boundary between India and Nepal, whereas southern extent can be delineated by an approximately 4km buffter to the south of river Sharda. The study area is dissected by many rivers like the Mohana, Suheli, Kauriala and Sharada etc. To the north of the study area, we have Siwalik hill ranges, from where Dudhwa is getting an ample amount of sediments in the form of sand, silt and clay. The study area mainly comprises of tertiary Sandstones, boulders, conglomerates and pebbles etc. The study area is mainly a flat land giving the structural disturbances any chance to play around.

Principles of Remote Sensing

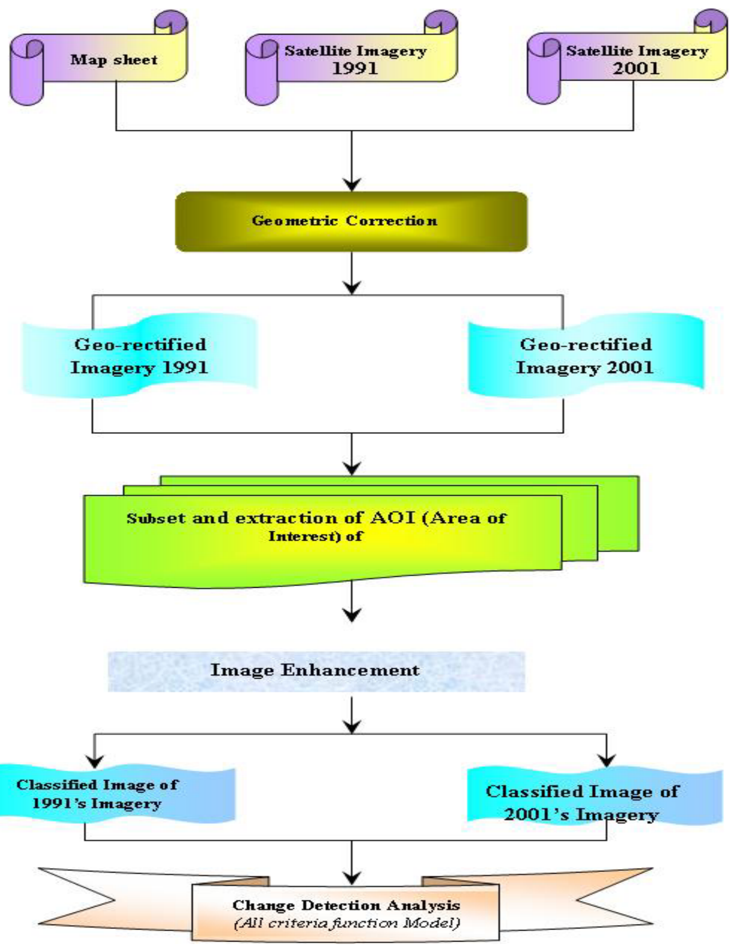
Detection and discrimination of objects or surface features means detecting and recording of radiant energy reflected or emitted by objects or surface material. Different objects return different amount and kind of energy in different bands of the electromagnetic spectrum, incident upon it. This unique property depends on the property of material (structural, chemical, and physical), surface roughness, angle of incidence, intensity, and wavelength of radiant energy. The Remote Sensing is basically a multi-disciplinary science which includes a combination of various disciplines such as optics, spectroscopy, photography, computer, electronics and telecommunication, satellite launching etc. And these technologies are integrated to act as one complete system in itself known as Remote Sensing System. There are a number of stages in a Remote System, working as links in a complete, and each of them is important for successful operation.

Data Source and Methodology

IRS-1A (Sensor-LISS I), 1C & 1D (Sensor-III) Images of March 1991, Nov. 1996 and Dec.2001 respectively were procured from NRSA, DOS, Balanagar, Hyderabad. Path/Row of those images are 26, 27/47-48 and 99/51 of LISS-I & LISS-III respectively.

The overall methodology can be divided into two major headings [i] data processing and [ii] data analysis, which has been given in the flow chart (refer fig:1).

Fig: 1 Flow chart showing methodology for the study (1991 to 2001)



Data Processing

(i) Geo-rectification:

The methodology adopted to extract the desired information includes Geometric correction of the satellite data, AOI masking, mosaicing, Image Enhancement, classification and change detection analysis. In geometric correction of the satellite images, polynomial equations are applied to convert source coordinates (image coordinates) to rectified coordinates. Least square regression method is used to calculate the transformation matrices from the GCS. First order transformation is a linear transformation. Transformation of second or higher one is non-linear transformations. The computation and output of higher order polynomial equation are more complex than that of a lower order polynomial equation. Therefore, higher order polynomial equations were applied to perform more complicated image rectification. The other referral material is used to validate and support the findings of data analysis is Root mean square (RMS) error, which was calculated with a distance equation:

$$RMS = \sqrt{\{(Xr - X1)^2 + (Yr - y1)^2\}}$$

Where X_1 and Y_1 are the input source coordinates and Xr and Yr are transform coordinates.

Resampling method was used to create the output data file. Since the grid of Pixel in source image rarely matches the grid for the reference image, the pixels were resampled to calculate the new data file values. Nearest neighborhood method is used in resampling the output pixel values.

(ii) *Evaluating training samples:*

Selecting training samples is often an iterative process. Spectral signatures that accurately represent various land use and land cover classes were identified on the basis of GPS (Global Positioning System) information collected from ground truthing. Adequate number of training sets has been taken to minimize the error level in the contingency matrix. Signatures were evaluated and manipulated using Erdas IMAGINE software, which were generated from the samples. Signature manipulation involved merging, deleting or appending from one file to other based on its resemblance with the training sets taken.

(iii) *Contingency Matrix:*

This evaluation classifies all the pixels in the selected AOI and compares the result to the pixel of a training sample. In this evaluation a quick classifications of the sample pixels were performed using the *Minimum distance* and *Maximum likelihood* decision rule. The resultant classification from Maximum likelihood method showed higher accuracy level for all sets of land use and land cover classes and hence, the same was taken for further spatial calculations and analysis.

Data Analysis

The last part of the study was achieved through temporal change detection analysis, which has been done using model maker of Erdas Imagine. This particular model has utilized the classified images i.e old and recent land use and land cover themes extracted from satellite imageries and has calculated the spatial area on the basis of change in the cell values (class themes).

Results

The Satellite images have been classified on the basis of spectral signature, which is nothing but the capacity to distinguish two adjacent objects on the basis of spectral radiation. Some other parameters that have been taken into considerations are shape, size and pattern. As agriculture and plantation were giving same reflectance, so it became practically impossible to discriminate the blend altogether and hence both the classes have been put into one category. Sal was giving high reflectance due high chlorophyll content in the vegetation cover, while grass and marshy land was giving little reflectance, absorbing most of it following the presence of water in the soil. The spatial statistics of various classes can be summarized as below (chronologically):

Table:1 Area Statistics of Land use/Land Cover Classes Of 1991 Satellite Imagery

CLASS	AREA (Sq Kms.)	AREA (%)
Dense Forest	979.982208	31.61742528
Grass Land	412.175808	13.29813716
Open Forest	97.10496	3.132923019
Marshy Land	293.137344	9.457567695
Agriculture/Plantation	432.197568	13.9441045
Fallow Land	566.203968	18.26758844
Water Bodies	38.235456	1.233600634
Open/Waste Land	217.37088	7.013094219
River Sand	63.09216	2.035559053
Total	3099.500352	100

Table:2 Area Statistics of Land use/Land Cover Classes of 1996 Satellite Imagery

CLASS	AREA (Sq Kms.)	AREA (%)
Dense Forest	795.3984	25.6716762
Grass Land	393.080256	12.68676056
Open Forest	106.272	3.429954565
Marshy Land	191.24352	6.172430973
Agriculture/Plantation	734.091264	23.69297352
Fallow Land	611.723	19.74350813
Water Bodies	111.228	3.589910666
Open/Waste Land	99.416448	3.208689962
River Sand	55.896768	1.804081739
Total	3098.35008	100

Table:3 Area Statistics of Land use/Land Cover Classes of 2001 Satellite Imagery

CLASS	AREA (Sq Kms.)	AREA (%)
Dense Forest	789.01056	25.49829082
Grass Land	328.478976	10.61538702
Open Forest	87.003648	2.811678869

Marshy Land	124.983936	4.039079969
Agriculture/Plantation	932.194944	30.1255509
Fallow Land	506.064384	16.35437786
Water Bodies	69.6528	2.250955109
Open/Waste Land	130.191552	4.207373416
River Sand	110.421504	3.56846887
Total	3094.366464	100

After classification the temporal change detection of the study area has been carried out to get the change or Loss of three major classes (See fig:2) i.e. Dense Forest, Grass Land and Marshy Land due various natural and artificial phenomena like siltation, flooding and agricultural practices (refer table: 4). Khamaria and Tandabardhan are some of the locations, in and around of which losses or major changes in Dense forest, Grass Land and Marshy Land has been interpreted.

Fig:2 Satellite imageries showing changes over time in the forest cover due to various activities

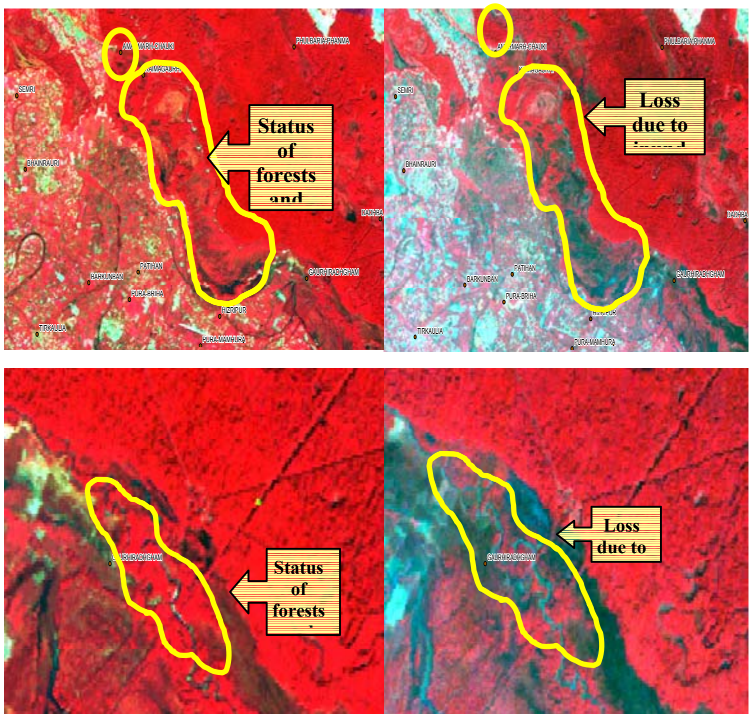


Table:4 Change in land use and land cover (desired classes only) over the region

Total (Study Area-1991 in Sq. Kms.)	AREA (Sq Kms.)(1991-1996)	AREA (Sq Kms.)(1996-2001)	AREA (Sq Kms.)(1991-2001)
Dense Forest-Agriculture/Plantation	148.2624	62.208	201.1392
Dense Forest-Fallow Land	106.272	14.5152	96.9408
Dense Forest-Water Bodies	12.4416	1.0368	9.8496
Dense Forest-River Sand	3.1104	52.0128	17.1072
Grass Land-Agriculture/Plantation	157.0752	167.4432	165.3696
Grass Land-Fallow Land	119.7504	49.7664	93.8304
Grass Land-Water Bodies	9.3312	4.6656	7.2576
Grass Land-River Sand	4.6656	6.7392	11.9232
Marshy Land-Agriculture/Plantation	36.288	65.3184	54.432
Marshy Land-Fallow Land	17.1072	21.2544	13.9968
Marshy Land-Water Bodies	9.3312	6.2208	4.1472
Marshy Land-River Sand	1.0368	8.2944	4.6656

Conclusion:

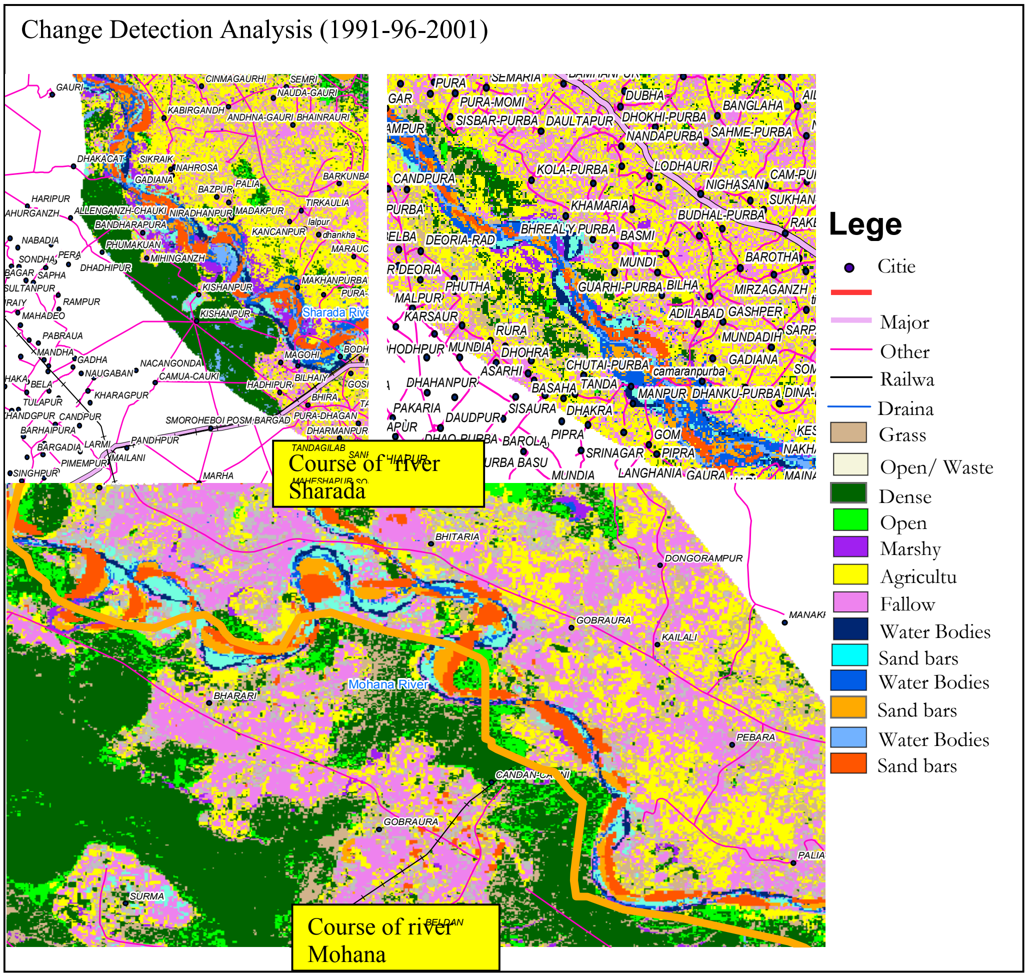
The major forest loss has been located along river Suheli, Mohana and Sharada. Kishanpur, Bhandarpur, piparia, Hazara, Purakalandar, Gaurhiradhgam, Amargarh-chauki, Badhera, Khamaria and Tandabardhan are some of the locations, in and around of which losses or major changes in Dense forest, Grass Land and Marshy Land has been interpreted (see fig:3).

The major changes/loss in Dense Forest, Grass land and Marshy land can be attributed to various activities like Sand and Silt deposition, inundation due flooding etc. This has resulted because of erosion of loose sediments like sandstones from high altitudes (Foot hills of Himalaya), where the velocity of river is much higher and deposits the sediments in and around the Dudhwa region, where the velocity dies down with the decreasing in slope. However, when the river system enters the flat land its lateral cutting increases leaving deep cutting (which is prominent in the steep slopes). All these are responsible for accumulating sand and silt and inundation in later part of flooding, which in return causing degradation to forest covers and shrinkage in marshy land, which is a prime habitat for *barasinghas*. The various causes of degradation to forest cover due various regions can be concluded as given in Table:5.

Table:5 Causes of degradation

Causes	Factors
Geomorphologic Causes	[a] Flat Terrain, hence lateral erosion is faster and easier. [b] Silts getting deposited in between the gaps of river boulders and pebbles make the river-bed relatively impervious and flooding capacity increases with decreasing infiltration.
Geologic Causes (lithological aspect)	[a] As the terrain is composed of softer rocks (sandstone of tertiary age), the contribution towards siltation is much more than that of hard and compact terrain of peninsular region.
Flood	[a] Natural barriers, sand bars and deposition of silt after the flooding, partially doesn't allow the water logged areas to recede to its original flow, when the velocity greedily slows down.

Fig:3 Result of change detection analysis showing areas changes in Dense forest, Grass Land and Marshy Land due to river action.



Recommendations:

The two key factors (Siltation & Flooding) behind the loss of forests and grassland can be addressed by ***aligning of river banks*** with the stones of river bed. The advantages of this method are: [i] increase the infiltration power of river, reducing flooding capacity; [ii] stop the lateral growth of river (reducing erosion activities inside the park); [iii] reduce insitu production and deposition of silt from the immediate surrounding, which is a major threat to Terai grassland; [iv] will facilitate the construction of roads along the river, whose prime moto is to reduce siltation from the adjacent areas; [v] stone alignment also works as a hurdle to soil eroding agents.

This is an immediate solution to the park, which is economically viable and cost effective, unlike construction of gabion structures, check dams and many other structures on streams and preventive measures for soil erosion at hilly slopes to put a check on the silts getting transported from foot hills of Himalaya to the flat terrain of Dudhwa region.

Acknowledgement

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Physical Accounting of Forest Resources

D.Pandey[1], S.Dasgupta[2], Prakash Lakhchaura[3]

Introduction:

Forests have acquired increasing importance in the recent past for their role as important source of subsistence, employment, revenue earning, raw materials to a number of industries in addition to playing a vital role in ecological balance, environmental stability, and biodiversity conservation. In addition to this, forests are important in the global carbon cycle because they store large quantities of carbon in vegetation and soil. It is, therefore, essential that forests are managed in a sustainable manner on sound scientific principles for which availability of data on forest resources (Physical Accounting) is critical. The structure of a physical stock account works like a balance sheet. The accounts begin with opening stocks to which additions are added and disposables are subtracted. The changes between the opening and closing stock levels are a result of both man-made and natural changes. Additions include new plantations, restocking, natural growth and natural extension while disposable include harvesting, degradation and fires. To prepare a physical stock of forest resources, accurate assessment of various parameters of forests including forest cover by density and type, growing stock by species and diameter class, annual increment, volume and extent of NTFP & medicinal plants are essential for conservation, valuation and sustainable development of the resources.

Though scientific forest management in India for the last 150 years has yielded considerable data on the forest resources of the country, the gaps in the database are still significant. The high diversity of forest types in the country and the vastness and spread of the forest resource are primarily responsible for this gap. As a result, the value of forest resources and its contribution to the country's GDP is poorly understood and grossly undervalued. Many important information on forestry resources for planners and policy makers are still not available. Some of them are availability of precise data of timber resources in the country for wood supply, accurate data on plantations (both young and old), data on availability of Non-timber Forest Produce (NTFP) including medicinal plants, carbon stock in forest & forest soil, accurate and precise data on forest fire, grazing, regeneration, fuel wood availability and demand etc. In absence of these information, it is very difficult for planners to make any short/long term strategy for conservation and sustainable development of forestry resources. In addition, benefits accruing from intangible data of forest resources have not been estimated and assessed which is reflected in the grossly undervalued contribution of forestry sector to the nation's GDP.

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Forest Resources in India:

Forestry is the second largest land use after agriculture. Of over 1 billion population of the country, about 300 million of the rural poor depend on forestlands. For approximately 100 million people, forests are the main source for sustaining livelihoods (fuel wood, non-timber forest products, construction materials, etc.) and generating cash income. Half of India's 70 million tribal people, the most disadvantaged section of society, subsist on forest resources. Seventy per cent of India's rural population depends on fuel wood to meet their domestic energy needs. About 470 million livestock use forests as grazing grounds. Degradation and deforestation are sensitive issues for India as they adversely affect not only the environmental functions of forests (e.g. wildlife refuge, watershed protection, prevention of soil and water run-off, and groundwater recharge) but also the subsistence functions of providing fuel wood, food, fodder, and cash income.

According to the State of Forest Report 2003, published by the Forest Survey of India (FSI), India has a recorded forest area of 77.47 million hectare or 23.57% of the total geographic area of the country. Nearly all of the forest areas in the country are state owned and they are managed by the state governments on the basis of long term working plans approved by the Union Government. However, the actual forest cover is 67.83 million ha (20.64 % of the country's geographical area) of which about 10 million ha lies outside recorded forest area. About 40% of the forest cover consists of degraded forests as indicated by their low canopy density.

Extensive afforestation activities have been undertaken in the country to increase the forest cover and overcome forest degradation. India's achievements in raising forest plantations, in term of area, has been impressive. Up to 2002, the total area of tree plantation, under different schemes, is 36.21 million ha. Of this, some 3.54 million ha were raised before 1980, 13.51 million ha during 1980s, and the rest after 1990. The current annual rate of planting is about 1.2 million ha. The quality of these plantations varies considerably.

The total growing stock in the country's forests, as estimated by FSI in its latest assessment is 6414 million cubic meter (m. cum) comprising 4,782 m.cum inside forest area and 1,632 m.cum outside recorded forest area (TOF). Forests contribute 1.1 per cent of the GDP of the country. However, this figure does not take into account its numerous non-market and external benefits and the vast amount of unrecorded removals of fuel wood, fodder and other produce by the population dependent on forest resources.

Despite insurmountable odds, India has been in the forefront of movement for conservation of its biodiversity. Establishment of a large number of protected areas is an ample testimony of the country's commitment towards safeguarding its rich and diverse biological resources. At present, the country has 92 National Parks and 500 Wildlife Sanctuaries with a total area 15.67 million ha or 4.75% of the geographic area of the country. In addition, 11 Biosphere Reserves have also been created with a geographic area of 4.76 million ha, which partly overlap the protected areas.

Data on Forest Resources with FSI:

Forest Survey of India, an organization under Ministry of Environment and Forest, responsible for assessment of the country's forest & tree cover & other resources on a periodic basis generates two kinds of information spatial as well as non-spatial. Both spatial and non-spatial information is based on latest technologies and are regularly updated. Various spatial and non-spatial information available with FSI are discussed below: -

Forest Cover:

Periodic assessment of forest cover provides a quantitative measure of the extent of land area under forest/tree cover along with the density. It also helps in monitoring the changes in the cover. FSI has been carrying out assessment of forest cover in the country using satellite based remote sensing data and has been publishing its findings in the State of Forest Report (SFR) every two years. The SFRs provide valuable information for policy formulation and planning both at national and state levels.

The table below depicts the forest cover of the country as assessed by FSI over the last two decades. It also tries to build a relationship between the forest cover and the increase in population during the last two decades.

Table 3: Forest cover estimates from 1987 to 2003

Assessment	Year	Data Period	Population estimates (in crores)	Forest cover (sq.km)	Percentage of geographic area
First	1987	1981-83	70.40	640,819	19.49
Second	1989	1985-87	76.70	638,804	19.43
Third	1991	1987-89	80.00	639,364	19.45
Fourth	1993	1989-91	83.50	639,386	19.45
Fifth	1995	1991-93	86.80	638,879	19.43
Sixth	1997	1993-95	95.97	633,397	19.27
Seventh	1999	1996-98	99.64	637,293	19.39
Eighth	2001	2000	103.32	675538	20.55
Ninth	2003	2002	106.82	678333	20.64

Source: *State of Forest Report*: FSI, *Statistical Abstract India 2003 published by Central Statistical Organisation*

From the above table we find that with a steady increase in the population of India from around 70 billion in 1982 to around 107 billion in 2002 (an increase of around 52 %) and considering the fact that around 30% of this population are dependent on forest resources for their sustenance and livelihood there hasn't been any significant loss in forest cover over the years from 1982-83 to 2002 which goes to show that even though the forest cover of the country is much below the goal set by the National Forest Policy, 1988, i.e. 33% of the country's geographic area and the world average of about 30% we have been able to sustain the forest cover around 20% of the geographic area in the past 2 decades which is very commendable.

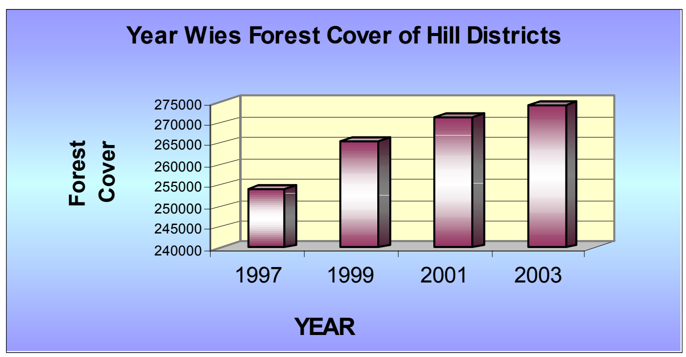
Forest cover Maps:

Forest cover maps at FSI are at present depicted on 1:50,000 scale. These maps show forest cover in three classes- (i) Very Dense Forest (VDF), having canopy density of more than 70%, (ii) Moderately Dense Forests (MDF) with canopy density between 40-70% (iii) Open Forest (OF) with canopy density between 10 -40 % and (iv) Scrub which are forest areas having less than 10% canopy density. These maps are generated for the Country/States/Union Territories and districts and area under forest cover for each density class at Country/State/District level is depicted. Besides density classes FSI also monitors the changes in the forest cover during intervening period. For the purpose of assessing change in the extent or density of a forest area, change maps are prepared by comparing the current forest cover maps with those of previous assessments. Change maps are very useful in identifying areas where changes in forest cover (positive as well as negative) are taking place due to shifting cultivation, encroachment, illicit felling, plantation etc. and also in designing appropriate strategy for rehabilitation of degraded forests. The district level information on forest cover changes is helpful in planning of forest resource at district level.

Forest Cover in Hill Districts:

The National Forest Policy (1988), aims at having a minimum of one third of geographic area of the country under forest and tree cover and enjoins maintaining two third of the area in hills under forest cover in order to prevent erosion and land degradation and also to ensure maintenance of ecological balance and environmental stability. It is, therefore, essential to know the extent of forest cover in the hill districts in the country. With this objective, FSI started assessing forest cover in the hill districts of the country since 1997. The extent of forest cover in hill district at the National level since 1997 to 2003 is depicting below in the form of a matrix.

Sl No.	Year	Forest Cover (sq.km.)	Percentage of Geographical area
1	1997	248281	36.76
2	1999	265526	37.32
3	2001	271326	38.34
4	2003	274383	38.77



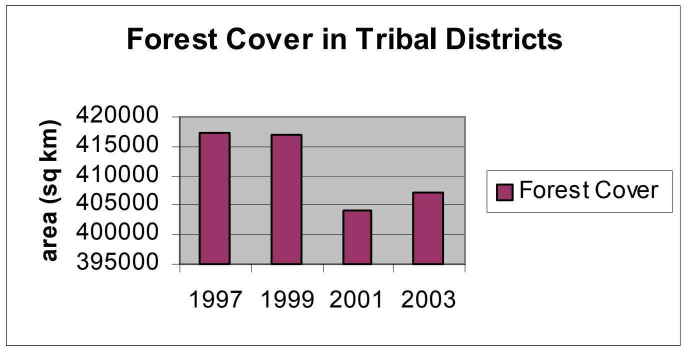
While it will be wrong to compare the forest cover in the hill district between 1997 to 2003 as the resolution of the sensors used and scale of interpretation were different, it is comparable between 2001 and 2003 were the same resolution of sensors and same scale of interpretation was used. From this we can infer that the forest cover in the hill districts at the National level has increased over the years. Significant changes in forest cover in hill districts is reflected in Jammu & Kashmir, Manipur, Meghalaya and Tripura where the forest cover has gone up between 2001 and 2003 whereas, in Karnataka, Arunchal Pradesh, Kerala and Himanchal Pradesh it has gone down.

Forest cover in Tribal Districts:

Tribals in the country are traditional forest dwellers. Forests play a significant role in the tribal economy, as these are a source of subsistence and livelihood for the tribal communities. It is commonly believed that the tribal communities live in harmony with nature and protect forests. Assessment of forest cover in tribal areas therefore acquires a special significance. Since the 1997 assessment, FSI is regularly providing information on forest cover in districts identified as tribal districts under the Integrated Tribal Development Programme of the Government of India which is depicted below:

Forest cover in Tribal District

Sl.No	Year	Forest Cover (Sq Km.)	Percentage of GA
1.	1997	417174	35.21
2.	1999	416827	35.18
3.	2001	404088	36.62
4.	2003	407298	36.92



Here again it will be wrong to compare the forest cover in the Tribal district between 1997 to 2003 as the resolution of the sensors used and scale of interpretation were different, however, it is comparable between 2001 and 2003 where the same resolution of sensors and same scale of interpretation was used. From this we can infer that the forest cover in the Tribal district at the National level has increased over the years. Significant changes in forest cover in Tribal district is reflected in Meghalaya, Mizoram, Tamil Nadu and Tripura where the forest cover has gone up between 2001 and 2003 whereas, in Chhatisgarh, Gujrat, Kerala and Lakshadweep it has gone down.

Extent of water bodies inside forest cover:

Since forests play an important role in precipitation and conserving water, FSI in its latest assessment made an attempt to assess water bodies inside forest cover. These water bodies include rivers, perennial rivers and streams, lakes, ponds, wetlands, creeks, straits etc. having an area of more than 1 ha.. This information may be utilized for identifying potential area inside forest area for raising nurseries for plantations purposes and also for taking up soil and moisture conservation works. The total area under water bodies inside forest cover as assessed in SFR 2003 is 17,396 sq.km. which is 2.56% of forest cover.

Mangrove Cover:

Mangrove forests are considered as the most productive and biodiverse wetlands on earth. These provide critical habitat for a diverse marine and terrestrial flora and fauna. Healthy mangrove forests are key to a healthy marine ecology. In fact, mangrove forests fix more carbon dioxide per unit area than phytoplankton in tropical oceans. Yet, these unique coastal tropical forests are among the most threatened habitats in the world.

Mangroves in India account for about 5 percent of the World's mangrove vegetation and are spread over an area of about 4,500 km^2 along the coastal States/UTs of the country. Sunderbans in West Bengal accounts for a little less than half of the total area under mangroves in India. Forest Survey of India is assessing the vegetation cover of the country including mangroves using remote sensing since 1983. The information on mangroves and change maps of mangroves cover prepared by FSI helps in planning future strategies for management of mangrove forest.

Thematic Maps:

FSI has a library containing 50,000 thematic maps on 1:50,000 scale prepared using aerial photographs. More than 70% of country's forest area has been covered under such thematic maps. These maps depict 48 forest land use classes and 15 non forest land uses, and are very useful for preparation of working plans/management plans of forest areas. These are also used by a number of central government organizations, Universities, Institutes, NGO's and researchers. However, these are not much in demand today as time taken for procurement of aerial photographs & map preparation is very long. Moreover, high resolution satellite images are more in demand these days.

Forest Type Maps:

FSI has recently taken up a project on preparation of Forest Type Maps based on classification given by Champion & Seth (1968). The classification divides India's forests into 16 major forest type groups and 221 forest types(including subtypes). The methodology makes use of GIS, Remote Sensing data, climate data and other ancillary data like soil, altitude, stock maps of state forest department etc. State and District wise maps at the scale of 1:50,000 scale will be produced which will be of immense value to state forest departments in preparation of working/management plans , researches, planners etc.

Assessment of coral reefs:

Coral reefs are one of the most productive but complex ecosystem with high biological diversity that occur in shallow waters through the tropics. They protect the coast line from wave action, provide shelter to reefs fishes, acts as breeding and security to communities inhabiting coastal areas. In India major coral reefs formations occurs in the Lakshadweep, Andaman & Nicobar Island, the Gulf of Mannar (Tamil Nadu) and Gulf of Kutchh. Coral reefs of these areas are reported to have been affected by various natural as well as anthropogenic pressures. The coral reefs managers often find it difficult to prepare effective management plans in absence of specific information on extent of reef areas, coral reefs maps and periodic monitoring mechanism. With a view to assist coral reef managers in developing effective management plans, FSI took up the following works:

i. Assessing extent of area under coral reefs in Andaman & Nicobar Island, Lakshdweep, Gulf of Mannar and Gulf of Kutchh using remote sensing and GIS.
ii. Preparing digital maps of coral reefs on 1:50,000 scale
iii. Monitoring periodic changes in coral reefs area through interpretation of satellite data.
iv. Developing Geographical Information System for Marine National Parks.
v. To develop a methodology to monitor health of coral reefs

The above task are on the verge of completion and once it is completed, it will provide a road map to coral reef managers.

Forest fire Monitoring and Detection :

It has been estimated that 53% of India's forests are affected by forest fires resulting in a colossal financial loss of Rs. 440 crores annually. For effective forest fire control and management, timely information on forest fire occurrence is necessary. FSI has taken initiative in near-real time monitoring of forest fire at the national level. It is using information based on MODIS satellite data to detect occurrence of fire in forest area on almost daily basis and disseminating the information to the concerned State/UT Forest Department for taking appropriate measures. Forest fire maps are also being generated at FSI.

Trees Outside Forest (TOF) & Tree Cover:

Generally, extensive tree wealth exists outside continuous forested areas in every country. Termed as 'Trees Outside Forests" (TOF), these are in the form of small woodlots and block plantations, trees along linear features, such as roads, canals, bunds, etc. and scattered trees on farmlands, homesteads, community lands and urban areas. TOF may lie within rural areas or urban areas and has correspondingly been termed as TOF (Rural) and TOF (Urban).

For assessment of rural TOF, LISS-III and PAN images for a district are merged and a classified image is prepared having three classes namely block, linear and scattered. On the basis of pilot study, optimum size of plots and numbers of sample points are determined in each stratum. Enumeration and measurement of all trees on each sample points is done and results are finally aggregated at the district level. For urban areas, the assessment is done using UFS blocks as sample points. The UFS blocks are division of urban centers of a district in blocks having well defined natural boundaries. These blocks are formed on the basis of population or household size. Using stratified random sampling and ratio method of estimation, species wise and diameter class wise number of stems & stems per hectare and volume of trees under each stratum for both rural and urban areas is estimated at the district level. District level estimates are then used for generating estimates at physiographic zone and finally at national level.

The area under tree cover is a computed area. It is an area that is deemed to be covered by the tree canopy of all the trees included in the assessment of tree cover if all these trees are hypothetically brought together to constitute a block of tree land or forest with 70 percent canopy density. FSI has been estimating the Tree Cover of the country since SFR 2001 and is given following table.

Assessment year	Tree cover (sq km)	% of GA
2001	81472	2.48
2003	99896	3.04

Besides estimation of Tree cover, spatial information on Block, Linear and Scattered plantation/trees for selected districts can be obtained from the classified TOF maps. From these maps, data pertaining to area under Block, Linear and Scattered can be calculated. In addition, such areas, which do not support tree vegetation, like rivers and water bodies, riverbeds, snow covered mountains, etc. which is termed as Unculturable Non Forest area can be calculated along with areas outside Recorded forest areas which can support tree vegetation, known as Culturable Non Forest Area(CNFA). Such information is available for selected districts of the country and has also been estimated for the country as a whole. This information is very useful for district level & country level planning for afforestation programmes

Estimation of Wood Volume(Growing Stock):

To cater to the needs of forest managers, planners and policy makers, information about availability of wood from important tree species growing inside and outside forest areas is very important. Detailed information on distribution of timber species, volume, biomass, number of stems, regeneration status, population structure, etc. within different zones and regions of the country is highly useful for effective planning. FSI has been generating such information through systematic and intensive field surveys. In 1995, FSI published the findings in the form of a book "Extent, Composition, Density, Growing Stock and Annual Increment of India's Forests". It provided information about wood volume (growing stock) in the forested regions of the country. As per the results obtained in this publication, the total wood volume of the country was estimated as 4740 million cubic meter. This information was based on satellite data, thematic maps (based on aerial photographs) and forest inventory data from different parts of the country over a period of 25-30 years. FSI has now expanded this activity to provide periodic information at national level on volume of wood existing within and outside forest areas. In the latest assessment wood volume has been estimated for all the trees above ground upto dbh 10 cm for the main stem and upto 5 cm diameter for branches.

The total volume stock of wood in the country is estimated to be 6,414 million cubic meter (m.cum) comprising 4,782 m.cum inside forest area and 1,632 m. cum outside recorded forest area (TOF). Maximum growing stock in forest area is found in Arunachal Pradesh followed by Uttaranchal and Andhra Pradesh. Similarly, maximum growing stock in TOF is observed in Andhra Pradesh followed by Maharashtra and Gujarat. As far as the total growing stock (in both forest area and TOF) is concerned, Arunchal Pradesh leads and is followed by Andhra Pradesh and Karnataka.

Conclusion:

India is committed to manage its forest resources in a sustainable manner. The National forest Policy adopted in 1988 has sustainability as its central theme, with its objectives revolving around overall conservation of forest resources. However, to achieve sustainable development of forests in India, it is imperative that data on forest resources are regularly collected, updated & monitored.

Despite of a lot of data available with FSI, there exist significant data gaps in the forestry sector. To name a few, data on growth, increment, yield & extraction of timber/fuelwood/fodder, carbon stock, biomass, estimation of NTFP's with special reference to medicinal plants, impact of forestry on livelihoods specially in JFM areas, plantaions details, etc. are inadequate and often guessestimated. Harmonization of data collected by various agencies (Central govt. institutions/State Forest Departments/ NGOs/Researchers etc.) is the need of the hour. There is an urgent need to develop a unified database for forestry related data by all concerned agencies without duplication of efforts. The importance of forestry data has been recognized both for policy formulation and planning purposes on one hand and for monitoring and evaluation of programmes on the other hand at all levels. For effective planning at various levels (national, state, region, district, village etc) a reliable, accessible and regularly updated data base on traditional as well as non-traditional aspects of forest resources containing spatial and non-spatial information is essential.

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2 Joint Director, Forest Survey of India, Dehradun

3 Deputy Director, Forest Survey of India, Dehradun

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Use of Agrochemicals in India

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Abstract

The agriculture sector in India has achieved the green revolution, which paved a way for self-reliance in the area of food production. This has been accomplished in part by increased irrigation and increased the use of fertilizers and pesticides. The inputs in terms of agrochemicals have posed a threat to the human health. Besides, several pests have become resistant to pesticides and the use of many pesticides has been banned. In the present paper two and three independent variable multiple regression models have been developed for the food production data for the period from 1955-56 to 2003-04. The partial regression values for the effect of fertilizers, pesticides and irrigation on yield (kg/ha) are 5.41 (kg/ha), 0.09 (g/ha) and 9.61 (%) respectively. The beta regression values revealed the effects of factors analysed in the order: Fertilzers > Irrigation > Pesticides.

Introduction

Driven by necessity to increase agricultural production, a great reliance is placed on the use of improved agro technology in India. It was on this account that the country could achieve self-sufficiency in food production to cater to the needs of one billion people. The major factors contributing to this feat are the use of high yielding varieties, meeting the nutritional requirements of the crops, preventing pest damage and increased irrigation.

The high yielding varieties largely translocate the photosynthate to the developing seeds rather than to other parts of the plant such as stem or roots, though compromising with the adaptability of plants to harsh conditions. This is in contrast to the wild varieties, which equip the plants with a potential to compete with other species in the field by translocating food synthesized to the stem to make them tall and sturdy. Whereas the wild relatives of cultivated varieties use 20% of food for translocation to seeds, the high yielding varieties transfer about 50% to the seeds. The maximum limit to this translocation is about 60%.

Consistent crop production over an area deprives the soil of essential nutrients. Nutrient removal from soil by wheat and rice is given in table 1 (Prasad, 1999., Joseph and Prasad, 1992., Dobermann *et al.,* 1998). The nutrients thus removed from the soil, therefore need to be replenished through fertilizers, manure etc. The world use of fertilizers has increased from 31 million tonnes in 1961 to 142 million in 2002 (UN FAO, 2005) (Fig. 1).

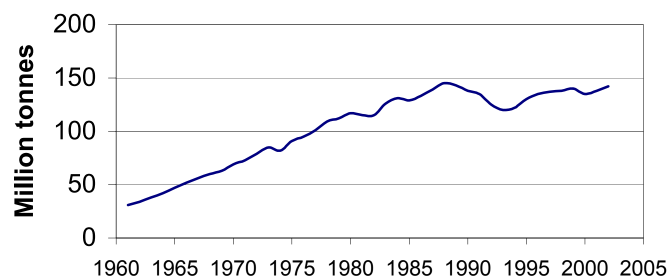
Despite the extensive use of pesticides, India suffers losses up to 20,000 crores of crops due to pest every year. Important national pests include cotton bollworm/ pod borer, tobacco caterpillar, diamond black moth, jassids, white flies, brown plant hopper, rice stem borer, sheath blight, blast, bacterial leaf blight, root rot and wilt pathogens, cotton leaf curl virus, leaf spots of ground nut, leaf blights of cereals, downy mildews and root knot nematodes (NCIPM, 2005).

Table 1. Nutrient removal from soil by wheat and rice per tonne of grain produced.

Nutrient removed (kg)	Wheat	Rice
N	28	10-31
P	4.4	1-5
K	41	8-35
S	4.9	NA
Ca	5.9	NA
Mg	4.2	NA
Fe	0.1	NA
Mn	0.03	NA
Zn	0.03	NA

NA = Data not available.

Fig. 1. World fertiliser use

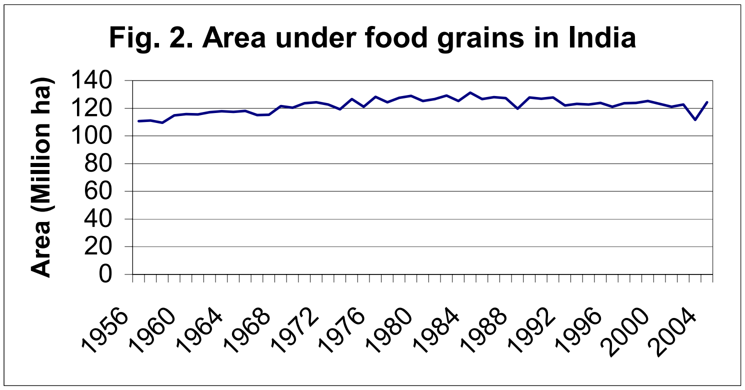


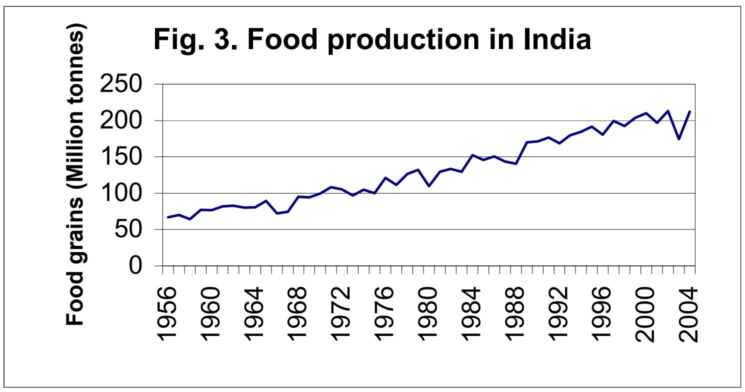
Globally, agriculture is the biggest consumer of water and consumes 70 % of the total water withdrawn. The average application rate of water in agriculture is 12000 m^3 / ha. For an area of 240 million ha world over, agriculture consumes 2880 km^3 of water. Most of the times, water is the limiting factor for crop production. Irrigation has been one of the important factors on account of which India could achieve green revolution. Data and policies with regard to food production and resources have been given by several authors and institutions, viz., Brown (2005), EconomyWatch.com (2005), FAO (2005) etc. The present paper reviews the impact of fertilizers, pesticides and irrigation on crop yield in India.

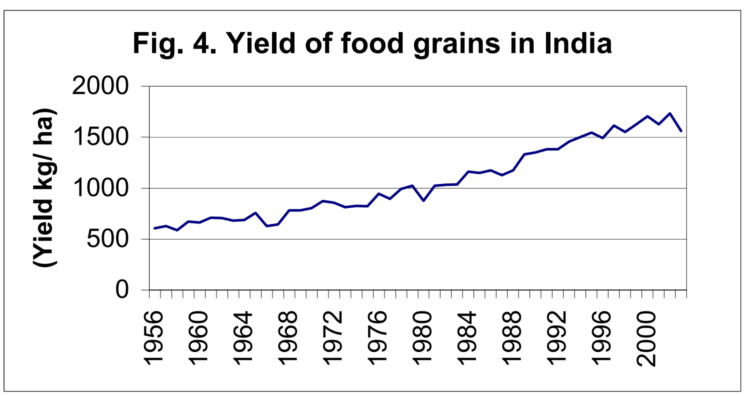
Food Production in India

Figs. 2 and 3 give area under food grains and food production in India since 1955-56. It is evident that the area has not changed substantially but food production has increased from 66.85 millions tonnes in 1955-56 to 212.05 million tonnes in 2003-04 (DES, 2004). This has been due to increase in yield from 605 kg/ha to 1562 kg/ha during this period

(Fig. 4). This increase has been possible due to increased inputs in terms of fertilizers, pesticides and irrigation.





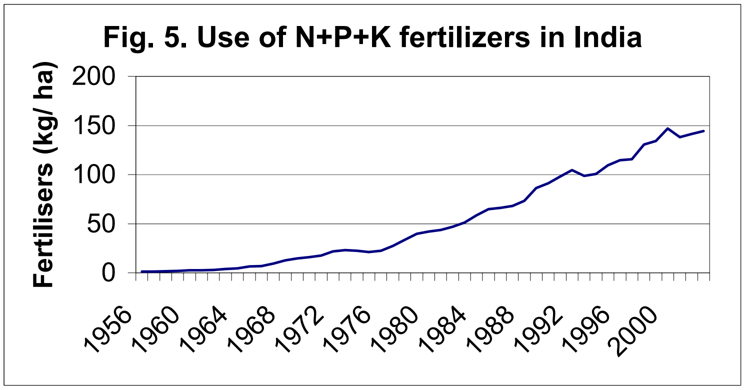


Agrochemicals, Irrigation and Yield

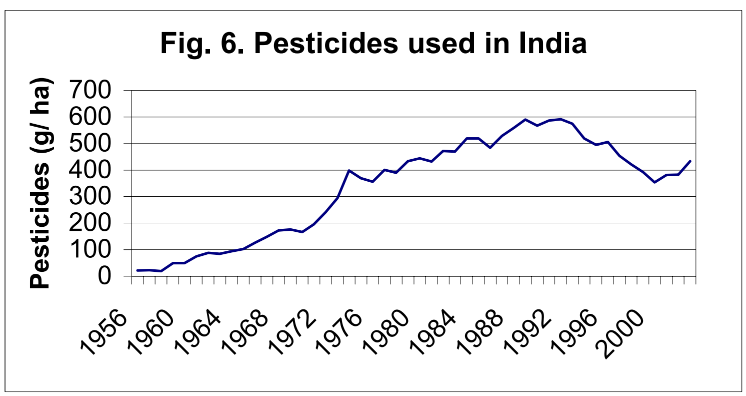
India ranks third in term of total fertilizer consumption (16.1 million tonnes) after China (39.3 million tonnes) and USA (19.3 million tonnes, table 2). There has been a consistent increase in use of fertilizers from 65600 tonnes in 1951-52 to 16.8 million tonnes in 2003-04 (NCIPM). In terms of per ha use the fertilizer application in India has increased from 1.183 kg/ha in 1955-56 to 144.34 kg/ha (Fig. 5). Fertilizer consumption is highest in Punjab, Andhra Pradesh, Haryana, Tamil Nadu, UP and West Bengal (PSCST, 2005).

Table 2. Fertilizer consumption in leading countries.

Fertilizer (Million tones)	China	USA	India
N	25.2	10.9	10.5
P	9.9	3.9	4
K	4.2	4.5	1.6
Total	39.3	19.3	16.1
Rank	I	II	III



Per hectare consumption of pesticides relatively less in India (570 g/ha) vis a vis Japan (12 kg/ha), Europe (3 kg/ha) and USA (2.5 kg/ha) (Singhal, 2000). Pesticides consumption in India per ha increased from 2353 tonnes in 1955-56 to 48350 tonnes in 2002-03, a 20-fold increase in 53 years (NCIPM, 2006) (Fig. 6). Among the states pesticides consumption is highest in Andhra Pradesh (17.9%) followed by UP (13.2%) and Punjab (11.8%). Per hectare consumption is highest in TN (1.2-2 kg/ha) followed by Punjab and Andhra Pradesh (0.8-1.2 kg/ha) (PSCST, 2005).



Pesticide consumption in Punjab has increased from 3300 tonnes in 1974-75 to 7400 tonnes in 1993-94 after which it has leveled off to about 7200 tonnes in 2002-03. Pesticide consumption in A.P. was substantially high in 1974-75 (10000 tonnes) increased to 17000 tonnes in 1983-84 and subsequently declined to 3706 tonnes in 2002-03 (NCIPM, 2006). With the use of pesticides in health sector, about 20 diseases have been brought under control viz., malaria, filariasis, dengue, Japanese encephalitis, cholera, typhus fever etc. DDT was instrumental to bring down the incidence of malaria from 75 million in 1952 to 2-4 million presently (Bhatnagar, 2001).

There are 186 pesticides registered for use in India. Consumption of pesticides in India is given in Figs. 7-9. Of all the pesticides used, insecticides are used maximum followed by fungicides and weedicides (NCIPM, 2005). 24 Pesticides have been banned for use in India. Cotton is the largest consumer of pesticides. With an area of about 8% under cotton, it consumes about 50% of the pesticides. One encouraging point is that the use of biopesticides has increased in recent years (Fig. 9, Table 3).

