# Land-Use Strategies for Tribals: A Socio-Economic Analysis

*The paper seeks to identify alternate land-use and management strategies to strengthen the livelihood base of poor marginal farmers in the dry forest peripheries of India. Land alienation, soil degradation, wild animal attacks, and declining access to forests have debilitated the livelihood base of this tribal community. Benefit cost analyses and stakeholder discussions reveal that millet-based dry farming with adoption of soil conservation or growing perennials on field bunds are economically efficient relative to current practices and enjoy stakeholder acceptance. Some other economically superior alternate land-uses are not acceptable locally, indicating the care with which tribal development policies need to be made.*

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## I
## Introduction

Of India's 84 million tribals (2001 Census), approximately 55 per cent live in and around dry tropical deciduous forests of central and southern India. These rural poor are, burdened by their dependence on marginally productive and increasingly unsustainable land-use practices. Over the years, many land-based development schemes have been formulated and implemented in this region to assist tribal communities. However, some of these schemes appear to hinder rather than support the socio-ecological resilience of these communities [Nadkarni 2000]. Without careful analyses of stakeholder preferences over and above economic implications of projects, conservation and development efforts can come to naught. In this article we attempt to highlight the importance of socio-ecological and economic analyses in land-use planning for forest-dependent tribal farmers.

We present results from a two-year study of land-uses and users in a dry degraded montane region of southern India. Our main interest was to understand what kinds of land-uses prevail in the region and whether alternate land-use strategies generally implemented by developmental schemes were feasible. We wanted to gauge whether ecologically more sensitive land-use strategies made economic and financial sense and vice versa. Thus, objectives of the study were (a) to understand the factors contributing to sustainable land-use practices given development policies, property rights and livelihood patterns and (b) to identify economic and socially acceptable land-uses by conducting detailed economic analysis of land-use options in degraded, dry deciduous forest tracts.

In order to meet these goals, we first identified and elicited farmer and expert opinions on current and potential land-uses that were considered feasible in areas bordering forests. We then undertook a benefit cost analysis of 14 feasible land-use systems thus identified. Financial and economic benefit cost analysis demonstrate that rain-fed teak plantation and dry farming with soil conservation measures are economically superior to current practices. In a second phase of analyses, we discussed the economically optimal land-uses with farmers and identified three millet-based dry farming systems as both economically efficient as well as acceptable to tribal farmers. These changes can be put into place with some support from the government and extension agencies. The most immediate assistance required includes extension support related to soil and moisture conservation, vegetative fencing and choice and availability of saplings. Equitable access to groundwater is another important requirement.

In the next section, we discuss the methods and different phases of this study. Section III presents a brief description of the study area, it's land-use history and current characteristics of it's inhabitants. Alternate and feasible land-uses that would expand the choices facing farmers are identified in Section IV. Sections V and VI present benefit cost analysis of different land-use systems and farmer preferences. Section VII concludes the paper with recommendations for improving dryland productivity in the region.

## II
## Research Methods

The major processes involved in the study are outlined below in their order of occurrence. Each component described below was equally significant to the study.

*Identification of stakeholders and land-uses:* In the year 2000 we undertook preliminary field visits to identify existing land management practices. Rapid rural appraisal was adopted to identify stakeholders in various ownership and operational categories of land. Group discussions were undertaken at the village level about existing and feasible land-uses.

*Expert interviews:* Next phase involved discussions with researchers attached to institutes located in the area: ecologists from Salim Ali Centre for Ornithology and Natural History (SACON, Anaikatty), forestry scientists from Institute of Forest Genetics and Tree Breeding (IFGTB, Coimbatore), staff members of Attappady Hill Area Development Society (AHADS, Agali) and government officials with the departments of forests and agriculture. The technical viewpoints gathered from them facilitated further classification of existing and other feasible land-use practices and helped segregate the positive and negative impact of each option.

*Household survey:* In order to obtain household level information about land-uses, a detailed questionnaire for interviewing the households was prepared, pretested, finalised and translated to local languages (Tamil and Malayalam). Since variation with respect to livelihood and landholding pattern between hamlets was found to be greater than variation within a hamlet between households, it was decided to cover more hamlets each with a few respondents. From about 100 hamlets lying near dry deciduous forests, we identified 62 hamlets and 120 households (4 per cent sample) for a detailed survey. Formal education is almost nil among the head of households with whom most of the interactions were to be held. Hence investigators were identified locally and trained for the survey to gather data on land-use practices, livelihood characteristics, and perceptions regarding land-use options. Transect and field walks helped to trace the impacts of land-use practices and their potential in local livelihood systems. Local markets were visited to obtain price data. Data collected from this survey are discussed in Sections III and IV.

*Identification and benefit cost analyses of alternate land-uses:* The preferences and perceptions on land-uses obtained from the household survey were discussed with technical experts researchers and officials mentioned above in order to develop a final list of potential land-uses for economic analysis. The identified land-uses were then subjected to benefit cost analysis (BCA). Section V discusses BCA in detail. Secondary sources were referred to for biometric observations on different tree species and benefits in carbon sequestration.