Fig. 7. Consumption of pesticides (2000-01)

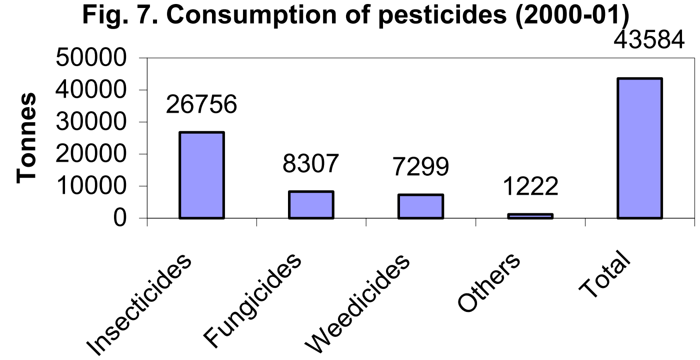


Fig. 8. Biopesticides consumed during 2000-01

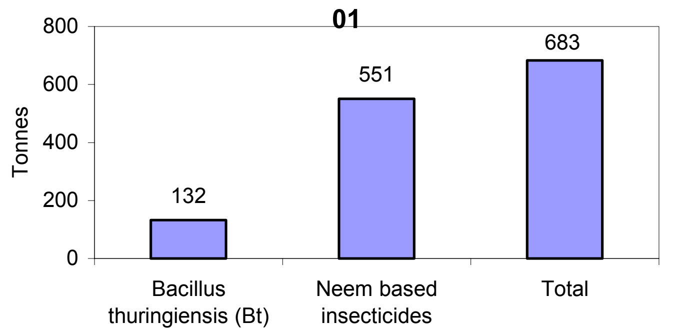


Fig. 9. Cropwise of consumption of pesticides in India (2001-02)

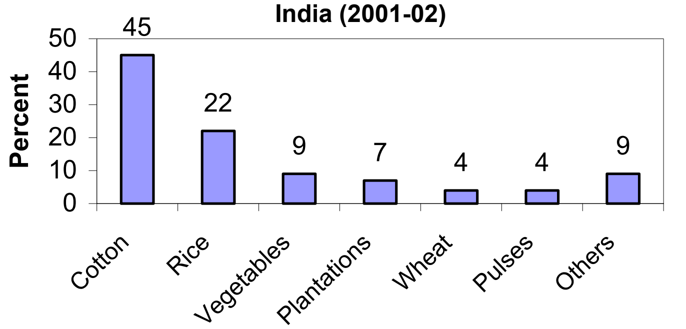


Table 3. Biopesticides registered under Insecticides Act of 1968.

Bacillus thuringiensis var *israelensis*, var. *kurstaki*, var. *galleriae*
B. sphaericus
Trichoderma viridae, T. harzianum
Pseudomonas fluorescens
Beauveria bassiana
Helicoverpa armigera
Spodoptera litura
Neem based pesticides

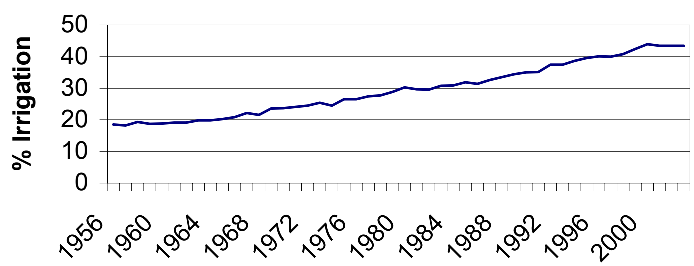
Most of the pesticides used have a high persistence in soil. Half-life of persistent organic pollutants (POPs) after Ritter *et. al.*, (1995) is given in table 4.

Table 4. Half life of Persistant Organic Pollutants (POPs)

S.N.	POP	Half life
1	Aldrin	Readily converted to dieldrin
2	Chlordane	1 year
3	DDT	10-15 years
4	Dieldrin	5 years
5	Dioxins and Furans	10-12 years
6	Endrin	12 years
7	Hexachloro benzene	2.7-22.9 years
8	Heptachlor	2 years
9	Mirex	10 years
10	Polychlorinated biphenyls	10 days-1.5 years
11	Toxaphene	100 days-12 years

Irrigation in India increased from 18.5 % in 1955-56 to 43.4 % in 2003-04 (Fig. 9). Irrigation accounts for large differences in the wheat yields of different countries such as France (6.8 tonnes/ha), which is highly irrigated, and Kazakhstan (1.1 tonnes/ha) with very low soil moisture content and irrigation.

Fig. 9. Irrigation % in India



In India cereals (rice, wheat, sorghum, corn) are cultivated over an area of 90.3 million ha, pulses on 24 million ha and oil seeds on 17.4 million ha (Table 5) (Gharda.com). India has a lower average crop yield of cereals and pulses as compared to the world.

Table 5. Area under some major crops

S.No.	Crop	Area ('1000 ha)
1	Rice	42500
2	Wheat	26000
3	Pulses	24000
4	Oil seeds	17400
5	Sorghum	16200
6	Cotton	8100
7	Groundnut	7900
8	Corn	6100

Linear Regression Analysis

Regression analysis of data for yield as a function of N, P, K and irrigation (table 6) revealed statistically significant ($p \leq 0.05$) linear relationships between variables (Fig. 10-14). For pesticides, however, the curve however recurved up backwards implying that the yield keeps on increasing due to other factors even after the application of pesticides decreased. The average yield for the 48-year data from 1955-56 to 2003-2004 has been 1062.3 kg/ha, with an average application of 53.9 kg/ha of N, P and K fertilizers, 336.5 g/ha of pesticides and 29.47 % of area under irrigation. It is further evident that the inputs during all these years have added tremendously but the yield increased only moderately (table 7).

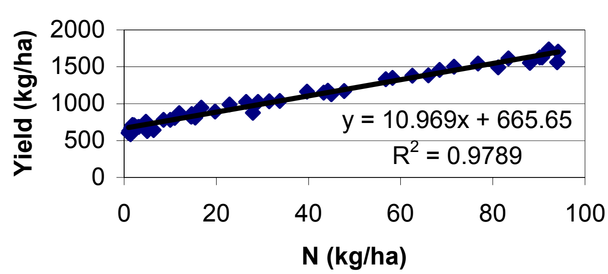
Table 6. Yield, per hectare agrochemicals and % irrigation in India.

Year	Yield (kg/ha)	N (kg/ha)	P (kg/ha)	K (kg/ha)	Pesticides (g/ha)	Irrigation (%)
1955-56	605	0.97	0.12	0.09	21.28	18.5
1956-57	629	1.11	0.14	0.13	23.03	18.2
1957-58	587	1.36	0.20	0.12	19.36	19.3
1958-59	672	1.50	0.26	0.20	49.15	18.7
1959-60	662	1.98	0.47	0.18	49.21	18.8
1960-61	710	1.82	0.46	0.25	74.58	19.1
1961-62	706	2.13	0.52	0.24	87.86	19.1
1962-63	680	2.83	0.70	0.31	83.93	19.8
1963-64	687	3.20	0.99	0.43	93.94	19.8
1964-65	757	4.70	1.26	0.59	102.11	20.2
1965-66	629	4.99	1.15	0.67	127.11	20.9
1966-67	644	6.40	2.16	0.99	148.66	22.2
1967-68	783	8.52	2.76	1.40	172.13	21.6
1968-69	781	10.04	3.17	1.41	176.04	23.6
1969-70	805	10.97	3.37	1.70	167.11	23.7
1970-71	872	11.96	3.72	1.83	195.62	24.1
1971-72	858	14.66	4.55	2.45	240.87	24.5

1972-73	813	15.42	4.87	2.91	294.77	25.4
1973-74	827	14.45	5.13	2.84	398.55	24.5
1974-75	824	14.58	3.89	2.78	369.45	26.5
1975-76	944	16.76	3.64	2.17	355.85	26.5
1976-77	894	19.76	5.11	2.57	401.05	27.4
1977-78	991	22.84	6.80	3.97	389.28	27.7
1978-79	1022	26.51	8.57	4.58	433.34	28.8
1979-80	876	27.94	9.19	4.84	443.78	30.3
1980-81	1023	29.04	9.58	4.93	432.43	29.7
1981-82	1032	31.51	10.24	5.21	471.33	29.6
1982-83	1035	33.77	11.49	5.81	469.19	30.8
1983-84	1162	39.68	13.19	5.91	518.53	30.9
1984-85	1149	43.31	14.89	6.62	519.06	31.9
1985-86	1175	44.22	15.66	6.31	483.37	31.4
1986-87	1128	44.94	16.34	6.68	528.85	32.6
1987-88	1173	47.76	18.27	7.36	558.90	33.5
1988-89	1331	56.79	21.31	8.37	590.73	34.4
1990-91	1349	58.26	23.78	9.21	567.12	35.0
1991-92	1380	62.56	25.20	10.39	586.93	35.1
1992-93	1382	66.02	27.25	11.16	591.88	37.4
1993-94	1457	68.43	23.09	7.18	574.86	37.4
1994-95	1501	71.60	21.75	7.40	518.54	38.7
1995-96	1546	76.76	23.67	9.08	495.37	39.6
1996-97	1491	81.17	23.94	9.55	506.24	40.1
1997-98	1614	83.36	24.09	8.33	454.07	40.0
1998-99	1552	88.02	31.60	11.08	421.79	40.8
1999-2000	1627	90.71	32.85	10.64	392.72	42.4
2000-01	1704	94.17	38.98	13.64	354.05	43.9
2001-02	1626	90.21	34.82	12.95	381.62	43.4
2002-03	1734	92.12	35.69	13.58	382.96	43.4*
2003-04	1562	93.94	36.04	14.36	433.63	43.4*

*Data used as that for 2001-02

Fig. 10 Regression between N and yield



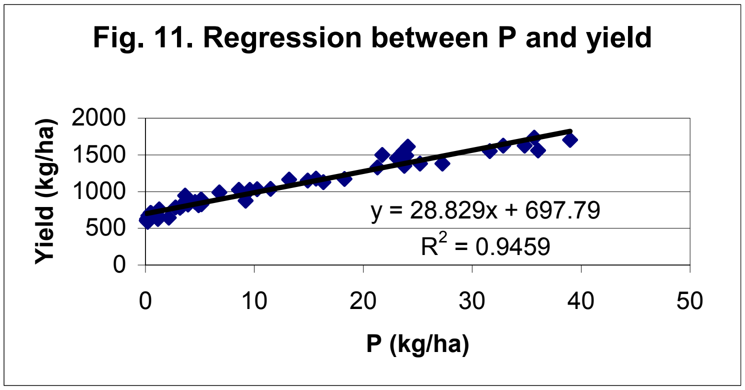


Fig. 11. Regression between P and yield
Yield (kg/ha)
2000
1500
1000
500
0
0
10
20
30
40
50
P (kg/ha)
y = 28.829x + 697.79
R2 = 0.9459

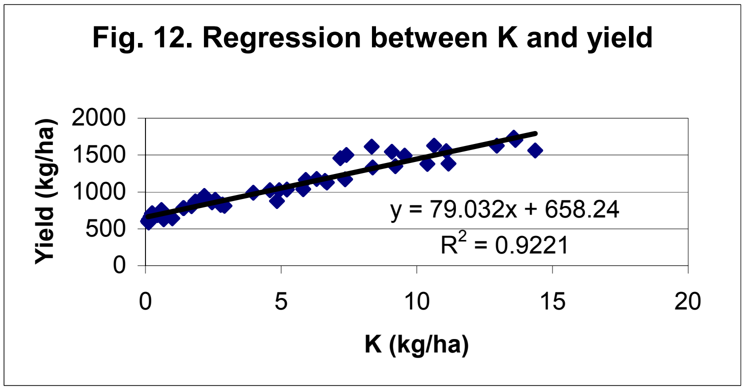


Fig. 12. Regression between K and yield
Yield (kg/ha)
2000
1500
1000
500
0
0
5
10
15
20
K (kg/ha)
y = 79.032x + 658.24
R2 = 0.9221

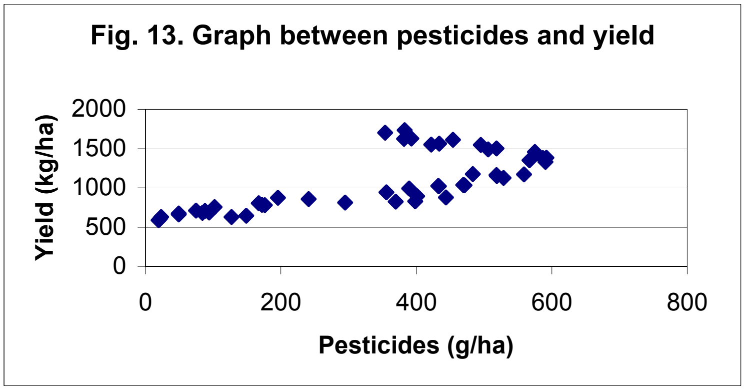


Fig. 13. Graph between pesticides and yield
Yield (kg/ha)
2000
1500
1000
500
0
0
200
400
600
800
Pesticides (g/ha)

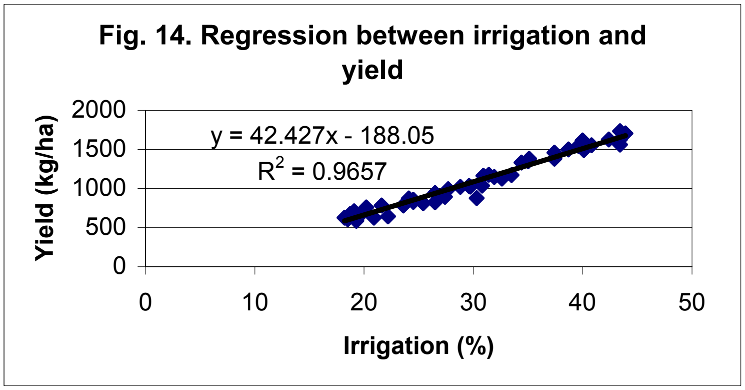


Fig. 14. Regression between irrigation and yield
Yield (kg/ha)
2000
1500
1000
500
0
0
10
20
30
40
50
Irrigation (%)
y = 42.427x - 188.05
R2 = 0.9657

Table 7. Relative increase in yield with increase in inputs from 1955-56 to 2003-04.

Increase in fertilizers	144.34/1.183 = 122.0 times
Increase in pesticides	433.63/21.28 = 20.37 times
Increase in irrigation	43.4/18.5 = 2.35 times
Increase in yield	1562/605 = 2.58 times

Though agrochemicals have great impetus on agricultural production, these ought to be used judiciously for soils deficient in nutrients, or infested with pests. Per hectare use of fertilizers and pesticides is higher in Punjab, Andhra Pradesh and Tamil Nadu vis-à-vis the eastern states. Excessive use of pesticides has led to increased incidence of cancer in Punjab. Besides many pests have become resistant to the pesticides.

Multiple Regression Analysis

In order to evaluate the combined effects of fertilizers, pesticides and irrigation on yield of food grains in India, multiple regression analysis was carried out between yield and other variables. The regression of yield on two independent variables revealed the simultaneous effect of two independent variables on yield. The partial regression coefficients in the regression equation quantify the effect of one independent variable eliminating the effects of other variables. For example, in multiple regression equation 1, addition of 1 kg/ha of nitrogen increases the yield by 8.27 kg/ha. β Regression coefficients are unit free coefficients and reveal the relative effects of variables. Higher the value of β coefficient the more important that factor is. For example in the first multiple regression equation N is more important than irrigation to increase the yield. The trends by two independent variable multiple regression establish that N>I, I>P, I>K, F>I, I>C, and F>C (Table 8).

Table 8. Two independent variable multiple regression and correlation analysis of yield (Y, kg/ha) on fertilizers (N, P and K), pesticides (C) and irrigation (I). * Indicates multiple correlation coefficients significant at p≤ 0.005.

1	Yield (Y, kg/ha) Nitrogen (N, kg/ha) Irrigation (I, %)	Y = 449.02 + 8.27 N + 10.67 I β (YN.I) = 0.7456 β (YI.N) = 0.2470 Relative effect of variables: N>I R = 0.9902*
2	Yield (Y, kg/ha) Phosphorus (P, kg/ha) Irrigation (I, %)	Y = 90.35 + 9.59 P + 28.86 I β (YP.I) = 0.3236 β (YI.P) = 0.6686 Relative effect of variables: I>P R = 0.9859*
3	Yield (Y, kg/ha) Potassium (K, kg/ha) Irrigation (I, %)	Y = -121.03 + 6.75 K + 39.98 I β (YK.I) = 0.0821 β (YI.K) = 0.9023 Relative effect of variables: I>K R = 0.0.9829*

4	Yield (Y, kg/ha) Total fertilizers (F, kg/ha) Irrigation (I, %)	355.82 + 4.69 F + 15.39 I β (YF.I) = 0.6353 β (YI.F) = 0.3566 Relative effect of variables: F>I R = 0.9886*
5	Yield (Y, kg/ha) Pesticides (C, g/ha) Irrigation (I, %)	Y = -213.15 – 0.13 C + 44.78 I β (YC.I) = -0.069 β (YI.C) = 1.037 Relative effect of variables: I>C R = 0.9836*
6	Yield (Y, kg/ha) Total fertilizers (F, kg/ha) Pesticides (C, g/ha)	Y = 639.63 + 6.83 F + 0.09 C β (YF.C) = 0.9259 β (YC.F) = 0.0848 Relative effect of variables: F>C R = 0.9885*

Three independent variable multiple regression analysis (Table 9) revealed that F>I>C. The negative partial regression coefficient of pesticides eliminating the effects of irrigation indicates the moderating effect of irrigation on the harmful effects of pesticides. All the correlation coefficients are highly significant ($p \leq 0.001$). The coefficient of determination is 97.8 %, implying that the three factors, fertilizers, irrigation and pesticides explain 97.8% variability in yield.

Table 9. Three independent variable multiple regression and correlation analysis of yield (Y, kg/ha) on fertilizers (N, P and K), pesticides (C) and irrigation (I). * Indicates multiple correlation coefficients significant at $p \leq 0.001$.

1	Total fertilizers (F, kg/ha), Pesticides (C, g/ha) Irrigation (I, %)	Y = 457.07 + 5.41 F + 0.09 C + 9.61 I β (YF.CI) = 0.7335 β (YC.FI) = 0.0473 β (YI.FC) = 0.2225 Relative effect of variables: F>I>C R = 0.9889*

It may be stated that most of the soils are deficient in nitrogen, sufficient in potassium (Fig. 15). The recommended N:P:K ratio is 4 : 2 : 1 (Indiaagronet, 2005), but the average ratio used in India is 7.3 : 2.2 : 1. In order to maintain better crop yield, the use of fertilizers be recommended as per the deficiency status of the soils.

Further since cotton is a highly profitable crop, its cultivation will always remain in demand (Table 10). This crop would require more inputs in terms of better varieties, better agronomic techniques, integrated pest management and awareness on the part of farmers and people. Krishna *et. al.* (2005) spelled out three models for sustainable agriculture in India: Integrated pest management, Low external input sustainable agriculture, and organic culture. An amalgam of these three models would largely sustain Indian agriculture for the larger interest of farmers and ecofriendly environment.

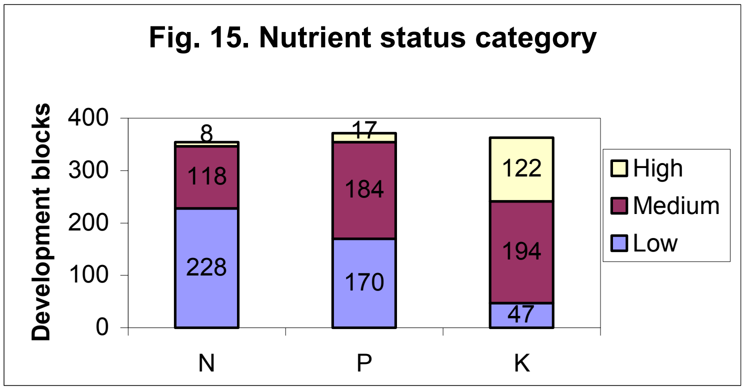


Table 10. Most profitable crops in descending order

Vegetables
Cotton
Soybeans
Fruits
Oilseeds
Plantation crops
Cereals

Conclusions and Recommendations:

The study leads to following conclusions:

The key factors leading to increased production are improved high yielding varieties, increased inputs in terms of fertilizers irrigation and pesticides, better farm technology, improved facilities for grain storage, distribution and management.

The use of chemicals is lop-sided. States like Punjab, Andhra Pradesh and Tamil Nadu use higher amounts of agrochemicals as compared to other states.

Cotton is a pesticide intensive crop consuming as much as 45 % of the total pesticides used in India. The crop requires extensive research for the development of pest resistant varieties and effective biopesticides to do away with this menace.

Among the factors studied, fertilizers play most important role, followed by irrigation, followed by pesticides. Nitrogen is the most important nutrient in this regard.

As per the three independent variable multiple regression model derived, 1 kg/ha of fertilizers have added to the yield by 5.41 kg/ha, 1 g of pesticides increased the yield by 0.09 kg/ha, and 1 % irrigation added to yield by 9.6 kg/ha during the period 1955-56 to 2003-04.

Priority should be laid to increase irrigation percentage in India. This would not only increase production, but also mitigate the harmful effects of pesticides.

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THE POSITION OF FOREST IN ORISSA – A CRITICAL ANALYSIS.

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Dr. B. N. Mohanty

Forest constitutes an integral part of our Eco- system. It is the nature's precious bounty to the mankind & plays a significant role in the development of a country .With the increase in population & increase in multifaceted needs of modern man, the dependence of human society on forest has also increased sizably resulting in depletion of forest cover all over the world which has become a serious threat to ecological balance & existence of living creature on the earth. In the absence of proper protection measures & proper package for afforestation activity, the problem is perceptibly rising day by day. At all India level the total forest coverage is 6,75,538 square kms which constitutes 23.38 percentage of national geographical area. Among the states of the country which have significant share in forest cover at national level, Orissa is one & the forest cover of this state is 48,838 square kms constituting 31.37 percentage of state's geographical area. It shares 6.36 percentage of area under forest at national level.

For healthy survival of living organisms on the Earth, a stable & balanced Eco system is the pre-requisite which preconditions forest to stand on 33% of surface area of earth. Our national govt. have also targeted to achieve this goal. Therefore, it is highly imperative to launch appropriate plans and programmes to accomplish this great and noble objective.

In the present paper an attempt has been made to study the situation of forests in Orissa with the help of available secondary data. The paper is focused to study the importance of forest on state's economy, existing system for forest accounting followed in the state & suggestions for improvement in accounting network etc along with discussing many other related aspects.

As per Orissa forest status report 2003-04 published by Principal Chief Conservator of Forests, Orissa, the situation of forest area in the state is as follows:-

Total Geographical area of the state	155707	sq kms.

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Classification forest in Orissa:-

i)	Reserve forest	26329.12	sq kms
ii)	Unclassified forest	20.55	sq kms
iii)	Demarcated protected forest	11685.68	sq kms.
iv)	Un demarcated protected forest	3838.82	sq kms.
v)	Other forest	16261.30	sq kms.
	Total	**58,135.47**	**sq kms.**

vi) Percentage of forest area to geographical area of the state:- 47%

vii) Out of total forest area :- .
a) Area under control of forest department 26349.67 sq kms (45.32%)
b) Area under control Revenue department 31785.80 sq kms. (54.68%)

The figures presented above speaks that though the recorded forest area under Govt. control is 58135.47 sq kms in the State, its 45.32 percent of area is under the control of forest Department which is supposed to have requisite expertise and technical know how for forest management and regeneration. On the other hand 54.68 percent of forest area comes under the administrative control of Revenue Department which does not have any system for scientific management of forest activities and therefore position of forest accounting relating to this department in particular can be well imagined . However the forest department of the state govt. is responsible for collection & compilation of the forest statistics of the state. The mute point is that the forest department itself does not have a built up statistical system for collection, compilation and analysis of forest statistics. In absence of proper and reliable data resources any plan or programme for forest conservation or protection is expected to have many deficiencies and will be far from field truth.

Hence keeping in view the need of forest cover for existence of human society, it is highly essential that a proper accounting system should be put in place so that grass root level detailed picture is available and steps are initiated in form of micro plans for conservation of existing forests along with taking steps for increasing forest cover in the state as per our national policy.

The actual forest cover in the State as furnished by Forest Survey of India in their 2001 Report is given below:

Forest cover in Orissa 2001

Type of forest	Area
Dense forest	27972 sq kms.
Open forest	20866 sq kms.
Total	**48,838 sq kms**

The mapping of forest survey of India is based on remote sensing technique with digital analysis. It is assumed that the estimates are nearer to the truth.. As per this estimate forest spreads over 31.36 percentage of the Geographical area of the state. Presuming that dense forest is the real forest area, it is seen that it constitutes 18 percent of the state's Geographical area. Since recorded forest area of the state is 58135.47 square kms and as per FSI report forest exists in 48,838 square kms it surfaces a fact that balance 9297.47 square kms of forest area does not have any vegetative cover at present. Hence the sparse forest area of 20866 square kms (FSI report-2001) along with above stated area of 9297.47 square kms where there is no vegetation need to be persued for raising thick vegetation in greater national interest for achieving 33% coverage norm in true sense. Though many plans and programmes are in-operation, there has been no substantive change in forest cover in the state as may be appreciated from the following table.

Estimates of forest survey of India.(Sq. kms)

Year	Dense forest	Open forest	Total
1997	26101	20629	46730
1999	26073	20745	46818
2001	27972	20866	48838

The picture presented in the above table though raises a ray of hope, still not encouraging. Orissa which was once known for its thick forest cover, flora & fauna has started suffering its adverse effects since many years. For achieving a high rate of progress, the resource crunch is of course a factor in the loan burdened state of Orissa.

In absence of detailed accounting system, effective planning and monitoring in way of micro approach is not becoming possible.

Now an attempt is made to examine the contribution of forestry sector to the net state domestic product of the state to examine commercial importance of forest for the state.

Contribution of forestry sector to NSDP of Orissa

(At constant prices of 1993-94)

(Rs. In lakh)

Year	Total NSDP	Contribution of forestry sector	Share of forestry in NSDP(%)	Percentage change over last reference point
1986-87	1321657	87838	6.64	
1988-89	1549932	83576	5.39	(-) 4.85
1990-91	1372354	71477	3.20	(-)14.47
1992-93	1520499	65949	4.33	(-) 7.74
1994-95	1697360	64381	4.00	(-) 2.38

1996-97	1652439	59651	3.60	(-) 7.35
1998-99	1948179	61203	3.14	(+) 2.60
2000-01	2031914	72141	3.55	(+)17.87
2002-03	2191092	76747	3.51	(+) 6.38
2003-04	2186191	75695	3.00	(-) 1.37

As evident from the above table the contribution of forestry sector to net state domestic product of Orissa in constant prices of 1993-94 was 6.64% in 1986-87 and its contribution shows a declining trend there after and finally its contribution is reduced to 3 % in 2003-04. It is also clear from above table that the decrease in % share is not owing to the increase in other sectors of state income rather the decrease is, by and large, due to decrease in absolute contribution of forestry sector itself. To drive the point home % change in contribution of forestry compared to its previous reference point has been calculated for absolute values in above table. Barring 3 years it shows that changes in contribution of forestry from year after year is in decreasing order. On the other hand available data presented in previous sections reveals that total forest cover shows a marginal increasing trend in the state. It is difficult to understand that with use of more scientific methods of management and conservation, if area marginally increases why contribution of forestry sector, a natural bounty, will show a declining trend. The position naturally points towards managerial aspects.

In the following table a comparative picture of investment in forestry sector vis-à-vis contribution of forestry to NSDP& output -input ratio is presented.

Investment in forestry, contribution of forestry and out-input ratio.

(Rs. In lakh)

Year	Investment in forestry in 1993-94 constant prices	% change over previous reference point	Contribution of forestry in 1993-94 constant prices	% change over previous reference point	Out put Input ratio
1987-88	6231.38	-	78901	-	12.66
1988-89	6055.79	(-)3	83576	(-) 5.92	13.80
1989-90	5883.13	(-)3	87979	5.26	14.95
1993-94	5275.30	(-) 10.33	62717	(-) 28.71	11.88
1994-95	4697.13	(-) 11	64381	3.00	13.70
1995-96	4702.99	0	59150	(-) 8.12	12.57
1996-97	4613.80	(-) 2	59651	0.84	12.92
1997-98	3982.42	(-) 14	68210	14.34	17.12

1998-99	5142.97	(+)29	61203	(-)10.27	11.90
1999-00	6403.34	(+)24	70708	15.53	11.04
2000-01	6951.35	(+) 8	72141	2.02	10.37
2001-02	8030.99	(+)15	72354	0.29	9.00
2002-03	6136.87	(-) 24	76747	6.07	12.50

The output – input ratio indicates that forestry is a very remunerative area of investment where in this varies from 9 to 17. Contribution of forestry over years is exhibiting a mixed trend of ups and downs but, by and large, it is showing an decreasing trend. The study of investments in forestry barring 4 years from 1987-88 to 2002-03 reveals that the investment is declining. A critical analysis of data drives home the point that there are contain extraneous points which are responsible for the fluctuations in output – input ratio.

The facts and figures presented and analysis carried out in this paper surfaces the fact that though the forest cover of the state is 48838 square kms only 27972 square kms is under the cover of dense forest where density is above 40% and it is about 18% of states geographical area. The open forest/shrubs stand on 20866 square. Kms constituting 13 % of state's geographical area and it is a forest for the sake of name since its density lies in the range 10% to 40%. In view of the national policy that 33% of area should be brought under forest cover, it is highly essential to take immediate steps for conversion of these open forests and shrub lands of Orissa to thick vegetative cover. If this alone can be done Orissa will be in nearest neighbor hood of 33% since thick forest and open forests at present constitute about 31% of state's geographical area. The job is comparatively easy for the state since an existing low level resource is needed to be taken forward with improvements. The ancillary information analyzed in this paper speaks that the forestry is a remunerative sector of worth investment. Hence this needs the interest and intervention of the state Govt. to come up with a master plan at least to accomplish the above job within a specified time frame. However the real bottleneck standing on the way is the non-availability of detailed statistics on forest account to take up a micro approach with can involve full participation of people at the grass root level. A strong statistics-cum-MIS system is highly imperative which will serve as the basic background of above stated master plan and will provide requisite help for strong monitoring and evaluation for applying corrective measures as and when needed in future.

As stated earlier the forest area including majority of open forests constituting 55% of state's forest area is under the control of Revenue department The main focus is to be given to up grade and regenerate the degraded forests on these lands. The plight is that though majority of forest area is under the control of Revenue department and there is no forest specific accounting system in this department. Even there is not a cell in this department to exclusively look after forest activities of this department.

In addition to funds specially provided by State or Central Govt. for forest activities, under many centrally sponsored programmes funds are available at district and block levels which can be dovetailed for this noble objective. But in absence of the background information, co-ordination and persuasion the situation still remains intact. The following suggestions are made to improve upon the situation with a view to ensure 33% thick forest coverage in the state within a specified time frame.

1. The forest survey of India may take up block level forest mapping at least in five years interval(considering the cost involved) through remote sensing technique so that inventory is available for block level planning of forest regeneration and conservation which will go a long way to achieve the goals of this great mission.

   Further for every resource planning knowledge of land use pattern is highly essential. Full fledged Block level land use pattern statistics is not available in Orissa for non availability of block wise forest cover The Directorate of Economics and Statistics, Orissa conducts scientific sample survey through a centrally sponsored scheme EARAS on basis of which block level land use is estimated covering forest partially i.e Gramya Jangal. Block level forest mapping will supplement EARAS estimates and at least Nine fold classification of land use can be formulated at block level which can fulfill need of many resource planning at block level.

2. There should be an exclusive cell in Revenue Department to look after forest activities in respect of forest land under its control. A high level official of forest department in the rank of principal conservator of forests should head this self who can perfectly co-ordinate between Revenue Department, principal chief conservator of forest and forest department apart from closely looking into forest development in revenue forest lands.

3. The State Govt. should come up with a master plan to convert open forest land and other no vegetation forest lands to thick forests within a reasonable time frame and more and more budgetary provision should be provided for degraded forest regeneration and conservation.

4. The Zilla Parishads at district level may be entrusted with the duty of dovetailing funds available at district/block level for organized investment in forestry sector.

5. The statistical cell in the office of the principal chief conservator of forest should be strengthened and preferably be headed by a statistical officer in the cadre of Deputy Director. Apart from this, to take care of forest accounting at lower levels, at least a statistical investigator may be posted in office of each divisional forest officer.

   The forest cover with density more than 40% (termed as dense forest) constitute only 18% of state's geographical area and hence the situation is already alarming. Therefore it is imperative that state govt. should take timely action before the situation goes beyond control.

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An Impact Study On Forest Resource Accounting Through Participatory Mode in West Bengal

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Abstract

'Participatory Development' involving the people has been recognized and perceived as an integral process for the success of all development schemes, especially so for the large unfenced sprawling forest resources surrounded often by the impoverished rural people. The Joint Forest Management or Participatory Forest Management entails the involvement of local people in management of forests. Government of West Bengal realized the need for a paradigm shift from traditional custodial forest management to participatory approach with the local people and issued an order in 1987 for bestowing 25% share of the revenue earned through sale of the regenerated crop. Then Government published an enabling resolution in 1989 recognizing the need of the people's participation in forest management and detailing the modes, procedures and usufruct sharing arrangement. This approach is change of power relationship between the forest department and community people with a bottom up concept. Realizing that active participation and involvement of the local people are vital for regeneration, maintenance and protection of the moribund Sal and other hardwood forests and or plantations in the district of Bankura and other parts of West Bengal. The Government issued an order in 1989 for recognition and formalisation of the Forest Protection Committee (FPC). This had been amended in 1990 and 1991 mainly to include a larger percentage of village households in each FPC. The FPCs had taken initiative that benefits their lot without disturbing the forest resources. The motivation of forest protection, felt by the FPC members initially was the effect of extension programme, organized by the Forest Department, Panchayat Raj Institution and NGOs. However, it is highly encouraging that in general the people are coming forward to accept the present day outlook of forest management in the dwindled forest patches. Several constructive works had been conducted by the FPCs in protecting the forests, generating the income for the sustainable livelihoods by maintaining the ecology of the forests. The present study envisages the physical resource accounting in some forest fringes through participatory way of statistical accounting. Again this paper had been prepared to discuss the concept, field methods and impact of participatory vegetation monitoring under the aegis of the sustainable ecology management.

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INTRODUCTION

At the advent of Sustainable Forest Management, the participation of the local people or the local community plays the pivotal role for managing the forest resources in a nutshell. The positive impact of the community participation in forest management implies the forest regeneration, monitoring and evaluation of the forest resources. In the present arena, the coordinated approach of forest department and the local people helps to carried out the researches on the forest resources to build knowledge and to construct techniques for getting maximum benefit from the forest fringes through optimum utilization of the forest resources. Under such a research climate, it is very helpful to conduct studies on the patterns of the ecological change in natural forests for planning forest management process in different strata. To endow with the vegetation status in localized perspective is very much essential for grass-root level planning in Joint Forest Management to understand and equip with the dynamic and varied environmental perspectives. In this regard Vegetation monitoring proved to be one of the most important tools for the local community wherein the people had amalgamated their indigenous technical knowledge with the modern scientific information in managing the forest resources.

CONCEPTUAL FRAMEWORK

The participatory vegetation monitoring is a process by which one can assess the species diversity and productivity of a given forest fringe with the active involvement of the local people.

Objectives of Participatory Vegetation Monitoring:

- To assess the scientific parameters of a forest for measurement by involving the local people like:
  a) Girth at Breast Height (GBH) / Diameter at Breast Height (DBH)
  b) Height of a tree
  c) Species richness
  d) Canopy cover
- To prepare indigenous baseline and standardize parameters;
- To identify local forest management options;
- To develop Participatory Forest Management strategy for tangible output.

Site Selection

Traditional method: Selection of site by throwing stone in any direction of the forest.

Materials required

- Measuring tape (cms)
- A long pole/ Abney level altimeter
- Color brush
- Rope (53 mts. long)
- Four iron pegs

Methods:

a) **Tapping local knowledge on vegetation:** This process helps to tap the local knowledge available in the forest fringes regarding the vegetation present in the forest with the help of local people through participatory mode. This knowledge helps the local people as well the forest policy makers to construct the a development plan on the basis of the forest resources available in the particular area by amalgamating the modern scientific forest management plan with the traditional management practices.

b) **Scientific method:** The method had been developed to analyse the forest resources in a given area of a whole forest embedded with the specific selected area analyses. The quadrate method had been discussed to analyse the resources in 10 x 10 sq.m area for getting an empirical idea regarding the forest resources present in the given forest.

Quadrate method:

Tree quadrate:

10 X 10 m^2, counting the number of the trees and their corresponding height and GBH

Shrub quadrate:

5 X 5 m^2, counting the shrub species and identifying them.

Herb quadrate:

1X1 m^2, counting the herb species and identifying them.

Analysis

- ✓ Tree quadrate: 1) Average number of tree,
  2) Average GBH and Basal area $(GBH)^2/ 4\pi$
  3) Average Height
  4) Biomass
  5) Species density
- ✓ Shrub quadrate: 1) Species density and identification
  2) Biomass
- ✓ Herb quadrate: 1) Species density and identification
  2) Biomass
- ✓ Canopy cover estimation by line transect method

Displaying of Information, obtained by Participatory Vegetation Monitoring

a) Tree (10m X 10m)

Name of the tree	July				November				March			
	Avg. No.	Avg. GBH (cm)	Avg. Height (Ft)	No. of climbers	Avg. No.	Avg. GBH (cm)	Avg. Height (Ft)	No. of climbers	Avg. No.	Avg. GBH (cm)	Avg. Height (Ft)	No. of climbers

b) Shrubs (5m X 5m)

Name of the shrub	July	November	March
1			
2			
3			

c) Herbs (5m X 5m)

Name of the herbs	July	November	March
1			
2			
3			

METHODOLOGY OF THE PRESENT STUDY

The research had been conducted in five Forest Protection Committee (FPC) areas under the Bishnupur Soil Conservation Forest Division in Bankura Distrct of West Bengal. The area had been selected purposively as the forest resources are very much income generating in this area. The five FPCs are: Talbandhi, Jhantibani, Shyamnagar, Chowkan and Nakaijhuri. The data were collected with the participatory method. The analyses were done according to the method of participatory vegetation monitoring. Ample participation had been expected from the villagers and their participation was also desirable during the process of data collection.

RESULTS AND DISCUSSION

The results had been presented below according to the Forest Protection Committee available during the process of data collection. The number of tree and specis density and the biomass in the 10 x 10 sq.m forest areas had been depicted. The discussions had been made under the subhead impact of Participatory Vegetation Monitoring.

1. Jhantibani:

Akashmoni (Acacia auriculiformis) Plantation

- ✓ Tree quadrate: 1) Average number of tree: 27
  2) Average GBH and Basal area $(GBH)^2/4\pi$: 28.3793cm, 64.064735cm^2
  3) Average Height: 31.55 ft.
  4) Biomass: 531.3286 Kg/100m^2
  5) Species density: 0.27/m^2
- ✓ Shrub quadrate: 1) Species identification
  Nil
- ✓ Herb quadrate: 1) Species identification
  Mutha (Cyperus sp.)
  Durba (Cynodon dactylon)

2. Shyamnagar:

a) Sal (Shorea robusta) Natural

- ✓ Tree quadrate: 1) Average number of tree: 15
  2) Average GBH and Basal area $(GBH)^2/4\pi$: 38.26667cm, 116.48142cm^2
  3) Average Height: 26.2 ft.

4) Biomass: 967.43541 Kg./ 100 m^2
5) Species density:0.15 / m^2

- ✓ Shrub quadrate: 1) Species identification
  Kend (*Diospyros montana*)
  Sida (*Sida cordifolia*)
  Bench (*Flacourtia indica*)
  Kalmegh (*Andrographis paniculata*)
- ✓ Herb quadrate: 1) Species identification
  Anantamul (*Hemidesmus indicus*)
  Mutha (*Cyperus sp.*)
  Durba (*Cynodon dactylon*)

b) Ucalyptus Sp. Plantation

- ✓ Tree quadrate: 1) Average number of tree:11
  2) Average GBH and Basal area $(GBH)^2/4\pi$: 41.2cm, 135.0236cm^2
  3) Average Height: 28.2 ft.
  4) Biomass: 1121.7064 Kg./100m^2
  5) Species density: 0.11/m^2
- ✓ Shrub quadrate: 1) Species identification
  Baichi (*Flacourtia indica*)
  Kend (*Diospyros montana*)
  Lilajhupi (*Cassia tora*)
  Bhutbhairab (*Gardenia latifolia*)
- ✓ Herb quadrate: 1) Species identification
  Jhirkunda (*Andropogon aciculatus*)
  Durba (*Cynodon dactylon*)
  Anantamul (*Hemidesmus indicus*)

3. Nakaijhuri:

a) Ucalyptus Sp. Plantation

- ✓ Tree quadrate: 1) Average number of tree: 8
  2) Average GBH and Basal area $(GBH)^2/4\pi$: 36.625cm, 106.70153cm^2
  3) Average Height : 29 ft.
  4) Biomass : 886.06673 Kg./100m^2
  5) Species density: 0.08/ m^2
- ✓ Shrub quadrate: 1) Species identification
  Bhutbhairab (*Gardenia latifolia*)
  Baichi (*Flacourtia indica*)
  Siakul (*Zizyphus oenoplia*)
- ✓ Herb quadrate: 1) Species identification
  Durba (*Cynodon dactylon*)
  Mutha (*Cyperus sp.*)
  Golpata (*Tinospora cordifolia*)
  Anantamul (*Hemidesmus indicus*)

b) Sal (Shorea robusta) Natural

- ✓ Tree quadrate: 1) Average number of tree: 18
  2) Average GBH and Basal area $(GBH)^2/4\pi$: 41.6470cm, 137.9698cm^2
  3) Average Height: 26.5 ft.

4) Biomass: 1146.2188Kg/100m^2
5) Species density: 0.18/m^2

- ✓ Shrub quadrate: 1) Species identification
  - Baichi (*Flacourtia indica*)
  - Kul (*Zizyphus jujuba*)
  - Siakul (*Zizyphus oenoplia*)
  - Sida (*Sida cordifolia*)
  - Khejur (*Phoenix acaullis*)
  - Palash (*Butea frondosa*)
  - Kend (*Diospyros montana*)
  - Bhabri (*Wedelia chinensis*)
- ✓ Herb quadrate: 1) Species identification
  - Durba (*Cynodon dactylon*)
  - Mutha (*Cyperus sp*)
  - Golpata (*Tinospora cordifolia*)
  - Anantamul (*Hemidesmus indicus*)

4. Chowkan:

Sal (Shorea robusta) Natural

- ✓ Tree quadrate: 1) Average number of tree: 14
  2) Average GBH and Basal area (GBH)^2/ 4π : 27.6667cm, 60.8876cm^2
  3) Average Height: 20.9285ft.
  4) Biomass : 514.89506 Kg./100m^2
  5) Species density: 0.14/ m^2
- ✓ Shrub quadrate: 1) Species identification
  - Baichi (*Flacourtia indica*)
  - Kul (*Zizyphus jujuba*)
  - Siakul (*Zizyphus oenoplia*)
  - Sida (*Sida cordifolia*)
  - Khejur (*Phoenix acaullis*)
  - Palash (*Butea frondosa*)
  - Kend (*Diospyros montana*)
  - Atang (*Combretum decandrum*)
  - Sirish (*Albezia lebbek*)
  - Bahera (*Termenalia chibula*)
- ✓ Herb quadrate: 1) Species identification
  - Mutha (*Cyperus rotundus*)
  - Banalu (*Diascorea elata*)
  - Bakhar (*Premna harbacea*)

5. Talbandhi:

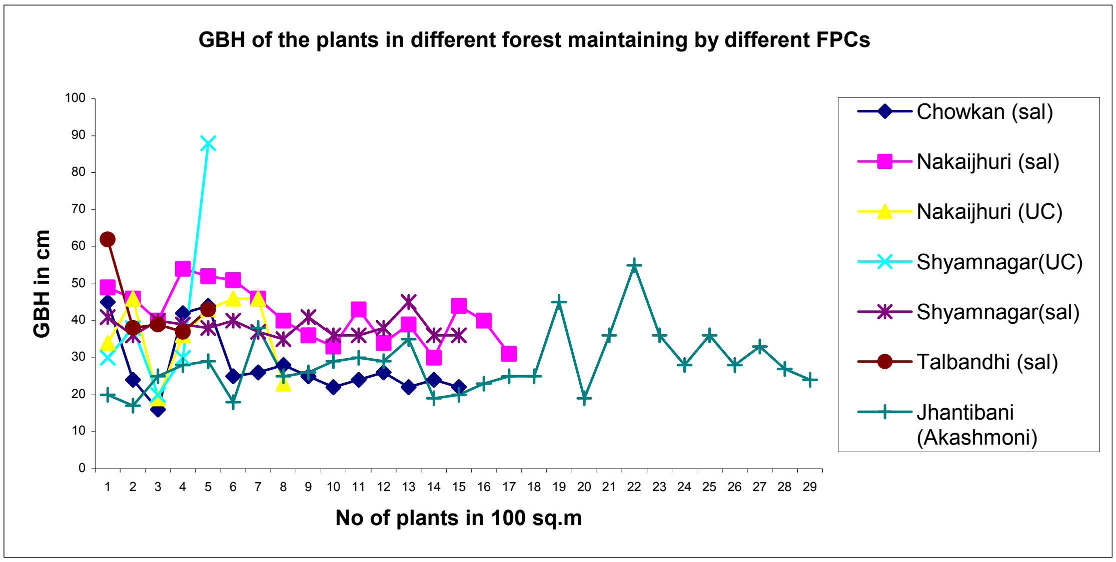
Sal (Shorea robusta) Natural

- ✓ Tree quadrate: 1) Average number of tree: 5
  2) Average GBH and Basal area (GBH)^2/ 4π: 43.8cm, 152.6031cm^2
  3) Average Height: 22.8 ft.
  4) Biomass: 1267.9685 Kg./100m^2
  5) Species density: 0.05/m^2
- ✓ Shrub quadrate: 1) Species identification
  - Mainakata (*Zizyphus jujuba*)
  - Sida (*Sida cordifolia*)
  - Kurchi (*Holarrhena antidysenterica*)

Kend (*Dyospyros montana*)
Bahera (*Tarmenalia belerica*)
Kalmegh (*Andrographis paniculata*)
Karanja (*Pongamia glabra*)

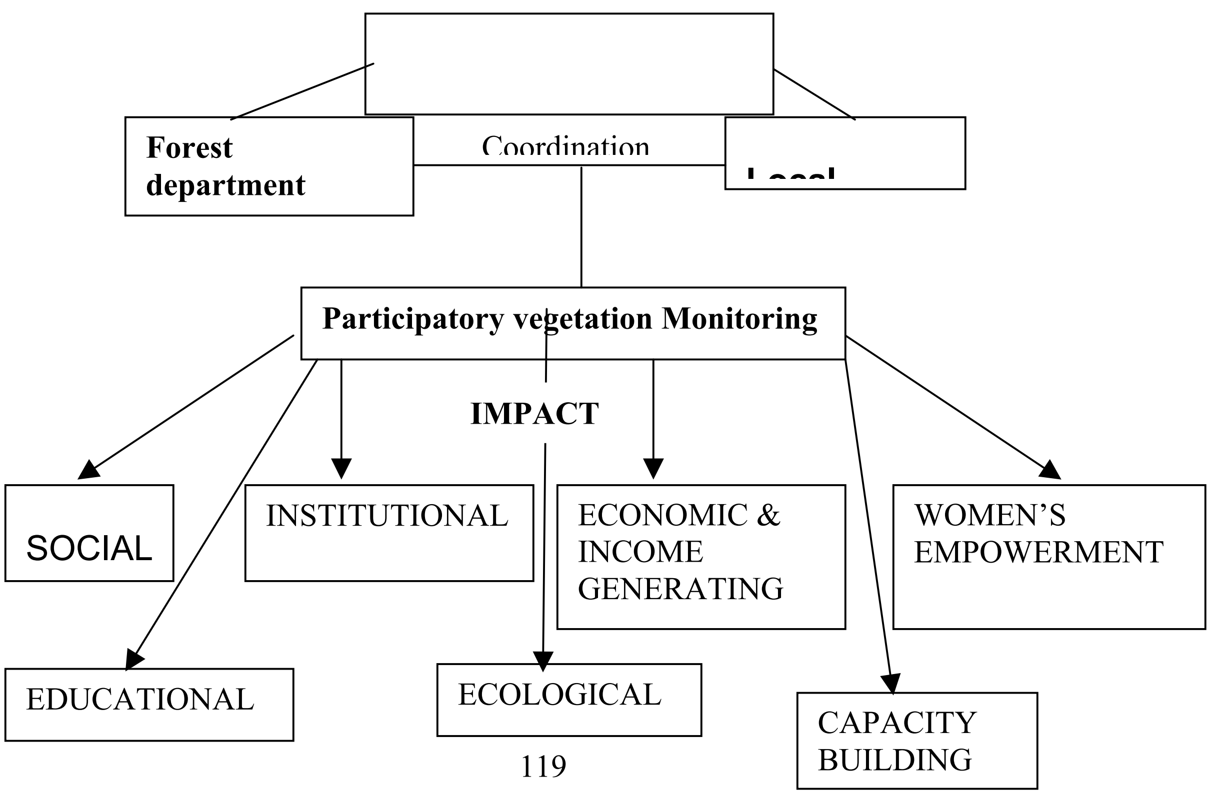
- ✓ Herb quadrate: 1) Species identification

Dudhalata (*Cissus quadragularis*)
Anantamul (*Hemidesmus indicus*)
Petmochra (*Helicteris isora*)



IMPACT OF PARTICIPATORY VEGETATION MONITORING

Implication of the information generated by the Participatory Vegetation Monitoring in the locality



Social Impact:

- Development of group cohesiveness and sense of belongingness;
- Modification of forest rules and regulation for a particular community;
- Conflict management;
- Organising community rituals in-group;
- Arrangement of social functions in a better way;
- Introducing inbuilt action for forest protection according to their tradition;
- Development of punishment and reward mechanism;
- Motivation for protection of forest;

Institutional Impact

- Development of coordinating approach, while working with the Forest Department;
- Development of the linkage with the other institutions like School, Panchayat etc.;
- Institutional recognition;

Economic and Income Generating Impact

- Adequate information for NTFP (Non Timber Forest Products) collection and marketing;
- Realization about the total economic value of the forest;
- Self Help Group (SHG) formation for self employment;
- SGSY (Swarna Jayanti Gram Swarojgar Yojana) Self Help Group formation and strengthening for self-employment;
- Augmentation of income through wage and self-employment;
- Creation of man-days for wage employment;

Women's empowerment

- Formation and smooth running of women's self help group;
- Involvement of women in decision making for sustainable forest management;
- Income generation by the women through self-employment;
- Collaboration with the male counter part for the protection of the forest;
- Sensitization of self regarding literacy and child's education;

Educational Impact

- Development of the mental set up for child education due to the interaction with the fellow villagers;
- Gaining of Scientific knowledge;
- Paves the way to mix the traditional knowledge with the scientific knowledge;
- Helps to identify the beneficial and harmful species in the forest;
- Utilisation of the knowledge of Participatory Vegetation Monitoring to meet the local needs;

Capacity Building Impact

- Development of the capacity in measuring the trees;
- Builds the capacity to plan according to the availability of forest resources;
- Builds the capacity to monitor the ecological aspect of the forest;

Ecological Impact

- Understanding of forest resources;
- Identification of the harmful activities and prepare to bring positive attitudinal changes;

- Regulation of grazing;
- Regeneration of the plant species;
- Prevention of illicit felling of trees.

Impact of the ecological analysis

- Species density as an indicator of the abundance of the species, which identifies the dominant and rare species;
- Basal area, which is a measure of productivity, provides the information on the proportion or dominance of larger and smaller trees in an ecosystem and indicates the status of standing biomass that is whether the forest is degrading or improving;
- Biomass is used as fuel for domestic activities and non-domestic activities, fodder, green manure, timber, food, medicinal raw material;
- Estimation of the forest product utilization helps to analyze the dependence of the local inhabitants on plant products;
- Ecological analysis helps to assess the income and employment generated by the different forest products;
- It serves as a tool to motivate the governments and forest local communities to protect forest and village plant resources;
- It helps to promote inclusion of non-timber plant product species in reforestation programme.

Apart from all these beneficial implications of the participatory vegetation monitoring this approach is a system approach and see the part from the whole holistically with a multidisciplinary interventions. The identification of medicinal plants of the forest helps to the villagers to use the plant accordingly during their illness. So, from this process they can identify the newer potential area of NTFP management and marketing.

CONCLUSION

The concept of Participatory vegetation monitoring is very clear to the villagers and they are doing the right thing to know the present vegetation status of their forest in a nutshell. The villagers or the FPC members of the aforesaid FPCs are conducting the participatory vegetation monitoring in their forest after getting trained by the NGO professionals successfully. They are getting the benefit of knowing the species of their forest. They are being aware about the harmful and beneficial species of their forests for utilizing them in their local situation. They are taking the help from the NGO to build their capacity regarding the income generating approach from their forest resources. They are working successfully with the forest department and they had built a sense of belongingness within themselves. They are deciding about the process of felling the trees and helping the forest department regarding the regeneration of the helpful species in their forest fringes. So, it’s an innovative approach to create awareness regarding the forest and its utilization in an appropriate manner. It is the high time to pay attention to the process of participatory vegetation monitoring which is giving such a valuable input in a very good number to the forest dwellers, for future planning and strategy making regarding the sustainable forest management. The planners and the policy makers should pay due attention to the process for the future scope of participatory forest management in terms of participatory vegetation monitoring. Along with this the economic analysis should be conducted to know the income of the forest dwellers from their forests.

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A Study 0n the Contribution of Different Plantation Schemes on Rural Life – A Case Study Of West Bengal

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INTRODUCTION

Massive degradation of the forest made the whole world ponder about the threat to their precious environment, which has been well appreciated in India since long. The thought and social processes concerning the environment issues are reflected in the Constitution of the Republic of India adopted in 1950. The Directive Principles of State policy, an integral and significant element of constitution of India, contains provisions, which reflect the commitment of the state to protect the environment with regard to forests and wildlife. The Directive principles of State policy enjoin upon the citizens of India the special responsibility to protect and improve the environment. The roots of the growing trends towards popular participation in our conservation and national resource development programme lie in this constitutional requirement. In 1970s the foundation of the present day institutional framework for the environmental programmes in India has been sown with the establishment of the National committee of environmental Planning and Coordination immediately after the historic Stockholm Conference on environment held in 1972. The committee gradually transformed to the Department of Environment in 1980 and five years later to a full fledged Ministry of Environment and Forests (MOEF) of the Government of India (GOI). The state governments also have their own Departments of Environment to implement the policies and programmes in the environment and forests sectors.

Current Status of India's Forest:

As per the forest survey of India's assessment in1999, India's total "notified forest area" is 76.84 million hectares, which is 23.38 percent of India's total geographical area of 328.7 million hectares. Actual forest cover area however, as per the forest survey of India, is only 63.3 million hectares, which is just 19 percent of the total geographical area, and far below the target of 33 per cent, as stipulated in the national Forest Policy, 1988. Per Capita Availability of forests in India is 0.08 ha which is much lower than the world's average of 0.8 ha.

Table: 2 Forest Cover as per 2001 Assessment

Land Use	Area in Sq. Kms.	Percentage of Geographical area
Forest Cover		
Dense Forest	416809	12.68
Open Forest	258729	7.87
Total Forest Cover *	**675538**	**20.55**
Non-Forest		
Scrub	47318	1.44
Total Non-Forest**	**2611725**	**79.45**
Total Geographical Area	**3287263**	**100.00**

Source : State of Forest Report
* : Includes 4482 km^2 under mangroves (0.14% of country's geographical area)
** : Includes Scrub

Changes of Forest Cover in India from 1989 to 2001

India's forest cover declined only marginally in the period 1989-1997, from 64 million hectares to 63.3 million hectares – a percent decline. Significantly, however this small decline was concentrated totally in dense forest cover, where a 3 per cent decline was registered. Over the same period open forests actually expanded by 1 per cent. Theses figures are suggestive of a degradation process whereby dense forest has been converted to open forest through over use. Major forest cover declines in this short period could be seen in three states, namely, Andhra Pradesh, Asam and Himachal Pradesh. States like Punjab, Maharashtra and Gujarat have an impressive increase in total forest cover during the same period.

From the following table it is revealed that in the year 2001, as compared to 1999, the total forest cover had increased by 38245 sq.kms. The states, which have shown significant decrease in the forest covers, are Arunachal Pradesh, Chhatisgarh, Meghalaya, Manipur, Mizoram, Nagaland and A&N Islands. Whereas the states of Assam, Bihar, Arunachal Pradesh, Karnataka, Tamil Nadu, Gujarat, Maharashtra, Punjab, West Bengal and Rajasthan have shown an increase in forest cover. However it has increased in 1999 by 3896 sq. kms. as compared to 1997.

Table: 1 Comparative Study of Forest Cover in India

States/Uts	2001 Assessment	1999 Assessment	1997 Assessment	Change in 2001	Change in 1999
Andhra Pradesh	44637	44229	43290	+408	+939
Arunacha pradesh	68045	68847	68602	-802	+245
Assam	27714	23688	23824	+4026	-136
Bihar	5720	4830	4832	+890	-2
Chhatishgarh	56448	56693	56435	-245	+258
Delhi	111	88	26	+23	+62
Goa	2095	1251	1252	+844	-1
Gujarat	15152	12965	12578	+2187	+387
Harayana	1754	964	604	+790	+360
Himachal Pradesh	14360	13082	12521	+1278	+561
Jammu & Kashmir	21237	20441	20440	+796	+1

Jharkand	22637	21644	21692	+993	-48
Karnataka	36991	32467	32403	+4524	+64
Kerela	15560	10323	10334	+5237	-11
Madhya Pradesh	77265	75137	74760	+2128	+377
Maharashtra	47482	46672	46143	+810	+529
Manipur	16926	17384	17418	-458	-34
Meghalaya	15584	15633	15657	-49	-24
Mizoram	17494	18338	18775	-844	-437
Nagaland	13345	14164	14221	-819	-57
Orissa	48838	47033	46941	+1805	+92
Punjab	2432	1412	1387	+1020	+25
Rajasthan	16367	13871	13353	+2496	+518
Sikkim	3193	3118	3129	+75	-11
Tamil Nadu	21482	17078	17064	+440	+14
Tripura	7065	5754	5546	+1320	+199
Uttar Pradesh	13746	10756	10751	+2990	+5
Uttaranchal	23938	23260	23243	+678	+17
West Bengal	10693	8362	8394	+2331	+13
A. & N. Island	6930	7606	7613	-676	-7
Chandigarh	9	7	7	+2	+0
Dadra & Nagar Haveli	219	202	204	+17	-2
Daman & Diu	6	3	3	+3	0
Lakshadweep	27	0	0	+27	0
Pondicherry	36	0	0	+36	0
Total	675538	637293	633397	+38245	+3896

Source: State of Forest Report, 2001

From the above table it is also accessed that the forest cover in the North-Eastern Region is about 64% of the geographical area. The forest cover decrease in the North Eastern Region was maximum during the year 1993-95. However there has been significant increase in the forest cover in 2001 over the year 1999 by 2374 sq.km. mainly due to increase in the forest area cover in Assam and Tripura while other North Eastern States have shown decrease in forest cover in the same period.

Though area under forests has virtually retarded the process of declining in the last decade, the quality of the forest cover is declining in terms of lowered “growing stock” and annual rates depicting lower volume of forest stock and productivity. Information on quality of forests was collected only from 1989 onwards. Quantitative changes in forest cover area do not imply an increase or decrease in the volume of growing stock or forest’s quality. Declines in forest cover can coexist with an increase in the stock volume because of compositional changes, for instance from open to dense forestlands.

Forest Policy:

The first policy in India was adopted in the year 1894. The policy made two major announcements. Firstly the claims of cultivation are stronger than the claims for forest preservation and secondly the material benefit was the only object of the forest administration.

The first forest policy suggested a rough functional classification of forest into the following four categories:

a) Forest, which was essential for climatic and physical background.
b) Forest, which supply valuable timber for commercial purposes
c) Minor forests, which produced only the inferior sorts of timber
d) Pastures, which were forests only in name

The first quarter of the 20th century brought some scientific approach in the forest activities the department adopted the method of regenerating of forest and silviculture system to be applied to different kinds of forest. Felling of trees was highly prohibited to the limit of anticipated growth. In 1906 the silviculture research was organized and the Forest Research Institute was established at Dheradun.

Destruction of forest started mainly with the two world wars. Besides, industrialization creates a great pressure upon the stability of world environment and ecological system. Domestic and industrial need also have an equal influence to create pressure on the natural forest. It is found from a statistics that there was 7 crores sq.km. forest land in the beginning of the century and the over exploitation of the forest land has constricted the forest area to 3 crores sq. km. in 1975. If the rate of deforestation continues without the required plantation then the forest area is likely to decline to 2 crore sq.km. In an average 25 lakh sq.km. is destroyed every year, daywise it is 1 lakh 37 thousands and it is 100 ha.per minute. Thus to make the world survive emphasis ought to be on plantation rather than deforestation. Following are some of the reasons of the depletion of the forest:

1) The pressure of the over population
2) The hope and ambition about the development of the country
3) The spread of agriculture and industry
4) The bulk need of increasing poor and undeveloped community.

The problem of worldwise deforestation was discussed in different international seminars and after the extensive research studies the experts have come to the conclusion that the forest cannot be conserved only with the central protection and revenue collection. To conserve the forest the following steps are ought to follow.

i) Favourable situation should be created so the poor and the rural people can participate as partner with honour
ii) The productivity of the forest should be maintained through proper technology, besides the environmental stability should be conserved in such a way the flow of benefits from the forest should become evergreen.

West Bengal and its Forestry:

West Bengal, is one of the smallest states of 88,752 sq.km., and has population of about 680.78 lakhs of which 72.52% resides in rural area and spread over nearly in 42000 villages. Density of the population is comparatively quite high and that is 903 per sq.km. against the national average of 273 per sq.km. The land and the man ratio are quite low in the state.

The forests in West Bengal have a complex history. During the past century and in the early decades of the on going century the forests came under the pressure of the extensive agro-economic movements and suffered from wide spread trespass. The total forest area of the state is 11,879 sq.km., which is 13.4 percent of the total geographical area. The per capital forest area of West Bengal is 0.02 ha. The quality and productivity of the forest are not uniform throughout the state. In the northern region of the state the hills, foothills and plains are covered with large forest track. Another large track of forest is found in the marshy, inter tidal zone in the south of the state and the small segment of southeastern track is covered with forest. Few states in India show the same type of physical diversity climate varies from moist tropical in the southeast to dry tropical in the southwest and from sub-tropical to temperate in the mountains of the north. Altitudes ranges from sea level to 3700 m, short winter season sunshine varies between 8.5 to 9.5 hour per day and in some rainy cloudy days it is about 4.5 to 5.5 hour per day.

Notwithstanding adverse land man ratio, conservation strategies have started paying dividends. Satellite image indicates the improvement of crop, increase in vegetation cover etc. With the initiation of protective measures there has been increase in quantity of N.T.F.P. per hectare of forest also.

The natural forest of West Bengal can be segmented into seven major types. The following table depicts types of natural forest in West Bengal:

Table: 3 Types of Natural Forest in West Bengal

Type of Forest	Places	Species
Alpine Forest	Over 3000m	Isuqa Brunoniance, Abies Densa Rhododendrons, arundinaria Bamboos.
Eastern Himalayan Forest	Wet Temperature Area over 1800m to 3000m	Micheliam Exceise, Michelia spp, Acer spp and various oaks
Sub Tropical Hill Forest	Northern Hill upto 1800m	Betuea Cylindrostachys, Alnus Nepalensis, Schina Wallichil, Enqelhardtia Spicata etc.
Wet Evergreen Forest	Foothills of Northern Bengal	Michelia Champaca, Terminalia Ailanthus Grandis, Phoebe spp.
Moist Decideous Forest	Northern Plain	Shorea Robustya, Chukrassia Velutina, iverrain Forest of Acacia Catechu, Dalbergia Sisoo Bombax Cebia etc.
Dry Decideous Forest	Lateride Zone of South Western Part of West Bengal	Sal, Pterocapus marsupium, Dipospryros Melanoxylon, Madhuca Longifolia, Schleichera Trijuga, Lagerstroemia Parviflora, Butea Monosperma
Mangrove Forest	In Ganga Delta of Southern West Bengal	Ceriops Decandra, Xylocarpus Granatum, Avicennia Officinalis Sonneratia Apetala, Rhizophora Mucronata, Phoenix Paludosa etc.

Systematic Forest Management (SFM)

The Systematic Management of forests in India started in the year 1864. The principal objective of SMF is to develop forests and treat them as a biological growing entity instead of acquiring timber for various purposes. Simultaneously the Government of India took an important decision to treat forest as a state property. The existing individual proprietorship of the forest at that time was banned and all the government forests were made in alienable. Mr. Dietrich Braandies, the first Inspector General of forest took the following immediate action based on the Government decision:

a) Exploration of resources
b) Demarcation of reserve
c) Protection of forest from fire
d) Control on shifting cultivation and

e) Assessment of growing a stock in valuable reserve

The legislation regarding forest management was made for the first time in 1865 and the Indian Forest Act was enacted. The act was not comprehensive and the main aim of the act was to protect the forests and the forest products. The act was revised in 1878 and under the new act the forest is divided into following two categories:

Reserve Forest: In a reserve forest everything is prohibited which was not specifically permitted and
Protective Forest: In a protective forest everything was permitted which was not specifically prohibited.

Joint Forest Management:

Participation of people in the protection and management of forests has been emphasized in the National Forest Policy, 1988. Pursuant to this policy, on 1st June'90 Government of India through its resolution formalized the JFM Programme. The JFM is being practiced through constitution of forest protection committees. The mechanism of sharing usufructs differs from state to state. About 36,130 committees are managing a total of 10.25 million ha of forest area under JFM. Following table shows the committee and area under their management.

In West Bengal community forestry is fast emerging as a stable rural institution and a vehicle to achieve rural development through people's participation. This community forestry is an idea of mid 70's. From 1981 through the aid of World Bank west Bengal has started the Social Forestry vigorously. How far this Social Forestry has made impact on the rural life of West Bengal has been studied in this project. The study will specifically focus on the socio-economic changes and bio-diversity induced by Social Forestry in the rural, urban and forest life of West Bengal.

The Joint Forest Management is envisioned to improve the people's attitude toward forest development, to provide continuing employment and income sources, and to ensure a firm research base for existing commercial operations. The challenge is to change the negative attitudes of the inhabitants so that they become involved and be more productive.

The pro-people land reform measures, initiatives of NGO's, involvement of people through three tier Panchayat Raj and planning process from the grassroots level blended with an institutionalized pro-people forest management have helped West Bengal to have an unique position in the world. West Bengal has won " J PAUL GETTY WILD LIFE PRIZE" of the worldwide life fund, which is equivalent to Nobel Prize.

The development of joint forestry to offset current problem should be guided by the following considerations:

♦ Involve the people in forestry activities by providing incentives without competing with their traditional
food production activities.
♦ Create a development strategy that will restore the confidence of the people toward government
development programs.

♦ Formulate strategies that would complement present reforestation activities with the view of
supplying raw materials to industry as well as sustaining smallholder production projects.
♦ Set up a system that will encourage traditional owners to release their lands for forestry development and uses.
♦ Design an integrated forestry system that will spur economic development in the area with a shorter
gestation period and
♦ Formulate production systems that will lower costs of forest rehabilitation and increase benefits for
the people and the government.

Table: 4 Area under Joint Forest Management

State/UTs	**Date of Notification**	**No. of JFM committee**	**Area under JFM ('000 ha)**
Andhra Pradesh	28.09.92	6575	1632.19
Arunachal Pradesh	03.10.97	10	5.29
Assam	10.11.98	101	3.06
Bihar	08.11.90	1675	935.08
Gujarat	13.03.91	706	91.07
Himachal Pradesh	12.05.93	203	62
Haryana	13.06.90	350	60.73
Jammu & Kashmir	19.03.92	1599	79.27
Karnataka	12.04.93	1212	12.8
Kerala	16.01.98	21	4
Madhya Pradesh	10.12.91	12038	5800
Maharashtra	16.03.92	502	94.73
Mizoram	18.09.98	103	5.87
Nagaland	05.03.97	55	0.65
Orissa	3.08.88	3704	419.31
Punjab	14.07.93	89	38.99
Rajasthan	16.03.91	2705	235.63
Sikkim	26.06.98	98	2.19
Tamil Nadu	8.08.97	599	224.38
Tripura	20.12.91	157	16.23
Uttar Pradesh	30.08.97	197	34.59
West Bengal	12.07.89	3431	490.58
Total		36130	10248.64

Creation of the man made forest depends upon the climate, nature of soil, agriculture practice, productivity of land etc. Based on these factors people engage their land either for short time or for long time period. In west Bengal some area of northern hill and coastal saline zone are not suitable for the cultivation of normal agricultural crops but are suitable for cultivating various rare and valuable species. The vacant land beside the road are planted with high growth tree species like Eucalyptus, Akasmoni etc. Under the Social Forestry Project, which was launched in 1981, a total area 1.4 million ha land was used for the cultivation of different kinds of trees. Different types of land, which were lying vacant like roads, paths, canals, wastelands etc. are used for the growing different kinds of plants. Roadside, rail and canal side lands are owned by the government. Before 1981 both the sides of the road were maintained by the Department of the Forest, but the plantation was quite low in compare of the requirement. In West Bengal, mostly in the middle and south Bengal's villages there are many tanks and ponds. The banks of the rivers are used for plantation thereby benefiting economically as well as environmentally the local inhabitants.

Different Plantation Model

In 1977 the contribution of forest-based industry was estimated around 2 percent of the state income. Due to the low productivity of land and unfavorable climatic condition huge portion of land remained fallow. Later these lands were used by forestry to meet the habitual needs of the rural people by generating income from the plantation. Initially the project attempted to achieve the following targets:

i) To reach the maximum number of small farmer and landless labors.
ii) To ensure that the total fuel cost does not exceed the state norms.
iii) To transfer responsibility of management and protection of village woodlots and strip plantation to the village panchayat after recovering the cost involved in the process.

The planting programmes are divided into following models

Table: 5 Different Models of Planting Programmes

Sl.No.	Component	Model No.	Details
1.	Strip Plantation	I	Planting beside National Highway
		II	Planting beside main roads
		III	Planting beside other roads
		IVA	Planting on Canal banks
		IVB	Planting on embankment
		IVC	Planting on riverbank
		IVD	Planting on railway land
2.	Village woodlot	V	Planting on hill
		VI	Planting on alluvial site
		VII	Planting on lateride
3.	Farm Forest	VIIIA	Planting on hill with incentive
		VIIIB	Planting on hill without incentive
		IXA	Planting on alluvial with incentive
		IXB	Planting on alluvial without incentive
		XA	Planting on lateride with incentive
		XB	Planting on lateride without incentive
4.	Rehabilitation of the degraded forest	XI	By coppicing
		XII	By Planting

The four pattern of plantation have different conceptual establishment, management, harvesting marketing, legal and funding features.

Strip Plantation

The strip plantation is a programme undertaken in the roadside, canals and railway land. The direct cost for raising and maintaining the strip plantation was the responsibility of the project authorities but the projection was instigated by the local committee. Gram Panchayat selects beneficiaries from the landless labours, marginal farmers, small farmers of SC and ST. all the activities of done by Bon-O-Bhumi Saskar Samity of Panchayat. The allotted beneficiaries are likely to do all the activities related to the growth of the plants. The work is distributed among the individuals, families or group by the panchayat.

The matured trees are disposed by the panchayat through an auction. Cost of creating plant, expected cost of seedling is recovered from the revenue collected from the sale of the trees. From the balance a percentage amount is distributed among the beneficiaries rest is credited to the fund of panchayat for the purpose of expenditure future afforestation work. The entire work system is under the joint forest management where the authority of forest officer, panchayat and beneficiaries are equally involved.

Woodlots

The scheme of village woodlots involves community participation on the uncultivated land leased to gram panchayat. The plantation of theses type were mainly on the land of schools, colleges, health centre, abandoned airstrips, social & cultural centre etc. for this scheme one hector land was used in each of 2500-gram panchayat. The cost of plantation was borne by the social forestry department. The gram panchayat was given the responsibility to protect and manage the plantation for two years. The successful gram panchayat in this scheme would opt for any of the following schemes.

a) **Loan Scheme** – loan of Rs.2000 without any interest were given for one hectare of land. After the 8th year Social Forestry wing recovered the loan from the sale of the product.
b) **Supervised Scheme** - Social Forestry took the responsibility of maintaining and protecting of the pantation of 2 hectare of land in each gram panchayat and recovered the costs by the sale of the product.

Farm Forestry

This work is done by the individual or the group of farmers. In group farm forestry the participants planted on their own land or on private wasteland or on the vested land leased to an individual on 'patta'. The total management of the farm forestry was under the control of the participants. Initially the participants took the help of the forest department regarding the planting process, protection of the plants and nursing of the plants. Later they have started everything of their own from producing seedling to the sale of the product.

Rehabitation & Reforestation of the Degraded Forest:

Degraded forest was rehabilitated through replanting with coppicing. Local villagers were permitted to collect 25 % of the produced fuel wood, fodder etc. at free of cost. The project couldn't reach the height of satisfactory success in every region. But the scheme was successful in a forest area of about 1200 ha. near Arabari, a village in Midnapur of South Bengal with the active participation of the local inhabitants.

The above mentioned schemes were all under West Bengal Social Forestry which was ended in 1991. In the year 1992 a new project was launched in west Bengal named as West Bengal Forestry Projetc. In this project production forestry activities and community forestry activities were summed up and some of the old models were changed. The main objectiove of this project were:

i) To prevent continuous degradation of the forest land in the state.
ii) To improve productivity of per unit forest area.
iii) To conserve bio-diversity and conserve the barren and unproductive lands through farm forestry.
iv) To introduce a sustainable and innovative protective sysytem covering all the forest area of the state.
v) To develop a system of joint forest management with participation of forest fringe population, through a clear-cut institutional framework.

The important models of the project are mentioned below:

Table: 6 Names of the Models under West Bengal Forestry Project

Model Name	Desciption
P1	Sal Plantation
P2	Teak Plantation
P3	Reverine Plantation
P4	Misc. Plantation in Northern Circle
P6	Hill Timber Plantation
R1	Forest regeneration from Viable Rootstock
R2	Forest Regeneration by Enrichment
R3	Reforestation with Tasar Host Plant
R4	Multitier Reforestation in South Bengal
R5	Multitier Reforestation in NorthernPlain
R6	Multitier Reforestation in North Bengal Hill
R7	Reforestation with Fuel wood Plantation in Northern circle
M1	Afforestation of Intertidal Banks
M2	Regeneration of Mangrove Degraded Forestry
S1	Strip Plantation
F1	Farm Forestry

Both the forestry project attempted to

i) save the natural forest and protect the ecology and
ii) develop the socio-economic condition of the rural and the forest people.

To fulfill the proposal of forest activities many plans and programmes have been taken under consideration with the help of Central as well State Government either jointly or individually. All the following development programmes were done with the help three tier Panchayat system. As a consequence there was huge participation of the local people.

i) Scheme of rural fuel wood plantation and afforestation of eco-sensitive non-Himalayan regions
ii) National Rural Employment Programme (NREP)
iii) Rural Landless Employment Guarantee Programme (RLEGP)
iv) Drought Prone Area Programme (DPAP)
v) Area Development programme i.e. Hill Development or Jhargram Development
vi) Decentralized People Nursery and
vii) Silvipastural Scheme.

Socio-Economic Impact of Community Forestry in West Bengal:

The main purpose of social forestry was to improve the lifestyle of the rural people and to minimize the pressure on the forestland by planting various wood fuel, fodder and forage food on the unused rural area and the government land. Social forestry is accompanied with some special characteristics related to the socio-economy.

i) Social forestry crops take a long term to mature in compare to other agricultural crops produced by the rural people.
ii) Crops of social forestry need community mechanism for their protection and distribution of benefits and absorption of cost.
iii) It helps the government to promote the rural development and to prevent land and forest deterioration.
iv) Social forestry system helps the government to earn the revenue by utilizing unused government lands as it is controlled by the community.

Economic Development through Social Forestry:

The rural people mainly depend on the forest products like timber, firewood, leaves, branch, bark, seed, fruit, roots etc. for their day-to-day life. As a consequence the forest areas were degrading and the deforested land were becoming the victims soil erosion. The recent social forestry schemes solve the dual problem.

Firewood is still in huge consumption by the rural people. About 63% of the total energy consumption is the firewood. In one estimate the quantum of the wood removed from the forest of India is 250 million cubic metres valued at 25000 million rupees. In West Bengal about 42% of the total consumption for different fuel is firewood. Against the total estimated consumption of 16.847 million cubic meter, the total supply is as follows. Eucalyptus is also grown in a large-scale meet the ever-increasing demand of the fuel and pulpwood.

Table: 7 Amount of wood Produced from the Different Sources

Sources	Million Cubic Meter (unit)
Fuel wood from Government Forest	0.520
Fuel Wood from Private Land	2.240
Fuel from Saw Mill etc.	0.200
Estimated Fuel Supply from other District	0.066
Total	3.026

Achievement of the Social Forestry:

The forestland area increased under social forestry project in West Bengal. The following table shows the achievement of the project.

Table: 8 Achievement under different Plantation Models

Year	Different Plantation Model Under West Bengal Social Forestry Project				
	SP	VWL	FF	RDFP	RDFC
1981	492	98	2902	2705	3010
1982	1182	357	6360	1270	700
1983	3387	694	11442	1650	1500
1984	4500	489	15157	1601	2000
1985	5289	512	18973	1470	1850
1986	2669	245	71900	0	0
1987	2600	0	15075	0	0
1988	1010	10	24375	130	6500
1989	985	0	19080	1000	16912
1990	1031	0	30000	2000	20613

From the above table it can be accessed that under the social forestry farm forestry and strip plantation were in highlight in West Bengal. Strip plantation number increased from 492 to 1010 from 1981 to 1987. Then the number has fallen and again the number improved in 1990. Farm forestry shows a quite impressive achievement. It started with 2902 in 1981 and reached 30000 in the nine years down the line. Rehabilitation of the degraded forest shows more effective by coppicing than by planting. By coppicing the number has increased from 3010 to 20613 while by planting declined from 2705 to 2000. Village woodlots showed the improvement in the first three years but then in the later period the scheme did not get any remarkable achievement.

Plantation Model Under West Bengal Forestry Project:

P1	P2	P3	P4	P5	R1	R2	R3	R4	R5	R6	R7	M1	M2	S1	F1
93310	**115**	**100**	**300**	**180**	**15000**	**-**	**-**	**1500**	**840**	**435**	**250**	**550**	**5000**	**800**	**18160**
94288	**100**	**100**	**303**	**209**	**5400**	**200**	**170**	**3500**	**727**	**534**	**253**	**650**	**7286**	**798**	**18204**
95283	**106**	**180**	**305**	**200**	**5754**	**130**	**212**	**3385**	**834**	**315**	**340**	**550**	**5000**	**796**	**36530**

Various forestry projects were launched successfully in the different districts of West Bengal. In this paper we will concentrate on the work done in Midnapur District of West Bengal. We present the survey report of 162 samples being studied by us.

In our study we wanted to find out how far the main objectives of Social Forestry have been achieved. For that purpose we had selected Midnapur District. This District has been divided into four forest divisions of which actually three divisions are related to planting work. We chose one division at random by random sampling method. The divisions are divided into ranges. From the division of the ranges we have selected Hizli range randomly. New name of the range is Kalaikunda range. This range consist of three social forest complexes namely

(i) Paljari
(ii) Sarsa and
(iii) Arjuni (Khemasul).

From theses complexes we chose Paljari and Arjuni for our study purposes. Paljari complex is consisted of 11 villages and Arjuni consist of 15 villages.

The villages differ from one another in terms of area. There are some villages with more than 1000 households whereas in some villages the number of households is less than 100. We concentrated our study more on Arjuni complex because forestry is much popular in this complex. We had selected seven out of 15 villages of Anjuni complex and from the Pinjari complex we have chosen 3 villages out of 11 villages. The villages so selected are Moulesole, Tangasole, Patna, Radhanagar, krishnarakhit Chalk, bhurukchati, Jotia, Rajabasa, Katasole and Sakpara.

From each village we have selected the villagers who are engaged in the social forestry. The studied number of villagers varies from villages to villages due to the variation in the population size.

Midnapur is the southernmost district of West Bengal and is the largest among the seventeen districts of West Bengal. It has an area of 14,018 sq.km. and a population of 83,31,914. The density of population is about 592 per sq.km. Percentage of urban people to total people is 9.85 and the major portion of the population i.e. 90.15 % live in the rural area of the district.

The soil characteristics of Midnapur district vary from place to place. Three types of soil are being found in the district. The northern part of the district is having late ride type of soil; southern part is composed of coastal saline type of soil and the rest of the district is in alluvium zone. The average temperature of the district is 36.5° C. the average annual rainfall is 1538.5 mm. In average July is the hottest month and December is the coldest month of the district.

Before the start of social forestry project, the forestland was 172144 sq.km. among which reserve forest was 236 sq.km. and the protected forest was 170, 098 sq.km. and unclassed forest land was 1810 sq.km.

The forest zone of Midnapur is divided into four divisions – (i) Kharagpur Social Forestry Division (ii) East Midnapur Division (iii) West Midnapur Division and (iv) Rupnarayan Planning and Survey Division.

In 1988 the total recorded forestland of the district is 1,709 sq.km. and that is 14.76% of total geographical area of Midnapur. The forest zone of the district is divided into four divisions namely
a) Kharagpur Social Division b) East Midnapur Division c) West Midnapur Division and d) Rupnarayan lanning and Survey Division.

In the district, community forestry is mainly popular and it gained a maximum achievement in the district.

Table: 9 Distribution of Agricultural Land in the different areas of the District

Quantity of Land	Moule sole	Tangas ole	Patna	Radhanagar Chalk	Krishna Rakhit	Bhuruk Chati	jotia	Raja Basa	Kata sole	Sak para	Total
0-0.99	**7**	**1**	**2**	**-**	**1**	**1**	**2**	**1**	**-**	**-**	**15**
1-1.99	**4**	**1**	**9**	**5**	**-**	**53**	**3**	**-**	**-**	**1**	**26**
2-2.99	**5**	**-**	**5**	**7**	**-**	**-2**	**2**	**1**	**-**	**-**	**22**
3-3.99	**4**	**4**	**5**	**3**	**1**	**-1**	**4**	**5**	**-**	**-**	**27**
4-4.99	**5**	**4**	**15**	**5**	**-**	**-2**	**1**	**-**	**-**	**-**	**32**
5-5.99	**4**	**6**	**6**	**9**	**-**	**--**	**5**	**2**	**-**	**-**	**32**
10 & above	**-**	**-**	**1**	**2**	**-**	**--**	**4**	**-**	**1**	**-**	**8**
Total	**29**	**16**	**43**	**31**	**2**	**9**	**21**	**9**	**1**	**1**	**162**

The above table gives the land holdings of the different farmers in the different villages. It was surprised to find out that in Patna, which is comparatively large village; about 34.5% of the total ppulation have 4.0 – 4.99 acre of land. It was also found that about 45% of the farmers have started to have land more than 4 acre and only 9% of the villagers have less than 1 acre of land.

Table: 10 Distribution of Agricultural Land in the different areas of the District

Land in Acre	Moule sole	Tangasole	Patna	Radhanagar Chalk	Krishna Rakhit	Bhuruk Chati	jotia	Raja Basa	Kata sole	Sak para	Total
0-0.99	**17**	**2**	**10**	**5**	**2**	**4**	**16**	**5**	**-**	**1**	**62**
1-1.99	**6**	**1**	**12**	**11**	**-**	**5**	**2**	**3**	**-**	**-**	**40**
2-2.99	**2**	**2**	**6**	**5**	**-**	**-**	**-**	**-**	**-**	**-**	**15**
3-3.99	**2**	**6**	**11**	**3**	**-**	**-**	**2**	**1**	**1**	**-**	**26**
4-4.99	**2**	**3**	**1**	**3**	**-**	**-**	**1**	**-**	**-**	**-**	**10**
5-5.99	**-**	**2**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**8**
10 & above	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
Total	**29**	**16**	**43**	**31**	**2**	**9**	**21**	**9**	**1**	**1**	**162**

From the above table it is accessed that the agricultural is distributed among the ten villages of the district. Maximum people possess the land less than 1 acre. Only one of Radhanagar Chalk out of 162 respondents own the agricultural plot more than 10 acre. With the increase of the area the percentage of people decreases. In Tangasole sixteen persons have an agricultural plot of their own out of which maximum person (6) have a land more than 3 acre. In Sakpara only one person was found having a plot of his own and that is also less than 1 acre. In Rajabasa also one person was found having an agricultural plot of his own and that within 3-3.99 acre. Thus we can see that villages like Sakpara, Katasole and Krishnarakhit the need of agricultural land is more in compare to the other areas of Midnapur. From the table it can also be assumed that the people of these areas mainly depend on the forest product for their day-to-day need.

Table: 11 Social Forestry land Distribution

Land in Acre	Moule sole	Tangasole	Patna	Radhanagar Chalk	Krishna Rakhit	Bhuruk Chati	jotia	Raja Basa	Kata sole	Sak para	Total
0-0.24	**1**	**-**	**-**	**3**	**-**	**2**	**-**	**3**	**-**	**-**	**9**
0.25-0.49	**6**	**3**	**5**	**7**	**1**	**1**	**6**	**-**	**-**	**-**	**29**
0.50-	**8**	**4**	**17**	**7**	**1**	**1**	**10**	**2**	**-**	**-**	**50**

0.99											
1-1.49	**5**	**3**	**11**	**11**	**-**	**3**	**1**	**-**	**-**	**-**	**34**
1.5-1.99	**3**	**1**	**4**	**3**	**-**	**2**	**2**	**3**	**-**	**1**	**19**
2-3.99	**4**	**5**	**4**	**-**	**-**	**-**	**1**	**1**	**1**	**-**	**16**
4 & above	**2**	**-**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**5**
Total	**29**	**16**	**43**	**31**	**2**	**9**	**21**	**9**	**1**	**1**	**162**

The above represents the distribution of land to the villagers by the social forestry department, West Bengal. From the table it is accessed that 97% of the villagers have used less than 4 acre of land for the social forestry work. About 50% of the villagers have engaged 0.50 acre to 1.49 acre of the land for the social forestry. 0.50-0.99 acre of land was distributed among the maximum people (about 31%) belonging to different villages. 1-1.49 acre of land was distributed to 21% of the total sample size. Maximum land distributed was 4 & above acre and that among 3% people belonging to Moulesole, Patna and Jotia. Maximum people were interviewed in Patna (43) and 40% people were given less than 1 acre of land, 26% people were given 1 to 1and 1/2 acre of land was distributed among 5% people. One person was only found in Sakpara and Katasola having distributed with more than 1 acre and 2 acre of land respectively.

Table: 12 Distributions of Planted Trees

No. Of Trees	Moule sole	Tangasole	Patna	Radhanagar Chalk	Krishna Rakhit	Bhuruk Chati	jotia	Raja Basa	Kata sole	Sak para	Total
0-99	**1**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**4**
100-249	**4**	**1**	**5**	**4**	**1**	**5**	**7**	**3**	**-**	**-**	**30**
250-499	**2**	**1**	**3**	**6**	**-**	**2**	**2**	**2**	**-**	**-**	**18**
500-999	**5**	**3**	**12**	**12**	**1**	**2**	**6**	**2**	**-**	**-**	**43**
1000-1999	**11**	**5**	**11**	**5**	**-**	**-**	**2**	**1**	**-**	**1**	**36**
2000-3999	**3**	**4**	**6**	**3**	**-**	**-**	**3**	**1**	**1**	**-**	**23**
3000-4999	**1**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**5**
5000 & Above	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**3**
Total	**29**	**16**	**43**	**31**	**2**	**9**	**21**	**9**	**1**	**1**	**162**

The types of tree planted in social forestry programme are Eucalyptus sp. and Akashmoni. The table reveals that maximum number of trees distributed was 5000 & above and that too among two persons in Moulesole and 1 person in Jotia. Among four (three from Patna and one from Moulesole) plants upto 99 were distributed. In Patna maximum level of plant distributed was 3000-4999 and that was among 2 percent people (1/43*100). About 28% (12/43*100) persons of Patna were given plants from 500-999. Maximum percent of people (27% - 43/162*100) were given the plants from 500 to 1000. In Krishnarakhit out of total 2 samples one was given the plants more than 100 and the other was distributed with more than 500 plants. In Tangasole 31% (5/16*100) people were distributed with 1000-1999 plants. In Radhanagar of Midnapur district 39% people were distributed with 500-999 plants. In Rajabasak maximum people were distributed with 100-249 plants. In Jyotia about 33% people (7/21*100) were distributed with 100-249 plants.

Table: 13 Distributions of Physical Returns

No. Of Trees	Moule sole	Tangasole	Patna	Radhanagar Chalk	Krishna Rakhit	Bhuruk Chati	jotia	Raja Basa	Kata sole	Sak para	Total
1-99	**1**	**-**	**3**	**4**	**-**	**-**	**-**	**-**	**-**	**-**	**8**
100-249	**3**	**1**	**5**	**1**	**1**	**5**	**5**	**3**	**-**	**-**	**24**
250-499	**3**	**1**	**6**	**10**	**-**	**2**	**5**	**3**	**-**	**-**	**30**
500-999	**4**	**2**	**14**	**7**	**1**	**1**	**3**	**1**	**-**	**-**	**33**
1000-1999	**9**	**4**	**6**	**6**	**-**	**-**	**2**	**2**	**1**	**-**	**30**
2000-3999	**4**	**2**	**7**	**3**	**-**	**-**	**2**	**-**	**-**	**-**	**18**
3000-4999	**2**	**4**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**8**
5000 & Above	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**5**
Total	**29**	**16**	**42**	**31**	**2**	**8**	**18**	**9**	**1**	**-**	**156**

The table shows the distribution of number of trees harvested by the farmers in the different villages. It is observed that out of 162 samples size physical return was found from 156 people. There was no Physical return from Sakpara. From Moulesole, Tangasole, Radhanagar Chalk, Krishnarakhit and Rajabasa the physical return was from the cent percent sample. About three percent (5/162*100) people of the total sample size had a physical return of 5000 and above trees. Maximum percentage of people (20% --- 33/162*100) had a physical return of 500-999 trees. From about 19 % of total sample size the return was of 1000-1999 plants. The lowest number of plants retuned by about 5% of the sample size. Thus we can see that the physical return of the sample is as good as the distribution of the plants.

Table: 14 Distributions of Financial Returns

Income Range Rs./Yr.	Moule sole	Tangasole	Patna	Radhanagar Chalk	Krishna Rakhit	Bhuruk Chati	jotia	Raja Basa	Kata sole	Sak para	Total
1-999	**4**	**-**	**3**	**4**	**-**	**-**	**1**	**-**	**-**	**-**	**12**
1000-4999	**10**	**4**	**13**	**17**	**-**	**7**	**11**	**4**	**-**	**-**	**66**
5000-9999	**8**	**5**	**14**	**5**	**2**	**1**	**1**	**4**	**-**	**-**	**40**
10000-14999	**4**	**4**	**9**	**4**	**-**	**-**	**3**	**1**	**-**	**-**	**25**
15000-19999	**2**	**2**	**3**	**1**	**-**	**-**	**1**	**-**	**1**	**-**	**10**
20000 & above	**1**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**3**
Total	**29**	**16**	**42**	**31**	**2**	**8**	**18**	**9**	**1**	**-**	**156**

Table 14 shows the village wise distribution of financial return received from the harvested plants of Social Forestry. It reveals that only two percent of the total sample size could earn an amount of Rs.20000 and above in one financial year. Maximum percentage (41% --- 66/162*100) of people could earn Rs.1000-Rs.4999 in one year and 55% (17/31*100) of the total sample size of Radhanagar belongs to this earning category. About 6% of the total sample size had an annual earning of Rs.15000-19999. The sample size of the financial return is same as that of physical return. About 33% (14/42*100) of the total interviewers of Patna had an annual earning of Rs.5000-9999. Maximum percentage people of Moulesole, Radhanagar, Burukchati and Jyotia villages had an earning of Rs.1000-Rs.4999 and maximum people of Tangasole, Patna, Krishnarakhit and Rajabasa had an earning of Rs.5000-Rs.9999. One person of Katasola had an annual earning of Rs.15000-Rs.19999 and the sample person of Sakpara village had no earning from the scheme.

Table: 15Two Way Distribution of Physical and Financial Return of S.F.Product

No. of Plants	Rupees Earned							
	1-499	500-999	1000-4999	5000-9999	10000-14999	15000-19999	20000 & Above	Total
1-99	**2**	**5**	**1**	**0**	**0**	**0**	**0**	**8**
100-249	**0**	**2**	**20**	**2**	**0**	**0**	**0**	**24**
250-499	**0**	**2**	**25**	**3**	**0**	**0**	**0**	**30**
500-999	**0**	**1**	**12**	**15**	**5**	**0**	**0**	**33**
1000-1999	**0**	**0**	**5**	**10**	**12**	**3**	**0**	**30**
2000-2999	**0**	**0**	**2**	**5**	**6**	**4**	**1**	**18**
3000 & Above	**0**	**0**	**1**	**5**	**2**	**3**	**2**	**13**
Total	**2**	**10**	**66**	**40**	**25**	**10**	**3**	**156**

The above table gives the two-way classification of the number of trees and the revenue earned by the farmers in the studied ten villages. Maximum number of sample earned by having the physical return of 500-999 plants. Only 5% (8/156*100) could earn by selling 1-99 plants. About 8% (13/156*100) people of the total sample size earned Rs.20000 & above from 3000 & above plants. Only two persons were found have earned Rs.1-499 from 1-99 plants. One person was found to have earned Rs.20000 & above by selling 2000-2999 plants. Maximum percentage of the income range Rs.1000-4999 was had a physical return of 250-499. About 6% (10/256*100) of the total people had an annual income return of Rs.15000-Rs.19999 after having a physical return of 1000-1999, 2000-2999 and 3000 & above respectively.

From the above table we have calculated the correlation coefficient between the number of plants and the revenue earned. This correlation coefficient comes out to be 0.6672. But the correlation coefficient between the number of plants and the revenue earned should have been 1.00 or very near to it, as it is expected the revenue earned is directly proportionate to the number of plants. But unfortunately this is not the case here. It may be said that the quality of the plants harvested in different villages are not uniform. Discrepancy in the growth of the plants may be attributed to spacing i.e. the distance between the two plants. The farmers who have planted the trees according to the specification provided by the forest Department resulted better yield than those who have planted too many species in small area. Thus though the number of trees are the revenue earned is not to the satisfactory level, which was also agreed by the villagers.

Table: 16 The Buyer of Forestry Product

Buyer	No. of Sold
Middleman	150
Common people	6
Total	156

In our study we have found that the buyers of forest product are of two types and they are middleman and the common people. The middlemen buy the product from the forest department and at a lower price and then sell it in the open market. People of this category exceed by almost 90% than that of the common people. The common people are very few in number and they buy directly from the forest department and for their personal consumption.

The second factor that may be attributed for the low correlation is the role of middleman. As there is no arrangement from the Department of forestry, Govt. of West Bengal to collect the harvested yields and market them, the farmers have to depend entirely on the middleman for the marketing. The farmers also have no knowledge about the prices of the commodity in the open market. Thus whatever price is offered by the middlemen have to be accepted by the villagers for the quick return of the products.

Table: 17 Different Marketing Problems

Nature of Problem	No. of People
Problem of Middlemen	94
Ignorance of Price	28
No problem	34
Total	156

The villagers of the forest area were accompanied with some problems of forest product. The cent percent people are not getting benefited from the project. Most of the people are finding the problem with middleman. About 60% of the total sample population complaint of having the same problem. The problem faced by another 18% people is that they are unaware of the price of the different products given out by the forest department. Twenty-two percent of the interviewers had no complain against any sort of problem.

Table: 17 Types of Consumption of the Earning from Social Forestry (Village wise)

Type	Moule sole	Tangasole	Patna	Radhanag ar Chalk	Krishna Rakhit	Bhuruk Chati	jotia	Raja Basa	Kata sole	Sak para	Total
Saving	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**2**
Househol d Expen.	**22**	**14**	**38**	**27**	**1**	**4**	**9**	**4**	**-**	**-**	**119**
Medical Expen.	**6**	**-**	**3**	**-**	**1**	**3**	**-**	**-**	**-**	**-**	**13**
Marriage Expnd.	**-**	**-**	**1**	**-**	**-**	**-**	**4**	**-**	**-**	**-**	**5**
Invest in Business	**-**	**2**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**3**
Invest in Agricultur e	**-**	**-**	**-**	**2**	**-**	**1**	**-**	**1**	**-**	**-**	**4**
Building Cons.	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**4**
Build Repairing	**1**	**-**	**-**	**1**	**-**	**-**	**1**	**1**	**-**	**-**	**4**
Purchase Vehicle	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**--**	**2**
Total	**29**	**16**	**42**	**31**	**2**	**8**	**18**	**9**	**1**	**-**	**156**

Social forestry has brought some changes in the life of the rural people. This statement is being supported by the above given table. From the table we can some people of all the studied villages had some advantages from the scheme rather than the village Sakpara and the money earned from the scheme was invested in different ways by the different people. Most of the people used the earning on their household expenditure. About 76% of the total sample was found spending the earning in their household expenditure. The earning had also helped some people to bear the medical expenditure. Some were found having a good earning from the scheme and could fulfill the dream of their life by buying cars – may the percentage is very low. More than 3 % people were found using the money for marriage purpose. Whatever way they spent but the scheme was beneficial.

Conclusion:

From our study we conclude that at one times of the century the forest degradation was quite alarming which was given immediate attention and the present forest circumstances has been improved by implementing different schemes by different government sectors. The schemes not only benefited the forest sector but also the inhabitants of the forest as well as nearby villages. Comparative study of the forest cover in India shows that in the year 2001 almost all the states of the country had a progress in the forest coverage except in Chhatisgarh and four other states of North Eastern region of the country. Thus to make the world survive emphasis ought to be on plantation rather than deforestation. As India's forest area is still much below the target level, awareness among the people still gets the priority. To conserve the forest favourable situation should be created and the productivity of the forest should be maintained through proper technology. Joint Forest Management should also be given priority, as the cooperation of people is another important aspect of forest conservation. Maximum land under joint forest management was undertaken in the state of Andhra Pradesh. There was a positive socio-economic impact of Social Forestry and Community Forestry in West Bengal.

In the district of Midnapur, community forestry is mainly popular and it gained a maximum achievement in the district. Besides we have also found in our study that Khragpur block is entirely made of laterite soil. So agriculture is not so popular in the area. The rainfall varies from 1200mm to 1300mm. Temperature raises to 48°C in the summer and goes down to 10-11°C during the winter season.