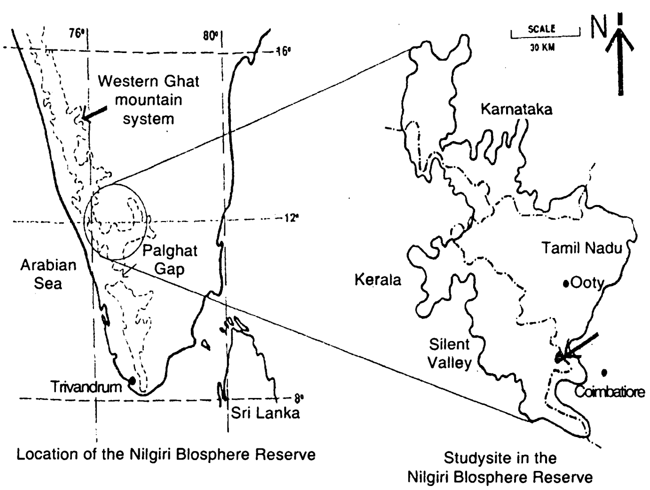
*Farmer ranking of economic land-uses:* The results of the benefit cost analyses were discussed with a subsample of respondents before making recommendations. Section VI discusses results of this comparative analysis and the implications are discussed in the concluding section.

## III
## Study Area

Study area is a tribal belt located around Anaikatty, 30-50 km north-west of Coimbatore city, near tropical dry deciduous forests (TDDF) bordering Kerala and Tamil Nadu in southern India. The area though falling under two different states is geographically contiguous and inhabited by the indigenous community (adivasi) of Irulas (referred to as natives or tribals henceforth). The study area is socio-economically backward compared to other parts of the two states (at 2001 prices, the average per capita income of respondents was less than one-third of that for the respective state). Forests in the area are ecologically sensitive and constitute part of Nilgiri Biosphere Reserve. The area of study is bounded in the north by Attappady hill ranges, in the south by suburbs of Coimbatore city, in the west by reserve forests of Western Ghats, and in the east by Thadagam valley (Figure 1). It consists of the dry tracts of Sholayur and Pudur panchayats in Kerala state and 24-Veerapandy, Tholampalayam and Velliyangad panchayats of Tamil Nadu. Adivasis of Irula sect form the majority – 45.4 per cent (2,105 out of 4,637) in 24-Veerapandy and 44.8 per cent (7,591 out of 16,941) in Sholayur panchayats as per 1991 Census of population.

*History of land-use and land rights:* The current situation of land-uses and livelihood pattern in the forest peripheral lands owned by Irulas should be viewed in the light of many ecological and social changes that took place over a short span of time to a cohesive community, which was isolated from rest of the society till latter part of 20th century [Buchanan 1870, Bijoy 1999]. History of landownership and uses in the area depicted in Table 1 gives an interesting backdrop for the evolution of land-use problems in Anaikatty. The area under different royalties till 18th century

**Figure 1: Study Area in Southern India**




had dense forests though the economically backward practised shifting cultivation and the well-to-do indulged in hunting. Timber extraction began on a commercial scale with the East India Company gaining control of major parts of the area while princely states and landlords owned the rest. Apart from shifting cultivation, "kumri"[1] cultivation also became a common land-use among natives. Shifting and kumri cultivation were later banned from the forests but timber continued to be extracted while extraction of non-timber forest products (NTFP) increased.

Towards the second half of 20th century, ownership of most of the forests was transferred to the respective state governments while a large chunk was still retained by landlords ("janmis"). Soon land reforms were implemented in these parts for distribution of land to the landless. Excess land acquired from landlords who clear-felled them prior to acquisition by the government, were allotted to landless. Rest of the private forests were nationalised.

Irulas of older generation were generally not concerned with material wealth and hard labour to raise savings [Buchanan 1870]. This "unconcerned" nature triggered alienation (rights shifting to non-natives) of their land in favour of settlers (mostly gounders) from the plains. Relatively fertile lands out of those distributed to the natives were alienated and farmers from the plains started settling in the area in large numbers. This paved the way for entry of various institutions and commercial establishments. Some of these areas, once populated mostly by natives have now been reduced to adivasi minority areas. For example in 1961, the population in Attapady block in Kerala, was 63 per cent adivasis. By 1991 adivasis had been reduced to just 30 per cent. A survey of 1977 by Integrated Tribal Development Project under government of Kerala, revealed that in Attapady block alone, 10,107 acres of adivasi lands were alienated (rights shifted to non-adivasis). As a consequence, majority of native population were confined to the immediate periphery of forests.