The rural people could upgrade their economic status through different forestry schemes. We have also seen that under the social forestry farm forestry and strip plantation achieved an appreciating successful in West Bengal. Strip plantation and farm forestry could be remarkably counted. The schemes could be taken into consideration for further development of the degraded forest. Emphasis on coppicing method could fetch a better improvement in the rehabilitation of the degraded forests. In our study we also found that the villagers have not got the actual return of the product from the market, still they are very much satisfied because the revenue that they have earned from the land was beyond their imagination. They have not earned a single penny from theses lands for the last five generations. The satisfaction is reflected from the fact that about 99% people agree to replant and only one per cent people had a negative attitude towards the re-plantation. Thus a handful of person still required to aware about the importance of the plantation. We can also access that quite a good number of villagers were benefited by the scheme of social forestry. They could have attempted to complete half done work and also could involve themselves in some of the social work like marriage etc. Though the Social Forestry Scheme is no more in implementation, but the benefited people always remember the scheme and it should have been much better if the scheme could have continued. We hope under Joint Forest Management scheme people will be equally benefited and will be more aware of the importance of the plantation.

Proposed Methodological Framework and Data Issues for Physical Accounting of Forestry Resources: Learning from the States of Madhya Pradesh and Himachal Pradesh[1]

Madhu Verma[2], .C.V.R.S.Vijaya Kumar[3], B.R.Phukan[4], Akhilesh Yadav[5] & Atanu Rakshit[6]

1. Introduction

1.1 Importance of Forest as Natural Capital

Forests are one of the most important components of the terrestrial environmental system and a complete resource base. They form an ecological system consisting of tree dominated vegetative cover. Forests, however, provide in many ways to the global system and play a multi dimensional role. They provide not only timber, fuel wood, pulpwood, fodder and fiber grass and non-wood forest produce & support industrial & commercial activities but also maintain the ecological balance & life-support systems essential for food production, health and all round development of human kind. Forests exercise control over the wealth of adjoining land use systems & also the wealth of urban areas. Degraded forests result into impoverished agriculture, horticulture, and in turn trigger migration of dependent communities to urban areas where they end up in low paid, unsecured informal sector. Lack of availability of fodder in such degraded forests also reduces productivity of livestock population and forces their trans-boundary movement. Tropical forests are the repository of more than half of the world's plant & animal species and are the major source of available biodiversity. The global concern about forest degradation and depletion therefore, relates to the twin problems of destruction of the carbon sinks affecting the global climate & extinction of species affecting bio-diversity. The rural poor in the third World have been blamed for deforestation in the past, but there has been an increasing realization that it is mainly the production centered forest policies and exclusive demand for non forestry developmental activities have accelerated deforestation.(Verma, 2000)

The loss of a forest is fundamentally economic in nature. So, it is that its conservation needs to be addressed in economic terms. For forests to be conserved, they need to be perceived as being more valuable than the usual, standard, utilities they provide' (DTE, 2005).

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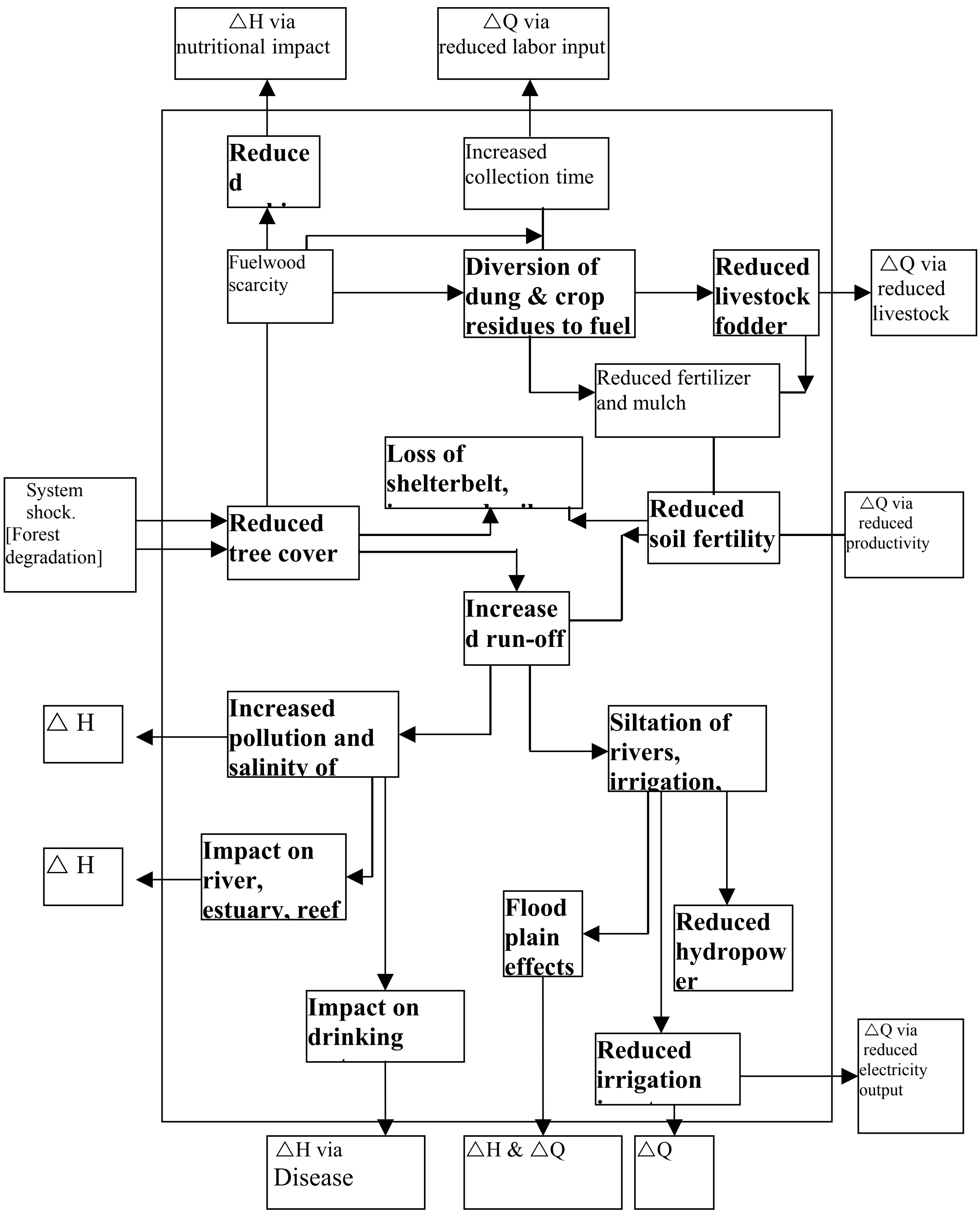
1.2 Forestry Linkages

Natural resources like forests and Wildlife are part of national wealth or stock, however, unlike many other goods and services these resources may not have a ready market. The use, overuse, misuse or abuse of such natural resources is a flow towards the welfare of society. Since their use adds to the welfare and abuse reduces it, their valuation and accounting on the lines of capital formation is necessary to understand the state of welfare of the nation. Forests have very high resource inter connection & the dynamics of an economic system is heavily dependent existence or non-existence of forests. Such resource inter-connections in the form of initial system shock due to forest degradation & its impact there of are shown in Figure.1.The diagram also depicts that forests have high co-efficient of forward linkages which may be negative in case of degradation of forest and positive in case of their protection.

Figure: 1 Forest Resource Inter-connections



△H = Change in Health ; △Q = Change in Quantity

Source: *Environmental & Natural Resource Economics*, David Pearce

1.3 Status of Recognition of Multiple Contributions of Forest

To achieve optimal use of forests, policy makers and stakeholders including the public at large need to be informed about the environmental, social and financial values of forests. The most important of all information is the economic value of forests in their own perspective. Estimation of such values specially the intangibles ones is essential to justify the positive impacts of forestry projects and programs not only on the local economy but also on the regional and global economies. It will also greatly help the policy makers in taking appropriate decisions regarding conversion of forests for non forestry purposes and to assess if the logging or other uses increase or decrease the intangible benefits. Further valuation shall facilitate policy makers to find ways to improve the funding from union and possibly international bodies for forestry sector so as to achieve sustainable forest management. However absence of such valuation process , the real worth of forests and the benefits that they provide is not understood properly and which becomes a major hurdle to practice sustainable forestry. Establishing a precise value on forest resources is an important step in incorporating the costs and benefits of using such resources into the conventional calculus of economic decision making. Once such valuation is complete, the projects and policies must be redesigned in order to reduce their negative impacts and improve their positive impacts and to shift the development process toward a more sustainable path.

The forests in India are also facing similar situations where the policies have failed to recognize the role of forests in socio-economic, ecological and cultural development of the state. The multi-sectoral contributions of forests have not been recognized on account of which the sector continues to receive little attention in the financial allocation over the plan periods. The forests and the people and sectors who depend upon them are facing increasing types and rates of change. There are multiple uses of forests by multiple stakeholders. Though there has been increasing pressure on forests but there has been little commensurate change in the policy and institutional framework to handle such pressures. There is an urgent need to evolve a multi-sectoral integrated strategy such that the need of various sectors and stakeholders can be met through sustainable management of forest resources and the contribution of the forestry sector of various states are recognized not only in the local economy but also in regional, national and global perspective.

1.4 Current Contribution of Forests in GDP of India

On account of non recording of multiple value and multisectoral contribution of forests , Despite making considerable contribution in India's economic and ecological systems, the forests of the country do not get proper recognition of their contribution in the national income (GNP) of the country. The value of forest reflected in the System of National Accounts (SNA) represents less than 10 % of the real value. In 2002-03, forests contributed Rs. 27013 crore to India’s GDP at the current prices, which was 1.2% of the GDP. The contribution of forest to India’s GDP has varied from 1.0 to 1.5 % over the nine year period from 1993-94 to 2002-03. Similarly the contribution of forestry and logging to India’s Net Domestic Product (NDP) also varied from 1.6% to 1.3% during the same period. The yearwise contribution to GDP and NDP is shown in Table 1 and 2.

Table 1: Contribution of Forestry and Logging to Gross Domestic Products (GDP) at Current Prices and 1993-1994 Prices in India

Year	Current prices			1993-1994 prices		
	Total GDP (Rs. Crore)	Contribution of forestry (Rs. Crore)	%	Total GDP (Rs. Crore)	Contribution of forestry (Rs. Crore)	%
1993-94	781345	11454	1.5	784513	11454	1.5
1995-96	1073271	13390	1.2	899563	11701	1.3
1996-97	1243546	14493	1.2	970083	11865	1.2
1997-98	1390148	16249	1.2	1016595	12114	1.2
1998-99	1598127	17840	1.1	1082748	12301	1.1
1999-00	1761838	19555	1.1	1148368	12753	1.1
2000-01	1902998	22422	1.2	1198592	13064	1.1
2001-02	2090957	24341	1.2	1267833	13244	1.0
2002-03	2249493	27013	1.2	1318321	13573	1.0

(Source: CSO, 2004)

Table 2: Contribution of forestry land logging to Net Domestic Products (NDP) at current prices and 1993-1994 prices in India.

Year	Current prices		1993-94 prices			
	Total NDP (Rs. Crore)	Contribution of forestry (Rs. Crore)	%	Total NDP (Rs. Crore)	Contribution of forestry (Rs. Crore)	%
1993-94	697992	11166	1.6	697992	11166	1.6
1995-96	955345	12999	1.4	800411	11392	1.4
1996-97	1107043	14042	1.3	862808	11546	1.3
1997-98	1238151	15736	1.2	901735	11785	1.3
1998-99	1430061	17260	1.2	960555	11960	1.2
1999-00	1579497	18919	1.2	1019297	12400	1.2
2000-01	1705103	21762	1.3	1062492	12702	1.2
2001-02	1873203	23629	1.3	1125286	12870	1.1
2002-03	2014450	26267	1.3	1168224	13194	1.1

(Source: CSO, 2004)

The current approach for accounting of forestry sector contribution to GDP grossly underestimates its contribution to the national economy as many tangible benefits are underestimated though some thumb rules have been used by CSO to consider value of unrecorded tangible benefits like timber, fuelwood and fodder. But ecological services are completely ignored on account of lack of markets available for them. Doing total economic valuation makes sense to as to provide the sector its due recognition and to receive adequate compensation in case of conversion or degradation of forest.

1.5 True Value of Forests including the Unrecorded Values of Forests

The economic value of a natural resource as natural capital or asset can be defined as the sum of the discounted present values of the flows of all goods and services from the resource. The economic concept of value is based on a premise of neoclassical welfare economics that the purpose of an economic activity is to increase the well being of the individuals, who constitute the society and that each individual is the best judge of what is “good” or “bad” for him or her. The basis for estimating economic value of a resource or an environmental amenity is its probable effect on human welfare. However, the anthropocentric focus of economic valuation does not preclude a concern for the survival and well being of other species of the ecosystem. People do value other species not only because of their direct utility to them but also because of altruistic or ethical concerns. The estimation of the economic values of natural resources and environmental amenities and services is necessary as there are no markets for most of them and as there are externalities in their use. Such values would help in determining the trade off between economic development and quality of environment and determining the extent of financial liability of firms and households, who degrade natural resources and pollute the environment. Further it helps in preparing green national accounts, i.e., accounts that incorporate national income accounts the benefits and costs of natural resources and environmental amenities and services.

On account of absence of any framework for estimation of such values, the present system of income accounting in forestry sector only takes note of contributions such as industrial wood, fuel wood and minor forest products, that too the recorded removals are accounted for, which are small portion of actual removals but no valuation and accounting is done for unrecorded tangible values and the whole stream of intangible values i.e. ecological services from forests. In India, forests meet nearly 40% of the energy needs of the country of which more than 80% is utilized in the rural areas, and about 30% of fodder needs of the cattle population. Forests products also play very important role in rural and tribal economy as many of the Non-Wood Forest Products (NWFP) provide sustenance to the rural poor. For landless families and marginal farmers forest related activities often represent the primary source of income. It is estimated that about 270 million tonnes of fuelwood, 280 million tonnes of fodder, over 12 million cmt of timber and countless non-wood forest products are removed from forests annually. At a conservative level of pricing (Rs. 500 per tonne of fuel/fodder) the value of these commodities will approximately aggregate to over Rs. 300,000 million per annuam. (MoEF, 1999).

More importantly the scores of other goods and services from forest such as watershed benefits, eco-tourism, C-sequestration and other eco-system services are not at all taken into account. Similarly on cost side the degradation and depletion of these sources is also ignored. If all such direct and indirect contributions from Indian forests are quantified, the standing forests of India would be worth Rs.59,20,190.2 crores (DTE, 2005). As a matter of fact, in the Current System of National Economic Account there exists insufficient accounting of tangible benefits, non-recording of intangible benefits, non- recording of illegal removal of forest produce, insufficient recording of authorized removals from the forests and insufficient recording of losses in the forests. Above all there is lack of system of Flow and Stock Accounting systems. For reflecting true contribution of forest of India in its National Income such that proper budget allocation can be done in relation to its contribution, it is imperative to value such contributions and set up an integrated System of Economic and Environmental Accounting of forests of India.

A study done by Verma (2000) for the state of Himachal Pradesh provides ample evidence of gross underestimation of such contributions in the State Domestic Product.

Table 3. Physical and Monetary Contributions of Forests in Himachal Pradesh (1999-2000)

Economic Value of Direct and Indirect Benefits		
	Physical value	Monetary value (Rs. crores)
Total growing stock	10.25 crore m3	40860
I. Direct Benefits		
A. Direct Consumptive benefits		
1.Salvage	3.50 lakhs m^3	32.00
2.Timber for right holders	1.06 lakhs m^3	60.00
3. Fuel wood	27.60 lakh tonnes	276.00
4.Fodder	92.0 lakh tonnes	690.00
5.Minor forest produce	1161.56 tonnes	25.00
Total Direct consumptive benefits		1083.00
B. Direct Non Consumptive Benefits		
6.Ecotourism	66.56 lakh - Tourists	6657
Total Direct Benefits(A+B)		7740

II. Indirect Benefits		
7.Watershed	6.77crore m3 - Growing stock in river Basin Forest Circle and 36986 km2 - entire forest area	73972
8.Microclimatic factors	969018 Households	145
9.Carbon Sink	14346 km2 - Area under tree cover and scrub forest	17645
10.Biodiversity/ Endangered Species	8966- Total no. of species found in Himachal Pradesh & 125 - Endangered species	7137
11.Employment Generation	48.40 lakh man days	25
Total Indirect Benefits (7+11)		98924
Total Economic Value(I+II)		106664

- It is evident from the table that except for some contribution by way of salvage removals, TD Rights and MFPS, all values go totally unaccounted despite having enormous monetary worth.
- The watershed values contribute the most (69%) followed by carbon sink values (16%).
- When TEV in terms of Rs/Hectare contribution of forests is calculated for the legal forest area (36,986 km2) it stands at Rs. 2.89 lakhs whereas for the actual forest cover (143, 46 km2) it approximates to Rs. 7.43 lakhs. If we take the contribution only in terms of intangibles, it stands Rs. 6.90 lakhs as against Rs. 53 thousand per hectare for direct values for actual forest cover and Rs. 2.89 lakhs as against Rs. 21 thousand for direct values for legal forests.
- The total contribution of forests amounts to Rs. 106664 crores but what is accounted is only Rs. 41 crores by way of revenue realized by the department. The total economic value so generated is compared with the value of the growing stock, total expenditure incurred on forests (Annual Budget) and the revenue realised from forests as per the following table.

Table 4. Contribution of Forests Vs Investments in Himachal Pradesh(1999-2000)

Forest Resource Contribution vs. Investment(Rs Crores)	
1. Value of Growing Stock	40860
2. Total Economic Value of Forests	106664
3. Total Expenditure incurred in forest (Annual Budget)	109
4. Revenue realised by forests	41
Contribution of Forests to the GSDP	
1. Total GSDP	9258
2. Forestry as logging	487
3. Forestry as % of GSDP	5.26
4. Total Economic Value of Forests (as per current estimation)	106664
5. Corrected GSDP	115434
6. Forestry as % of corrected GSDP	92.40

The table finds that total economic value is 2.61 times the value of the growing stock, 980 times the total expenditure incurred in the forestry sector of Himachal Pradesh and 2607 times the revenue realized by the forests annually. This comparison proves gross underestimation of forestry sector's contribution in the economy of the State. When the GSDP of the State is corrected for total economic value calculated through the current study the contribution of forestry sector increases from 5.26% of GSDP to 92.40 % of GSDP.

The framework adopted in the above study could be adopted for the Indian economy as a whole to reflect the monetary value of contributions and the opening and closing stock model would be useful to assess the net changes in the current year.

Similarly another study relating to the contribution of forests to GDP of the country by Chopra *et.al* (2002) provides an estimate of net contribution of some ecological values to the GDP of the country (Box 1).

BOX 1: **Contribution of Forests to GDP in India**

A study done by Kanchan Chopra, Pushpam Kumar and BB Bhattacharya, Institute of Economic Growth, New Delhi (2002), India estimated the value of goods and services provided by the forestry sector in India to be in the tune of Rs. 25984.53 Crores. Net of repairs, maintenance and other operational costs, the gross domestic product from the forestry sector came to Rs. 23003.43 Crores. Of the gross value, some 52.21% was output of fuel wood, 9.27 % was industrial wood, 15.91% was NTFP and eco-tourism and carbon sequestration contributed 13.85% and 6.76% respectively.
This increase in domestic product from forestry is 93.87% of the CSO reported product of Rs. 11,865 Crores for 1996-97. As a percentage of GDP at market prices, the forestry sector contributed 2.37% (1996-97 GDP at 1993-94 prices) instead of 1.2 as earlier for the same year reference.

The estimation of Gross Value Added from the “Forestry and Logging” sector in India is presently carried out by the production approach. It aims at estimating the value of output at factor cost in the first instance and then deducting the value of various inputs at purchaser’s prices. The economic activities included in the present system are as follows:

- Forestry (eg. Planting and conservation of forests, gathering of forest products, charcoal burning carried out in the forests)
- Logging (eg. Felling and rough cutting of trees, hewing or rough shaping of poles, blocks etc.) and transportation of the forest products to the sales depot /assembly centers and
- Farm-yard wood (industrial wood and fuel wood collected by the primary producers from trees outside regular forests).

The forest products are being classified into the following broad groups viz.

- Major products comprising industrial wood (timber, round-wood, match and pulp wood) and fuel wood (fire wood and charcoal wood) and
- Minor products comprising a large number of heterogeneous items such as bamboo, fodder, lac, sandal wood, honey , resin gum , tendu leaves etc.).

The collection of data related to such activities, outturn of products and prices thereof is done by Central Statistical Organization, MOSPI, GOI, from the state forest departments on a financial year basis.
A serious limitation of such out-turn data is that they represent only authorized exploited forest resources and a substantial quantity of production goes unrecorded. This usually comprises of

- Unrecorded and unauthorized removals of timber and firewood from reserved /protected forests and
- Unrecorded production from private owned forests and non-traditional forest areas (trees in village commons, field ridges, canal sides, road sides, fruit trees no longer productive etc.).

Central Statistical Organization, the agency responsible for computing and developing the National Accounts for the country, uses a norm of 10% of recorded production for estimating the value of unrecorded production from all the states of the country. This norm was based on a timber trend study done way back in 1957-58. A revision done for unrecorded fuel-wood production now base itself on household consumption of fuel-wood as recorded by NSSO Surveys.

Being an unorganized sector for the most part, reliable data on other non-wood /minor forest produces (MFP) are usually not available. In many of the states only the royalty value realized by the state-trading agency for the MFP are available, which seldom reflects the economic value of the products. Types of minor forest produce often run into several hundreds, given the rich bio-diversity of the country and the strong user base of such products, both nationally and internationally. The market chain for such products is also very complex and the open market price movement difficult to track.

The current data available from the states on production and prices suffer from other limitations as well. One of the significant is the non-availability of species wise production and prices. Forest timber in the country has a lot of variability with regard to their quality and the prices even vary within the same species. Depending upon climatic and other factors, trees belonging to the same species may belong to different quality classes.

1.7 Major Limitations of Existing System of Forest Resource Accounting

1. Underestimation of True Contribution of Forests

Benefits from forests to the national economy are at presently grossly underestimated with the result that the actual benefits are several times higher than those reported and incorporated in the national income accounts. For example, it has been estimated that the value of forest reflected in the System of National Accounts (SNA) represents less than 10 % of the real value. The under valuation of material goods alone from the forests of India is reflected in their estimated (real) value of about US $ 43.8 billion, compared to forestry recorded share of GNP of US$ 2.9 billion, representing only about 1.3 % of the total GNP. The difference (between the estimated and recorded contributions) will increase further if an imputed value is assigned for the environmental contribution of the forests to the society, mostly in terms of ecological services provided.

2. Inadequacy of the System of National Accounts

With regard to forestry, the System of National Accounts (SNA), which India also follows currently, has treated cultivated forests and natural forests quite differently. For cultivated forests, the SNA records both production and changes in the forest stock so that consequences of depletion or re/afforestation are accounted for (though how much of this is followed in India is debatable and could be a subject of a study). For natural forests, however, the SNA records only the income from logging, but not changes in natural forest stocks. This can result in quite misleading economic signals: income from over exploitation would be recorded as part of GDP, but the corresponding depletion of the forests stocks (the economic equivalent of depreciation) would not be recorded. Similarly the benefits from afforestation would not be recorded as capital formation. More importantly, both cultivated and natural forests provide non-marketed (timber and non-timber) products that are often not included in the national accounts, although they are extremely crucial to rural livelihoods, at least in the Indian context (though this is mainly because of measurement difficulties in most countries, since SNA does include such products).

3. Non-cognizance of Intermediate and Environmental Services

Most of the non-marketed services from forests, on the other hand, are either omitted or wrongly attributed to other sectors of the economy. Forests services provide intermediate inputs to other sectors such as livestock grazing, agriculture and tourism, but the value of these services is not recognized and hence, is attributed to the using sector, not to forestry. Ecosystem services such as watershed protection and carbon storage may not be represented at all. Thus the total benefits from forestry are being under-estimated, and other sectors of the economy are not fully aware of their dependence on healthy forests.

Above all the present system of recording a single figure by the state forest department for volume and price prevents realistic assessment of forest assets whereas the production and price data should be maintained not only species wise but also quality/class wise for the same species. Recognizing the need for a realistic valuation of forest benefits and costs, an appropriate accounting framework for integrating Forest Resource Accounts (FRA) into the National Income Accounts (NIA), is needed. It will provide better understanding of the full range of goods and services supplied by the forests which is essential for the optimal utilization of forests, and may provide an economic rationale for sustainable forestry.

Forest stakeholders the world over are considering the transition to sustainable forest management (SFM). Two related constraints on moving towards SFM are the high cost of information production and usage, and the gap between current practices and SFM. Forest resource accounting helps to keep down the costs of information usage by focusing on what is essential only-i.e. the information which is required to set, achieve and review forest policy and management goals. This helps bridge the gap between current and improved practices in a step- by step manner, practical manner. A well developed FRA system would be base for many decision making and policy objectives.

2. Comprehensive System of Forestry Resource Accounting (FRA)

2.1 System of Environmental and Economic Accounting (SEEA) Framework

Improvements in methods of existing System of national accounts (SNA) were debated in 1992 during UNCED held at Rio de Janeiro, which recommended the System of Integrated Environmental and Economic Accounting (IEEA). UN Statistical Division in 1993 suggested a satellite system of environmental and economic accounting (SEEA) showing environmental related sectoral activities along with their physical accounts of flow changes, valuation and links to the main SNA (Figure 2).

Figure 2 :Satellite System of Integrated Environmental and Economic Accounting(SEEA)

Core System	Satellite Systems		
System of National Accounts (SNA)	Environment-related disaggregation of conventional national accounts	Additional valuation of the economic use of the environment	Framework for the Development of Environmental Statistics (FDES)
Description of economic activities	**Physical data on environment**al economic interrelationships	**Extension of the product**ion boundary of the SNA	Description of the environment and interacting socio-demographic and economic activities.

Source: SEEA, 1993

2.2 Scope of Forest Resource Accounting (FRA)

2.2.1 Provisioning Function of FRA

FRA provide a realistic estimate of the contribution of forest in the GDP of the economy and since the budgetary allocation in India is nearly following the *quid pro quo* technique of budgetary allocation in relation to contribution to GDP, states with large geographical areas under forests like M.P., H.P. Arunancahl Pradesh, Uttaranchal, Chattisgarh etc. could make a strong case for higher budgetary allocation for their forestry sector so as to promote sustainable development. Else the states will always face resource crunch in the forestry sector. Further the communities conserving forests like JFM committees will also have sustained interest in investing in this natural capital. When the contributions shall get recorded through a system of FRA, the contributing stakeholders can also be identified and this would help setting up a compensation/payment /incentive based mechanism to such conservationists. The logic has already been accepted by the Planning commission and other fund allocation agencies and as per the recent development an amount of Rs. 1000/- (On thousand crores) has been allocated from the centre for distribution amongst the states conserving large areas under forests. If a regular system of FRA is established, it will further help in such budgetary allocations leading to improved management of India's forests.

India in fact could learn a lesson from Brazil and consider levying an ecological value added tax to compensate for the loss of revenue to those States, which have done a good job of protecting their forests. The Planning Commission has accepted the logic of this argument and may soon initiate the necessary action in this direction. In Brazil, the tax lived by most states in 1992 has worked wonders. The tax proceeds are used to compensate those municipalities, which have large conservation areas. India has to follow this kind of strategy for motivating the State

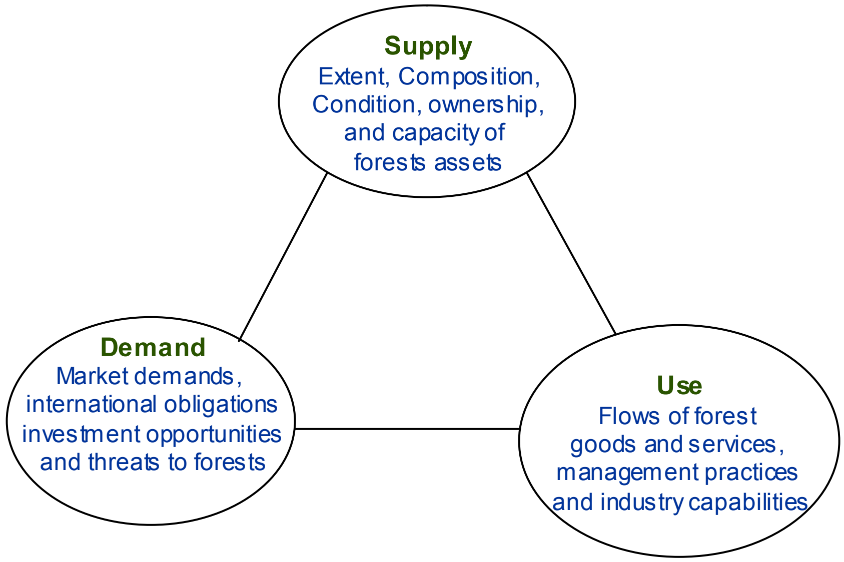
Governments to protect and enhance the area under tree plantation and forests (Mago, 2003). To adopt such a model, a strong political will is a must at the state and national levels to formulate an appropriate policy for the purpose and for is successful implementation.

2.2.2 Driving Forces of FRA

As per IIED and WCMC policy paper , 1996 the reasons for developing the system of FRA could be many such as

(a) Cost-effective information and monitoring : like other production factors, information is expensive and should be produced for specific policy and management objectives only.
(b) Participatory policy development : in almost all cases the participation of a broad range of stakeholders is central to the success of forest policy development. Participation facilitates trust, cooperation and information sharing, which are essential for the long term welfare of forests.
(c) Continuous improvement of information and monitoring (leading to continuous improvement of policy and management performance) small steps are advocated, resulting in the achievement of larger goals over time, constant re-examination of infrastructure, human resources and working practices is necessary to ensure the highest performance.
The key information areas and FRA cycle and typical FRA products are depicted in the following figures 3 & 4:

THE FRA APPROACH - Key Information Areas



2.2.3 Beneficiaries of FRA

The FRA so developed could be of immense use to national and state legislatures, natural resource management agencies, forest owners and concessionaires, forest industry and trade groups, local communities dependent on forests and supporting NGOs, international fora, secretariat to conventions and donor agencies etc.(IIED, WCMC, 1996). Depending on need, the particular FRA 'products' selected for a given location may contain State-of-the forests Report (baseline data and maps selected criteria and indicators),Balance sheet of forest stocks and flows (including non-timber forest products), Concession monitoring and forest investment programme, Forest valuation (national or forest unit level), Audits of forest management (by different stakeholders) and administration, Forest sustainability assessment (according to national standards/ international principles) , Country level forest management certification etc. FRA can also play a key role in cross-sectoral initiatives such as land capability information system, national environmental management system, national biodiversity database and national resource accounts (monetary or physical).

2.3 Functional FRA Framework

2.3.1 Initial Framework

The typical FRA exercise accounts for forest land and related ecosystems, biological assets in the forest and other assets related to forests.

(i) Land

Forest land is explicitly distinguished as a land category. SEEA Forest land classification includes Non- exploitable virgin forests, whereas they are not included in SNA. SEEA clearly distinguishes economic forest land (Cultivated and Uncultivated) from Non- Economic (Environmental) Forest land

Cultivated economic forest land corresponds to land over which ownership rights are enforced, and for which natural growth and/or regeneration of timber and other biological assets is under the direct control, management and responsibility of institutional units and is likely to produce economic benefits to the owner of the land (SEEA, 2003).

Uncultivated economic forest land is similar to the Cultivated Economic Forest land but for which the natural growth and/or regeneration is not under the direct control, management and responsibility of institutional units, although growth and regeneration are likely to produce economic benefits to the owner of the land. Non- Economic Forest land (Environmental) covers land of both protected and non-exploitable forests.

(ii) Ecosystem:

Forest land, regardless of its classification may be categorized according to the associated ecosystems and can be further classified according to its state or management objectives.

(iii) Biological resources

Biological resources include timber resources, crop and plant resources, aquatic resources and animal resources other than aquatic that brings use benefits today or that may do so in future. Each category of biological resource is again subdivided into cultivated and non-cultivated sub categories.

(iv) Other assets

Other assets related to forests include: produced assets such as forest roads and other structures, non-residential buildings, equipment for forestry and logging industries, accommodation for tourists or visitors.

There are two features that distinguish the SEEA from other database about the environment:

- Integration of environmental data with economic accounts, and
- Comprehensive treatment of all important natural resources linking them with the economic sectors that rely on them, and those sectors that affects them.

2.3.2 Physical Accounting of Forest Resources

Environment statistics attempt to compile raw data from multiple sources, and present them in a coordinated manner; they can be further aggregated and presented in the form of stocks and flows in physical terms in the form of following major Accounts which is the objective of natural resource accounting.

- **Asset accounts record stocks & changes in stocks** of natural resources over time. Forest asset account typically includes balance account for forest land & stocks of standing timber, accounts to record forest health are also included.

- **Forest flow accounts, include supply & use tables** for detailed forest products (wood &non wood, marketed & non-marketed) by sector, which are linked to the input output (IO) tables & social accounting matrices (SAMs) used in economic models. Forest flow accounts also include measures of forest ecosystem services, environmental degradation associated with forest use.
- **Environmental protection & resource management expenditures accounts** identify expenditure undertaken by public & private sectors to manage resources & protect environment.
- **Environmentally adjusted aggregates** include commonly used indicators of macroeconomic performances than have been adjusted to better reflect sustainability. For this component of the SEEA, forestry accounts provide the addition to GDP of unvalued forest goods & services, the subtraction from NDP of economic cost of deforestation or loss of forest service due to change in management.

The methodological framework and its parameters for FRA used in this study are given in the following Box 3.

Box 3: Components of the Forest Resource Accounts:

1: Forest related asset accounts **Wooded land:** Land area & economic value by main species, natural &cultivated forest land, available for wood supply/ not available, etc. **Standing timber: V**olume & monetary value of the main sp., natural &cultivated forest land, available for wood supply or not available, etc. Depletion & depreciation of standing timber.
2: Flow accounts: Forest goods & services(volume & economic value) **Forestry & logging products:** Market & non market production **Non timber products:** Output of game, edible plants, medicinal plants, etc. **Forest services:** Direct intermediate inputs to other sectors, e.g. 1. Livestock grazing 2. Recreation & tourism 3. Carbon sequestration 4. Protective services: 5. Biodiversity & habitat preservation 6. Protective services **Supply & use tables for wood products, forestry & related industries** **Degradation of forests** due to forestry & non forestry activities, such as defoliation **Environmental degradation** cause by forest related activities
3:E**xpenditure on forests management & protection** Government expenditures Private Sector expenditures
4:Macroeconomic aggregates Value of forest depletion & degradation Measures of national wealth, national savings & net domestic product adjusted for forest depletion / accumulation.

5. Memorandum items:
Employment , income, exports from non timber goods & services
Number of household dependent on NTFPs.
Rights of forest exploitation
Stumpage fees & other taxes / subsidies for forestry & related industries
Manufactured assets like roads. Buildings & equipment for forestry, logging.
Tourism & other uses of forestry.

Source SEEA 2003

According to SEEA, in principle wooded land and standing timber should be treated as separate assets. Various components of SEEA for forest resources are explained below:

(i) **Wooded land:** Ideally, the value of forestland is based on the market value of the bare land that is revealed through sales of land. Where data are not available, the SEEA recommends that land value to be estimated based on the basis of tax values, or other administrative data, or as share of the market value for forest estates (land & standing timber combined).

(ii) **Standing timber:** Timber asset value is the discounted future stumpage price of mature timber after deducting the cost of bringing the timber to maturity. The stumpage price is the price paid to the owner of the forest for standing timber , or in the absence of such markets, the stumpage value can be estimated by deducting the cost of logging & transportation from the price received for raw wood, costs include thinning (net of any income), other forest management costs & rent on forest land.

Although conceptually preferred, Euro stat found the present value approach to standing timber to be complicated & required a great deal of data. Consequently, the stumpage value approach was recommended**.**

(iii) **Non Timber Forest Product (NTFP) :** Traded informally in scattered markets poses practical and even some theoretical problems related to validity of any such valuation exercises (refer FAO Forestry Paper 127 – Valuing Forests: issues and guidelines) Hence, valuing forest products for subsistence use has been done indirectly using surrogate prices.

(iv) **Environmental Protection Services:** Because of the difficulty in establishing the level of services provided by a forest and the change resulting from a given change in forest use, the SEEA-2003 and the Euro stat framework makes no recommendations regarding valuation of these protective services.

(v) **Valuation of Deforestation and Forest Degradation** There are two alternative approaches; one approach applies the stumpage value to the excess of felling over natural growth. The other approach measures the difference in asset value from the beginning to the end of the period. The latter approach takes into account both excess of felling over natural growth as well as change in stumpage value during the period that affects asset value.

The European pilot Programme does not recommend monetary estimates of the cost of deforestation or defoliation. The SEEA –2003 provides two different conceptual approaches to valuing degradation: the maintenance cost approach & the damage cost approach. The revised SEEA-2003 proposes a concept of depletion cost more consistent with economic depreciation: the change in asset value from one period to the next. Calculating the cost of degradation relies on good data linking the physical status of a forest and the services it provides.

2.4 Proposed FRA Framework and Methodology

2.4.1 Framework

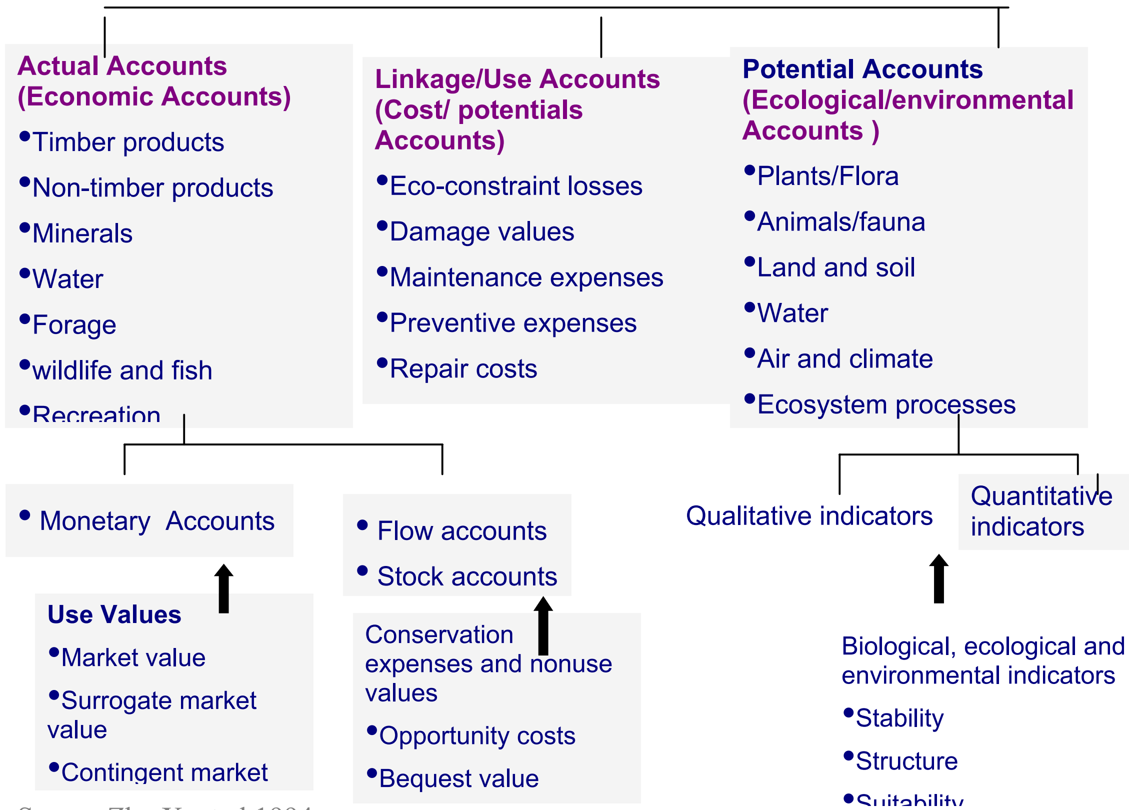
A typical resource accounting exercise for the forestry sector would take into account the existing system of recording of the stocks and flows, and then try to create linkage with potential accounts. This is done usually by either expanding the assets boundary or by accounting for implicit depletion/degradation of assets which were not done before. The system of Forest Resource Accounting proposed by Xhu et al talks on the concepts of Actual accounts, Linkage accounts and Potential accounts has been adopted particularly in respect of parameters indicated in Figure in the next page.

(i) Actual capacity accounts measures the flow of Goods and services flowing from the forest ecosystem to the Economy currently. These flow can be assessed by the construction of Asset Accounts both Physical and Monetary asset accounts.

(ii) Potential capacity accounts records the various Ecosystem features which determines both the Actual Capacity and Potential flow of benefits of those features, based on various Ecosystem quality indices.

(iii) Linkage Accounts tries to link together the Actual Capacity Accounts and Potential Capacity Accounts, and consists of estimates of costs of various ecological imperatives required to maintain some Ecological indicators at specified level or to avoid losses in flow of future goods and services (Potential benefits)

Fig 5 : A Proposed System of Forest Resource



Source:Zhu X. et al 1994

Valuing depletion and degradation within a national accounting framework is a viable proposition today, as a result of significant progress in valuation techniques for environmental resources and as a result of the expanding foundation that theoretical developments are placing under the methods of "green" national accounting (Hamilton, 2002). But the very complexity of forest –economy and land-economy interactions, especially in a country like India, makes forest and land related adjustments prone to error, if not guided by economic theory as well as complete set of relevant and reliable data to support the assumptions of such theories. The SEEA proposes a framework of creating and linking a system of satellite environmental accounts to the national income accounts which this study has adopted.

One of the major lacunae in the present system of accounting for the contribution of the "forestry and logging" in the national income accounts is the high degree of underestimation that riddles the computation. One of the major reasons for this is the fact that a varied type and amount of forest outturn is attributed to other sectors, mainly agriculture and livestock, fisheries and tourism. For example all forest food and food additives, forest grazing and fodder are reported under agriculture for most part. Non -wood construction materials (thatching materials, bamboo, grass, fibres, etc.) are estimated to be used by 250 million Indians living below the poverty line, with a value of 2500 million US Dollars (UN-CSD/IPF, 1996).

Forestland transferred to support development in other sectors like mining, irrigation, hydropower, surface transport etc. adds to the capital stock of these recipient sectors, while forestry hardly gets compensated for such transfers. Hence the major focus of the accounting exercise had been to rectify the imputation of zero cost to the consumption of the above mentioned resources.

2.4.2. Methodology

Asset accounts record stocks and changes in stocks of natural resources over time. Forest asset account typically includes balance account for forest land and stocks of standing timber.

The Forest related asset accounts can be of the following types, both in

Physical and ***Monetary*** terms:

Area Accounts (Wooded Land): Land area and economic value by main species, natural and cultivated forest land, available for wood supply/ not available, etc.

Volume Accounts (Standing timber): Volume and monetary value of the main sp., natural and cultivated forest land, available for wood supply or not available, etc., Depletion and depreciation of standing timber.

2.3.4 Sources of Information:

The following box 4 is the illustrative list of sources of information regarding the forestry sector and the data they maintain.

Box 4 : Data Agencies and Information Sets

Data Agencies	**Information**
Directorate of Economics & Statistics	Socio-economic development indicators Estimates of state domestic product Estimates of gross fixed capital formation Land use data List of available infrastructure facilities Production account of non departmental enterprises Estimates of mineral reserves Productivity of important reservoirs Catchment area of river basins List of monuments & protected areas
Watershed Mission	Information on project areas undertaken by them, investment and impacts.
Data Agencies	**Information**
Forest Department	Production figures of timber, bamboo and fuelwood for the past ten years for each division. Revenue –expenditure figures of the sector. Plantation and other development schemes related data. Division wise data from Working Plans related to annual requirements, yields, type of Management circles etc.
Forest Survey of India	State forest reports Estimates of fuel wood & fodder from forest Estimates of annual increment of forest stock
Wild life Institute of India	Details of protected areas
Indian Institute of Remote Sensing	Bio-diversity characterization of western Himalayas
Indian council of Forestry Research & Education	Different types of forestry related primary and secondary studies
National Sample Survey Organization	Estimates of operational land holdings Estimates of fuel-wood consumption Estimates of seasonal variations in operational land holdings.

Such varied and scattered sources make collection and collation a mammoth task. The task is not made easier by the fact that the format and time interval for data recording are greatly varied among agencies. It has often been found that even the data estimates for the same parameters sometimes vary, albeit by marginal amounts but still noticeable, between agencies. Substantial part of the data sets required for FRA is just not available. Usually, these gaps pertain to aspects of ecological services of land and forests, Increment values of timber of various species for at macro level, tourism benefits from forests, and exploitation and consumption figures of non-timber forest products. One of the most important reasons for their non-availability is the fact that recording of such data sets does not serve any immediate management objectives of the department/ agency concerned. Resource accounting has never been a priority at the regional, and even the national level. Though its well understood that some types of information can only be availed of from primary studies, these kinds of information usually supplements the secondary data sets during the process of making monetary entries in the system of accounts.

2.3.3. Construction of Physical Accounts

The framework adopted for constructing the volume and area accounts in physical terms is explained below.

Opening stocks: The opening stocks represent the growing stock of resources present at the beginning of the accounting period. For the present accounting the opening stock volume is taken as total growing stock of Himachal Pradesh as per as the estimates of Forest Survey of India (2005), For the area accounts the area under Forest cover as per as the State of Forest Report (SFR) 2003 is at the beginning of the accounting period is taken as the opening stock. Different forest strata in terms of volume and area are grouped into major categories based on the forest area by species composition as per state forest department estimates. The total legal extent of the forests in both the states is more than what is shown in the Accounts, since large areas un-culturable forest area, and water bodies has been excluded as hardly it is covered with any canopy cover.

Changes due to economic activity: Additions to the timber stock can originate from growth and regeneration of the initial stock and from reforestation and afforestation. Reductions can be classified into production (harvesting), natural degradation (fire, earthquake, etc.), and deforestation by man. SEEA has a separate category depletion, which includes only those losses of wooded land / timber that are due to economic activity. Depletion of timber includes felling that exceed net natural growth, but does not include loss of timber due to storms or fires. Depletion of forestland would refer to a permanent change in land use due to economic activity such as such as land use diversion for non forestry purposes, if forest land is degraded to the point where it no longer meets the definition of forested land (tree cover falls below 10%) then the land is reclassified.

Changes due to economic activity refer to human production activities such as logging /harvest, logging damage, illegal logging and afforestation that affect (decrease or increase) the stock of forests. The volume of Growing stock decreased due to logging is derived from the production statistics of timber. The total fuel-wood extracted from the state forest was estimated Based on NSSO 54th round Survey on Common Property resources in India. It was based on the NSSO estimate of fuel-wood collection from Government Forest (Table 14.1, Report no. 452, 1999), by all the Rural Households. The average quantity collected from the Government Forest was extrapolated for the current Number of Rural Households in the state collecting Fuel-wood. The Urban households were not used in the extrapolation of Fuel-wood collection from the government forest. This estimate of fuel-wood Extraction, hence obtained does not indicate the dependence of rural people on fuel-wood, which requires the estimate of quantity of fuel-wood consumed during the year. The total fuel-wood extracted (in tonnes) was converted in Cubic meters based on fuel-wood conversion factor (ICFRE 2003). The species wise breakup of timber as well as fuel-wood extraction was estimated based on the percentage composition of the respective species in the total growing stock.

Statistics on the Volume of timber cut illicitly and loss in revenue due to illicit logging is provided by the Ministry of Environment and Forest (2004), but as the figure seems to be very low, may be all the cases of illegal logging are not reported. Therefore for the estimation of illegal logging the Central Statistical Organization (CSO), norm of 10 percent of the total recorded production of timber is used for the state for Himachal Pradesh. For the state of Madhya Pradesh records are available with the state forest department pertaining to number of stumps felled illegally. The numbers of stumps were converted into illegally felled volume based on the average volume of stumps as obtained by FSI (2005) during estimation of volume of tree outside forest in Madhya Pradesh.

Area subjected to logging (Timber, Fuel-wood and Illegal) as included in the area accounts is not available and has been derived from the volume accounts by dividing the total volume harvested with the Average growing stock per square km of the respective species.

The volume additions due to afforestation are arrived by multiplying the total afforested area with the mean annual increment per square kilometer, of the respective species.

Other volume changes

Other volume changes comprise additions to stock (due to natural growth and regeneration) and reductions (due to stand mortality, insect infestations, forest fires and natural calamities). The mean annual increment of different species is estimated based on Von Mentals' formula[7] . Volume added due to regeneration is computed by multiplying the area regenerated with the Mean Annual Increment (MAI) per sq. km of respective species. The area for area regenerated and afforested has been obtained from the records of state forest departments and the respective breakup of species wise area has been obtained based on species wise forest composition of the state.

The State forest Department statistics (Madhya Pradesh and Himachal Pradesh) reveal that there is no Loss of Growing Stock due to forest Fire, except ground vegetation. Therefore the volume of forest stock affected by fire is derived by multiplying the naturally regenerated volume and the afforested volume with the Extent of area affected by the fire. There is no instances of attack of insects and pests in the accounting Year. The area opened for Grazing throughout the year as per as the State forest Department records is considered to be under heavy grazing. The extent of forest area under forest cover from the total area under heavy Grazing was

[7] Average rotation age taken from FSI 1995

obtained by the proportion of forest area under forest cover and the forest blank of the state's total recorded forest area. The volume lost due to grazing is derived by multiplying the naturally regenerated volume with the extent of forest area with forest cover subject to heavy grazing.

Other accumulations:

Other accumulations indicate the Diversion of forestland for non-forestry purposes (e.g. for agriculture, industrial, irrigation purposes) and encroachment. The extent of Forest area diverted was provided by the state Forest Department. There is no information on, whether the area diverted was under forest cover or was forest blank and the extent of growing stock loss due to Diversion. The extent of forest area under forest cover from the total area diverted was obtained by the proportion of forest area under forest cover and the forest blank of the state's total recorded forest area. The species wise break up the total forest area transferred for non forestry purposes has been obtained based on the percentage composition of forest cover area of respective species. The volume reductions due to such transfers are derived by multiplying the area transferred with the growing stock per sq. km. The annual forest area encroached is derived by dividing the cumulative area encroached since 1980 till 2004 by 24 (1980-2004). Then the volume loss due to encroachment has been assessed in a similar manner to forest area diverted. The area diverted has been treated has permanent loss to the forest area, but though encroached land is though not serving the purpose of forestry, but it hasn't been treated as loss to forest land, till it is legally settlement is reached.

Closing stock:

The closing stocks are computed as opening stocks less reductions plus additions. In practice, closing stocks are the actual stocks available at the end of the period and any difference in the computed and the actual stock are accounted as statistical discrepancy.

3. Forests of Selected States of Himachal Pradesh and Madhya Pradesh

3.1 Overview

Table 5 : Overview of Forests

Details	Himachal Pradesh	Madhya Pradesh
Per cent of India's forests	**2.126**	**11.44**
Per cent of India's dense forests	**2.5**	**10.65**
Per cent of state's geographical areas	**25.8**	**30.2**

3.2 Forest Stock of H.P.

The Forests of Himachal Pradesh known for their grandeur and majesty are like a green pearl in the Himalayan crown. This life supporting systems are presently under great stress due to impact of modern civilization, economic development and growth in human and cattle population. Endowed with natural beauty, this Himalayan State has a geographic area of 55,673 Km^2 (1.7 percent of country's geographic area). The human population of the state is 6.08 million, of which 54.8 million is rural and 6 million is urban (Census 2001). Many large rivers (the Chenab, the Ravi, the Beas, the Sutlej and the Yamuna) flow through the state having a relatively thin population density of 109 people per sq. km. According to Livestock Census 1992, the total livestock population of the state is 5.11 million (DES 2002-03) which is 1.1 percent of country's total livestock population. The state ranks 5th among all the states and Union Territories in respect of percentage of area recorded as forest area and the total recorded forest area is 37,033 Km^2 as per records of the Forest Department.

However as per FSI Report 2001, the total forest cover is 12,521 Km^2, out of which 10, 429 Km^2 is dense forest, 3,931 $Km^2$is open forest and 397 $Km^2$is tree cover. In addition to these it has scrub cover of 3,087 Km2. The state at present has 2 national parks and 32 wild life sanctuaries covering about 7103.4 Km^2 of area. The per capita forest cover availability is 0.24 hectares

According to latest Forest Department Statistics, HP, 2004, legally defined forests are classified into the following categories:

Table 6 : Legal Classification of Forests of HP

	Legal Status of Forest	Area (Km^2)	Percentage
1.	Reserved Forests	1896	5.1
2.	Demarcated Protected Forests	11400	30.8
3.	Un-demarcated Protected Forests	21643	58.4
4.	Unclassed Forests	977	2.7
5.	Others (managed by Forest Department	369	1.0
6.	Not managed by Forest Department.	748	2.0
	Total	37033	100

The forests of the State have been classified on an ecological basis as laid down by Champion and Seth, and can be broadly classified into Coniferous Forests and broad-leaved Forests. Distribution of various species follows fairly regular altitudinal stratification. The vegetation varies from Dry Scrub Forests at lower altitudes to Alpine Pastures at higher altitudes.

In between these two extremes, distinct vegetational zones of Mixed Deciduous Forests, Bamboo, Chil, Oaks, Deodar, Kail, Fir and Spruce, are found. The richness and diversity of our flora can be gauged from the fact that, out of total 45,000 species found in the country as many as 3,295 species (7.32%) are reported in the State. More than 95% of the species are endemic to Himachal Pradesh and characteristic of Western Himalayan flora, while about 5% (150 species) are exotic, introduced over the last 150 years.

Map 1 : Forests of HP (Source : SFR, 2005)

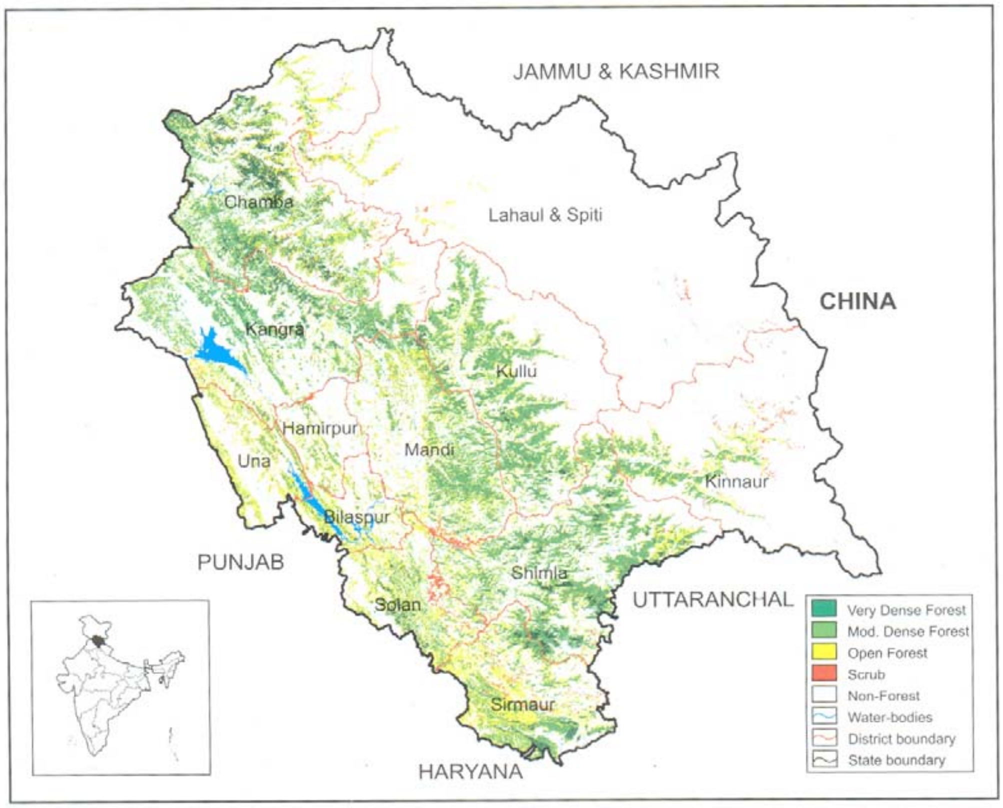
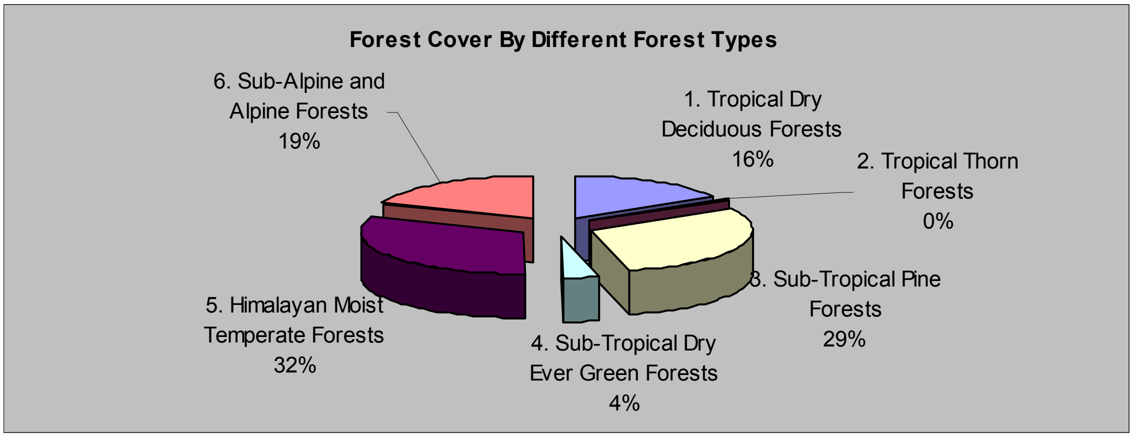


Figure 6: Area under Different Forest Types of HP

8



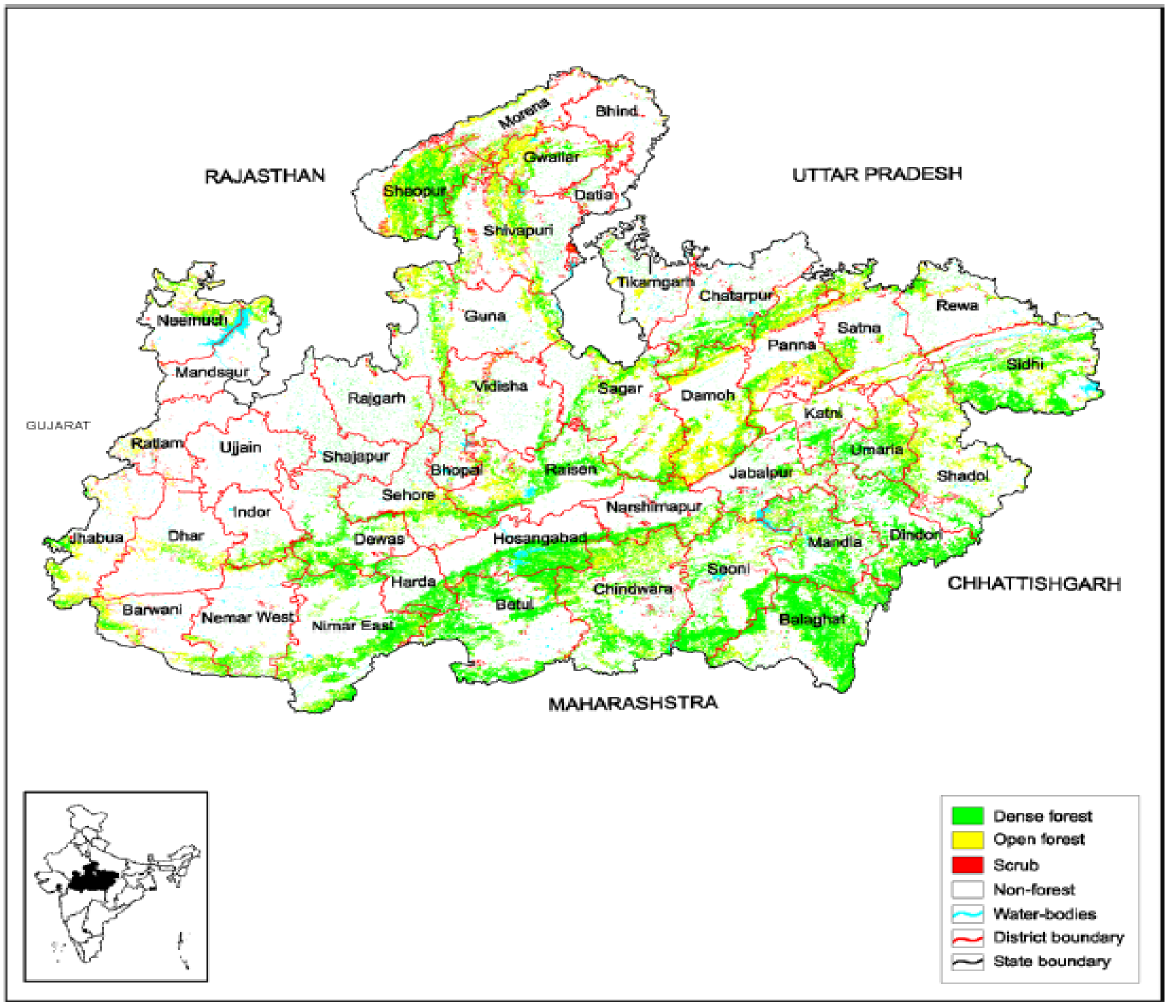
Total growing stock for the Year 2001 as estimated by the state forest department is 95,262,000 Cubic Metres based on that the annual prescribed yield from forests is 612000 Cubic Metres. At present the forests are not being looked as a source of revenue and sustained supply of raw material. Rather, the emphasis now is on protection and conservation of forests, environment and wild life

3.3 Forest Stock of Madhya Pradesh

There are four important forest types viz. Tropical Moist, Tropical Dry, Tropical Thorn, Subtropical broad-leaved Hill forests. Based on species composition, there are three important forest formations namely Teak forest, Sal forest and Miscellaneous Forests. Bamboo bearing areas are widely distributed in the state. To obviate pressure on the natural forests, plantations have been undertaken in forest and non-forest areas to supplement the availability of fuel wood, small timber, fodder etc.

The total forest area of the state is 95,221 sq. km constituting 31% of the geographical area of the state and 12.44% of the forest area of the country. According to the SFR 2001, it has a total forest cover and tree cover of 83,016 KM^2 of which 44,384 constitutes KM^2 dense forest, 32,881 KM^2 open forest, and 5,751 KM^2 of tree cover. In addition to these it has scrub forest of 3,452 KM^2.

[8] http://hpforest.nic.in/frst2.



Map 2 : Forests of M.P. (Source : SFR, 2005)

Per capita forest and tree cover availability is 0.14 hectares. About 40 percents of such forest areas grow economically important species like teak, Sal, Bamboo, Tendu tree (Diospyros melanoxylon) etc. The State, at present, has nine national parks and 25 sanctuaries covering about 10.80 thousand Sq. Km area, which has tremendous potential of earning economic benefits from nature tourism.

The total growing stock of the State is (volume of timber / wood) is 500 lakh cubic meter. The total revenue earned by the department from sale of timber, khair and bamboo was Rs. 510 crores in 2002-03, whereas it was Rs.287.55 crores in 2000-01. Tribal population constitutes 19.9 percent of the state's population, being away from the mainstream of development, most of the villagers are dependent on forests for their livelihood. Of the total 52,739 villages in the state, 22,600 villages are located in or near forest areas. Concessional supply of bamboo, fuel wood, poles & small timber is available for bonafide domestic needs of people living within 5 km of forest fringe. The supply is given from the notified nistar depots at specified rates. The value of concession under nistar sale is substantial. The value of concession rose from Rs. 6.94 Crores (2000-01) to Rs. 8.47 Crores in 2002-03.

In addition to these, there are a host of items like leaves, flowers, fruits, bark, seeds, roots etc. commonly referred to as non-wood forest products (NWFP), which contribute significantly in socio-economic development of the rural communities. It is difficult to estimate the exact number of people dependent to some extent on forest, since data captures by either the census operation, or by NSSO do not capture employment sources that give support for brief periods. In case of people collecting NTFPs, the period of direct persons days of employment is not very significant, say ten to fifteen days to month or so at the maximum overall in a year. But the forest produce plays a significant role in people's livelihood, especially in times of emergency.

Based on extraction of data from various sources the following FRA tables have been generated to fit in the proposed framework and are attached in Annexure.

4. Outcome of FRA System

At the end of the process of forest resource accounting system the following would be the major outputs:

- Physical asset accounts- Commercial working
- Physical asset accounts- Volume and Area
- Monetary asset accounts- Volume and Area
- Flow accounts- Goods and Services
- Degradation and Depletion account- Physical and Monetary
- Expenditure for forestry management & protection
- Accounting matrix for ecological services/amenities

5. Issues and Concerns

Despite availability of various frameworks to develop physical and monetary accounts to eventually create FRAs, the system is bested with various problems especially in a developing country's context. Some such problems are listed below.

5.1 Valuation Problems

The country has vast forestry resources with sixteen forest types and 221 forest sub-types spread over different agro climatic zones throughout the length & breadth of the country. Even near correct valuation of goods and services from these varied forest types is a huge task. A number of valuation studies are available, however, they neither represent all the forest types covered by statistically drawn samples nor do they encompass all the relevant use & non-use values. This creates problem for proper aggregation and ultimately arriving at even a near approximate value.

Ideally, broad based studies are required to be carried out taking the country as a universe and data collected from statistically drawn samples from all over the spread of forestry resource in question. This is however a huge task, requiring a co-ordinated effort from a number of institutions and funds. The only study as already mentioned, presently available at country level is by Chopra et al, 2001 which have taken into account five components on output side, viz., Industrial wood, fuelwood, NTFP, eco-tourism and C-sequestration. Findings from range of studies conducted at micro level in different parts of the country have been amalgamated by using econometric techniques to arrive at values of output for NTFP and eco-tourism. A new methodology has also been applied to estimate the flows of C-sequestration benefits. The said study reported a range of 1.7 to 4.58% as contribution of forests to GDP with an average value of 2.37%.

This value however does not include a number of goods & services such as watershed benefits, ecosystem services and biodiversity values.Another drawback of the above study is that some of the values, like per ha value reported for C-sequestration as per the internationally emerging carbon price, may not be occurring in reality. A mean total value of Rs. 1779 crores have been arrived for the annual range of carbon flows from 10.85 million ha plantations with age more than 10 years. This value of 1779 crores is disproportionately on a higher scale compared to an estimated value of around 25-50 crores on annual basis during the period 2008-2012. This calls for a critical appraisal of the methodologies applied.

5.2 Data Gaps

Introspection through review of literature and available data sets to create FRAs reveal that are quite a few gaps in the knowledge about the biophysical measurement and economic valuation of ecological services from forests and how to account for them in national accounts. Similarly reliable estimates of timber and non timber forest .products collected by local population from the forests are not available and there are no systematic studies available to quantify forest type, species and density wise benefits emanating from forests.

5.3 Integration of values of Forestry sector in National accounts

It can be visualized from the above discussion that the task of integrating valuation of forestry ecosystems and income accounting has a long way to go in India but the beginning has to be made immediately. Integration means that the economic activity in the forestry sector is fully accounted in terms of its actual, potential and use accounts linkages (as per FRA framework proposed by Xu. *et al*) with the other sectors of the economy. As the integration process is currently subjected to many constraints, alternatively satellite accounting system can be used for forestry sector. These accounts being complimentary to but outside the integrated system of national accounts and thus are better referred as 'complimentary' accounts. These accounts through light on linkages of the forestry sector with the rest of the economy. Vincent(1999) proposed that the following

adjustment is needed in the conventional GDP in order to account for the linkages of the forestry sector with other sectors of the economy:
Adjusted Net Domestic Product (NDP) = Conventional GDP + Non- Markey values of forest benefits - depreciation of human capital + Net accumulation of natural capital

5.4 Need for National Level studies from secondary and primary sources (experts, institution, models etc.)

For using FRA as a tool for realistic assessment of the contribution of the forestry sector in the country's economy it is essential that national level coordination committee/ Working/Expert group be set up for FRA which should comprise of forest valuation and accounting experts, institutions which have experience in partial and comprehensive system of accounting and practitioners. The experts in the committee shall take cue from the existing framework and shall develop methodology for various forest types, densities and species by carrying out studies across various regions. Further the pool of experts should also impart training on the basic concepts, methodology and uses of the new system of FRA to the personnel of forest departments who in turn shall actually be implementing the proposed system.

6 . Recommendations

To implement the proposed system of FRA in India and to overcome impediments in the system of economic valuation of forests of the country for estimating their true contribution, the following recommendations are made:

1. Creation of National Level Coordination Committee /Working/Expert group for FRA

A national level coordinated effort needs to be initiated to estimate economic value across various forest types, species and densities. For the purpose a National Level Coordination Committee comprising of experts in the area may be constituted. Institutions and individuals working in the area of forest resource data generation, valuation and accounting along with the practitioners may be the members.

2. Bridging the data gaps

The major data gaps that the sector is subject to are inconsistent data from different sources of the sector as well as other line departments, and lack of resource inventory data. Some of the specific data gaps are forest resource stock and exploitation data, change in forest stock, time series data on ecosystem services provided by forests and biodiversity, data on encroachment, data on resources drawn from forests by industrial units and data on intermediate consumption by industrial units etc. On account of lack of data from secondary sources, primary level studies need to be conducted o cover varied dimensions to bridge the existent data gaps.

3. Pilot implementation at selected sites:

The system evolved by the group may be initially tested in some pilot sites to gain experience and validating of the procedure of FRA.

4. Dissemination of Knowledge about FRA amongst all concerned

As the forests have multistakeholder and multisectoral linkages, the knowledge so generated by the expert group shall be disseminated in the form of working or policy papers on 'developing framework for valuing forests to guide the policy' to them for inculcating appreciation of the concept and need for such a system.

5. National Level Stakeholder Workshop

National Level Stakeholder Workshop may be conducted inviting parties which lay a claim on forest land mainly for developmental purposes like Ministries of Rural Development, Irrigation, Power, Infrastructure, Mining, Railways and Surface Transportation and also NGOs.

6. **Preparation of a manual to facilitate operationalization**

A manual containing basic concepts, methodology for economic valuation and accounting of forests may be prepared for handy use by the end users. Necessary capacity building regarding new system of FRA should also be done amongst the personnel of Forest Departments who are expected to be involved in implementing the proposed system. In this manner the new system of FRA shall be operationalised throughout the country.

7. **National Sensitization Workshop for State Forest Heads for better dissemination and implementation of the proposed system**

A national level sensitization workshop may be held for familiarizing the PCCF / CCF concerned with the basic concepts and relevance of the proposed system of FRA for better dissemination and implementation of the proposed system. Appreciation at the top level shall certainly help in effective implementation and monitoring of the system.

8. **FRA as a component of Working Plan**

The new system of FRA proposed through the efforts of the expert group shall comprise of tools and techniques of capturing values of tangible and intangible goods and services provided by forests and shall produce a set of accounts for systematically recording such values in the system of national accounts. The proposed system can be implemented at the functional unit level which may be a division or state level. Since the forest sector is a dynamic sector and any change in it will have a multiplier effects on itself as well on the other sectors; it is essential that the exercise of valuation and accounting be taken on regular basis. For the purpose it is proposed that that the exercise should be made a component of the existing working plan preparation exercise. As the working plan is prepared every 8-10 years, the FRA shall also be automatically done. In fact if FRA exercises are performed first, important signals can be generated for the new working plan.

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Annex I

FRA of state of HP as estimated under CSO Project executed by IIFM (2003-2005)

Table 1 : Asset Accounts of Different Categories of Forests in Himachal Pradesh (Volume in 000' cum) 2001-02					
Activity/Forest types	**Pine**	**Deodar**	**Fir/ Spruce**	**Other Sp.**	**Total**
***(1)Opening Stocks* [**standing volume]	**89232.4**	**54225.7**	**137889.1**	**58073.8**	**339421**
(2)Changes due to economic activity(--)					
Depletion (--)	488.8	297.1	755.3	318.1	1859.3
Timber Logging/harvest	97.7	59.4	151.0	63.6	371.7
Fuel-wood extraction	370.56	225.18	572.61	241.16	1409.52
Illegal logging	9.77	5.94	15.1	6.36	37.17
Logging damage	10.747	6.534	16.61	6.996	40.887
Afforestation (+)	21.18	10.30	21.82	13.78	67.08
Net Changes (net of depletion and afforestation)	467.59	286.76	733.50	304.34	1792.19
(3)Other volume changes					
Additions (+)					
Natural growth (Mean Annual Increment)	1487.2	723	1532.1	967.89	4710.19
Regeneration	1.89	0.91	1.95	1.23	5.99
Total	1489.09	723.91	1534.05	969.12	4716.18
Reductions (--)					
Forest fires	2.71	1.32	2.79	1.76	8.57
Stand mortality/insects and other diseases	0	0	0	0	
Animal grazing	118.61	57.11	122.37	77.19	375.91
Total	121.32	58.42	125.16	78.95	384.48
Net Volume Changes (net of additions and reductions)	1367.77	665.49	1408.89	890.17	4331.70
(4)Other accumulations (--)					
Encroachment on forest land	3.214	1.953	4.966	2.092	12.225
Transfer of land to other activities	4.106	2.495	6.343	2.673	15.616
Net volume change (5=2+3+4)	892.86	374.28	664.08	581.07	2511.66
(6)Closing Stocks (6=1+5)	**90125.26**	**54599.98**	**138553.18**	**58654.87**	**341932.6**

Note : Framework Adapted From Haripriya 2000

Table 2 : Volume (Monetary Accounts of Different Categories of Forests in Himachal Pradesh (In 000' Rs.) 2001-02					
Activity/Forest types	**Pine**	**Deodar**	**Fir/ Spruce**	**Other Sp.**	**Total**
(1)Opening Stocks **[**standing volume]	**82054724.21**	**134029879.6**	**39794932.15**	**16760156.75**	**272639692.7**
(2)Changes due to economic activity(--)					
Depletion (--)	439574.7	718087.9	213193.3	89790.5	1460646.4
Timber Logging/harvest	89841.2	146819.2	43578.8	18355.0	298594.2
Fuel-wood extraction	340749.3	556586.8	165256.7	69600.0	1132192.8
Illegal logging	8984.12074	14681.92176	4357.8751	1835.50236	29859.41996
Logging damage					
Afforestation (+)	**19476.32**	**25458.55**	**6297.27**	**3976.92**	**55209.07**
Net Changes (net of depletion and afforestation)	**-420098.35**	**-692629.38**	**-206896.07**	**-85813.58**	**-1405437.37**
(3)Other volume changes					
Additions (+)					
Natural growth (Mean Annual Increment)	1367572.606	1787041.992	442165.5921	279334.0219	3876114.212
Regeneration	1737.97	2249.25	562.77	354.98	4904.97
Total	1369310.58	1789291.24	442728.36	279689.00	3881019.19
Reductions (--)					
Forest fires	2489.017861	3250.884017	804.8712518	508.2506306	7053.02376
Stand mortality/insects and other diseases	0	0	0	0	
Animal grazing	109071.82	141148.62	35316.039	22276.27	307812.76
Total	111560.84	144399.51	36120.91	22784.52	314865.78
Net Volume Changes (net of additions and reductions)	**1257749.74**	**1644891.73**	**406607.45**	**256904.48**	**3566153.40**
(4)Other accumulations (--)					
Encroachment on Forest Land	2955.61	4827.48	1433.30	603.68	9820.08
Transfer of land to other activities	3775.70	6166.19	1830.50	771.46	12543.85
Net Value change (5=2+3+4)	**830920.09**	**941268.7**	**196447.55**	**169715.75**	**2138352.1**
(6)Closing Stocks (6=1+5)	**82885644.3**	**134971148.3**	**39991379.7**	**16929872.5**	**274778044.8**

Table 3 : Forest asset accounts for wooded land (2001-02) (In Sq. Km.)

Categories of Changes	Available for wood supply	Not available for wood supply	Total
Opening area	**14,353.00**	**22680**	**37,033**
Changes due to economic activities Afforestation Afforestation in blank area Deforestation(Area diverted for non forestry purposes) and Encroachment	188.25 +16.10 -1.19	-16.10 - 1.884	
Other changes Natural Regeneration Artificial Regeneration	4.27 13.98		
Changes in classification Demarcated Un-demarcated	29.33 -29.33		
Closing area	**14367.91**	**22662.016**	**37029.92**

Table 4 Flow Accounts for Himachal Pradesh Forest Goods and Services

Economic Value of Direct and Indirect Benefits		
	Physical value	Monetary value (In Cores Rs.)
Total growing stock	339421000 M^3	27263.97
I. Direct Benefits		
A. Direct Consumptive benefits		
2.Timber Logging	408870 M^3	33
3. Fuel wood	1409520 M^3	113
4.Fodder (collection)	931065.20Tonnes	81
5. Grazing (livestock)	7,30,800 Livestock 4448422.622 tonnes fodder	387
6..Minor forest produce	1161.56 tonnes	29
Total Direct consumptive benefits		1363
B. Direct Non Consumptive Benefits		
7.Ecotourism	19,99,931 Indian 58,230 Foreigners	454 31
Total Direct Benefits(A+B)		1848

II. Indirect Benefits		
8.Watershed	339421000 M^3Growing stock and 37033 Sq. kms. of recorded forest area	73972
9.Microclimatic factors	969018 Households	145
10.Carbon Stock Carbon flux	170920630 tonnes 1005640 tonnes	16492 97
11.Biodiversity/ Endangered Species	8966- Total no. of species found in Himachal Pradesh & 125 - Endangered species	4144
12.Employment Generation	48.40 lakh man days	25
Total Indirect Benefits (7+12)		94875
Total Economic Value(I+II)		96723

Framework Adopted from Verma, 2000

Table 5 : Carbon Stock accounting for Himachal Pradesh Forest (2001-02)

	1	2	3 = 1/2	4	5= 1*4	6	7= 5*6	8
Species	Growing stock Volume (000m3)	Area Sq. Km.	Volume/ Sq.Km.	Basic Density (tonnes/ m3)	Stem Biomass ('000 tonnes)	Biomass Exp. Factor	Above ground biomass ('000 tonnes)	Root-Shoot ratio
1	2	3	4	5	6	7	8	9
Deodar	54225.7	593.4	91381.36	0.59	31993.16	1.3	41591.11	0.24
Fir/ Spruce	137889.1	810.9	170044.5	0.36	49640.08	1.3	64532.1	0.24
Pine	89232.4	1445.2	61743.98	0.59	52647.12	1.3	68441.25	0.24
other Species	58073.8	11503.5	5048.359	0.5	29036.9	3.4	98725.46	0.27
All species total	339421	14353	23648.09		50528.3		273289.9	

	9=7*8	10=7+9	11=10*.5	12=11*3.67	13=12*$6	14=13*43.82
Species	Below ground biomass ('000 tonnes)	Total Living Biomass ('000 tonnes)	Carbon Content ('000 tonnes (0.5*TLB)	Carbon dioxide in ('000 tonnes)	value of carbon stock* US $	In INR Crores
1	10	11	12	13	14	15
Deodar	9981.867	51572.98	25786.49	94636.42	567818.50	2488.18
Fir/ Spruce	15487.7	80019.8	40009.9	146836.3	881018.03	3860.62
Pine	16425.9	84867.15	42433.58	155731.2	934387.33	4094.49
other Species	26655.87	125381.3	62690.67	230074.7	1380448.49	6049.13
All species total	68551.34	341841.3	170920.6	627278.7	3763672.34	16492.41

Table 6 Expenditure for Forestry and Wildlife Management, Protection, Extension and Soil Conservation of Himachal Pradesh Forest Department- (Value in '000 Rs.)

Particulars	Year 1993-94				Year 2001-02			
	State sector	Central sector	Charged	Total	State sector	Central sector	Charged	Total
Direction and Administration	162272		84	162356	6,13,901		19	6,13,920
Commu nication and Building	32,315			32,315	52,220			52,220
Forest conservation development and regeneration	55,426	1,885		57,311	92,984	7,278		100,262
Social and farm forestry	2,96,965	46,851		3,43,816	3,81,537	21,451		402,988
Forest Produce	9,011	9,575	252	18,838	7,488	6,619		14,107
Assistance to public sector and other undertakings					7,17,415			7,17,415
Other Expenditure	26,754		30	26,784	71,524			71,524
Environmental conservation and Wildlife	21,504	10,609		32,113	45,811	22,353		68,164
Agricultural research, Education and Training	16,284			16,284	58,358			58,358
Soil and water conservation	18,320	49,594		67,914	49,550	46,721		96,271
Total	**3,41,886**	**1,18,514**	**366**	**413,915**	**20,90,788**	**1,04,422**	**19**	**2,195,229**

Table 7 Timber Depletion Accounts (Physical) for Himachal Pradesh (2001-02)

(In'000' cum)

Activity/Forest types	Pine	Deodar	Fir/ Spruce	Other Sp.	Total
Opening Stocks	89232.4	54225.7	137889.1	58073.8	339421
Closing Stocks	90125.26	54599.98	138553.18	58654.87	341932.6
Net volume change (of additions and reductions)	892.86	374.28	664.08	581.07	2511.66
Volume loss of Forest fires	2.71	1.32	2.79	1.76	8.57
Net volume change of economic activity	895.57	375.6	666.87	582.83	2520.23

Table 8 Timber Depletion Accounts (Monetary) for Himachal Pradesh (2001-02) (In '000' Rs.)

Activity/Forest types	Pine	Deodar	Fir/ Spruce	Other Sp.	Total
Opening Stocks	82054724.2	134029879	39794932	16760156	272639692
Closing Stocks	164940368	269001027	79786311	33690029	547417737
Net volume change (of additions and reductions)	82885644	134971148	39991379	16929872	274778044
Volume loss of Forest fires	2489	3250	804	508	7053
Net volume change of economic activity	82888133	134974398	39992183	16930380	274785097

Annex I

FRA of state of MP as estimated under CSO Project executed by IIFM (2003-2005)
Table 9: Area Accounts of Forests of Madhya Pradesh (2003-04)

Area in square km

Activity/Forest types	Sal	Teak	Other Misc. species	Total forest cover	Water bodies inside forest cover	Forest Scrub/Blank	Total recorded Forest Area		
Opening Stocks	**5598.9**	**25670.5**	**45159.51**	**76429.01**	**1324**	**17,468**	**95,221**		
Area subject to logging	631.15	2893.70	5090.59	8615.42					
Timber Logging/harvest	77.62	355.86	626.03	1059.5					
Fuel wood	530.02	2430.06	4274.95	7235.03					
Illegal logging	19.51	89.45	157.36	266.31					
Logging damage	4.00	18.33	32.25	54.58					
Total Area Afforested and Regenerated	97.03	328.82	783.52	1325.96					
Area Afforested									
Forest land	28.14	12.95	227.84	385.52					
Non forest Land	0.9	4.4	7.7	13.0					
Area Regenerated	67.94	311.51	548	927.45					
Area Subject to Natural Disturbances	2644.4	12124.2	21328.83	36097.41					
Area subject to forest fires	39.2	179.7	316.1	535.0					
Area subject to grazing	2605.2	11944.5	21012.72	35562.41					
Encroachment	2.11	9.69	17.04	28.84	0.50	6.59	35.93		
Transfer of land for non-forestry purposes	2.97	13.63	23.97	40.57	0.70	9.27	50.54		
Closing Area	5596.01	25656.9	45135.54	76388.44	1323.30	17458.72	95170.46		
Total Change in area	2.97	13.63	23.97	40.57	0.7	9.27	50.54		

Table 10 Volume Accounts of Forests in Madhya Pradesh 2003-04

Volume In '000' cum				
Activity/Forest types	**Sal**	**Teak**	**Other Misc. Sp.**	**Total**
(1)Opening Stocks [standing volume]	**15896.68**	**72884**	**128217.32**	**216998**
Changes due to economic activity				
Depletion (--)	1624.53	7448.22	13102.89	22175.63
Timber Logging/harvest	52.51	240.76	423.54	716.81
Fuel-wood extraction	1505.25	6901.36	12140.86	20547.48
Illegal logging	55.41	254.03	446.89	756.33
Logging damage	11.4	52.1	91.6	155.0
Afforestation **(+)**	82.59	49.15	668.69	800.43
***(*2)Net Changes (net of depletion and afforestation)**	**-1541.94**	**-7399.07**	**-12434.20**	**-21375.20**
Other volume changes				
Additions (+)	**268.15**	**1844.21**	**2595.47**	**4707.83**
Natural growth (Mean Annual Increment)	**264.94**	**1822.1**	**2564.35**	**4651.39**
Regeneration	**3.21**	**22.11**	**31.12**	**56.44**
Reductions (--)	186.18	1140.49	1703.56	3030.24
Forest fires	**1.85**	**12.75**	**17.95**	**32.56**
Submergences	61.05	279.91	492.42	833.39
Animal grazing	123.28	847.82	1193.19	2164.29
(3)Net Volume Changes (net of additions and reductions)	**81.97**	**703.72**	**891.90**	**1677.60**
(4)Other accumulations (--)	**14.44**	**66.19**	**116.43**	**197.06**
Encroachment	6.00	27.50	48.38	81.88
Transfer of land to other activities	**8.44**	**38.68**	**68.05**	**115.18**
Net volume change (5=2+3+4)	**-1474.40**	**-6761.53**	**-11658.73**	**-19894.66**
(6)Closing Stocks (6=1+5)	**14422.28**	**66122.47**	**116558.59**	**197434.36**

Table 10.3: Monetary Accounts of Forests in Madhya Pradesh (2003-04

Value in Million Rs.				
Activity/Forest types	**Sal**	**Teak**	**other Misc. Sp.**	**Total**
(1)Opening stock	**20045.7**	**91906.7**	**23720.2**	**135672.6**
Changes due to economic activity				
Depletion (--)	359.1	1646.4	1861.1	3866.6
Timber Logging/harvest	66.2	303.6	78.4	448.2
Fuel-wood extraction	208.7	956.8	1683.2	2848.6
Illegal logging	69.9	320.3	82.7	472.9
Logging damage	14.3	65.7	16.9	96.9
Afforestation (+)	104.1	62.0	123.7	289.8
(2)Net Changes (net of depletion and afforestation)	**-254.9**	**-1584.4**	**-1737.4**	**-3576.8**
Other volume changes				
Additions (+)	338.1	2325.6	480.2	3143.9
Natural growth (Mean Annual Increment)	334.1	2297.7	474.4	3106.2
Regeneration	4.1	27.9	5.8	37.7
Reductions (--)	234.8	1438.2	315.2	1988.1
Forest fires	2.3	16.1	3.3	21.7
Submergences	77.0	353.0	91.1	521.1
Animal grazing	155.5	1069.1	220.7	1445.3
(3)Net Volume Changes (net of additions and reductions)	**103.4**	**887.4**	**165.0**	**1155.8**
(4)Other accumulations (--)	**18.2**	**83.5**	**21.5**	**123.2**
Encroachment	7.6	34.7	9.0	51.2
Transfer of land to other activities	10.6	48.8	12.6	72.0
Net volume change (5=2+3+4)	**-169.8**	**-780.5**	**-1594.0**	**-2544.2**
(6)Closing Stocks (6=1+5)	**19875.9**	**91126.3**	**22126.2**	**133128.4**

Table 11 Forest asset accounts for wooded land (2003-04) **(In Sq. Km.)**

Categories of Changes	**Available for wood supply**	**Not available for wood supply**	Total
Opening area	76429.01	18,791.9	**95,221**
Changes due to economic activities Afforestation Afforestation in non forest land Deforestation(Area diverted for non forestry purposes) and Encroachment	 +385.52 +13 -69.41	 -385.52 - 17.06	
Other changes Natural Regeneration Artificial Regeneration	 927.45 0		
Changes in classification Demarcated Un-demarcated	 0 0		
Closing area	**76,758.12**	**18389.32**	**95,147.44**

Adapted from Euro stat 2002a.

Table 12 Flow Accounts for Madhya Pradesh Forest Goods and Services

Economic Value of Direct and Indirect Benefits		
	Physical value	Monetary value (In Crores Rs.)
Total growing stock	216.99 Million M^3	13567.26
I. Direct Benefits		
A. Direct Consumptive benefits		
2.Timber Logging	2.46 Million M^3	154
3. Fuel wood	20.54 Million M^3	285
4.Fodder (collection)	0.3 Million Tonnes	22
5. Grazing (livestock)	3.27 Million Livestock 7.13 Million tonnes grazed fodder	22 533
6..Minor forest produce	22.21 Lakh std. bags of tendu patta 10722.5 Tonnes other MFPs.	160
Total Direct consumptive benefits		1177
B. Direct Non Consumptive Benefits		
7.Ecotourism	545267 Indian 18223 Foreigners	137
Total Direct Benefits(A+B)		1314
II. Indirect Benefits		
8.Watershed	216.99 Million M^{3-} Growing stock & 95,221 Sq. kms. of recorded forest area	189490
9.Carbon dioxide Stock Carbon dioxide flux	922.05 Million -16.23 Million tonnes	24243 - 427
10.Biodiversity/ Endangered Species	670 Medicinal plant species.	10479
11.Employment Generation	480 Lakh Man days	360
Total Indirect Benefits (7+12)		224145
Total Economic Value(I+II)		225459

Framework Adopted from Verma, 2000

Table 13 Expenditure for Forestry Management and Operations

(Rs. In Lakhs)

Particulars	**2001-02**	**2002-03**	**2003-04**
Direction and Administration	17.63	38.31	49.5
Communication and Building	81.47	98.12	137.9
Forest Conservation, Development and Regeneration	2596.2	6770.53	8944.11
Compensatory afforestation and plantation in lieu of settlement	2342.46	1724.92	1378.67
Social and Farm Forestry	140.74	40.1	42.78
Assistance to Public sector and other undertakings	0	0	0
Forest Resource Survey and Utilization	4	25.5	27.17
Environmental Conservation and Wildlife	72.87	69.91	84.65
Education and Training	6.89	15.41	26.59
Soil and water conservation	92.12	82	78.77
Expenditure from Forest Corporation budget	585.68	773.41	782.61
Other expenditure	17.68	18.13	17.88
Total	5957.74	9656.34	11570.63

Table 14 Timber Depletion Accounts (Physical) for Madhya Pradesh (2003-04)

(In'000' cum)

Activity/Forest types	Sal	Teak	Other Misc. Sp.	Total
Opening Stocks	15896.68	72884	128217.32	216998
Closing Stocks	14422.28	66122.47	116558.59	197434.36
Net volume change	-1474.40	-6761.53	-11658.73	-19894.66
Volume loss due to Forest fires	1.85	12.75	17.95	32.56
Depletion of Timber/ Net volume change due to economic activities	-1472.55	-6748.78	-11640.8	-19862.1

Table 15 Timber Depletion Accounts (Monetary) for Madhya Pradesh (2003-04)

(In Million Rs.)

Activity/Forest types	Sal	Teak	Other Misc. Sp.	Total
Opening Stocks	20045.7	91906.7	23720.2	135672.6
Closing Stocks	19875.9	91126.3	22126.2	133128.4
Net volume change	-169.8	-780.5	-1594.0	-2544.2
Volume loss due to Forest fires	2.3	16.1	3.3	21.7
Depletion of Timber/ Net volume change due to economic activities	**-167.5**	**-764.4**	**-1590.7**	**-2522.5**

Table: 16 Carbon Stock Madhya Pradesh Forest 2003-04

	1	2	3 = 1/2	4	5= 1*4	6	7= 5*6	8
Species	**Growing stock Volume (000m3)**	**Area Sq. Km.**	**Volume/ Sq. Km.**	**Basic Density (tonnes/m3)**	**Stem Biomass ('000 tonnes)**	**Biomass Exp. Factor**	**Above ground biomass ('000 tonnes)**	**Root-Shoot ratio**
1	2	3	4	5	6	7	8	9
Sal	15896.68	5598.90	2839.25	0.72	11445.61	3.4	38915.07	0.27
Teak	72884.00	25670.50	2839.21	0.56	40815.04	3.4	138771.14	0.27
other Species	128217.32	45159.51	2839.21	0.50	64108.66	3.4	217969.44	0.27
All species total	**216998.00**	**76428.91**	**2839.21**		**116369.31**		**395655.65**	

	9=7*8	10=7+9	11=10*.5	12=11*3.67	13=12*1000	14=13*$6	15=14*43.82
Species	**Below ground biomass ('000 tonnes)**	**Total Living Biomass ('000 tonnes)**	**Carbon Content ('000 tonnes (0.5*TLB)**	**Carbon dioxide in ('000 tonnes)**	**carbon dioxide in tonnes**	**Value of carbon stock @ of $6 per tonnes of Carbon dioxide**	**IN Crores**
1	10	11	12	13	14	15	17
Sal	10507.07	49422.14	24711.07	90689.63	90689631	544137786.2	2384.412
Teak	37468.21	176239.34	88119.67	323399.2	3.23E+08	1940395163	8502.812
other Species	58851.75	276821.19	138410.60	507966.9	5.08E+08	3047801345	13355.47
All species total	**106827.03**	**502482.68**	**251241.34**	**922055.7**	**9.22E+08**	**5532334294**	**24242.69**

Environmental Impact of Subsidies: Case of Agriculture

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1. Introduction

The issue of subsidies in general and agricultural subsidies in particular has been in debate in India, since early nineties. Some of the reasons that have been advanced in support of farm subsidies are: food security, income redistribution, stability in food prices and encouragement to use new farming methods. Farm subsidies have, however, put enormous strain on government budgets. In addition to straining budgets, subsidies distort prices of agricultural inputs and thereby affect levels of input use. This has an effect on the availability of inputs and resources used in agriculture. When supply of inputs is constrained by natural or other factors, the sustainability of agricultural development may be affected. Excessive and inefficient use of agricultural inputs such as fertilisers, water and pesticides is also reported to have detrimental consequences for the environment and human health and welfare.

In this paper, we provide an analytical framework to identify the environmental impact of subsidies to agricultural inputs and analyse its implications for the sustainability of agriculture. To deal with this topic we have focused on fertiliser, irrigation and power. Subsidies to these inputs are given in different forms and sizes. A number of studies have attempted to measure the magnitude of these subsidies. Depending on the definition of subsidy used, the magnitudes of subsidy have varied. However, there exists one commonality between the policy implications of these studies. All the studies bring out that in addition to straining budgets, subsidies to these inputs distort their prices and thereby affect levels of their use, which have wide ranging implications for the environment and the economy. Here, we bring out the environmental implications of the subsidy-induced demand of these inputs in agriculture.

2. Agricultural Subsidies and the Environment

Agriculture has a significant impact on environment, particularly on soil, water, biodiversity and air. The specific impact depends, among other factors, on the type and quantity of crops produced, the farming practices employed, the level and mix of inputs such as fertilisers and pesticides applied, irrigation methods, and site specific environmental conditions. Farmers will be concerned about the environmental performance of the agricultural sector if they are faced with adequate incentives to include the environmental costs and benefits of their activities in their production decisions. Markets do not penalise farmers for harming the environment, nor offer rewards for avoiding or reducing harmful effects. Government pricing policies of both agricultural inputs and outputs have encouraged a commodity mix narrower than would be the case if these policies were not in place, and have promoted high levels of water, fertiliser and chemical use. This, in turn, has exacerbated environmental pollution, especially soil erosion, and surface and groundwater pollution. The mechanism is a form of derived demand for inputs (Harold and Runge, 1993).

There are three main challenges involved in identifying/evaluating the environmental impact of both environmentally perverse and environment supporting subsidies:

- The impact is likely to differ from one environmental situation to another, because the sensitivity of an ecosystem will differ according to the specific situation, and most subsidy measures will extend beyond a single ecosystem. Often environmental degradation is visible after a long period of time, so these long-term impacts have to be taken into consideration while analysing the environmental impacts.

- Human behaviour will be affected not only by the particular subsidy in question, but also by all the other government programmes that affect a given individual. There may be multiple subsidy programmes, perhaps with conflicting objectives, that are relevant.

- Some subsidy programmes may make payments that are inconsistent with the programme's own goals. For example, the programme may have outlived the life span envisaged by its designers, or it may apply to "fringe" areas where circumstances do not match those which its designers foresaw (Barg, 1996).

3. Perverse Subsidies and the Environment

Subsidies that encourage human action causing damage to the environment are perverse because they create incentives to behave in ways which decrease social welfare. In order to analyse such situations, one must first examine the environmental problems that arise from the human activity that is encouraged by these subsidies. Thus, one must come at the problem from both directions: *define the subsidy and how it affects the human behaviour, and define the environmental situation and how it is affected by the subsidy induced behaviour*. Panayotou's list of *Economic manifestations of Environmental Degradation* is a useful starting point for analysing such situations. This is presented in Box 1.

Box 1. Representative List of Economic Manifestations of Environmental Degradation

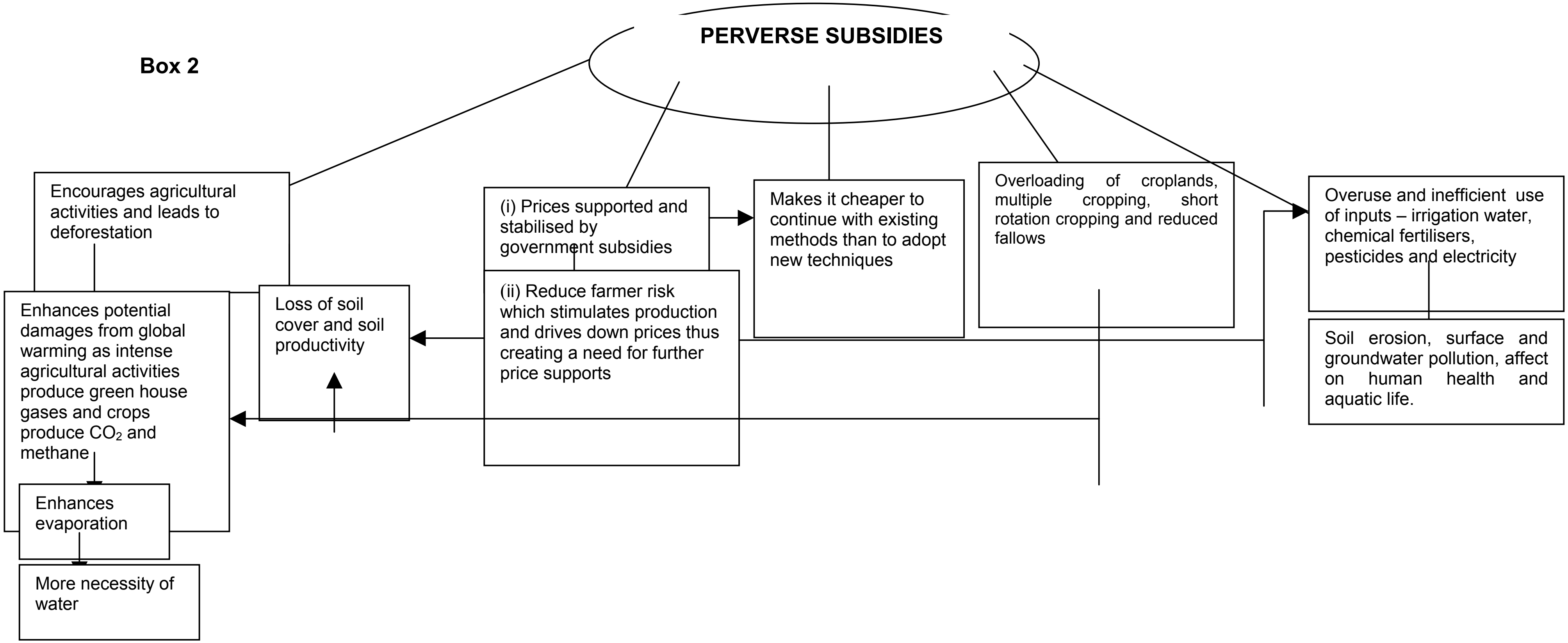
- ♦ Overuse, waste and inefficiency co-exist with growing resource scarcity (shortages).
- ♦ An increasingly scarce resource is put to inferior, low-return, and unsustainable uses, even though superior, high-return and sustainable uses exist.
- ♦ A renewable resource, capable of sustainable management is exploited as an extractive resource (i.e. it is mined).
- ♦ A resource is put to a single use, when multiple uses would generate larger net benefits.
- ♦ Investments in the protection and enhancement of the resource base are not undertaken, even though they would generate a positive net present value by increasing productivity and enhancing sustainability.
- ♦ A larger amount of effort and cost is incurred, when a smaller amount of effort and cost would have generated a higher level of output, more profit and less damage to the resource.
- ♦ Local communities and tribal and other groups, such as women, are displaced and deprived of their customary rights of access to resources, regardless of the fact that, because of their specialised knowledge, tradition and self-interest, they may be the most cost-effective managers of those resources.
- ♦ Public projects are undertaken that do not make adequate provision for, or generate sufficient benefits to, compensate all those affected (including the environment) to a level where they are decidedly better off "with" than "without" the project.
- ♦ Failure to recycle resources and by-products, when recycling would generate both economic and environmental benefits.
- ♦ Unique sites and habitats are lost, and animal and plant species go extinct without compelling economic reasons which counter the value of uniqueness and diversity and the cost of irreversible loss.

As long as agricultural subsidies nurture hidden costs in the form of environmental damage, they may be considered as perverse subsidies. Box 2 illustrates broadly the ways in which ill-targeted subsidies in agriculture could be perverse.

4. Impacts of Environmental Stressors and Indicators of Environmental Stress

In order to evaluate the impact of subsidies to agricultural inputs it is important to identify their potential impacts on environmental resources, and human health and welfare. The chemical and/or physical changes in the environment associated with an activity or source - in this case agricultural inputs - are described as stressors, which is a term used to denote the types and levels of pollutant emissions or habitat alterations. Through the media of air, land and water, such environmental changes and pollutants ultimately affect resources, people, wildlife and plants (Table 1). The impacts may have far reaching effects or may affect the receptor on a smaller scale. They can be on-site (localized) or off-site (regional or even global) impacts, physical (e.g. loss of species diversity) and chemical effects (such as diseases), socio-economic impacts (e.g. loss of income, resettlement of people or land abandonment) or near-term and long-term impacts.

Box 2


PERVERSE SUBSIDIES
Encourages agricultural activities and leads to deforestation
(i) Prices supported and stabilised by government subsidies
Makes it cheaper to continue with existing methods than to adopt new techniques
Overloading of croplands, multiple cropping, short rotation cropping and reduced fallows
Overuse and inefficient use of inputs – irrigation water, chemical fertilisers, pesticides and electricity
Enhances potential damages from global warming as intense agricultural activities produce green house gases and crops produce CO_2 and methane
Loss of soil cover and soil productivity
(ii) Reduce farmer risk which stimulates production and drives down prices thus creating a need for further price supports
Soil erosion, surface and groundwater pollution, affect on human health and aquatic life.
Enhances evaporation
More necessity of water

5. Environmental Impacts of Subsidies to Agricultural Inputs: Evidence from Literature

In practice, many subsidies are not only excessive but ill targeted and also tend to become open ended and continued long after they have served their purpose. Recently it has been increasingly recognised that many subsidies directed towards agriculture impose a high cost on society through their adverse impact on environmental resources. In this context, this section reviews the existing literature on the subject with an objective to examine the environmental impact of the subsidies to fertilisers, surface irrigation, pesticides and power and its implications for the sustainability of natural resources and agriculture.

5.1 Power Subsidy: Impact on Groundwater Depletion

It is generally perceived that reducing energy consumption implies reducing production. However Singh (1999) reports that this is a misconception. His study cites Mitra (1992) who found that the linkage between energy consumption and economic growth has been broken decisively by the developed countries after the oil crises, which broke out in the early seventies. Middle income and lower middle income countries too have shown that efficiency of energy use can significantly reduce the consumption of energy without impairing economic growth targets. However the low income countries, among them India most prominently, have remained stuck with high energy intensity in their economic development processes and profiles. The persistent neglect of the energy conservation in agriculture is a glaring example of this. The irrational pricing policy of electricity results in the inefficient use of electricity on the one hand and inefficient use of water on the other.

Myers, et.al. (1998) notes that irrigation subsidies encourage wasteful use of scarce water worldwide. Power subsidies too, encourage withdrawal of groundwater for agricultural use, leading to a decline in the water table. These have implications for both the availability of scarce water resource and the environmental problems entailed by its overuse and wastage, namely groundwater depletion, and soil depletion which have serious impact on agriculture

Sidhu and Dhillon (1997), on the basis of a study conducted in Punjab show that the low rates of electricity and the flat rate system of charging have induced farmers to shift to tubewell irrigation, water intensive crops and over irrigation which have resulted in

Table 1. Taxonomy for Evaluating Potential Impacts of Environmental Stressors

	Effects Category											
	Environmental Resources							Human Health		Human Welfare		
Potential Burdens to Water												
	Ground Water Contamination	Surfacewater Contamination	Ground Water Level	Coastal, Marine & Freshwater Ecosystems	Terrestrial Ecosystems	Biodiversity /Endangered Species	Sedimentation	Mortality	Morbidity	Material loss	Aesthetics	Resource Use
Stressor	✓	✓		✓		✓			✓			✓
Pesticides	✓	✓		✓	✓	✓		✓	✓			✓
Irrigation (surface)	✓	✓	✓				✓			✓	✓	✓
Electricity			✓								✓	✓
Potential Burdens to Land												
	Contamination	Waterlogging	Salinity	Erosion	Terrestrial Ecosystems	Biodiversity /Endangered Species	Nutrient Leaching	Mortality	Morbidity	Material loss	Aesthetics	Resource Use
Fertilisers	✓				✓							✓
Pesticides	✓				✓	✓			✓			✓
Irrigation (surface)		✓	✓	✓	✓		✓			✓		✓
Electricity				✓	✓							✓

Stressor	Effects Category											
	Environmental Resources							Human Health		Human Welfare		
Potential Burdens to Air												
					Terrestrial Ecosystems			Mortality	Morbidity	Material loss	Aesthetics	Resource Use
Pesticides					✓			✓	✓			

Resource Use : Changes in the productivity or value of commercial, subsistence or recreational uses of such natural resources as forests (e.g., for timber), agricultural lands (e.g., for crops), fisheries (e.g., for subsistence diets) or wildlife (e.g., for ecotourism).
Coastal and Other Marine Ecosystems : Includes reef, fishery, and other biological resources in saline water.
Freshwater Ecosystems : Includes wetlands, watersheds, and other biological resources in fresh water (sweetwater).
Biodiversity/Endangered Species : Impacts on the diversity of flora and fauna, species that are endemic or unique, and species habitats and corridors (e.g., flyways for birds)
Terrestrial Ecosystems : Flora and fauna, minerals, soil, forest or grassland habitat.

a sharp decline in the groundwater level and consequently, the electricity requirement for drawing groundwater is increasing year after year. The groundwater level has declined in 86 per cent of the area of the State. The decline was more than 5 metres in 29 per cent of the area implying 7 to 10 per cent increase in electricity demand. Further, there was a sharp shift from dry crops to water intensive crops. For instance, the area under rice which is a irrigation intensive crop increased from 292 thousand hectares in 1970-71 to 2276 thousand hectares in 1994-95. The marginal lands too were put under the water intensive crops. The study also reveals that the zero marginal cost of irrigation due to the rate system of charges for electricity has induced the farmers to over irrigate. Only 54.7 per cent of the farmers applied the required number of irrigations, the remaining over irrigated the rice crop to various degree.

Subsidy on electricity has affected the efficiency of irrigation systems too. A study conducted by the Punjab Agricultural University (1997) on the operational efficiency of electricity operated tubewells found that 33 per cent tubewells were operating at 50 per cent of efficiency, 21 per cent were at 40-50 per cent level of efficiency and the remaining were operating at less than 45 per cent level of efficiency.

Joshi (1997) reports that the water table in the good aquifer regions of Haryana has declined ranging between 1 and 83 cm during the last one decade posing serious threat to the agricultural economy of Haryana.

In coastal regions, fresh groundwater supplies are vulnerable to contamination by salt water intrusion. Overdraft of these fresh water zones causes salt water intrusions. Katar Singh (1999) shows that the groundwater table has gone down drastically in many areas of the country such as Mehsana district in north Gujarat and Coimbatore district in west Tamil Nadu. It is estimated that in Mehsana district, water table has been falling at the rate of 5-8 metres annually and that some 2,000 wells dry up every year. In the coastal areas of Gujarat, excessive extraction has depleted the groundwater aquifers and the vacuum so created has been filled in by intrusion of sea water – a phenomenon called salinity ingress. It is estimated that salinity ingress is increasing at an alarming rate of one-half to one km a year, along 60 per cent of the 1,100 km long Saurashtra coast. The salinity ingress has rendered groundwater in those areas unfit for both domestic and agricultural uses and has adversely affected crop yields. Singh fears that “ sometimes, these effects are slow in coming, but by the time they are recognized it may be too late to correct the damage.”

5.2 *Irrigation Subsidy: Impact on Waterlogging, Salinity and Soil Erosion*

Increase in soil salinity is recognised worldwide as a major deprecating factor in agricultural growth. Myers (1998) notes that world-wide, 454,000 sq. km of the 2.8 million sq. km. of land is salinized which is enough to reduce crop yields, with crop losses worth almost $11 billion per year. The study also notes that the problem derives primarily from subsidies that encourage careless and prodigal use of seemingly plentiful water supplies. Government subsidies encourage wasteful use of water, and eliminate any incentive to use it sparingly. Mexico loses a million metric tons of grain a year because of soil salinity, enough to feed five million people and Pakistan today spends more on pumping out salt-laden water than on irrigation.

Joshi and Jha (1992) show that in the long run, waterlogging and salinity lead to land abandonment, while in the short-term and medium-term, there are adverse productivity impacts. Presently, salinity affects productivity in about 86 million hectares of the world's irrigated land. At least 2 to 3 lakh hectares of irrigated land are lost every year due to salinisation and waterlogging. In developed and developing countries, salinity and waterlogging together are responsible for the decline of about 1.1 million tons of grain output each year.

India, being predominantly agriculture based economy and with many inefficiencies in its irrigation subsidy policies, is no exception to this problem. Myers (1999) notes that in India 100,000 sq. km out of 420,000 square km. of irrigated croplands have been lost to cultivation through waterlogging, and 70,000 square km. are affected by salinization. It is estimated that Indian farmers could cut back on irrigation water use by 15 percent without reducing crop yields simply by eliminating over-watering. Marothia (1997) shows that subsidized canal irrigation and subsidized electricity (in some cases free) for tubewells, remunerative output price support, availability of HYV seeds and higher returns encouraged the farmers to opt for water intensive crops. Nearly 1/4th of the cultivable command area under all canal projects in India is suffering from waterlogging and soil salinity. This has adversely affected the crop productivity and restricted the choice of crops. As precise statistical data are not yet available as to the amount of irrigated lands that have fallen into disuse because of waterlogging and salinity, these concerns are inadequately addressed in most of the irrigation investment decisions.

The study by Joshi and Jha (1992) focuses primarily on the problem of soil alkalinity and waterlogging in the Sharda Canal Command area and attempts to measure its impact at the farm level in terms of resource use, productivity and profitability of crop production. Four villages in the Gauriganj block were chosen for the study covering the 1985-86 cropping year. The study finds that overuse of canal irrigation and underuse of groundwater has disturbed the water balance of the area causing waterlogging and increase in salinisation in the command area. The reason for under-exploitation of rather good quality groundwater is low water rate on canal irrigation. It has been shown that the cost of tubewell irrigation is much higher (Rs. 825 per hectare for paddy) as compared to the rate of canal water tariff (Rs. 143.26 per hectare for paddy). Such a wide difference in the cost of irrigation has led the farmers to discontinue the use of groundwater, resulting in an increase in water table and soil alkalinity.

The study further notes that crop choices are severely restricted under degraded soil conditions. Under salt affected and waterlogged soils, crops like pulses, sugarcane, potato and a number of other crops are not grown. In such situations intensity of land use goes down and in the extreme such problems lead to abandonment of cultivation. Thus land degradation aggravates land scarcity. Results of the study on productivity and profitability of crop production were far more revealing. Though in farmers' perceptions, yields of paddy and wheat halved in about eight years time due to increasing soil degradation, estimates of the study indicated that paddy and wheat yields went down by more than 51 per cent and 56 per cent respectively on salt-affected soils. For wheat, the net income fell by 92 per cent. The unit cost of production rose by 59 to 61 per cent for paddy and by 85 per cent for wheat when cultivation is extended on salt affected soils. The study concludes that with the same level of resources as used on normal soils, gross output would decline by 63-64 per cent on salt affected or waterlogged soils. The study concludes that underpricing in favour of canal irrigation is, by and large, responsible for such a situation. Joshi (1994), based on primary data reports that the crop productivity in Western Yamuna and Bhakra Canal Command showed a declining trend in comparison to normal soils.

Sharma, Parshad and Gajja (1997), finds that in Haryana about 70 per cent of the geographical area is facing the problem of rising water table due to the dominance of canal irrigation, lack of adequate drainage and low extraction of ground water. Gangwar and Toorn (1987) put the economic loss due to rising and poor quality of water in Haryana at Rs. 26.8 crores and anticipates it to rise to a level of Rs.71.9 crores in 2000. The State is also salt affected. Singh (1984), estimates that an area of 450 thousand hectares under salinity/alkalinity and waterlogging. More severely affected districts are Karnal, Kurukshetra, Jind, Hisar, Sonipat and Rohtak.

In the Central-Southern districts of Jind, Hisar, Sirsa and Bhiwani, where most of the area is canal irrigated , the water table rose at a fast rate during 1974-91 (0.7 metre in Rohtak to 6.5 metre in Sirsa district) leading to waterlogging and secondary salinity. Moreover, these areas are underlain by brackish water. So waterlogging is assuming gigantic proportions in various canal command areas. The worst affected districts are Rohtak, Jind, Hisar and Sirsa.

To sum up, the widespread and repeated use of irrigation water without provision for adequate drainage, and crop intensification in favour of high water requirement crops without utilising the groundwater has resulted in rapid rise in watertable in the areas with poor quality groundwater, leading to the problem of waterlogging and salinity. On the other hand, the regions endowed with good quality groundwater are being over exploited without maintaining the water level at a reasonable depth. According to Karwasra, Singh and Singh (1997) both the situations are undesirable for the sustainability of agriculture. Unplanned intensive irrigation also lead to infestation of weeds and inception of water borne diseases.

5.3 *Fertiliser Subsidy: Impact on Soil Productivity, and Groundwater and Surface Water Contamination*

Three main fertilisers used in agriculture are urea (N), di-ammonium phosphate (DAP) and Potash (K). Of these the production of urea is under the retention price scheme. There is a flat rate subsidy on DAP. Potash, which is mainly imported, also has a flat rate subsidy. One of the main purposes of retention price scheme is to develop the urea industry in the country. Every individual plant is assured a fixed rate of return. Hence the retention prices are fixed for each individual plant. The subsidy on urea is the difference between the retention price (adjusted for freight etc.) and the price that the farmer pays. According to Gulati and Narayanan (2000), the fertiliser subsidy bill in 1988-89 amounted to Rs. 112 billion. In the eighties there was an unprecedented growth in the fertiliser subsidy in India. Parikh and Suryanarayana (1992) show that the rate of fertiliser subsidy on domestic production has increased from Rs. 565.72 per tonne to Rs. 1383.33 per tonne in 1987-88.

Application of fertilisers and pesticides is essential in order to increase food production and achieve the targeted agricultural production. However, studies reveal that indiscriminate use of fertilisers have proved detrimental. According to a study Mehta (1971), in Gujarat region, nitrogen leaching for 90 cm. soil depth under 564 mm. rainfall was 14kg/ha. out of 180kg/ha. N applied. In a rice field near Delhi, loss of 14.3 kg/ha. was reported from an application of 120kg/ha (Mahalanobis, 1971). Handa (1987) found that the main cause of groundwater pollution is indiscriminate and higher dose of fertilisers and pesticides. The study also finds that the nitrate content in the soil sample of the States where lower doses of fertilisers are used is considerably low as compared to the States where per hectare use of fertiliser is higher. It must be noted the soil health has direct impact on crop yield.

According to Sidhu and Byerlee (1992), in relatively more developed districts of Punjab, such as Ludhiana, fertiliser use has already exceeded the recommended dose at least for nitrogen. Hence marginal contribution of fertiliser to yield increases is predicted to be substantially lower in future. The study computed the land, labour and fertiliser productivity for the years 1975 and 1985 for various states of India and expressed them as percentages of Punjab figures. The results show a decline in fertiliser productivity in Punjab, Haryana, Uttar Pradesh, Madhya Pradesh and Rajasthan due to application of increasing amounts of fertilisers to maintain current levels of yield.

Sah and Shah (1992) find that in irrigated areas of Gujarat where fertiliser use is widespread and has reached 1.5 times or more than the recommended amounts, the issue of fertiliser use efficiency has become increasingly important. The analysis based on a sample of 330 farmers located in 42 villages of 5 important soil-crop zones in Gujarat, finds that excessive use of fertilisers is widespread; only one out of 5 farmers who had received soil test recommendations, used fertilisers as recommended. Farmers' inability to visualise the effect of nutrient balance on crop output distorts their perceptions about yield response, resulting in overuse.

Singh, Singh and Kundu (1997) analyses the environmental consequences of the rice-wheat cropping system in Haryana. The study finds that increasing fertiliser use has led to diminishing marginal gains to nutrient ratio from 14.65 to 9.36 for rice and from 21.5 to 8.67 for wheat between 1970-75 and 1990-94.

Nagaraj, Khan and Karnool (1998) examine the resource use efficiency in cultivation of various crops under different cropping systems in Tungabhadra Command Area (Karnataka). The results of the study show that the regression coefficients for manure and fertilisers are negative and non-significant in production of paddy indicating a negative influence on the gross returns from paddy and that the input is used in excess of requirements.

According to Joshi (1997) adoption of nutrient responsive high-yielding varieties, and application of inorganic fertilisers without soil test and widespread application with wrong nutrient balance have resulted in nutrient imbalance of the soil in many parts of the country. As a result, the actual productivity from using inorganic fertilisers was much lower than that of the potential. Nearly 70 per cent of the fertiliser was applied to rice and wheat in Haryana. Tomer and Khatkar find that the farmers in Haryana were applying overdoses of fertiliser, particularly of nitrogenous fertiliser in most of the crops. The recommended ratio of N, P, K (4:2:1), is not being maintained due to subsidies in favour of nitrogenous fertilisers. Some economists argue that soil nutrient related problems were due to imbalance of subsidies for the major nutrients. Nutrient deficiency and loss of organic matter were among other important reasons for declining productivity of rice and wheat.

Ray (1998) observed that although, use of fertilisers, pesticides and water are unavoidable for achieving the targeted agricultural growth, indiscriminate use of these inputs creates environmental problems. The study analyses fertiliser consumption data for Andhra Pradesh, Punjab, Haryana, Tamil Nadu, Bihar, Madhya Pradesh, Orissa, and Rajasthan from 1981 to 1995 and concludes that

1. due to use of more and more fertilisers the return from per unit of fertiliser was decreasing for both the crops and in almost all States;

2. the return from per kg. of fertiliser is highest in less developed States where the rate of use of fertilisers is substantially lower as compared to the States where a high dose of fertiliser has been used; and

3. due to the use of higher dose of fertilisers and pesticides, the pollution of soil and groundwater is more and as a consequence, the marginal physical productivity of fertilisers declined significantly.

The study notes that increasing trends in bringing land under rice and wheat and other profitable crops and applying higher doses of fertilisers are not likely to change in the near future. Therefore, efforts be made to ensure judicial use of fertilisers and pesticides so that only a small portion is left unutilized which reaches the soil and groundwater.

Joshi (1997) reports that degradation of natural resources has undermined production capacity in different regions. Therefore future productivity levels and growth in production will have to rely on availability of resource friendly technologies and practices.

Jikun Huang and Scott Rozelle (1995) in an analysis of the slower growth of grain yields in China in the late 1980s, observe that the intensification of China’s agricultural practices and other rural activities appear to have caused an increase in environmental stress that created a drag yield growth.

5.4 Environmental Impact of Indiscriminate Use of Pesticides

Deep concern is expressed about the excessive use of pesticides in developing countries, which is reported to have led to environmental degradation. Jumanah Farah (1994) shows that some pesticides persist longer than others or break down to even more toxic components, extending the time span in which they could contaminate agricultural crops, surface and underground water, and surface water bodies. Pesticides affect not only the location of their application but also the ecosystems far removed due to their mobility in air and water. Further, pesticides usually kill pests and their natural enemies alike. Pests are also very adept at developing resistance against the chemical pesticides intended to control them. Thus pesticide use initiated to suppress pests may lead to greater pest outbreaks. The study notes that towards the late 80s, with the growth of herbicide use, at least 48 weed species had gained resistance to chemicals. Another source estimates that from 1930 to 1960, the number of resistant anthropod species (insects, mites, ticks) rose from just 6 to 137, an average increase of 4 resistant species per year. In the period of 1960-80, on an average 13 species per year are reported to have gained resistance to chemical pesticides. It was estimated that in 1990 approximately 504 insect and mite species had acquired resistance to pesticides in use.

The wipe out of essential predatory insects due to excessive and uncontrolled pesticide treatments has created new pests. For instance, in cotton production in the Canete Valley in Peru, spraying to control the tobacco budworm led to the rapid build-up of the cotton aphid. As chemical treatment intensified to counteract this resistance build-up, other pests developed because their natural predators were eliminated. In Mexico, the tobacco budworm developed resistance to all known pesticides and caused the cotton planted area to drop from more than 280,000 ha to a mere 400 ha in the 60s. Similarly, in Nicaragua, 15 years of heavy insecticide use on cotton were followed by 4 years in which yields fell by 30per cent.

Pesticide-related poisoning could occur in human beings as a result of excessive exposure to pesticides, through inhalation or on consuming heavily or untimely pesticide treated crops. Karwasra, Singh and Singh (1997) assess the impact of agricultural development on nature and extent of resource degradation in Haryana. They observe that in the central-southern districts, intensive canal irrigation has led to waterlogging and increase in salinity and this has encouraged profuse growth of weeds and insect-pests. To control such infestation and to propel any further harvest, intensive chemical control measures will have to be employed. The study notes that the direct ill-effects of farm chemicals have started showing its presence in the form of nitrate concentration in water and pesticides residue in different food items. Bhatnagar and Thakur (1998) show that in Haryana from 1966 to 1993 both consumption and coverage of area by pesticides has shown accelerating growth rates. Consumption of pesticides has grown at a higher rate than the growth in areas covered by the use of pesticides.

Farah (1994) notes that the pesticide users are hardly aware of the negative externalities on the environment. In the absence of government intervention through regulations and taxation, they tend to overuse pesticides and this tendency is further exacerbated due to international and national institutional economic policies which directly or indirectly lead to farmers applying more pesticides than they would otherwise.

According to Joshi (1997) pesticide consumption in Indian agriculture has increased manifold during the last three decades. Five states, namely, Andhra Pradesh, Gujarat, Maharashtra, Punjab and Tamil Nadu, accounted for more than 90 per cent of the pesticide use in the country. Although the average consumption of pesticide in India is low, 33 grams/hect., indiscriminate use of pesticide in some pockets is causing several environmental and health problems. Farah (1994) reports that, during the 1989/90 season, $27 million worth of pesticides were used in the district of Guntur in the state of Andhra Pradesh. With an average overuse of 20 per cent, $5.4 million of pesticides were wasted, which could have been avoided through better pest management. The yield losses due to pest resistance were estimated at $39.7 million. Gandhi and Patel show that in pesticide application, the red triangle label (extremely hazardous) chemicals have a share of 26 per cent in Andhra Pradesh, 39.7 per cent in Punjab and as high as 65 per cent in Gujarat of the reported use. The yellow triangle label (highly hazardous) group constitutes 59 per cent each in Andhra Pradesh and Punjab and 34 per cent in Gujarat of the reported use. An analysis of the pesticide use behaviour found that pesticide use levels are determined significantly by the extent of irrigation. The intensity of use is higher on small farms. Joshi (1997) shows that with the increase in pesticide use in Punjab, 525 insects have already developed resistance to pesticides. Marothia (1997) reports that nearly 70 per cent of all pesticides consumed by Indian farmers belong to banned or severely restricted categories in the developed countries. The Indian Council of Medical Research conducted an extensive study in 1993 covering all the states of India. Results of this study indicate that the samples far exceeded the tolerance limits of pesticide residuals in the case of milk, canned fruit products, poultry feeds and vegetables. The report emphasises that the private benefits of pesticides use should be evaluated against their social costs. It has been estimated that only 10 per cent of the total food grains production can be saved from increased pesticides use. Once the health hazards and other costs are imputed these benefits appear too meager.

Pesticides also find their way into the river through agricultural runoffs because the upstream catchment areas are intensely cultivated. Around 150 tonnes of pesticides and herbicides are used in the agricultural and plantation areas. The deadly impact of these chemicals has caused destruction of several types of fish and aquatic organisms in recent years.

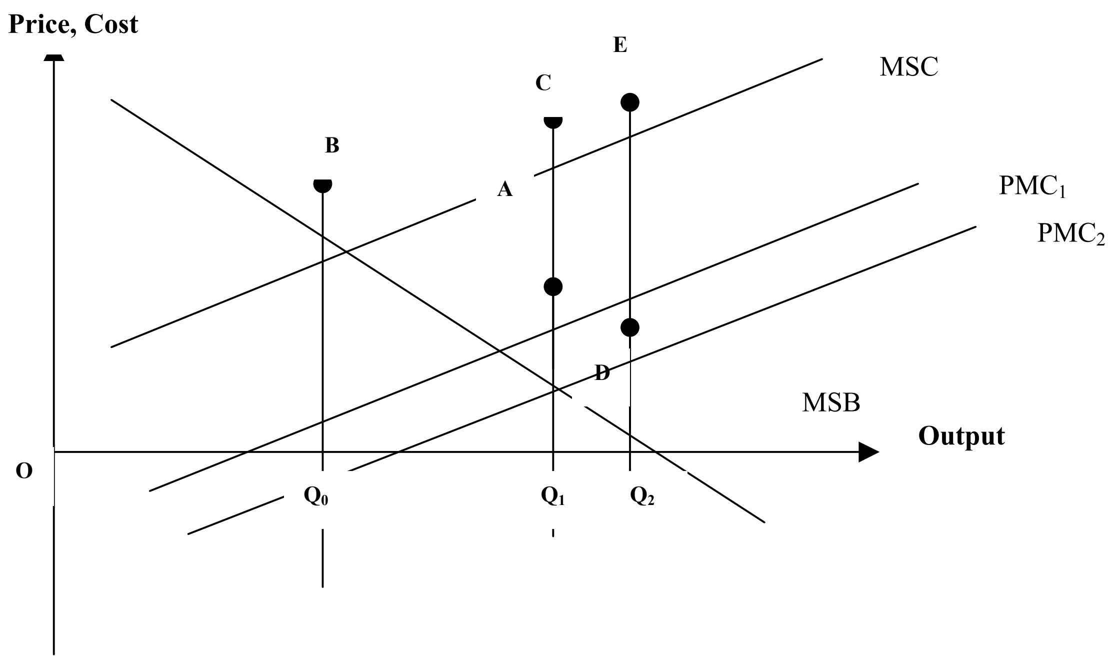
6. Identifying Environmental Impact of Subsidies to Inputs: An Analytical Framework

This section presents an analytical framework to identify the environmental impact of subsidies to agricultural inputs and analyse its implications for the sustainability of agriculture, and distinguish whether the subsidy is environmentally positive or perverse. This exercise focuses on three agricultural inputs, namely, fertilisers, irrigation and power.

Since individuals do not necessarily bear the full burden of welfare costs arising from pollution/environmental degradation caused due to their actions they may not have adequate incentives to take these costs into account in making decisions about their consumption and/or production activities. This results in an equilibrium like **A** (Fig. 3.1), where Private Marginal Cost (PMC_1) equals Marginal Social Benefit (MSB) and the output is Q_1. However the optimal equilibrium point is B, where the Marginal social Cost (MSC) equals MSB. It may be noted that at A, the social welfare loss is the area ABC. The government should intervene and take measures such that the PMC coincides with the MSC and there is no welfare loss. However, if the Government gives input subsidies instead, the PMC would shift down to PMC_2, and new equilibrium would be reached at D. Consequently, the social welfare loss would be EBD. It would be noted that the output Q_1 is already socially excessive because environmental externalities are ignored by the economic agents. Further subsidies would result in an increase in welfare loss by CEDA.

As mentioned earlier excessive use of fertiliser, pesticides, surface irrigation and electricity leads to adverse impacts on not only environmental resources but also on human health and welfare (Table 1). This section deals with their potential adverse impacts on two environmental resources, namely, water and land resources. These impacts can be on-site or off-site, quantitative or qualitative, and near-term or long-term. It would be seen from Table 1 that the potential burdens of these stressors to land are: soil contamination, water logging, salinity, erosion and nutrient leaching. The main negative consequences of soil degradation are on-farm decline of crop production, and off-farm damages as a result of siltation and contamination of water bodies. The magnitude of on-farm effects of soil degradation is not well documented. In general, quantitative empirical work on the relation between soil degradation and yields is scarce, because it requires long-term, longitudinal research. The key soil characteristics that affect yield are organic matter content, nutrient contents, waterholding capacity, soil acidity, topsoil depth and salinity. Yields may decline if one or more of these characteristics is unfavourably affected (depending on which factors are limiting yields in a certain region). Though soil stocks are often large enough to buffer soil degradation but after a critical level of e.g., soil acidity has been reached, a rapid productivity decline may take place.

Figure 1



In what follows an analytical model is presented to analyse the link between subsidies to farm input, impact on soil and water resources, and agricultural productivity.

6.1 The Crop Yield Function

There is evidence in the empirical literature (see Section 5) that subsidies to agricultural inputs encourage excessive and improper use of these inputs leading to environmental degradation which, in turn, results in a drag yield growth. Since there may be a point at which yields may respond more to the relief of environmental stress than to additional factor intensification, it is important to both identify the environmental factors that may partially be responsible for the slow down of agricultural output and study their impact on agricultural production. A crop yield function with traditional inputs and environmental quality/stress as independent variables is used to identify the effects of inputs used and environmental quality/stress on yield. Negative yield elasticities with respect to the environmental factors would indicate that environmental degradation has adverse effect on output. The coefficients of the traditional input variables would allow to compute the marginal productivity of inputs used. For illustration the yield function can be written as:

$$Y(t) = f\,[F(t), W(t), L, K\,] + g\,[E(t)] \qquad (1)$$

Where Y denotes the quantum of output of the crop in question per unit area and F, W, L, K, are fertiliser, water input, labour and capital per unit area respectively. E denotes the state of the environment or environmental quality (quality of soil, quality and availability of water etc.) and it is a stock variable. The assumption is that the impact of inputs and environmental quality e.g., soil quality on yields, are separable. Y is to be maximised subject to cost constraints.

Inefficient use and overuse of inputs is taken to have significant impact on the environmental quality variables year after year. Therefore, E(t) = f (F,W), where F and W are input applications of the past periods. The harmful impact of inefficient and overuse of inputs on agricultural productivity is through E. The effects of environmental degradation say land degradation are assumed to appear to the user of the land as loss of current possibilities and/or loss of production potential.

E comprises E_1, E_2 and E_3 – quality of soil, quality of water and availability of water respectively. It may be noted that the impact of inputs used on E_1, E_2 and E_3 may differ from one region/environmental situation to another. Further, there can be many indicators of deterioration in a given environmental resource – say soil – such as salinity, nutrient imbalance, top soil erosion, compaction of top soil. All of these may not be present/relevant in a given situation. Also, all of these may not be caused due to the use of a single agricultural input/practice. Further, deterioration/depletion in an environmental resource as well as crop yield are highly dependent on climatic and hydrological conditions. It is therefore quite likely that the environmental impacts will differ between regions having different climatic conditions and soil conditions. Of the E_1, E_2, E_3, obtaining an estimate of E_1 is most tricky. E_1 is the soil quality variable determined by a set of physical and chemical properties of the soil. These can be adversely affected overtime through excessive use of irrigation, fertiliser, pesticides and other inputs, and beneficially affected through amelioration measures such as use of organic fertiliser, leveling, provision of drainage etc. Some of these properties may be affected by the actions of others such as neighbouring farmers.

Soil degradation can be considered as the cause of declining yields, or as the consequence of agricultural practices, or as an integral part of agricultural production. In the latter case, the question of cause and effect is no longer relevant, because the processes are endogenised. *Yield functions in which soil/environmental quality is included as a determining variable, like the one used here, consider soil/environmental quality as a cause of yield decline*.

Although the yield function allows one to identify the impact of environmental stress and input use on yield, it does not help to find the extent to which environmental stress is actually is driven by subsidy induced demand for inputs under consideration.

One way to evaluate the effects of subsidy is to estimate the price elasticities. If the price elasticity for, say, fertiliser is negative, then a lower consumer price (everything else unchanged) may lead to higher consumption of fertiliser per unit of land, and hence increase in the stress on the environment. The demand for these inputs is taken to be a function of own price, price of complementary inputs, crop price and non-price factors like availability of credit and cropping pattern. The relative importance of independent variables can be assessed from the demand function. A high magnitude of own price elasticity would indicate that the demand for input is sensitive to its price. A declining (over time) marginal physical productivity of that input (which can be calculated from the yield function) coupled with high own price elasticity would indicate that there is a link between subsidy, demand for input, environmental stress and decline in productivity. Since fertiliser, water and electricity are the three variables which are subsidised and hence targeted here, it would be useful to briefly mention the likely environmental impact of use of these inputs.

6.2 Environmental Damage and Input Use

There are two classes of water quality problems associated with nitrogen fertilisers: high concentrations of nitrate in groundwater and damages from eutrophication in coastal and marine waters. High concentrations of nitrate may cause illness to livestock and also create oxygen deficits. Nitrogen transport leads to acidification of soils and of the waters of streams and lakes. There are limits as to how much plant growth can be increased by nitrogen fertilization. When the vegetation can no longer respond to further additions of nitrogen, the ecosystem reaches a state described as “nitrogen saturation”. As ammonium builds up in the soil, it is increasingly converted to nitrate and acidifies the soil. Nitrate being highly soluble also leaches into groundwater and runs off into streams. As these negatively charged nitrates seep away, they carry with them positively charged alkaline minerals such as calcium, magnesium and potassium – vital for plant growth – resulting in decrease in soil fertility. As calcium is depleted and the soil is acidified, aluminum ions are mobilised eventually reaching toxic concentrations that can damage tree roots.

“Water has an economic value and should be recognised as an economic good. Failure to recognise the economic value of water, has resulted in wasteful and environmentally damaging uses of the resource, rather than in achievement of efficient and equitable use, and encouragement of conservation and protection” (UN, 1992). Such policy pronouncements notwithstanding economic realities too often have not influenced water policy. Water is frequently artificially priced below its real value, thereby promoting wasteful and inefficient use and, consequently, increased scarcity, with dire consequences on quality. One of the most persistent environmental problems is contamination of ground and surface water by agricultural activities, application of pesticides, chemical fertilisers, and soil erosion. Chemical contamination can occur from residues that accumulate in the soil, run off into streams, and leach into deep-percolating groundwater. Contamination of streams and ground water causes health hazards for livestock and humans. Deep percolating water from irrigation accumulates and, when it reaches the topsoil, creates salinity which eventually eliminates agricultural productivity. Unsustainable extraction of groundwater may also adversely affect the crop productivity, restrict the choice of crop, cause salinity ingress in coastal areas and cause drying of wells. Over pumping of groundwater away from coastal areas can also lead to salt-water intrusion. This may cause irreversible damage to groundwater acquifers because it compromises their capacity to retain fresh water from rainfall and other sources.

6.3 Input Demand Functions

The two inputs considered here are fertiliser and water. Demand functions for these inputs can be derived by maximising the yield function subject to cost constraint. And for the given price of inputs the level of inputs demanded (F*, W*) can be determined. If F*> $\overline{\mathrm{F}}$ - where $\overline{\mathrm{F}}$ is environmentally sustainable amount of fertiliser for the given crop – it would imply that fertiliser consumption is more than the environmentally sustainable amounts hence any element of subsidy in fertiliser would be essentially perverse. Conversely, if F*< $\overline{\mathrm{F}}$ it would imply a positive subsidy. However, since information available in India on recommended doses of inputs used does not take the environmental sustainability into account such a comparison may not be appropriate until reliable information is made available on environmentally sustainable doses of inputs. Demand function for fertiliser may be written as:

$F = g_1 (P_F, P, P_W)$
(2)

where P_F, P and P_w are price of fertiliser, price of output and price of water – the complementary input – respectively.

$$\frac{\partial F}{\partial P_F} < 0, \frac{\partial F}{\partial P_W} < 0, \frac{\partial F}{\partial P} > 0$$

The demand function for water:

Water for irrigation has various sources: rainfall, surface water bodies and water from underground sources. Both groundwater and surface (canal) water may be used for irrigation. As noted earlier, there are substantial subsidies on surface water for irrigation and on electricity used in pumping groundwater. In regions where groundwater is brackish, canal water becomes the main source of irrigation. Regions where canal network is underdeveloped and groundwater is of good quality, use of groundwater is predominant. In some regions in spite of well developed canal systems irrigation is largely dependent on groundwater because it is relatively less costly due to huge subsidies on electricity. Thus, we formulate demand functions separately for canal water (W_1) and groundwater (W_2).

The demand function for canal irrigation can be written as:

$W_1 = g_3 (P_C, P, P_F, R)$
(3)

Where R is the rainfall for relevant months of crop in a state/farm.

$$\frac{\partial W_1}{\partial P} > 0$$

$$\frac{\partial W_1}{\partial P_C} < 0 \qquad \forall P_C < P_0 \qquad ....(a)$$

$$W_1 = W_0 \qquad \forall P_C \geq P_0 \qquad ....(b)$$

$$\frac{\partial W_1}{\partial R} > 0$$

Similarly, demand for groundwater would depend on the crop price (P), electricity charges (P_e), P_F and R.

$W_2 = g_3 (P_e, P, P_F , R)$
(4)

$$\frac{\partial W_2}{\partial P} > 0$$

$$\frac{\partial W_2}{\partial P_c} < 0 \qquad \forall \qquad P_e < (P)_0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(c)}$$

$$W_2 = W_0 \qquad \forall \qquad P_e \geq (P)_0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(d)}$$

$$\frac{\partial W_2}{\partial R} < 0$$

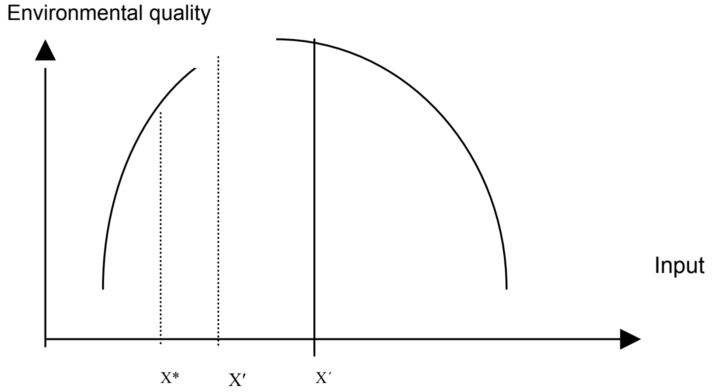
A low/high value of own price elasticity would imply low/high demand sensitivity of input with respect to its price. Those regions where input price elasticity is low and environmental benefits per unit decrease in application of that input is high, could be used as target zones to reduce subsidies. *An increase in input price would only marginally reduce its consumption (due to low price elasticity), thus current yield levels would not be affected much, at the same time burden of subsidies on the fiscal system and environmental stress would be reduced.*

6.4 Identifying Impact of Input Use on the Environment

This section attempts to identify the impact of use of agricultural inputs viz; fertiliser and irrigation on environmental resources: soil, and surface and underground water. *While the use of agricultural inputs helps improve the crop yield as well as maintain the environmental quality of soil, excessive use of these inputs results in environmental degradation which, in turn, negatively affects the yield and leads to increased welfare costs.*

Let Ê - an index of quality of an environmental resource – be a function of the input X used [Ê = z(X)] over the years. For any given environmental quality of a resource, use of input X upto X' leads to improvement in quality of this resource (Figure 2). Input use in excess of X´ in any period would lead to a decline in quality of this resource.

Figure 2



$$\frac{\partial \hat{E}}{\partial X} > 0 \forall X < X'$$

$$\frac{\partial \hat{E}}{\partial X} = 0 \, for X = X'$$

$$\frac{\partial \hat{E}}{\partial X} < 0 \forall X > X'$$

(i) As noted earlier, indiscriminate use of fertiliser has both on-farm and off-farm negative externalities. Thus, for fertiliser we consider 2 effects; (i) effect on soil quality and (ii) effect on water quality[1]. Let E_1 and E_2 be the soil and water quality indicators respectively.

$E_1 = h_1 (F)$ and $E_2 = h_2 (F)$
(5)

F is assumed to affect E_1 and E_2 over time.

[1] Affects groundwater through leaching and affects surface water bodies through agricultural runoffs.

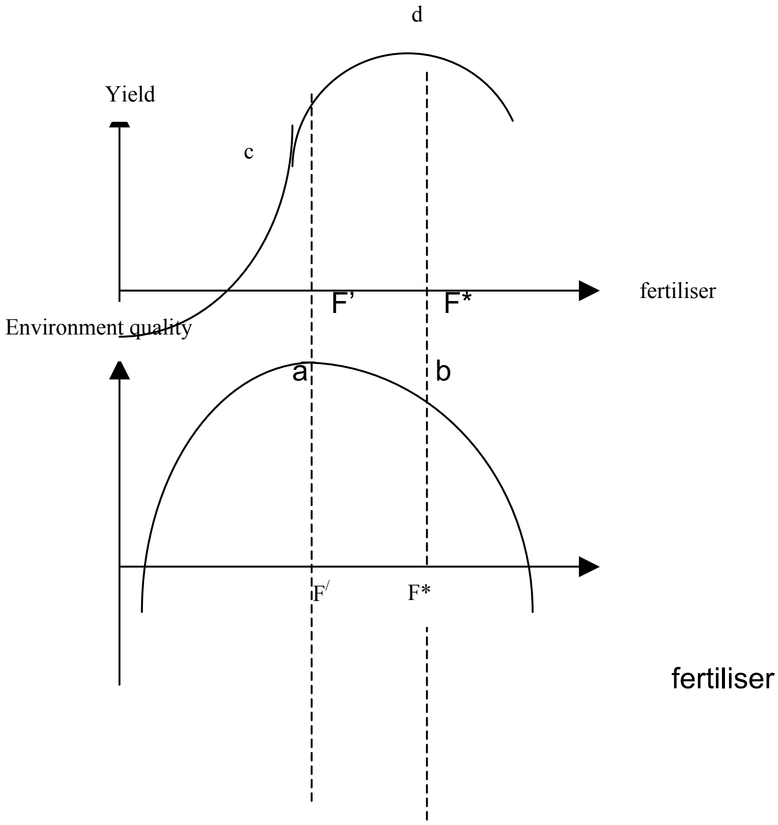
Fertiliser application improves the nutrient level of the soil on one hand and on the other hand every unit of fertiliser used disposes some toxic elements. The environment can withstand disposal of chemical residues to some extent. However, greater use of certain fertilisers affects the nutrient balance of soil and deposits too much synthetic residues, and the overall soil quality deteriorates and this deterioration is exhibited in decreasing improvements in yield per unit of fertiliser used in excess of $X^{/}$.

If environmental quality function was available for different agricultural and environmental situations it would be straight forward to determine the environmentally sustainable levels of the given inputs. However, this information is not available in the Indian context. Given this, an alternative way to identify the impact of input use on environmental quality and crop yield could be as follows.

There is evidence in the empirical literature to show that yield is sensitive to the quality of environmental resources. This is depicted in Figure 3. Let us take the environmental resource and input to be the soil and fertiliser respectively. It would be seen from Figure 3 that if the quantity of fertiliser applied is less than F′ in any period, the quality of soil would be on the left of the point 'a' (implying no negative effect on soil due to fertiliser application in period t) and increasing returns to scale for fertiliser for the given crop would be obtained. When soil quality is on the right of point 'a' but between points 'a' and 'b', changes in fertiliser application would have an impact on the yield which would manifest itself in deceleration in the rate of growth of yield. If current practices/levels of fertiliser use are such that the soil quality is on the right of 'b', an absolute decline in yield would be observed. Thus, the marginal productivity curve can be taken as a proxy to the environmental quality curve. However, the environment quality curve will be unique for the given crop, input, soil type, and any other relevant factors.

It may be useful to mention here that incorporating environmental information directly into production function analysis, using econometric techniques is becoming increasingly popular (Mausolff and Farber, 1995; Pattanayak and Mercer, 1998; and Byiringiro and Reardon, 1998). The limitation of this approach is that it is difficult to unequivocally determine the exact effects of soil/environmental degradation on yields in the short-run. Comparative studies of more or less severely degraded phases in the same region may show the difference between severely and slightly degraded soil (Weesies et al., 1994; Olson et al., 1994), but do not provide the information to quantify the dynamic effects of soil degradation on yields.

Figure 3



As noted earlier, the environmental impact of inputs used may differ from one region/environmental situation to another, both in ways and magnitudes under different cropping system and farming methods. Further, there can be many indicators of deterioration in a given environmental resource, all of these may not be affected in a given situation. Therefore, there is a need for case studies focussing on one or more significant impacts of an area's predominant production practices. To gauge potential improvement/deterioration in environmental resource due to alternative production practices and inputs use, long-term field studies would be required. The rates of erosion of natural resources obtained from such studies would allow quantification of environmental costs under different scenarios and in framing of related policies.

(ii) Waterlogging and salinisation of soil are externalities which arise due to excess and inefficient use of canal irrigation. The impact of water logging and salinity on soil quality can be represented by:

$E_3 = h_3 (W_1)$ (6)

(iii) Several studies have shown that subsidies on electricity have induced excessive withdrawal and application of water which has led to decline in groundwater table. This resource assumes special importance as it has a bearing on sustainable agricultural development. Let the state of groundwater table be represented by:

$E_t = \text{Groundwater level}_{t-1} + \text{Water recharge}_{(t)} - W_{2(t)}$ (7)

E_t determines both the cost and availability of water for future agriculture. The sustainable quantity of water withdrawal would vary from region to region depending on the groundwater level and water recharge rate in the given region. Electricity consumption e is related to water withdrawal by the following function:

$$e = h_4 (W_2) \tag{8}$$

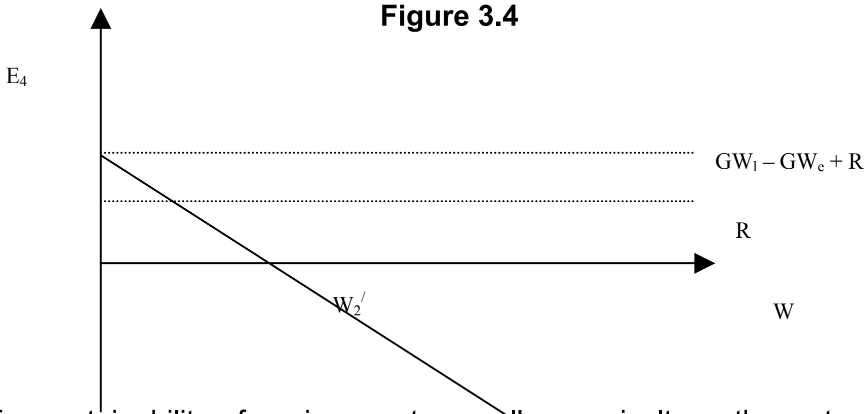
$$e = h_5 (P_e, P, P_F) \tag{9}$$

In (7) above if the rate of water withdrawal (W) is more than the rate of natural recharge (R), the groundwater level would fall. Let GW_l be the groundwater level at the beginning of period t, GW_C be the critical level of groundwater below which the groundwater is in danger of terminal decline. The existence of a critical level may be explained by factors such as salinity ingress in coastal areas and salt water intrusion and irreversible damage to groundwater aquifers in areas away from coastal areas. The state of groundwater at time t can be represented as:

$$E_4 = (GW_l – GW_C) + (R – W) \tag{10}$$

This relationship is shown in Figure 3.4.

Figure 3.4



For sustainability of environment as well as agriculture, the water withdrawal should not exceed $W_2^{/}$.

The demand functions for fertilisers and irrigation water (2), (3) and (4) would give $\frac{\partial F}{\partial P_F}, \frac{\partial W_1}{\partial P_W} and \frac{\partial W_2}{\partial P_e}$. We generalise this as $\frac{\partial X}{\partial P_X}$, or the change in input (X) demanded per unit change in price. Let $\frac{\partial E}{\partial X}$ be the rate of environmental quality change due to the change in the quantity of X.

$\frac{\partial E}{\partial X}$ can be obtained from (5), (6) and (10).

Hence, $\frac{\partial E}{\partial X}.\frac{\partial X}{\partial P_X} = \frac{\partial E}{\partial P_X}$

(11)

From this expression we can get the environmental quality change due to change in price of the given input at the corresponding level of input use and price.

7. Distinguishing between Positive and Perverse Subsidies

From Figures 2, 3 and 4 we have the environmentally sustainable levels of inputs use - X, F and W_2. It would be seen from these figures that the optimal levels of input correspond to the inflexion points of the yield function for fertiliser and surface irrigation. The environmentally sustainable level of withdrawal of groundwater is at W_2.

If F* (input demand of the farmer) > F′ and W* > W′ for surface irrigation and $W^* > W_2$ for groundwater irrigation, then the subsidy element in P_F, P_W and P_e would be perverse. In other words, the price change necessary to bring down input use to its optimal level is perverse subsidy. If F* and W* are less than optimal levels then the necessary price change to increase input use to optimal level would be positive subsidy.

From the demand functions we will get $\frac{\partial F}{\partial P_F}$ and $\frac{\partial W}{\partial P_W}$. F*>F would indicate the need to decrease F* through change in P_F.

$\Delta F = F^* - F'$

The necessary change in price will be ΔP_F, where

$$\frac{\partial F}{\partial P_F} = \frac{\Delta F}{\Delta P_F} or \Delta P_F = \frac{\Delta F}{\partial F / \partial P_F}$$

Therefore, ΔP_F is the amount of perverse subsidy in the given input.

The analytical framework presented above focussed its attention in identifying the environmentally optimal levels of input use and also served to derive the price changes needed in order to move the farmers towards the social optimum.

We next address this issue as an optimal control problem and obtain a price structure for the given input that will address the problem of overuse and will be environmentally optimal. This is done for nitrogenous fertiliser and the control variable for the social planner is the price of nitrogenous fertiliser. A similar analysis for water can be found in Nir Becker, et. al. (2000).

8. An Environmentally Optimal Nitrogen Fertiliser Price Regime

Until recently, the supply of nitrogen available to plants -- and ultimately to animals -- has been quite limited. Although it is the most abundant element in the atmosphere, plants cannot use nitrogen from the air until it is chemically transformed, or fixed, into ammonium or nitrate compounds that plants can metabolise. In nature, only certain bacteria and algae (and, to a lesser extent, lightning) have this ability to fix atmospheric nitrogen, and the amount that they make available to plants is comparatively small. As a consequence, nitrogen is a precious commodity -- a limiting nutrient -- in most undisturbed natural systems. All that has changed in the past several decades. Driven by a massive increase in the use of fertiliser, the burning of fossil fuels, and an upsurge in land clearing and deforestation, human activities now contribute more to the global supply of fixed nitrogen each year than natural processes do. There is a limit to the amount of nitrogen that natural systems can take up; beyond this level, serious harm can ensue. In terrestrial ecosystems, nitrogen saturation can disrupt soil chemistry, leading to loss of other soil nutrients such as calcium, magnesium, and potassium, acidification of soil and ultimately to a decline in fertility. Curbing the nitrogen overload will mean acting on several fronts. Making fertiliser applications more efficient is one of the most promising options. This problem is also evident in developing countries like India where one of the major factors resulting in the overuse of nitrogen fertiliser is the improper price structure of the fertiliser. Nitrogen fertiliser is heavily subsidised and this results in its overuse, so much so that fertiliser subsidy bill touched Rs. 100 billion in 1997-98 almost 1one per cent of GDP[2]. Here we will present a framework for attaining an environmentally optimal nitrogen fertiliser price regime. But first we need an understanding of environmental impact of nitrogen fertiliser overuse.

8.1 The Nitrogen Cycle[3]

Nitrogen is an essential component of proteins, genetic material, chlorophyll, and other key organic molecules. All organisms require nitrogen in order to live. It ranks fourth behind oxygen, carbon, and hydrogen as the most common chemical element in living tissues. Until human activities began to alter the natural cycle, however, nitrogen was only scantily available to much of the biological world. As a result, nitrogen served as one of the major limiting factors that controlled the dynamics, biodiversity, and functioning of many ecosystems.

The Earth's atmosphere is 78 percent nitrogen gas, but most plants and animals cannot use nitrogen gas directly from the air as they do carbon dioxide and oxygen. Instead, plants — and all organisms from the grazing animals to the predators to the decomposers that ultimately secure their nourishment from the organic materials synthesised by plants — must wait for nitrogen to be "fixed," that is, pulled from the air and bonded to hydrogen or oxygen to form inorganic compounds, mainly ammonium (NH_4) and nitrate (NO_3), that they can use.

The amount of gaseous nitrogen being fixed at any given time by natural processes represents only a small addition to the pool of previously fixed nitrogen that cycles among the living and nonliving components of the Earth's ecosystems. Most of that nitrogen, too, is unavailable, locked up in soil organic matter — partially rotted plant and animal remains — that must be decomposed by soil microbes. These microbes release nitrogen as ammonium or nitrate, allowing it to be recycled through the food web. The two major natural sources of new nitrogen entering this cycle are nitrogen-fixing organisms and lightning.

2 Gulati, A. and Sudha Narayan (2000), "Demystifying fertiliser and Power Subsidies in India", EPW March 2000.

3 For details see; Kasica, Amy Fay (1997), "Something to Grow on", Cornell Cooperative Extension, Dept. of Floriculture and Ornamental Horticulture, Cornell University.

8.2 *Human-Driven Nitrogen Fixation*

During the past century, human activities clearly have accelerated the rate of nitrogen fixation on land, effectively doubling the annual transfer of nitrogen from the vast but unavailable atmospheric pool to the biologically available forms. The major sources of this enhanced supply include industrial processes that produce nitrogen fertilisers, the combustion of fossil fuels, and the cultivation of soybeans, peas, and other crops that host symbiotic nitrogen-fixing bacteria[4].

The impacts of human domination of the nitrogen cycle that we have identified with certainty include:

- Losses of soil nutrients such as calcium and potassium that are essential for long-term soil fertility;

- Substantial acidification of soils and of the waters of streams and lakes in several regions;

- Increased global concentrations of nitrous oxide (N_2O), a potent greenhouse gas, in the atmosphere as well as increased regional concentrations of other oxides of nitrogen (including nitric oxide, NO) that drive the formation of photochemical smog;

- Greatly increased transport of nitrogen by rivers into estuaries and coastal waters where it is a major pollutant.

8.3 *Nitrogen Saturation and Ecosystem Functioning*

There are limits to how much plant growth can be increased by nitrogen fertilisation. At some point, when the natural nitrogen deficiencies in an ecosystem are fully relieved, plant growth becomes limited by scarcity of other resources such as phosphorus, calcium, or water. When the vegetation can no longer respond to further additions of nitrogen, the ecosystem reaches a state described as “nitrogen saturation.”

As ammonium builds up in the soil, it is increasingly converted to nitrate by bacterial action, a process that releases hydrogen ions and helps acidify the soil. The build-up of nitrate enhances emissions of nitrous oxides from the soil and also encourages leaching of highly water-soluble nitrate into streams or groundwater. As these negatively charged nitrates seep away, they carry with them positively charged alkaline minerals such as calcium, magnesium, and potassium. Thus human modifications to the nitrogen cycle decrease soil fertility by greatly accelerating the loss of calcium and other nutrients that are vital for plant growth. As calcium is depleted and the soil acidified, aluminum ions are mobilised, eventually reaching toxic concentrations that can damage tree roots or kill fish if the aluminum washes into streams. Trees growing in soils replete with nitrogen but starved of calcium, magnesium, and potassium can develop nutrient imbalances in their roots and leaves. This may reduce their photosynthetic rate and efficiency, stunt their growth, and even increase tree deaths.

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4 Brah, N. and Fred Schellaman (1999), "Green Purchasing of Agri-foods", Background Paper, Department of environmental management, De Bilt, Netherlands.

8.4 Future Prospects and Management Options

8.4.1 Fertiliser Use

The greatest human-driven increases in global nitrogen supplies are linked to activities intended to boost food production. Modern intensive agriculture requires large quantities of nitrogen fertiliser; humanity, in turn, requires intensive agriculture to support a growing population. Consequently, the production and application of nitrogen fertiliser has grown exponentially, and the highest rates of application are now found in some developing countries with the highest rates of population growth. Curtailing this growth in nitrogen fertiliser production will be a difficult challenge.

The challenge is to obtain a price structure for the nitrogen fertiliser that will address the problem of overuse and will be environmentally optimal. Here we try to address the issue as an optimal control problem, where the control variable for the social planner is the price of nitrogen fertiliser.

In some optimal control models the environmental degradation is taken as a flow variable[5]. However Foster (1980) uses pollution both as a stock and a flow variable. In this model we capture the environmental impact of the overuse of nitrogen fertiliser (thus taken as flow variable), as well as the impact of nitrogen fixed in the ecosystem (taken as a stock variable).

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5 Foster, Bruce A. (1980), "Optimal Energy Use in a Polluted Environment", *Journal of Environmental Economics and Management*, pp. 321-333.

8.4.2 The Model

Let *P(t)* denote the price of nitrogen fertiliser normalised by the price of output of the agricultural produce. Let *n(P)* be the demand/use of nitrogen fertiliser. *N(t)* is a measure of nitrogen fixed in the ecosystem. The agricultural yield depends on the use of nitrogen fertiliser and the nitrogen fixed in the ecosystem:

$$Y = F\,[N(t),\, n(P)] \tag{1}$$

We assume an additive quadratic functional form for yield (*Y*) in terms of use of nitrogen fertiliser (*n*) and the nitrogen fixed in the ecosystem (*N*). The yield function takes the following form:

$$Y = \alpha + \beta N - \gamma N^2 + \delta n - \varepsilon n^2 \tag{2}$$

The nitrogen fertiliser demand by the farmer is obtained from his optimisation behaviour. Assume a simple profit maximising behaviour of the farmer who is faced with a production function that is quadratic in nitrogen fertiliser use. We get a simple linear demand function of nitrogen fertiliser for the farmer. Demand for nitrogen fertiliser *n(P) is*:

$$n = \xi - \eta P \tag{3}$$

The change in nitrogen fixed in the ecosystem an any point of time will depend on the use of nitrogen fertiliser and the natural rate of change in the stock. Thus we have the following relation:

Since *n* depends on *P*, the only other variable in the model is *N*. In the model

$$\dot{N} = \lambda - \omega P - \nu N \tag{4}$$

P is the control variable as *n* can be substituted by it. Since *N* is the dynamically driven by the control variable *P*, it is clear that *N* plays the role of state variable here and the equation of motion for *N* is given by *(4)*.

8.4.3 The Optimal Control Problem

If a social planner is appointed to plan and chart the optimal time path of the price variable *P* taking the environment impact of fertiliser use into account the optimal control problem in the infinite horizon that he must solve takes the form:

$$\underset{P}{Maximise} \int_0^{\alpha} Y[N, n(P)] e^{-pt} dt$$

$$subjectto\ \dot{N} = \lambda - \omega P - \nu N \tag{5}$$

$$N(0) = N_0$$

$$and \quad P(t) \geq 0$$

Where *p* is the discount factor.

8.4.4 The Maximum Principle

The current value Hamiltonian for the problem is:

$$H_c = Y() + m(\lambda - \omega P - vN) \tag{6}$$

Where

$$m = \mu e^{\rho t} \tag{7}$$

and μ is the costate variable i.e. shadow price of the state variable *N.* The maximum principle conditions are:

$$\underset{P}{Maximise} \quad H_c$$

$$\dot{N} = \frac{\partial H_c}{\partial m} \qquad \text{(equation of motion for } N\text{)} \tag{8}$$

$$\dot{m} = -\frac{\partial H_c}{\partial N} + \rho m \qquad \text{(equation of motion for m)}$$

and the transversality conditions

To maximise H_c with respect to the control variable *P*, where $P \geq 0$, the Kuhn–Tucker condition is $\partial H_c/\partial P \leq 0$, with the complementary slackness proviso that $P(\partial H_c/\partial P) = 0$. But inasmuch as we can rule out the extreme case of $P = 0$, we postulate $P > 0$. It then follows from the complementary slackness, that for maximisation we must satisfy the condition:

Where $n_P = \partial n/\partial P$, from (9) we obtain the condition:

$$\frac{\partial H_c}{\partial P} = \delta n_P - 2\varepsilon n n_P - \mathrm{m}\omega = 0 \tag{9}$$

$m(t) = \; - P(t)$

(10)

Where $\chi = 2\varepsilon\eta^2/\omega > 0$, and $\varphi = (-\delta\eta + 2\varepsilon\eta\xi)/\varpi$, hence we can not be sure about the sign of φ.

Condition *(10)* does maximise H_c because:

$$\frac{\partial^2 H_c}{\partial P^2} = -2\varepsilon\eta^2 < 0 \tag{11}$$

The equation of motion for the state variable N can be read directly from the second line of *(8)*, but it can also be derived as:

$$\dot{N} = \frac{\partial H_c}{\partial m} = \lambda - \omega P - vN \tag{12}$$

And the equation for motion for the current value multiplier *m* is:

$$\dot{m} = -\frac{\partial H_c}{\partial N} + \rho m = -(\beta - 2\gamma N - \nu m) + \rho m \tag{13}$$
$$= -\beta + 2\gamma N + (\nu + \rho)m$$

The ensuing discussion will be based on the current value maximisation principle conditions *(10), (12)* and *(13).* Since there is no explicit *t* argument in these, we have an autonomous system. This makes possible a quantitative analysis by a phase diagram.

8.4.5 Constructing a Phase Diagram

Since the two differential equations *(12)* and *(13)* involve the variables *N* and *m* the normal phase diagram will be in *Nm* space. We shall depart from this procedure and using (10) we will eliminate the m variable. In doing so we shall create a differential equation in *P*. The analysis can then be carried out with a phase diagram in the *NP* space. We begin by differentiating *(10)* with respect to t, to obtain the following expression:

This expression together with *(10)* when used in *(13)* gives us:

$$\dot{P} = \Phi - \Gamma N + \Psi P \tag{15}$$

Where Ψ = $(\nu+\rho) > 0$, $\Gamma = 2\gamma/\chi > 0$ and $\Phi = [\beta-+(\nu+\rho)\phi]/(-\chi)$. Hence we do not know the sign of Φ. We now have to work with the differential equation system given by *(15)* and *(12)*. To construct the phase diagram, we first draw the following curves:

$$\mathrm{N} = (\Phi/\Gamma) + (\Psi/\Gamma)P \qquad \text{(Equation for } \dot{P} = 0 \text{ curve)} \tag{16}$$

These curves are drawn in *NP* space in figure 1.

$$\mathrm{P} = (\lambda/\omega) - (\nu/\omega)N \qquad \text{(Equation for } \dot{N} = 0 \text{ curve)} \tag{17}$$

8.4.6 The Phase Diagram Solution

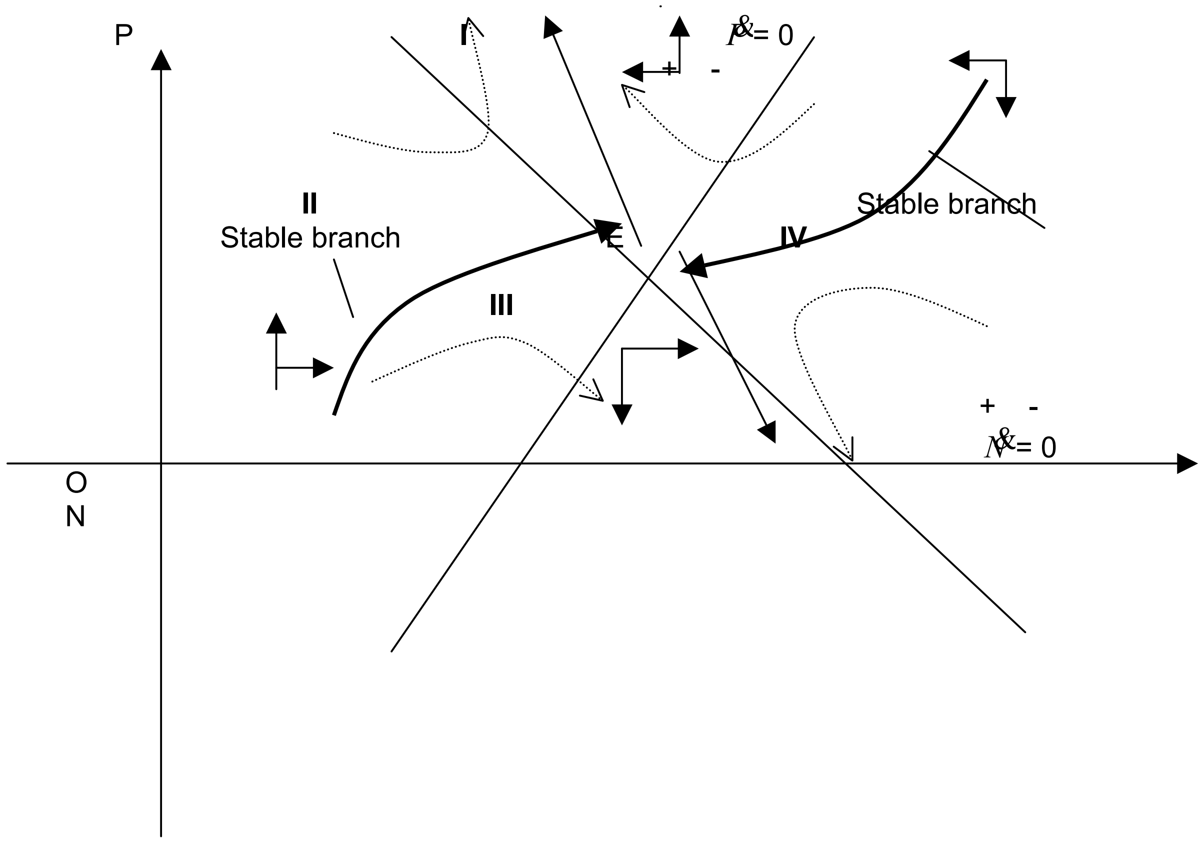
To prepare an analysis of phase diagram, we have, in figure 3.5, added vertical and horizontal sketching bars. Point E where both N and P are stationary represents the intertemporal equilibrium of the system. At any other point however either N or P (or both) would be changing over time. For clues about the general directions the streamlines (Phase trajectories) will take, we partially differentiate *(15)* and *(12)* to get:

$$\frac{\partial \dot{N}}{\partial P} = -\omega < 0 \tag{18}$$

$$\frac{\partial \dot{P}}{\partial N} = -\Gamma < 0 \tag{19}$$

and

Figure 3.5



According to *(18)*, as *P* increases, $\dot{N}$ Should follow the (+, 0, -) sign sequence. So, the *N*-arrowheads must point eastward below the $\dot{N} = 0$ curve, and westward above it. Similarly *(19)* indicates that $\dot{P}$ should follow the sign sequence (+, 0, -) as *N* increases. Hence *P* arrowheads should point northward to the above $\dot{P} = 0$ curve, and southward below it. The streamlines drawn in accordance with such arrowheads yield a saddle-point equilibrium at point E, ($\bar{N}, \bar{P}$), where $\bar{N}$ and $\bar{P}$ denote the intertemporal equilibrium values of *N* and *P,* respectively.

The only way the system can ever move towards the steady state is to get onto one of the stable branches – the dark lines – leading to point E. this means given the initial nitrogen fixed in the system N_0 we must choose an initial price P_0 such that the ordered pair (N_0, P_0) lies on a stable branch. The dynamic forces of the model represented by the solution of simultaneous equation system *(15)* and *(12)*, would lead us to the intertemporal equilibrium E. The requirement that we must choose an initial price P_0 such that the ordered pair (N_0, P_0) lies on a stable branch takes care of the transversality conditions.

8.5 Conclusion

If the system is not on one of the stable branches then the dynamic forces of the model will lead us into a situation of either

(i) ever increasing N accompanied by ever decreasing P (along the stream lines that point towards the Southeast), or

(ii) ever increasing P accompanied by ever decreasing N (along the stream lines that point towards the Northwest).

Situation (i) implies ever-increasing nitrogen fixation, which will have serious long-term environmental consequences, and situation (ii) implies ever-increasing nitrogen fertiliser price leading to decreasing nitrogen fixation, which in the long term will have serious consequences for food security. Hence the environmentally optimal solution is to choose an initial price P_0 such that the ordered pair (N_0, P_0) lies on a stable branch, then the dynamic forces of the model represented by the solution of simultaneous equation system *(15)* and *(12)*, would lead us to the intertemporal equilibrium E. Point E gives the environmentally optimal price of nitrogen fertiliser $\overline{P}$ in the equilibrium and the stable branches give the environmentally optimal time path of the nitrogen price.

Physical and Economic Accounting of Land Resources: A case of State of Gujarat

Indira Hirway

Land is one of the basic components of environment. It performs three major functions as far as the interface between environment and economic development is concerned:

1. Land performs environmental functions, such as, retention of water and moisture as well as retention of soil nutrients to support vegetation cover, maintenance of geological properties of land etc. for sustenance of environment, bio diversity etc.

2. Land performs economic functions related to agriculture and allied activities such as, production of food crops, non-food crops and raw materials for industries, production of fuel and fodder for human beings and animals, production of mineral resources, sustaining forest produce – all of which support and promote economic development, and

3. Land also has other economic functions in the non-agriculture sector. It provides space for housing and settlements in rural and urban areas, as well as for industries, trade and other non-agricultural uses.

All these functions are, to an extent, independent of each and there is a need to maintain a balance among them so that none of these functions encroaches upon the others in a non-sustainable way.

Sustainable land use therefore implies that land is utilized in a way that it can perform all the three functions in a sustainable manner. It is important therefore that the pattern of land utilization or the allocation of land among various uses is done in such a way that it minimizes conflicts and makes most efficient trade-offs between the different uses, and in the process provides the greatest sustainable benefits. Land degradation therefore should be viewed in the context of its different uses.

How can one define land degradation? It is clear that all degradation of land, i.e. loss of soil and moisture of land under non-agricultural use need not be treated as land degradation. Land degradation can be said to be taking place,

1. When land under wasteful uses increases that is, land under "barren and uncultivable land" increases, or land under cultivable wasteland, fallow land or wasteland increases.
2. When forests are cut off for different reasons in a way that it affects environmental sustainability adversely. That is, land under forests is reduced beyond the required environmental norms, with the result that it affects environmental sustainability adversely.
3. When land under cultivation declines, implying reduction in agricultural production. Though it can be argued that if this land is put to some better alternative use, the decline in cultivated land should not be seen as a negative development. However, we assume this decline as a negative development in Gujarat (India) where a significant proportion of workforce is still engaged in agriculture and where there is considerable wasteland available for non-agricultural use.

4. When agricultural land is degraded reducing agricultural productivity.

Process of Land Degradation

What are the major factors, which have been responsible for land degradation in the state: One can list the following as the major factors responsible for land degradation in Gujarat:

- Lack of awareness and knowledge combined with poor organization of agricultural research and extension has contributed to soil degradation.
- Lack of proper provision for drainage and improper management of canal irrigation systems has contributed to water logging and salinity in canal irrigated command areas.
- In the absence of community organization for their management, common pool resources like gaucherlands and wastelands are prone to degradation due to unregulated use and
  Rising requirements of fuel wood and timber due to increasing human population
- and of fodder due to increasing livestock population have led to degradation of forest area, Gauchar lands and wastelands.
- Improper disposal of industrial wastes is causing soil degradation.
- Pricing methods for and subsidies on agricultural inputs have contributed to salinity of soil.
- Lack of proper policies for the use of land, water and natural resources as well as poor implementation of the existing policies have contributed to soil degradation.

Impact of Soil Degradation :

The impact of land degradation is likely to be as follows:

- It has reduced the productive use of areas (net sown area)
- It has adversely affected cropping pattern and intensity of cropping.
- It has reduced productivity and income available from crop lands, forest lands and grass lands, and

It has led to increase in migration of people in search of employment and income and.

Quick Valuation:

Under the present exercise of quickly valuing the cost of land degradation we undertake the following:

1. We examine the changes in the land put to wasteful use during the 1980s and 1990s, and estimate its value using the right price.
2. We examine the changes in the cultivated area (net sown area) during the 1980s and 1990s, and estimate its value using the right price, and
3. We examine the land degradation in general during the period, and estimate its monetary value.

All the three exercises mentioned above define land degradation as the process of loss of current or potential biological or economic productivity of land. This may take place due to climatic variations and human activities. This broadly includes the process of soil erosion by wind and water, soil salinity and alkalinity, water logging, long-term loss of vegetation, and deterioration in various other physical, chemical and biological or economic properties of land. Land degradation, however, is a wider concept and it includes soil degradation as well as degradation of water, vegetation, land scape and micro climatic components of an ecosystem.

The major sources of data on land degradation for Gujarat are as follows:

- Land utilization statistics from the Department of Agriculture, Government of Gujarat.
- Statistics on soil and land for Gujarat published by natural Bureau of Soil Survey and Land Use Planning (NBSS & LUP), Nagpur.
- National Remote Sensing Agency (NRSA), and Remote Sensing and Communications (RESECO), Gandhinagar.
- Central Soil Salinity Research Institute, Karnal (Salt Affected Soils of Gujarat: Extent, Nature and Management).
- Taluka level soil survey reports, Department of Agriculture, Gandhinagar and Soil Survey Divisions at Mehsana and Nadiad.
- Other Estimates by Independent Scholars and Institutions like SPWD.

The major problems with these data, however are that (a) these data are not time series data. They do not give comparable estimates of wasteland in the 1980s and 1990s (except for the land utilization statistics of the government of Gujarat, which are not fully satisfactory. As a result, we cannot estimate the value of land degradation in the 1980s and 1990s, and (b) we do not have data on the wasteland separately for agricultural land and other land. We therefore cannot separate the degradation on agricultural land and on other areas.

Using the long-term data of Land Utilization Statistics and other data, which give information on changes during short periods, we have tried to estimate the value of land degradation in this section.

A. Land put to wasteful uses: Land Utilization Statistics

Though there are some problems with the land utilization data, the official data presented by the Department of Agriculture*. Government of Gujarat, we use these data because these data do present the broad land use pattern correctly and because these are the only data available on a time series basis to cover the period of the present study.

According to these data, at present (Three yearly average in the late 1990s), Gujarat has about 19.60 m. hectares of geographical area, which makes it the seventh largest state in India. The reporting area of the state is 18.83 m. hectares for which land use statistics are available. Of this total reporting area about 51% is under cultivation (which includes current and other fallow land), and 49 % is uncultivated area.

The uncultivated area includes 6% of land under non-agricultural use and about 10% under forests (the actual forest cover is only on about 6% land). The rest of the area, that is, barren and uncultivable land (14%). grazing and pasture land (4%) and uncultivable waste (15) can be treated as land put to wasteful use or wastelands. The total wasteland comes to about 6.21 m hectare or 33% of the reporting area of the state, which is excluding forest wastelands. Since forest wastelands have been dealt with separately, we focus here as land degradation in non-forest areas.

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* We have discussed these in our earlier report.

As per the land utilization classification, the land put to wasteful uses includes barren and uncultivable land, permanent pastures and cultivable waste. The following table 5.1 presents these data for 1980-81, 1990-91 and 1995-96.

Table 5.1: Land under Wasteful Use in Gujarat 1980-81 to 1995-95 (in '00 ha)

	1980-81	1990-91	1995-96	Change 1980-81 to 1995-95
Barren and uncultivable land	25038	26081	14495	-10543
Cultivable waste	19805	19785	6515	-13290
Permanent pastures	8471	8472	289	-8182
Total	**53914**	**54338**	**21299**	**-32615**

Source: Department of Agriculture, Gandhinagar

The table indicates that the total land under wasteful use has declined in the state by 3261500 ha. During the 1980s and 1990s (almost). This is a decline of about 60%!!

However, when we looked at the district data carefully, it became clear that the decline is due to the abnormal behaviour of Kachchh district where the main decline has taken place. Though this decline has not been explained well by experts, it is agreed that at least a part of the decline is statistical, emanating from changes in the classification of land. When Kachchh district is excluded from the changes in land out to wasteful uses, the picture changes to Table 5.2

Table 5.2: Land under Wasteful Use in Gujarat (excluding Kachchh) 1980-81 to 1995-95 (in '00 ha)

	1980-81	1990-91	1995-96	Change 1980-81 to 1995-95
Barren and uncultivable land	7712	8999	10180	+2468
Cultivable waste	3793	3036	3033	-760
Permanent pastures	7771	7771	7770	-1
Total	**19275**	**19806**	**20983**	**+1708**

Source: Department of Agriculture, Gandhinagar

Table 5.2 shows that when Kachchh is excluded, one observes an increase in the land put to wasteful use by 170800 hectare during the early eighties and late nineties. This is an increase of about 9%.

The valuation of this increase can be done by using the replacement method. Under the assumption that the cost of rejuvenation of oone hectare of land is Rs 6000 to Rs 7000, the value of this increased wasteland will be Rs 108.48 crores to Rs 119.56 crores.

B. **Wastelands in the state**

When such lands are included, as The above estimates of wastelands, however, do not include the land degradation that has taken place in other land uses, such as land under cultivation or land under fallow lands. several studies have shown, Gujarat has much larger area under degraded lands. Table 5.3 presents these alternative estimates on wastelands in Gujarat.

Table 5.3: Estimates of wastelands in Gujarat. (Lakh ha.)*

Source	**Year**	**Wasteland (Lakh ha.)**
National commission on Agriculture	1976	175
Directorate of Economics and Statistics GoG	1978-79	38.40
NWDB, MoEF	1985	123
SPWD* and Government of India	1988	71.53
NBSS & LUP**	1994	81.34
Land utilization Statistics***	1995-96	75.50
NRSA	1988-95	75.50

Source: As mentioned in the table.

Notes:

* Covers non-forest area – according to this estimate by Bhumbla and Khare 24.17 Lakh Ha. Of this wasteland is located in net sown area.

** Covers Non-forest area & excludes salt flat/Rann areas.

*** Covers non-forest area and excludes cultivated area.

The above table presents different sets of data, which are not comparable due to the different coverage and different methods adopted in arriving at the estimates. However, the table clearly indicates that the estimates of wastelands arrived at by using the land utilization data are gross under estimation. The estimates of NRSA (based on Satellite imageries) and of NBSS & LUP are three to four times higher.

If we assume that the estimates of national Wasteland Board (MoEF), 1985 are broadly comparable with the NBSS & LUP estimates of 1994, we can say that the wasteland (in non-forest areas) in the state has increased by 9.81 lakh ha., the cost of regeneration of which will be Rs. 588.60 crores to Rs 686.70 crores.

C. Land Under DPAP and DDP :

Alternatively, one can use the areas under DPAP (Drought Prone Area Programme) and DDP (Desert Development Programme) in the late seventies/early eighties and mid /late nineties to estimate the increase in wastelands in the state (tables 5.4 and 5.5). The table indicates that there has been a considerable increase in the coverage of DPAP and DDP in the state. There were 51 blocks under these programmes in 1980-81 (43 under DPAP and 8 under DDP) which increased to 99 blocks in the nineties (52 under DPAP and 47 under DDP). In term of the area covered by these programmes, the coverage of DDP increased by more than six times during this period, while there was a marginal decline in the area under DPAP (the decline was due to all the talukas of Kachchh and Jamnagar shifting to DDP). The table clearly indicates that there has been gross degradation of environment (including land) in Kachchh, Jamnagar, Banaskantha, Surendranagar and Rajkot, the districts affected by desertification in North Gujarat and North Saurashtra.

Table 5.4: Area & number of Talukas under DPAP & DDP in the year of 1980-81 to 1999-2000

		1980-81						1999-2000					
Sr. no.	District	No. of Taluka			Area in Sq. Kms.			No. of Taluka			Area in Sq. Kms.		
		DPAP	DDP	Total	DPAP	DDP	Total	DPAP	DDP	Total	DPAP	DDP	Total
1	Ahmedabad	2	0	2	4432.24	0.00	4432.24	2	0	2	4432.24	0.00	4432.24
2	Amreli	8	0	8	5361.11	0.00	5361.11	9	0	9	6183.39	0.00	6183.39
3	Banaskantha	0	6	6	0.00	6820.10	6820.10	0	7	7	0.00	7985.37	7985.37
4	Baroda	0	0	0	0.00	0.00	0.00	5	0	5	3513.69	0.00	3513.69
5	Bharuch	0	0	0	0.00	0.00	0.00	7	0	7	5686.35	0.00	5686.35
6	Bhavnagar	3	0	3	2590.94	0.00	2590.94	7	0	7	6105.50	0.00	6105.50
7	Dangs	0	0	0	0.00	0.00	0.00	1	0	1	1723.57	0.00	1723.57
8	Jamnagar	2	0	2	2135.39	0.00	2135.39	0	9	9	0.00	8822.38	8822.38
9	Junagadh	0	0	0	0.00	0.00	0.00	7	0	7	4891.70	0.00	4891.70
10	Kachchh	7	0	7	19821.95	0.00	19821.95	0	9	9	0.00	22135.38	22135.38
11	Mahesana	0	2	2	0.00	1916.73	1916.73	0	2	2	0.00	1916.73	1916.73
12	Panchmahals	7	0	7	6622.69	0.00	6622.69	10	0	10	7863.23	0.00	7863.23
13	Rajkot	5	0	5	3954.35	0.00	3954.35	0	11	11	0.00	9296.88	9296.88
14	Sabarkantha	0	0	0	0.00	0.00	0.00	1	0	1	368.38	0.00	368.38
15	Surendranagar	9	0	9	10468.74	0.00	10468.74	0	9	9	0.00	10468.74	10468.74
16	Valsad	0	0	0	0.00	0.00	0.00	3	0	3	2606.41	0.00	2606.41
	Total	43	8	51	55387.41	8741.80	64129.21	52	47	99	43374.46	60625.48	103999.94

Sources: - A statistical profile of Drought Prone Areas and Desert Areas in Gujarat State, Directorate of Economics and Statistics: Government of Gujarat

- Gujarat Economic Development through Maps, Directorate of Economics and Statistics: GoG, Gandhinagar1995

Table 5.5: Expenditure to be incurred for rejuvenation of increased area of DPAP & DDP from the year 1980-2000 by watershed

Sr. no.	District	Difference in Area from Year 1980-2000	Capital cost in Lakhs		Maintenance cost in Lakhs	
		In Hectare	With 6000 Rs per Hectare	With 7000 Rs per Hectare	5% of the total cost	
1	Ahmedabad	0.00	0.00	0.00	0.00	0.00
2	Amreli	82228.00	4933.68	5755.96	246.68	287.80
3	Banaskantha	116527.00	6991.62	8156.89	349.58	407.84
4	Baroda	351369.00	21082.14	24595.83	1054.11	1229.79
5	Bharuch	568635.00	34118.10	39804.45	1705.91	1990.22
6	Bhavnagar	351456.00	21087.36	24601.92	1054.37	1230.10
7	Dangs	172357.00	10341.42	12064.99	517.07	603.25
8	Jamnagar	668699.00	40121.94	46808.93	2006.10	2340.45
9	Junagadh	489170.00	29350.20	34241.90	1467.51	1712.10
10	Kachchh	231343.00	13880.58	16194.01	694.03	809.70
11	Mahesana	0.00	0.00	0.00	0.00	0.00
12	Panchmahals	124054.00	7443.24	8683.78	372.16	434.19
13	Rajkot	534253.00	32055.18	37397.71	1602.76	1869.89
14	Sabarkantha	36838.00	2210.28	2578.66	110.51	128.93
15	Surendranagar	0.00	0.00	0.00	0.00	0.00
16	Valsad	260641.00	15638.46	18244.87	781.92	912.24
	Total	3987073.00	239224.38	279095.11	11961.22	13954.76

Source: Difference in area taken from A statistical profile of Drought Prone Areas and Desert Areas in Gujarat State, Directorate of Economics and Statistics: Government of Gujarat and Gujarat Economic Development through Maps, Directorate of Economics and Statistics: GoG, Gandhinagar1995.

Cost of watershed rejuvenation comes around Rs. 6000 to Rs. 7000 per hectare as per AKRSP and the maintenance cost is 5% of the Capital cost

The cost of this deterioration has been calculated (Table 5.5) under the assumption that per hectare cost of rejuvenation is Rs.6000 to Rs. 7000. The total cost of rejuvenation ranges between Rs 2392.24 crores to Rs 2790.95 crores. It needs to be added that this includes not just land degradation, but overall environmental degradation in some sense.

D. Changes in Net Sown Area :

As seen above, in the context of Gujarat (India) a decline in NSA may be considered a negative development for land utilization. Table 5.6 presents data on the changes in NSA in Gujarat during the period 1980-81to 1995-96. The table shows that NSA declined from 96.06 Lakhs ha. In 1980-81 to 94.25 lakh ha. in 1995-96, implying a decline of 181800 ha.

Table 5.6: - Net Area Sown (Three Yearly Average)

Sr. No.	State/Districts	Area (in 00 hectares)		
		1980-81	1990-91	1995-96
1	Jamnagar	5941	5678	6065
2	Rajkot	7180	7277	7388
3	Surendranagar	6575	6244	6581
4	Bhavnagar	6253	6281	6230
5	Amreli	4952	4981	4949
6	Junagadh	6116	5743	5760
7	Kachchh	6631	5729	5876
8	Banaskantha	8264	8146	8287
9	Sabarkantha	4438	4339	4286
10	Mehsana	6796	6835	7080
11	Gandhinagar	486	459	475
12	Ahmedabad	5897	5332	5555
13	Kheda	5171	5166	5142
14	Panchmahals	4755	4754	4736
15	Vadodara	5352	5395	5385
16	Bharuch	4344	4257	4199
17	Surat	3953	4220	2989
18	Valsad	3293	3068	3080
19	Dangs	0	0	0
Gujarat		96064	93903	94246

Source: Land Utilisation Data, Department of Agriculture, and Government of Gujarat

The value of this land is computed using the average value of agricultural production per ha. According to CMIE, this value was approximately Rs. 12,000/- per ha. in Gujarat. Using these data the total value of the loss of NSA will be Rs 218.16 crores.

Common Property land Resources or Pastures / Grazing Lands:

Land under this use was allotted to villages under a special government declaration as the Revenue Administration Manual wanted that some land should be allotted for grazing animals as per the fixed norm of 40 acres for every 100 adult cattle breeds. In other words, this land was not necessarily a naturally pasture land, or developed Pastures. It was a mere nomenclature in case of most villages. Also, the norm was arbitrarily determined for all villages, irrespective of their specific geo-climatic conditions. The norm did not have any scientific bearing, as it was a mere administrative convenience. In the present days of stall feedings, fodder crop cultivation and feedings from farm residues, the norm is not that relevant also. The relevance of pastures/grazing land today is mainly for sheep and goats, the number of whom varies place to place. In addition, this land has special importance for the livelihood of the poor, and some utility value for general village population.

- Farmers, mainly small and marginal farmers use this land for some agricultural operations.
- General population uses this land for collection of fuelwood, leaves/fodder, fruits, gum products etc.
- This land is also used for natural calls – public space as latrines
- If some common facilities are created/ available on there lands, these are used by the poor
- The *Prosopis Juliflora* on these lands are used by the poor for making income by selling its products (fuel wood, Datun) and by manufacturing charcoal.

According to land utilization statistics. 4.5% of the reporting area in the state is grazing land or pastureland. As several studies have pointed out, the two major problems with respect to this land are (a) declining size and (b) deterioration in the quality of this land. Both these affect the livelihood of people, and particularly the poor, adversely. It is important therefore the estimate the value of the depletion and degradation of common lands.

One major problem with CPLR is the lack of adequate data. Since the official data do not include the large-scale illegal encroachment on these lands, the official data do not really present the real picture. However, with the available data we attempt the value of changes in CPLR in Gujarat.

Table 5.7: -Permanent Pastures And Other Grazing Land (Three Yearly Average)

Sr. No.	State/Districts	1980-81	1990-91	1995-96
		Area (in 00 hectares)		
1	Jamnagar	774	774	774
2	Rajkot	860	868	868
3	Surendranagar	447	460	460
4	Bhavnagar	704	704	704
5	Amreli	449	463	470
6	Junagadh	1143	1114	1114
7	Kachchh	700	701	701
8	Banaskantha	716	696	696
9	Sabarkantha	343	343	343
10	Mehsana	560	545	544
11	Gandhinagar	34	29	29
12	Ahmedabad	337	328	328
13	Kheda	269	275	275
14	Panchmahals	251	275	279
15	Vadodara	331	336	336
16	Bharuch	234	243	243
17	Surat	242	242	242
18	Valsad	78	78	78
19	Dangs	0	0	0
Gujarat		8471	8472	8471

Source: Land Utilisation Data, Department of Agriculture, and Government of Gujarat

Table 5.7 presents changes in CPLR in the state during 1980-81 to 1995. The value indicates that (1) 8 districts have experienced some increase in CPLR. (2) 5 districts have experienced no change and (3) 6 districts have experienced a decline in CPLR during 1980-81 to 1995-96. The total size of CPLR has remained almost the same during the period. It appears that the available data, which do not reveal the realities at the ground level, cannot be used for any estimates of the changes in the CPLR during the period from the early eighties to late nineties.

Land Degradation and Agricultural Productivity:

An impact of land degradation can be seen in terms of decline in agricultural productivity. This could be referred in changing cropping pattern, changing cropping intensity or changing yield (or value) per hectare. However, The available data on these parameters do not reflect what we would like to measure.

- Cropping pattern changes due to various factors, such as changing prices, availability of new seeds, as well as declining yields. It is difficult to distinguish these impacts.
- Cropping intensity usually changes due to availability or non-availability of irrigation facilities, shift to perennial crops as well as low moisture in soil. Once again it is difficult to separate the impact of each of these variables.
- Yield per hectare may reflect the productivity of land for a particular crop, and it normally declines with a decline in land quality. However, use of fertilizers and manures improves the yields, concealing the declining productivity. Thus the available data on yield do not reflect the changes in the quality of land.

The above issues therefore need a careful primary survey. In this quick valuation, we have to ignore these changes in land quality.

Defensive Expenditure: Efforts on Improving Quality of land

The central and state governments have made several efforts to improve quality of degraded land under several programmes like social forestry programmes (on non forest lands) and water shed development programmes including programmes under DPAP and DDP. Since these programmes aim at fighting the degradation of land and environment in general, these should be considered as 'defensive' expenditure to be deducted from the state domestic production statistics. In the following paragraphs we present some of the major defensive expenditure.

A. Social Forestry on Non Forest Lands

The concept of social forestry was conceived in the 1970s as a tree raising programme, whereby the rural population could access to steady supply of firewood, fodder, small timber and minor forest products.

The social forestry programme has three basic components:

1. Farm forestry, whereby the farmers are encouraged to plant trees on their own lands by accessing free or subsidized distribution of seedlings.
2. Woodlots planted by the forest department for the needs of the community, mainly along the roadsides, canal banks and other public lands, and
3. Community wood lots planted by village communities themselves on community lands, to be shared equally by them.

The first attempt in this area in the State was however made as early as in 1961 when the afforestation of ravines was taken up. Under the project, ravine lands belonging to the government and the Panchayats were to be reclaimed for agriculture and afforestation. The entire project was handed over to the

Forest Department for execution. However, though the project was successfully implemented in physical terms, it encountered opposition from social and political fronts. The project was then handed over to the Agriculture Department.

Another attempt undertaken to grow trees outside the forest area by way of plantations along the roads was made in 1969. In fact, Gujarat was the first state to adopt the social forestry programme in 1969. The government sanctioned a scheme of roadside plantations under direct supervision and control of the Department of Forests. The main objectives of this first stage of Social Forestry Programme were to provide shade to the road users, increase the aesthetic value of the roadside and make available firewood and small timber to the villagers so as to save burning of cow dung and organic materials (which could then be used as organic manure). To facilitate effective protection of these strips along the roadside and canal banks, the Government of Gujarat declared them as Protected Forests in 1972. This effectively put the FD into charge of the strip plantations. In 1980 the Forest Department tried to include the village community participation in protecting the strip plantations and hence the system was changed with a 50:50 arrangement with the local panchayats. Another scheme known as the Supervised Woodlot Scheme was introduced in the year 1974. The forest department in collaboration with the local panchayats raised four-hectare woodlots in different villages of fuelwood, fodder and fruit species on the community lands. In return, the villages were allowed collection of fuel, fodder and fruit, in addition to a 50:50 share of the profit when trees were harvested.

Farm Forestry or Forest Farming project was also launched in 1972 under which farmers were provided seedlings free of cost for raising trees as commercial crops on their lands.

In 1978 a scheme of raising plantations on deforested areas in Dangs was introduced (the deforestation had resulted into severe soil erosion and negative results to the tribals). These plantations were known as the Malki Plantations and aimed at bringing these areas back under tree cover, so as to minimise soil erosion and thereby also increase the income of the tribals by mainly planting teak and timber on these lands.

The social forestry programme received a boost when the World Bank decided to aid the programme. The main aim of the World Bank aided programme which started in 1980 were:

- Increasing supplies of fuelwood to rural areas
- To provide poles, bamboos, small timber, fodder, grass, fruits, oilseeds and other NTFPs from the same plantation.
- The project was to introduce improved crematoria, develop and introduce improved stoves. It was also supposed to generate gainful employment to the poorest section of the population in tree planting and maintenance.
- Lastly, the project envisaged soil conservation to protect the environment.

As seen from Table 5.8, by the end of 1994-95 the total area under strip plantations was 80914 hectares, are under village woodlots ---- to104701 hectares, u while the malki plantations in Dangs covered an area of 2238 hectares. It is clear from the table that the area added under strip plantations is slowly declining over the years since the project was started in 1969. For example, the World Bank aided project covered 16411 ha. under social forestry in the seventies and in the next five years covered another 37590 ha. In the latter part of the eighties and early nineties however the area covered under the strip plantation decreased drastically to 7423 ha. and 7839 ha. respectively. This would not necessarily mean that the component has been a total failure in the later years as it could also be that most of the area that could be covered under strip plantations has already been covered.

In the village woodlot component of Social Forestry, the area of the woodlots set up at the initiative of the Forest Department is higher than the self-help woodlots. It is also interesting to note that most of these woodlots are rain-fed.

In the entire social forestry programme only the Farm Forestry component seems to have done very well, as it was the most lucrative of all the other components. In fact, it was found that a number of farmers converted irrigated land to farm forestry partly due to uncertain prices of agricultural crops and partly because tree growing posed less growing and management problems *(The State of Environment - the Second Citizen's Report, 1984-85)*. The World Bank evaluation report raised concerns about the achievement of the program, as it could not fulfil the fuel and fodder needs of the community. The village woodlot component worked well from 1975 to 1982. After 1980, when the emphasis shifted to optimising the production of firewood and fodder through self-help schemes and community responsibilities, it failed to take off *(ibid.)*. Some studies have revealed that the performance of village woodlots programme has left much to be desired. One such study *(Pandey and Jain, 1991)* found that none of the woodlots met the demands of fuelwood and fodder for the poorer sections of the villages and they remained another way of generating cash income. Besides the success of the scheme remained limited to tree plantations while the main objectives of optimising fuelwood and fodder production and renovation of gauchar land for common benefits were defeated since the these were non-issues for the Panchayat (dominated by the richer sections of the villages). Thus notwithstanding the Forest Department and Government's tall claims, a number of questions have already been raised as to how "social" is the social forestry programme in Gujarat.

It is to be noted that we do not have data about the actual coverage of social forestry programmes in the state. The official data present targets and financial achievements, but not the actual coverage of the program. Unfortunately, no comprehensive evaluation of the program has been undertaken in the recent years. The costs and benefits of social forestry programmes will have to be worked out through a few micro studies for detailed accounting of land resources at a later stage..

Table 5.8: Achievements Under Social Forestry Programme (1970-71 to 1994-95)

Year	Strip Plantation (in hectares)				Village Woodlots (in hectares)							Reforestation of degraded forests (in hecatres)			Village Fire woodlot plantations (in ha.)	Malki Plantations (in ha.)	Resor-ation of deg. famrla-nd (in ha.)	Fodder develo-pment (in ha.)	Enviro-nment plantat-ions (lakhs)	Total area (in ha.)
	Road	Rail	Canal	Total	Departmental		Self-help		Total		Total of village woodlots	Casual labour	Social Security	Total						
					Irr	Rf	Irr	Rf	Irr	Rf										
70-71	75	0	50	125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	125
71-72	143	0		143	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	143
72-73	175	0	45	220	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	220
73-74	292	0		292	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	292
74-75	1436	0	532	1968	0	906	0	0	0	906	906	0	0	0	0	0	0	0	0	2874
75-76	2318	0	352	2670	0	2704	0	0	0	2704	2704	0	0	0	0	0	0	0	0	5374
76-77	1523	0	432	1955	0	2280	0	0	0	2280	2280	2000	0	2000	0	0	0	0	0	6235
77-78	3557	0	240	3797	0	2865	0	0	0	2865	2865	4000	0	4000	0	40	0	0	0	10702
78-79	3561	0	472	4033	0	4153	0	0	0	4153	4153	4078	22	4100	0	59	0	0	0	12345
79-80	3331	0	799	4130	0	4668	0	0	0	4668	4668	5577	23	5600	0	65	0	0	0	14463
Total	**16411**	**0**	**2922**	**19333**	**0**	**17576**	**0**	**0**	**0**	**17576**	**17576**	**15655**	**45**	**15700**	**0**	**164**	**0**	**0**	**0**	**52773**
80-81	3827	-	200	4027	225	4285	0	69	225	4354	4579	5617	336	5953	0	200	0	0	0	14759
81-82	5847	-	300	6147	399	5621	0	124	399	5745	6144	5408	592	6000	0	200	206	0	0	18697
82-83	7597	200	400	8197	689	5244	0	1768	689	7012	7701	5508	492	6000	0	166	312	0	0	22376
83-84	6931	1610	535	9076	827	5897	0	2479	827	8376	9203	5400	600	6000	0	220	393	303	0	25195
84-85	7686	1857	600	10143	1696	7346	0	1539	1696	8885	10581	5747	550	6297	0	214	610	158	0	28003
Total	**31888**	**3667**	**2035**	**37590**	**3836**	**28393**	**0**	**5979**	**3836**	**34372**	**38208**	**27680**	**2570**	**30250**	**0**	**1000**	**1521**	**461**	**0**	**109030**
85-86	1600	436	832	2868	877	3172	111	667	988	3839	4827	5312	492	5804	375	135	3270	0	0	17279
86-87	1149	515	214	1878	418	2256	241	676	659	2932	3591	4166	449	4615	100	201	3520	0	0	13905
87-88	1259	436	475	2170	731	2236	209	268	940	2504	3444	5186	639	5825	360	85	3440	0	0	15324
88-89	1625	694	450	2769	750	3494	129	171	879	3665	4544	6055	918	6973	0	109	7476	130	0	22001
89-90	1790	374	289	2453	398	2168	469	1094	867	3262	4129	3822	998	4820	0	97	3426	80	0	15005
Total	**7423**	**2455**	**2260**	**12138**	**3174**	**13326**	**1159**	**2876**	**4333**	**16202**	**20535**	**24541**	**3496**	**28037**	**0**	**627**	**21132**	**210**	**0**	**83514**
90-91	1766	343	414	2523	700	4280	63	100	763	4380	5143	7745	1060	8805	0	201	6791	474	0	23937
91-92	2336	396	454	3186	879	4618	81	541	960	5159	6119	11835	1045	12880	0	82	7047	285	199	29798
92-93	2424	287	452	3163	738	4909	73	428	811	5337	6148	13119	1031	14150	0	89	8208	309	212	32266
93-94	1313	113	295	1721	459	4884	107	592	566	5476	6042	0	0	13300	0	75	9027	618	319	30783
94-95	-	-	-	1260	-	0	0	0	40	4890	4930	0	0	9198	0	0	9586	50	0	25024
Total	**7839**	**1139**	**1615**	**11853**	**2776**	**18691**	**324**	**1661**	**3140**	**25242**	**28382**	**32699**	**3136**	**58333**	**0**	**447**	**40659**	**1736**	**730**	**141808**
G. total	**63561**	**7261**	**8832**	**80914**	**9786**	**77986**	**1483**	**10516**	**11309**	**93392**	**104701**	**100575**	**9247**	**132320**	**835**	**2238**	**63312**	**2407**	**730**	**387125**

Source: Department of Forest, Government of Gujarat.

Table 5.9: Transformation of forest types in Gujarat (1991-1997 assessments)

Type of change	Name of districts
Dense to Open	Bharuch, Mehsana, Panchmahals, Sabarkantha, Dangs, Valsad
Open to Dense	Amreli, Junagadh
Dense to Non-forest	-
Open to Non-forest	Ahmedabad, Bhavnagar, Kheda
Both Open and Dense to Non-forest	Surat
Increase in Open	Banaskantha, Vadodara, Gandhinagar, Jamnagar
No change	Kachchh, Rajkot, Surendranagar

Source: FSI Reports, 1991, 1993, 1995 & 1997

The table shows that except for some improvement in Amreli and Junagadh, where some forest area has shifted from open to dense, almost all the changes are for the worse. These changes are shifting of forest areas from dense to open, dense to non-forest and increase in open forests in general.

Appendix I

Barren And Uncultivated Land, Cultivable Waste, Permanent Pastures And Other Grazing Land

Sr. No.	State/ Districts	1980-81	1990-91	1995-96	1980-81	1990-91	1995-96	1980-81	1990-91	1995-96
	Area (in 00 hectares)	**Barren And Uncultivated Land (three yearly average)**			**Cultivable Waste (Three Yearly Average)**			**Permanent Pastures And Other Grazing Land (Three Yearly Average)**		
1	Jamnagar	1142	1585	1573	287	374	339	774	774	774
2	Rajkot	1122	1106	1073	124	128	128	860	868	868
3	Surendranagar	1306	1302	1292	336	135	134	447	460	460
4	Bhavnagar	1021	1008	1009	349	329	296	704	704	704
5	Amreli	103	162	190	92	101	102	449	463	470
6	Junagadh	222	309	1546	164	125	122	1143	1114	1114
7	Kachchh	17326	17082	4315	16012	16749	3482	700	701	701
8	Banaskantha	200	351	347	333	251	251	716	696	696
9	Sabarkantha	278	360	358	176	143	148	343	343	343
10	Mehsana	63	133	132	233	141	140	560	545	544
11	Gandhinagar	3	2	2	10	14	14	34	29	29
12	Ahmedabad	766	718	718	242	227	229	337	328	328
13	Kheda	327	327	328	25	24	100	269	275	275
14	Panchmahals	295	378	372	334	130	124	251	275	279
15	Vadodara	43	277	282	314	92	91	331	336	336
16	Bharuch	105	213	193	387	394	392	234	243	243
17	Surat	605	610	610	186	228	225	242	242	242
18	Valsad	113	158	155	201	199	199	78	78	78
19	Dangs	0	0	0	0	0	0	0	0	0
Gujarat		25038	26081	14495	19805	19785	6515	8471	8472	8471

Source: Land Utilisation Data, Department of Agriculture, and Government of Gujarat

Appendix II

District wise percent share of CPLRs

	1980	1985	1990	1995
Ahmedabad	18.69	15.83	15.52	15.42
Amreli	11.82	11.04	10.95	10.85
Banaskantha	11.96	11.43	10.55	10.49
Bharuch	14.12	11.03	10.89	10.96
Bhavnagar	22.3	21.37	21.77	20.74
Dang	7.58	7.25	6.45	0
Gandhinagar	7.49	NA	7.04	6.91
Jamnagar	28.97	27.13	27.32	26.41
Junagadh	28.42	26.8	26.51	26.3
Kachchh	47.47	45.36	43.83	43.35
Kheda	9.33	9.2	9.36	9.45
Mehsana	11.76	9.65	9.15	9.1
Panchmahals	11.93	10.65	8.99	8.77
Rajkot	20.37	NA	18.93	18.71
Sabarkantha	13.49	11.76	11.57	11.69
Surat	14.27	13.92	13.92	13.79
Surendranagar	27.01	21.84	18.7	18.61
Vadodara	13.06	9.3	9.08	9.21
Valsad	12.04	11.21	8.45	8.45
Gujarat	21.05	19.29	18.53	18.23

Source: "Ranns and Desertification" Phase I Report - Gujarat institute of Desert Ecology, Kachchh 1999

Environmental Issues in the Management of Land Resources

Dr. J.B.Lal

The basic issue in any natural resource management is sustainability. Unfortunately, sustainability like happiness defies definition. But we should remember that every sensible word has a sense, and not necessarily a definition. The essence of sustainability is that a system is productive and useful not only for the present generation, but also for the generations to come.

How many generations, one may ask. Seven generations. That's the concept I gathered from my forefathers in the eastern U.P.I come from. Sustainability is a multi-dimensional process. The major dimensions are: ecological, technical (which includes silvicultural in regard to forest), socio-economic and institutional. All the dimensions have to be taken care of, if we don't want to create problem in the sustainability of a system. The basic goals in the management of forest and other land resources are three: stability and productivity of physical environment, and equity in social environment. All the goals are to be taken care of.

If the goals and dimensions are combined, a goal-dimension matrix is obtained. The imperceptible functioning of the matrix is the key to sustainability.

There are 4 bio-productive systems are: forests, grasslands, croplands, and water bodies (fisheries). It's not wise to treat any system in isolation. The current international buzz word in the management of land resources is INRM. For the scientists it may be a new process, but not for Apatanis, a wise tribal community of Arunachal Pradesh. Apatanis are managing the 4 bio-productive systems in an integrated manner for over 400 years. IK should never be ignored. The Indian tragedy of land resources management has been that we have ignored one bio-productive system, viz. grasslands totally. We should make up for that.

One of the terms most used in the environmental discussions, and, perhaps, least understood is 'ecological balance'. It's the balance between the 'diversity' and 'perpetuity' of a living system. We have rarely tried to determine the critical number species of an ecosystem which could maintain its perpetuity. It should be done now.

Eventually it's ecosystem approach in management which saves a living natural resource. Odum, the famous ecologist, defined ecosystem approach as integration of ecology and economics. I've gone two steps further and defined the approach in my book, India's Forests: Myth and Reality, as Ecosystem Approach = Ecology + Economics + Technology + Ethnology. In the end, let me enumerate some of the environmental issues in the management of forests and other lands.

1. Forests do serve as carbon sinks, but the new researches in Durope indicate, they aren't 100% protector of global warming. They release methane which is one of the green-house gases.
2. Every unit of forest cannot be expected to produce all the tangible and intangible benefits at the same level. We have to fix priorities for every unit, that is, to classify forests on a functional basis. We have Pas. We may have tribal reserves, and energy producing areas wood, bamboo, and grasses all can produce electricity. Forest Policy, 1952, did stipulate functional classes, but 1988 one does not.

3. We should restore the missing link between forest and the tribal. Giving the tribal various rights won't help. Forests have to be developed to meet his needs. And, then rights and duties go together. We only talk of rights.
4. It should be taken into account that our ecological deficit is basically on account of absence of grasslands, and not by loss of forest cover.
5. For a stable environment, we should take energy-weighted view of land use. Urban areas consume about 10 times the energy a natural system does, and croplands trice as much. On an energy-weighted basis urban areas should not exceed in extent natural and semi-natural systems.
6. Water and energy are the most important factors influencing environment. Forests and grass-lands both can conserve water, improve its quality, and can produce energy.
7. We should have an environment which is both stable and productive. Mature climax communities are more stable, while the communities in succession stage and plantations are more productive.
8. TEV and EIA are most objective decision – making criteria in land use.

Lastly, I'd say that statistics is useful if it imparts not only knowledge, but also wisdom, i.e. correct application of knowledge.

Status Of Forest And Land Resources In Jharkhand

Pravin Kr. Gupta

Ministry of Environment & Forests, Govt. of India has launched a Scheme during the 10th Five year Plan for assisting the State Government/UTs to bring out State of Environment (S.E.) Reports on triennial basis. The State of Environment (S.E.) Reports Provides an over view of prevailing Bio-Physical and Socio-Economic Conditions in a particular area. This gives an opportunity to assess how human activities affect the environmental conditions and their implications on human health and economic wall being?

'India' is a non-profit research development and consultancy organization established in 1983 under the Society Registration Act. it fosters the new relationship in the people, technology and environment interactions needed to attain the goal of sustainable development. Here three circumstances arise:-

1. Green Issues : - Term used to describe the issues related to agriculture, deforestation, land conversions & destruction of pristine areas.

2. Blue Issues : - Term used to describe the forms of water related issues, i.e. ground and surface, marine and costal water etc.

3. Brown Issues: - Term used to describe the issues related to industrialization, urbanization, transport energy and other pollution related issues.

Jharkhand: At a Glance:-

(i)	Geographical Area	:	*79,714.00 Sq. K.M.*
(ii)	Forest Area	:	*23,605.47 Sq. K.M.*
(iii)	% of Forest Area to Country's Geographical Area	:	*3.1%*
(iv)	Population	:	*269.10 Lakhs (Rural – 77.8% Urban – 22.2%)*
(v)	Per Capita Forest Area	:	*0.088 hectare*
(vi)	Average Density of Population	:	*338 Persons/Sq. K.M.*
(vii)	% of Tribal Population to State Total Population	:	*22.5%*
(viii)	Literacy	:	*54.13% (Male – 67.94% Female – 39.38%)*
(ix)	No. of Commissionaries	:	*5*
(x)	No. of Districts	:	*22*
(xi)	No. of Sub-division	:	*33*
(xii)	No. of Community Blocks	:	*211*
(xiii)	No. of Panchayats	:	*3744*
(xiv)	*No. of Revenue Villages*	*:*	*32615*

Jharkhand Forest: At a Glance

Recorded Forest Area:-

Reserved Forest (RF)	:	4387.20 Sq. KM.
Protected Forest (PF)	:	19,184.78 Sq. KM.
Unclosed Forest (UF)	:	33.49 Sq. KM.
TOTAL	:	23,606.47 Sq. KM.

Forest Cover:-

Dense Forest (> 40%)	:	11787 Sq. KM.
Open Forest (10 - 40%)	:	10850 Sq. KM.
Scrub Forest	:	976 Sq. KM.
% of Forest	:	28.40%

(a) Physical Accounting of Land Resources:-

Land Utilisation Statement of Year 2001-02, 2002-03 & 2003-04 are attached as Annexure – I to III.

(b) Physical Accounting of Forestry Resources:-

Table - I

District wise Forest Cover

District	Geographical Area (in Sq. KM.)	Forest Cover (in Sq. KM.)			%	Scrub (in Sq. KM.)
		Dense Forest	Open Forest	Total		
Bokaro	1929	270	304	574	29.76	58
Chatra	3732	945	950	1895	50.78	35
Deoghar	2479	73	15	88	3.55	3
Dhanbad	2996	70	104	174	5.81	21
Dumka (includes Jamtara)	6212	231	257	488	7.86	109
Garhwa	4092	670	705	1375	33.60	59
Giridih	4963	324	459	783	15.78	26
Godda	2110	163	227	390	18.48	22
Gumla (includes Simdega)	9077	1231	1255	2486	27.39	58
Hazaribagh	5998	909	1253	2162	36.05	66
Koderma	1435	229	387	616	42.93	3
Lohardaga	1491	392	165	557	37.36	11
Pakur	1571	79	215	294	18.71	17
Palamu (includes Latehar)	8657	2616	1244	3860	44.59	205
West Singhbhum	9907	2103	1624	3727	37.62	84
East Singhbhum (includes Saraikela)	3533	597	288	885	25.05	60
Ranchi	7698	735	997	1732	22.50	68
Sahibgang	1834	150	401	551	30.04	71
Total	79714	11787	10850	22637	28.40	976

Table - II

Division-wise Details of Forest Area

Sl. No.	Name of the Forest Division	Reserved Forest (Hact.)	Protected Forest (hact.)	Unclassed Forest (Hact.)	Total Forest Area (Hact.)
1	Saranda	81808	3988	86	85882
2	Kolhan	58716	11258	68	70042
3	Porahat	50628	15816	98	66542
4	Chaibasa South	31	50875	---	50906
5	Chaibasa North	6486	61540	---	68026
6	Dhalbhum	53050	51863	---	104913
7	Ranchi East	11742	80182	---	91924
8	Ranchi West	26290	73744	---	100034
9	Gumla	12101	118717	16	130834
10	Giridih	8776	113020	---	121796
11	Hazaribagh West	673	176524	340	177537
12	Hazaribagh East	1743	102055	---	103798
13	Bokaro	---	51901	---	51901
14	Chatra South	752	101828	---	102580
15	Chatra North	---	93372	---	93372
16	Koderma	15630	73408	---	89038
17	Dhanbad	10825	15555	---	26380
18	Daltonganj South	58081	46044	45	104170
19	Daltonganj North	3987	126661	---	130648
20	Garhwa South	549	123586	---	124135
21	Garhwa North	---	78705	---	78705
22	Latehar	20648	111736	---	132384
23	Deoghar	2866	73922	---	76788
24	Dumka	12803	135389	420	148612
25	Sahebganj	50	10471	2276	12797
26	Giridih Afforestation	485	16318	---	16803
Total		438720	1918478	3349	2360547

(c) Land Pollution Factor & measurements:-

Jharkhand State Pollution Control Board was constituted after the separation of the Jharkhand State from Bihar on 9.9.2001 under the Prevention and Control of Water pollution Act, 1974. Soon after declare from actual cut off dated i.e. 15.12.2001, the board started implementing environmental legislation within the territorial jurisdiction of the State.

- The water (Prevention and Control of Pollution) Act, 1974, as amended and the Rules made there under.
- The water (Prevention and Control of Pollution) Cess Act, 1977, as amended and the Rules made there under.
- The Air (Prevention and Control of Pollution) Act, 1981, as amended and the Rules made there under.
- The Environment (Protection) Act, 1986 and the Rules made there under.
- The Hazardous Wastes (Management and Handling) Rules, 1989 as amended.

- The Bio-Medical Wastes (Management and Handling) Rules, 1998 as amended.
- The Recycled Plastics manufacture and usage Rules, 1999
- The municipal Solid Wastes (Management and Handling) Rules, 2000.
- The Noise Pollution (Regulation and Control) Rules, 2000.
- The Batteries Wastes (Management and Handling) Rules, 2001.
- The Ozone Depleting Subslantes (Regulation and Control) Rules, 2001.
- The Public liability insurance Act, 1991 and the Rules there under.

Even though the primary objective of the Board is the proper implementation of the Provisions of different environmental legislation within Jharkhand its ultimate aim is to provide a better, cleaner and greener environment for the people of the State for years to come.

The major mandates of the Board include:-

- To lay down, modify or annul standards.
- To ensure functioning of proper treatment system for treatment of liquid, gaseous or solid wastes generated from the industries.

The statutory and other functions:-

- Consent to established,
- Consent to operate,
- Authorisation for hazardous waste management,
- Authorisation for Bio-medical waste management,
- Generation and dissemination of data related to environmental quality through regular monitoring and surveillance.
- Prevention, Control and alatement of air pollution in the state in the state and improvement in the ambient air quality.
- Issuing directives for pollution control measure to the polluting units.
- Identification of locations in the state sever pollution problems and minimizing pollution in these area with the help of suitable treatment of effluent and/ on disposal of the effluent at a safe location.
- Identification of major air pollution agencies and enforcement of provisions of the Air Act for the Control of air emissions.
- Minimising discharge of effluent into streams and water bodies and promotion of recycling and re-use of treated effluent on land for irrigation and development of green belts.

(d) Economic Accounting of Land and Forestry Sectors:-

Year wise revenue figures of the Forest Department

(Rs. In Lakhs)

Sl. No.	Year	Receipt by State Trading Organization	Receipt by Forest Development Corporation	Other Receipts	Total Revenue
1	1991-1992	4227.080	51.000	998.730	5276.810
2	1992-1993	4513.430	40.000	160.080	4713.510
3	1993-1994	4478.910	---	2599.560	7078.470
4	1994-1995	4243.710	---	340.080	4583.790
5	1995-1996	4250.580	---	640.880	4891.460
6	1996-1997	3187.740	100.000	300.040	3587.780

Sl. No.	Year	Receipt by State Trading Organization	Receipt by Forest Development Corporation	Other Receipts	Total Revenue
7	1997-1998	1920.030	200.000	378.130	2498.160
8	1998-1999	999.165	450.000	706.250	2155.415
9	1999-2000	1185.250	654.750	1624.180	3464.180
10	2000-2001				
	(1.11.2000 to 14.11.2000)	800.745	245.250	583.842	1629.837
	(15.11.2000 to 30.11.2000)	254.677	---	63.773	318.450
11	2001-2002	794.000	697.571	1491.571	2983.142
12	2002-2003	697.863	1505.807	2203.670	4407.34
13	2003-2004	449.457	1791.789	2241.245	4482.491
14	2004-2005	344.172	124.533	468.705	937.41

ANNEXURE - V

Measurement of Biodiversity

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Abstract

The biodiversity of an ecosystem can be quantified in terms of species richness and evenness. Several indices have been proposed to measure biodiversity. Some of these are: McIntosh, Margalef & Menhinick, Shannon & Weiner, Simpson, Brillouin, Berger-Parker indices. Diversity indices have been applied to the successional stages in the ecosystem, vertical diversity of a forest and many other new areas. The present paper reviews the measurement of biodiversity in an ecosystem.

Introduction

Biodiversity may be defined as the totality of genes, species and ecosystems of an area. It may be studied at three levels of organization (Wikipedia, 2006):

1. Genetic diversity: The diversity of genes within a species.
2. Species diversity: Diversity among species.
3. Ecosystem diversity: Diversity at ecosystem and landscape levels.

The UN Earth Summit held at the Rio de Janeiro in 1992 gave an explicit description of biodiversity: The variability among living organisms from all sources, including interalia terrestrial, marine and aquatic systems and the ecological complexes of which they are a part: this includes diversity within species, between species and the ecosystems.

Measurement of species diversity is one of the most important aspects of community characterization. Diversity index is a value we associate with any sample, community, transition between two communities or pooled communities. Over the years, several indices have emerged, each having its specific applications. Whittaker (1972) classified diversity at the three levels, Alpha, Beta and Gamma diversity. Alpha diversity is the within habitat or intracommunity diversity. Alpha diversity has two components – species richness and evenness. Beta diversity is the between habitat or inter community diversity. It is the change in species composition along environmental gradients. Gamma diversity is the landscape level diversity.

Since diversity is a measure of the species content and proportional distribution of the species, its measurement is constrained by influx and out flux of species, hidden species, sampling variations, experimental errors and mathematical assumptions. The present paper describes the indices commonly used for the quantitative measurement of species diversity at community and ecosystem levels. Extensive studies have been carried out by Baumgartner (2005), Greig-Smith (1978), Hulbert, (1969), Keylock, (2005) Latham (2005), McIntosh, (1967), Meffe (2002), Magurran, (1988), Parker, (1979), Ponce-Hernandez (2004), Smith (1986), Southwood, and Henderson (2000), Wilson and Mohler (1983), www.worldagroforestry.org, 2005 and many others.

Alpha diversity

This is the most widely studied diversity. It has two components:

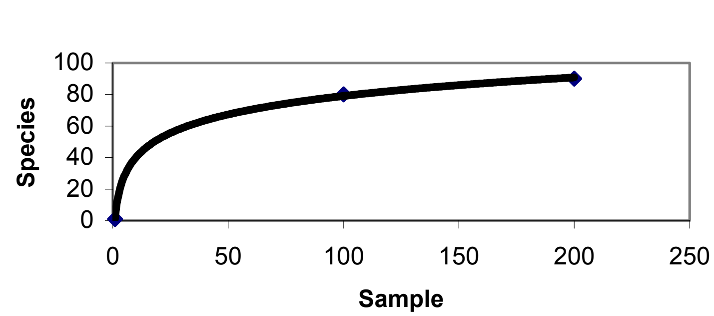
A) Richness
B) Equitability or Evenness

Species richness is a measure of the species content of the area presented in terms of number of individuals or unit area or some other parameter. More the number of species, higher will be the species richness index. Species richness indices are also known as variety indices. Equitability indices represent the relative abundance of different species of the area in terms of their evenness of distribution. A community having species with equal number of individuals for each species will have a higher evenness indices as compared to a community in which dominance is concentrated in one or few species. Indices that combine both these components are known as heterogeneity indices.

Estimation of total number of species: The number of species encountered in a sample will vary with the size of the sample. More the number of samples more will be new species recorded and larger the sample size; higher will be the species count. The maximum number of species in any community may be estimated from species accumulation curve or by the Chao's method.

Species accumulation curve: The curves plotted between cumulative numbers of species against and sampling effort are known as species accumulation curves (Fig. 1). The sampling effort may be expressed in terms of number of samples, sampling area and number of individuals.

Fig. 1. Species accumulation curve



The slope of the curve decreases with the sampling effort and approaches a limiting value. The curve may follow Michelis - Menten equation and transcribe a hyperbola.

$$S(n) = S_{max}\, n / (B+n)$$

Where S(n) = Number of species up to the n^{th} effort (say number of samples),
S_{max} = Maximum no. of species in the community,
n = Effort (number of samples)
B = Constant

The equation may be written in the form:

$$1/S(n) = [(B/S_{max}) / (1/ n)] + (1/S_{max})$$

The y-intercept of the regression of the double reciprocal plot between 1/S(n) and 1/n will provide the value of $1/S_{max}$.

Chao's index: Chao's index for estimation of total species richness is given by the equation:

$$S_{max} = S_{obs} + (a^2 + 2b)$$

Where
S_{max} = Maximum no. of species,
S_{obs} = Actual number of species observed in different samples,
a = Number of species represented by one individual each (Singletons),
b = Number of species represented by two individuals each (Doubletons).

An example for computation of S_{max} by Chao's method is given in table 1. Let there be 3 quadrats (Q1 through Q3) and a total of 5 species observed A through E).

Table 1. Computation of S_{max} by Chao's method.

Sp.	QI	QII	QIII
A	1*	0	0
B	0	2**	0
C	4	3	3
D	5	1	4
E	0	1*	0

S_{obs} = 5
a = 2 singletons (marked by *)
b = 1 doubleton (marked by **)

S_{max} = 5+(4+2) = 11

Species richness:

The simple richness indices follow from the function

$$E [S] = f (k, N)$$

Where E [S] is the expected value for number of species, N is the number of individuals and k is a constant, defined as the richness index (Peet, 1974). Some of the richness indices are as follows:

Species richness index: The simplest richness index is the total number of species (S) present in the community.

Biodiversity index: This is the average number of species (S) per sample of N individuals. This is the most effective index for forest areas (Woodwell, 1967). This index implies linear relationship between number of individuals and species.

$$R = S/N$$

Menhinick's index: This index implies that number of species is directly proportional to square root of number of individuals.

$$R_{MEN} = S / N^{1/2}$$

Margalef's index: This index assumes that number of species vary logarithmically as the number of individuals.

$$R_{MAR} = (S-1)/ \log N$$

Odum's index: Odums's index (Odum et. al., 1960) is similar to the Margalef's index.

$$R_{ODUM} = S/ \log N$$

Berger – Parker dominance index: This is a dominance index and gives the proportion of most abundant species (N_{max}) to the total number of individuals of all the species (N_t) in the sample.

$$d = N_{max} / N_t$$

Fisher's α: Fisher suggested that number of individuals representing different species follow a logarithmic series.

$$S = \alpha \log (1+ N/ \alpha)$$

Where α is a constant. The value of Fisher's α is computed by iteration.

Average number of species per log cycle of importance: Whittaker defined log cycle of importance as $\log S_1 - \log S_n$, where S_1 is the number of individuals of the most common species and S_n is the importance of least common species.

$$E_{W1} = S/ (\log S_1 - \log S_n)$$

Whittaker's second richness index is based on dividing the number of species with 4 times of the geometric standard deviation of the sample.

$$E_{W2} = S/ 4 \sqrt{Var_{GM}}$$

Where, $Var_{GM} = [\Sigma(\log p_i - \log p_{GM})^2]/ S$,
p_i being the proportion of the species (n_i / n), and p_{GM} is the geometric mean of the p_i values.

Rarefaction approach to reduce the sample to a standard size: Since the number of species drawn from a sample will vary with sample size, Hulbert (1971) gave method for reduction of a sample to a standard size. Expected number of Species E(S) in a sample of n individuals drawn from a population of N individuals consisting of S species is given as

$$E(S) = \Sigma[1- \{^{(N-Ni)} C_n / {}^N C_n \}]$$

Information measures

Shannon – Weiner index: Shannon – Weiner index is based on information theory, which states that any message may be transmitted by means of a binary code. This index gives the information content per individual within an infinite population in a community. Larger the information content, more heterogeneous the sample will be. The assumptions to the Shannon's index (Poole,1974) that the sample drawn from the infinitely large population consists of all the species contained in the community. Shannon-Weiner index is given by the equation

$$H' = - \sum p_i \log_2 p_i$$

Where H' = Information content in bits
$p_i = n_i / N$ = Proportion of number of individuals of the i^{th} species (n) with respect to the total number of individuals of all species (N) in the sample.

The formula may also be presented using natural log or $\log_{10}$, and the units of information will be then natural bels or decits respectively.

$$H' = - \sum p_i \log_e p_i$$

$$H' = - \sum p_i \log_{10} p_i$$

The minimum value of H' is 0 if there is only one species in the sample and $H = H_{max}$, if all the species in the sample have equal number of individuals. Shannon – Weiner index is the most widely computed index in diversity studies.

Brillouin's Index: Brillouin's index is the information content per individual in a finite sample representing the total species content of the community. It is given as under:

$$H = (1/N) \log (N! / \Pi N_i !)$$

Where N_i is the number of individuals of the i^{th} species, n is the total number of species and Π represents the products of N_i ! values. The units of information will be the same as those for Shannon-Weiner's index. Minimum value of H will be 0 for single species communities. This index is also widely computed for diversity studies.

Simpson – Yule index: This index is based on the probability that the two individuals selected at random from a sample will belong to the same species (Simpson, 1949). For an infinite sample this will be

$$C = \sum p_i^2$$

Where p_i is proportion of number of individuals of the i^{th} species with respect to total number of individuals of all the species and (ni / N).

For a finite sample

$$C' = \sum \left[n_i (n_i - 1) / N (N-1)\right]$$

The minimum value for Simpson's index is 1 for single species communities. The value decreases with increasing heterogeneity.

Berger – Parker index or Gini's index: Berger-Parker proposed subtraction of Simpson's index from its maximum value, 1.

$$D = 1 - \Sigma p_i^2$$

The value of D varies from 0 to 1 for homogeneity to heterogeneity. This index is also known as complementary Simpson's index.

Pilou's index: This index is complementary to the Simpson's index for finite sample.

$$D' = 1 - \sum \left[n_i (n_i - 1) / N (N-1)\right]$$

Where Reciprocal Simpson's index gives the equitability of species.

Reciprocal Simpson's index:

$$D = 1 / C$$

The larger the value of D, the greater the equitability of species in the sample. The index ranges from 1 to S.

McIntosh diversity index: McIntosh proposed that a community may be presented as a point in an n-dimensional hyperspace with each dimension representing the abundance of a species. The distance between the community and the origin is given by $\sqrt{\sum n_i^2}$.

$$D = (N - U) / (N - \sqrt{N})$$

Where $U = \sqrt{\sum n_i^2}$, N is the total number of individuals of all the species.

Generalized expressions of the heterogeneity indices

Good's series of indices: Good suggested that most of the indices could be expressed in form of the equation given below:

$$N_a = \sum p_i^m (-\log p_i)^n$$

Where m, n = 0, 1, 2, 3…This gives,

$C_{o,o}$ = Species richness index (S)
$C_{2,o}$ = Simpson's index (Σp_i^2)
$C_{o,o}$ = Shannon's index (H').

Hill's series of indices: Hill (1973) proposed expression of the form

$$N_a = [\sum p_i^a (-\log p_i)]^{1/(1-a)}$$

Where $a \geq 0$, $a \neq 1$. This gives,

N_o = Species richness index (S)
N_1 = approaches limit to Exp (H') where H' is Shannon-Weiner's index.
N_2 = Reciprocal Simpson's index ($1 / \Sigma p_i^2$)

Evenness indices

The evenness of the sample is described by several indices. Theses are:

Evenness (V) = $(D - D_{min}) / (D_{max} – D_{min})$

Evenness (V') = D / D_{max}

Pielou's J' = H' / H'_{max}

Where D_{max} and D_{min} represent the maximum and minimum values of Simpson's reciprocal diversity indices and H' is the Shannon-Weiner's index.

Comparison of two communities

Two most commonly used indices are Shannon – Weiner index (H) and Reciprocal Simpson's index (D). It may sometime happen that the computation of Shannon – Weiner index and Reciprocal Simpson's index yield diametrically opposite interpretation. Consider two communities A and B. If $H_A > H_B$ but $D_A < D_B$, or vice versa, the two communities are said to be non comparable (table 2). That is, one index shows that one community is more diverse, the other index shows that the other is so. An interesting example by Tothmeresz (1975) is given in table 2.

Table 2. Example showing comparison of three samples (Tothmeresz, 1975)				
	Species	QI	QII	QIII
Number of individuals	I	33	42	32
	II	29	30	21
	III	28	10	16
	IV	5	8	12
	V	5	5	9
	VI		5	6
	VII			4
Shannon's H		1.38	1.45	1.75
Simpson's D		3.71	3.56	5.22

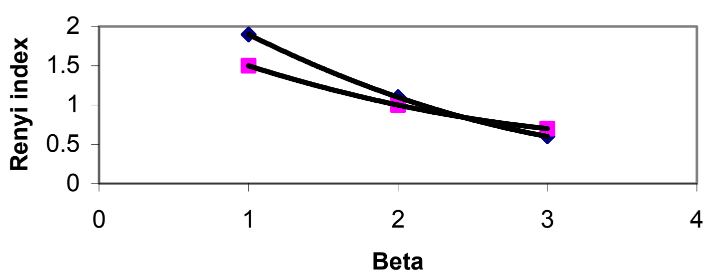
The data shows that $H_B > H_A$ but $D_A > D_B$. Thus Q Iand Q II are not comparable. Interpretation may be made for other pairs of quadrats as well. The indices used for the comparison of such communities are Renyi index and Hill index.

Renyi index: This index (Renyi, 1961) is used for the comparison of two communities. H_β is computed for different values of β, where β is the order ($\beta \geq 0$, $\beta \neq 1$), and p_i is the proportion of number of individuals of the *i* th species (n) with respect to the total number of individuals of all species (N).

$$H_\beta = \frac{\text{Log} \sum p_i^\beta}{(1 - \beta)}$$

A graph between β and H_β is plotted (Fig. 2). If the two curves intersect, the communities are not comparable.

Fig. 2. Diversity ordering



Hill index (N_α): It is an index similar to Renyi index, H_β = log (N_α) and interpreted similarly.

β – Diversity

β – Diversity is a measure of the change in diversity along a gradient. The simplest index for this measure is Species turn over rate defined as the Number of unique species for two habitats per species.

$$\text{Species turnover rate} = 100\,(a+b)/c$$

Where a = Number of species unique to area A, b= Number of species unique to area B, and c = Total species pool.

Some of the indices of β - Diversity commonly used are given below (Henderson, 2003., Routledge, 1977., Whittaker, 1972., Wilson and Schmida, 1984).):

1. Whittaker's β_w
2. Cody's β_c
3. Routledge's β_R
4. Wilson and Schmida's β_T

Table 3. β – Diversity indices.

β – Diversity index	**Formula**	***Explanation***
Whittaker's β_w	$\beta_w = S/ (\alpha - 1)$	S = Total number of species, α = The average species richness at the two habitats.
Cody's β_c	$\beta_c = [g(H) + l(H)] / 2$	g (H) = The number of species gained, l (H) = The number of species lost moving along a transect.
Routledge's β_R	$\beta_R = \dfrac{S^2}{2r + S} + 1$	S = Total number of species, r = Number of species with overlapping positions.
Wilson and Schmida's β_T	$\beta_T = [g(H) + l(H)] / 2\alpha$	g (H) = The number of species gained, l (H) = The number of species lost moving along a transect, α = The average richness of species at the two habitats.

Similarity between two communities: The similarity between two communities can be measured using Jaccard's coefficient, Sorensen's coefficient or Mountford's coefficient. A 2X2 contingency table is prepared for the presence-absence data of species at two different sites. Similarity coefficients are computed as per table 4.

Table 4. Similarity coefficients.

Coefficient	Formula	Explanation
Jaccard's coefficient	$C_J = a / (a+b+c)$	Where a = number of species common to two sites b, c = Number of species present at one site only.
Sorensen's coefficient	$C_S = 2a / (2a+b+c)$	
Mountford's coefficient	$C_M = 2a / (2bc – (b+c)a$	

Diversity as effective number of species

A distinction is made between information content and diversity indices. A diversity index is defined as effective number of species or numbers equivalent of a community (Jost, 2006). It is a value that a community having equal number of individuals of all the species will produce. For example, if the diversity index is 5 for a community having 14 unequally distributed species. This would imply that in terms of diversity, this community is equivalent to a community having 5 equally distributed species. In the true sense then the Shannon-Weiner index (H') is not a diversity index, nor is Simpson - Yule's concentration (C). These are measures of information content of the community. Their diversity indices are respectively, Exp (H') and Reciprocal Simpson's (D) indices. Similarly, Gini – Simpson's index, Renyi's entropy are information measures.

γ - Diversity

γ - Diversity is the diversity of pooled communities. An example for the computation for the richness contents of diversities at different levels is given in table 5.

Table 5. Calculation of richness component of α, β, γ species diversity.

Species #	Habitat A	Habitat B	Habitat C
1	+		+
2	+	+	+
3	+		
4	+	+	
5	+		+
6			+
7		+	
8		+	
9		+	+
10		+	
α Diversity	5	6	5
β Diversity	$\alpha_{ab} = 7$	$\alpha_{bc} = 5$	$\alpha_{ac} = 4$
γ Diversity		$\gamma_{abc} = 10$	

Whittaker's multiplicative law of diversities

The Shannon's entropies at the α and β levels are additive to produce γ entropy.

$$H'\alpha + H'_{\beta} = H'\gamma$$

Exponentiating both sides gives

$$\text{Exp}\ (H'\alpha)\ \text{Exp}\ (H'_{\beta}) = \text{Exp}\ (H'\gamma)$$

$$\alpha \text{ Diversity x } \beta \text{ Diversity} = \gamma \text{ Diversity}$$

Thus the β Diversity between two communities can be computed as the difference of γ Diversity and the mean of α Diversities. An example of computation of some of the information and diversity indices on the basis of hypothetical data (table 6) is given in table 7.

Table 6. Hypothetical data

	No. of individuals				
Sp.	QI	QII	QIII	QIV	QV
A	2	1	6	5	10
B	2	1	1	5	0
C	2	1	1	0	0
D	2	1	1	0	0
E	2	1	1	0	0

Table 7. Information and diversity indices

	QI	QII	QIII	QIV	QV
Taxa (S)	5	5	5	2	1
Individuals (N)	10	5	10	10	10
Dominance	0.2	0.2	0.4	0.5	1
Shannon's (H')	1.609	1.609	1.228	0.6931	0
Simpson's 1-C	0.8	0.8	0.6	0.5	0
Evenness Exp (H')	1	1	0.6826	1	1
Menhinick's	1.581	2.236	1.581	0.6325	.3162
Margalef's	1.737	2.485	1.737	0.4343	0
Fisher's α	3.98	0	3.98	0.7517	.2766

Conclusions

Extensive literature is available on diversity indices. These present quantitative measures for the study of plant, animal and microbial communities. The use of diversity indices have been extended for vertical structure of forest ecosystems, succession of communities (Petrere Jr. et. al., 2004)., rainfall data (Bronikowski, 1996) and many other such fields. Though now several softwares are available for computation of data, each study has its specific requirements and requires software development for specific use. The present paper may thus help in quantitative analysis of communities.

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Use Of Remote Sensing Technology For Forestry Resources

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&

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1.0 Introduction

In the broadest sense, **remote sensing** is the measurement or acquisition of information of an object or phenomenon, by a recording device that is not in physical or intimate contact with the object. It implies sensing things that are at a distance and detecting and measuring some of their properties without actually coming into contact with them.

In simple terms, it is utilisation at a distance (as from aircraft, spacecraft, satellite, or ship) of any device for gathering information about the environment. The technique can make use of devices such as a camera, laser, radar, sonar, seismograph or a gravimeter. Modern remote sensing normally includes digital processes but can as well be done with non-digital methods. This kind of data collection normally makes use of the emitted or reflected electromagnetic radiation of the examined object in a certain frequency domain (infrared, visible light, microwaves). This is possible due to the fact that the examined objects (plants, houses, water surfaces, air masses) reflect or emit radiation in different wavelengths and in different intensity according to their current condition. Some remote sensing systems use sound waves in a similar way, and others measure variations in gravitational or magnetic fields.

Remote sensing technology is roughly categorized into sensing (hardware) data processing (software technologies). Sensing technologies include sensor technology for obtaining the information on the object technology for platforms (artificial satellites, aircraft and so on) that carry the sensors and the technology for data, recording and transmitting. Remote sensors are devices that collect electromagnetic radiation and transmit them. Remote sensors that use radio waves include radar and radiometers in radio waves and those using light include cameras, radiometers and laser radar that is also known as lidar. Vehicles or

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structures on which remote sensors are installed are called platforms, which include artificial satellites, aircrafts and towers on the ground. Data processing technologies include those for retrieving data precisely physical properties of the objects acquired by sensor, those for data display (image processing) and those for building databases.

Remote sensing from artificial satellite is a very important means of monitoring the global environment since it allows repetitive acquisition of extensive data for global environment on short time. To verify the quantitative physical data obtained through remote sensing technology, ground truth data, which are physical quantities directly measured on the ground, are often used. While the global environment has deteriorated in recent years, this technology, which is a very powerful means to monitor global change, has seen dramatic development alongwith the rapid progresses made in satellite borne sensors and in data processing technologies by computers (Furuhama et al).

2.0 Remote Sensing

Conservation of forests is one of the major concerns of the global society, as forests are being depleted at an unprecedented and alarming rate, as they are vital for sustaining the global environment including human life. Depletion of forests has many ecological, social and economic consequences, one among them being the loss of biodiversity. Forests, the renewable natural resource on earth, occupy a unique position among the various natural resources as they support life on earth in many ways and their services cannot be substituted by any other means. In developing countries like India, dependence of people on forests is inevitable. As a result, there is loss of forest cover at an alarming rate and it has been found by researchers that population has been the single most driving force for global deforestation.

It involves the management of a broad range of natural resources within a forest area, which in addition to timber, herbs, fruits etc, provide such resources as grazing land for animals, wildlife habitat, water resources and recreation facilities. In preserving such a renewable natural resource, remote sensing technology can play a vital role in providing accurate, effective and reliable forest information to the forester's and can observe as large an area as necessary, at lower cost and lesser time compared to other methods. Due to the versatility of remote sensing, it has become an invaluable tool for forest management since it helps the forester's in their task of growing healthy tress by assessing the environmental conditions either in an existing forest or prior to planting one.

GIS has evolved as means of assembling and analyzing diverse data pertaining to specific geographic areas, using the spatial locations of the data as the basis for the information system (Shelton and Estes 1979). Kalensky (1992) stated that remote sensing and GIS are closely related. They are complementary information technologies that are both needed and operationally used for natural resources mapping and for forestland use planning, making forest inventories, disaster assessment and risk forecasting and for environmental monitoring. If they operated separately in an institute for management of natural resources, it would be harmful. It would result in costly duplication of various activities, training and some equipment and negatively affect the efficiency of project implementation. Good enough, D.G. (1988) also suggested that for the integration of remote sensing and the GIS, the remote sensing data must use the digital image analysis system.

Use of GIS in decision making and too in environmental problems is well established. Use of remote sensing and GIS for resource mapping, spatial analysis and decision-making has been widely reported by many researchers. GIS is a decision making tool based on geographically referenced information. GIS uses different levels of geographical information, such as elevation, hydrology, or local roads and infrastructure, to create a multi-layered representation of a site. Some sensing methods that area used in combination with GIS are aerial videography and thematic mapper sensing. These data are available for large areas and can be in to provide information on forest age, tree species distribution, and even estimate volume.

GIS technology has been widely accepted by the public as well as private forestry agencies in the developed countries as a result of the benefit of using this technology over current forest maps. It is used to assess the existing forest resource and develop forest schedules and harvest schedules and treatment programs to project future timber supplies and for other operational planning activities. Forestry inventory data is collected using remote sensing techniques. The conventional forestry inventory was done progressively with a small portion of the forest being inventoried each year and to update the forest cover map it would take 20 years or more with expensive manual drafting. With GIS, the forest cover maps can be updated on a constant basis and it provides the forest managers with more current data than what was previously available. With this technology, the average age of the information in the forest database could be reduced from 20 years to only a few weeks. The time factor alone has led to a wider acceptance and large demand for GIS application in forestry.

In itself, the use of GIS update the forest inventory maps is not much more than automated cartography but it is the analytical power of the software that sets it apart from cartography. It can store forest information in many ways that could not be previously done. It can be used to calculate the harvestable timber in the forest or model the spread of forest fire.

3.0 Applications of Remote Sensing in forestry

Remote sensing data can be used to provide forest related information to governments and civil society in a timely and cost effective way. The use of satellite data to map forests has become an increasingly common way to pinpoint deforestation, active fires and logging in protected areas.

For detailed species identification associated with forest stand analysis, very high resolution, multi spectral data is required. Being able to view the images in stereo helps in the delineation and assessment of density, tree height, and species. In general, monitoring biophysical properties afforests requires multi spectral information and finely calibrated data.

Forest cover typing and species identification are critical to both forest conservation managers and forestry companies interested in their supply inventory. Forest cover typing can consist of reconnaissance mapping over a large area, while species inventories are highly detailed measurements of stand contents and characteristics (tree type, height, density).

Forests are often at risk of being destroyed by forest fires. Remote sensing contributes to fire fighting efforts, as well. Data on wind direction and speed, and the dryness of surrounding areas can help predict the directions and speed at which a fire spreads. With this information, firefighters can be dispatched with maximum effectiveness and safety, and fires can be put out before they cause much damage. Thus it can be used in efforts to reduce the risk and minimize damage if a fire occurs. Weather information, such as measurements of precipitation and temperature, allows foresters to calculate risk assessments and isolate the areas most susceptible to fire. Those areas can be closely monitored by satellites, such as high resolution Advanced Very High Resolution Radiometer (AVHRR) and Satellite Pour Observation de la Terra (SPOT), Images from these satellites are readily available and small fires show up on them almost immediately.

During every stage of forest management, foresters can use remote sensing data to estimate future urban spread and population growth. Then, forest management can be planned taking into account the future needs of settlements. Urban planning data can also be applied to the management of urban forestry, to create inventories of storms are exhaustively mapped using remotely sensed.

Remote sensing provides a means of quickly identifying and delineating various forest types, a task that would be difficult and time consuming using traditional ground surveys. Data is available at various scales and resolutions to satisfy local or regional demands large scale species identification can be performed with multi spectral, hyper spectral, or air photo data, while small scale cover type delineation can be performed by radar or multi spectral data interpretation. Both imagery and the extracted information can be incorporated into a GIS to further analyze or present with ancillary data, such as slopes, ownership boundaries, or roads.

Hyper spectral imagery can provide a very high spatial resolution while capturing extremely fine radiometric resolution data. This type of detailed spectral information can be used to generate signatures of vegetation species and certain stresses (e.g. infestations) on trees. Hyper spectral data offers a unique view of the forest cover, available only through remote sensing technology.

Requirements for data for remote sensing depend on the scale of study to be conducted. For regional reconnaissance mapping, moderate area coverage, with a sensor sensitive to differences in forest cover (canopy texture, leaf density, spectral reflection) is needed. Multi temporal datasets also contribute phonology information that may aid in interpretation by incorporating the seasonal changes of different species. Similarly, for effective planning, management and sustainable utilization of forest resources, the information includes, a) present forest cover status; b) the change it has undergone at a specific period, preferably the latest; and c) the forest area that is likely to be affected in the near future.

4.0 Lidar Remote Sensing for Forestry Applications in Indian Context

Remote sensing is a very valuable tool for a country like India of vast geographical dimensions and diversity. There is no other way in which one can obtain so much relevant information on a rapid, repetitive, real time basis. Lidar remote sensing has the unique advantage of providing three-dimensional data through direct and indirect retrievals with unprecedented accuracy. It has enormous potential for forest ecological research, because it directly measures the physical attributes of vegetation canopy structure that is highly correlated with the basic plant community measurements.

Lidar (Light detection and ranging) remote sensing is a breakthrough technology for forest studies. It offers a great potential for conservation and management of India's invaluable forest wealth. For both economic and environmental reasons, it is critical to measure and understand the spatial organization of forest ecosystems. Typical remote sensing images allow analyzing various attributes of forests, but are limited in their ability to represent spatial patterns only in two-dimensional space. The advantage of using lidar remote sensing for forestry applications is that it provides data on three dimensional forest structures characterizing vegetation height, vertical distribution of canopy material, crown volume, sub-canopy topography, biomass, vertical foliage diversity and multiple layers, height to live crown, large tree density, leaf area index, and physiographic or life form diversity through direct and indirect retrievals.

Thus, lidar technology offers an emerging challenge to the management of India's forests, the panorama of which ranges from evergreen tropical rain forests in the Andaman and Nicobar Islands, the Western Ghats and the north-eastern states, to dry alpine scrub high in the Himalaya to the north. The technology could be utilized to address various aspects of forest ecosystem management, not possible previously with the data available from aerial photographs, optical and radar satellites or even by ground measurements. If cautiously planned, lidar can form the most scientific and accurate means of forest management in the country, viz. the three-dimensional data set can be used to redefine the existing 'forest types' classification that group Indian forests into 16 major and 22 minor forest types based on structure, physiognomy and floristic properties of vegetation. But increased transparency and accountability are required to bring about sustainable forest management. Accountable resource management can only occur if information on the stocks and use of resources is available in order to ensure transparency.

5.0 Advantage of Digital Interpretation over Visual Interpretation

Digital Image Processing (DIP) technique offers a more objective assessment of forest cover at a larger scale and has better cartographic presentation thereby overcoming the limitations of visual interpretation to a large extent. Some important advantages are highlighted below:

(i) Since visual interpretation is based on individual interpretation skill and experience, there is always a possibility of subjectivity in the assessment while in computer based digital interpretation, individual subjectivity is minimized to a great extent.

(ii) Method of computation of area is different in visual interpretation from digital interpretation. In the former, it is done using dot-grid templates by manual calculation, while in digital method; it is done by computer software and is based on number of pixels in each class. Due to change in scale of interpretation alone the area of forest cover in large forested regions may be reduced as the openings which were not discernible on the smaller scale are easily picked up on the larger scale. Conversely, in other areas, the area of forest cover may show increase as small patches of forests are picked up on the larger scale, which were not discernible on smaller scale.

(iii) In digital interpretation it is possible to enhance visual impact of the image for better interpretation.

(iv) Digital interpretation allows application of different transformations and algorithms for classification of the image.

6.0 Limitations of Remote Sensing Technology

However, there are still certain limitations with remote sensing technology when used for assessment of forest cover. Some of the major ones are listed below:

- Since resolution of data from LISS-III is 23.5 m, the linear forest cover along roads, canals, bunds and rails of width less than the resolution are generally not recorded.
- Young plantations and species having less chlorophyll contents in their crown do not give proper reflectance and as a result are difficult to be interpreted correctly.
- Considerable details on ground may be obscured in areas having clouds and shadows. It is difficult to interpret such areas without the help of collateral data.
- Variation in spectral reflectance during leafless period poses problem in interpretation.

It can thus be concluded that the integration of remote sensing and GIS, therefore have the potential for providing the necessary information of forest land use planning, in particular the existing forest areas and their status. In addition, forestland use planning can be conducted easily and effectively by using the GIS as a tool. However, the successful of the integration of remote sensing and the GIS for forestland use planning depends on the reliability of the existing information, which are sources for the GIS.

7.0 References

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