Land that remained with tribals derived its productivity from adjacent forests and produced subsistence crops with minimum inputs. Lack of awareness about land conservation techniques in settled agriculture, and dearth of monetary resources catalysed a decline in productivity and subsequent indebtedness. Clear felling triggered ecological disturbances and curtailment of traditional forest rights and land alienation eroded the traditional base of livelihood. Slowly, parts of adjacent state-owned forests were transformed to open access scrub jungles. When shifting cultivation was abolished after independence, the Irulas found it difficult to adjust to the market-oriented way of life. The state tried to integrate these communities with mainstream economy through various development schemes. However, "economic unfreedom" [Sen 2000] persisted even after years of benefit distribution in the form of rations, livestock and land.

Tribals of this region became completely dependant on government programmes or casual labour in the farms owned by settlers. Recurring drought conditions and wild animal intrusions reduced the scale of operations even in settler farms, often depriving the natives of employment opportunities. In such circumstances, pressures of livelihood and lack of education often make them susceptible to exploitation by smugglers and bootleggers. Thus, the ethnic forest-dwelling native community of Irulas, which was earlier transformed to dryland subsistence farmers, has now been reduced to the status of underemployed wage labourers.

At present degraded cultivated lands, extensive fallows and increasing construction activities dot the landscape just outside the dry deciduous forests. The area is now known for its brick-kilns and wild elephant raids. Thus the current land-use in Anaikatty area is characterised by recurring drought, raids by wild elephants, land degradation, ambiguous land rights and unregulated extraction of water and mining of soils. These factors were the foci of many of our discussions with stakeholders in Anaikatty.

*Land-livelihood linkages in Anaikatty:* The household and village surveys provided numerous insights into land-use dynamics at the interface of forests and commercial agriculture in Anaikatty area. Weakening community rights, loosening social cohesion and fading ethnic traditions together with land alienation have resulted in a lack of entrepreneurship or inability to utilise traditional skills for sustained livelihood. Consequently, land in whatever limited extent, quality or right regime, is probably the only productive asset belonging to the natives, apart from manual labour. This is the main reason underlying the study objective of finding an appropriate management strategy to improve the productivity of these lands.

Tables 2 and 3 present information about farm household characteristics in the region. Average size of holding and the extent and proportion of own titled land is low. Nearly 35 per cent of the average 1.44 ha of land possessed by a native farmer lies fallow. Land possessed was positively and significantly correlated with the extent of fallow (r=0.59 n=102), nullifying the advantage of increased acreage. Small families without adequate labour potential leased out land thereby reducing the size of operational holding to manageable levels. Cultivated lands of about 0.94 ha contributed 20 per cent of annual household income, which includes the value of crop consumed, and marketed farm produce.

Bullocks and cows rarely form part of a native farmer's stock. They succumb easily to fodder and water scarcity in times of drought, depriving farmers of crucial draft power for the next cropping season. This trend is a pointer to a vicious cycle wherein ecological degradation leads to poor biomass production (both on and off farm), which leads to fodder scarcity and there by a paucity of draft power and other resources for cultivation which in turn makes the farmer more impoverished and dependant on foraging, ultimately leading to more degradation.

Excess land acquired by the state land reforms is periodically distributed to the landless, most of which was cleared forest area. Nearly 10 per cent of the respondents (12 respondents) had received titles for such lands in the recent past as part of different government policies. All of them have got rights for lands lying at least six to seven km away from their hamlets, and there appears to be a distinct apathy in managing these lands because of inaccessibility and degradation. These beneficiaries of land reforms continue to lease-in other lands for cultivation purposes where again conservative management practices are discouraged owing to lack of ownership rights. As a result, both the owned and leased lands were not being managed for long-term productivity.

The survey reveals that more than 31 per cent of respondents had incurred crop losses due to drought in the year 2001-02. About 24 per cent of the respondents had not attempted cultivation in the second crop season, predicting crop failures due to soil moisture deficit.

**Table 2: Asset Details of Survey Respondents***

| | Tribal Households (n=102) | |
|---|---|---|
| | Mean | (±) Std Error |
| Household size | 4.5 | 0.16 |
| Total land (ha) | 1.44 | 0.16 |
| Own titled land (ha) | 0.80 | 0.08 |
| Titled land /total | 0.63 | 0.05 |
| Fallow /total | 0.35 | 0.04 |
| Irrigated land/total | 0.14 | 0.03 |
| Livestock units owned | 3.00 | 0.44 |

**Table 3: Other Characteristics of Farm Holdings***

| | |
|---|---|
| Average distance to reserve forests (km) | 0.81 |
| No of people given title deeds recently | 12 |
| Mean number of employed days/year/person | 80 |
| Households with drought related crop loss | 32 |
| Households leaving land fallow due to drought | 25 |
| Annual loss in crop yield due to wild elephants (per cent) | 51 |

**Source*: Household survey.

**Table 1: Brief History of Land-Uses in the Aniakatty Area***

| Era | Ownership | Land-use |
|---|---|---|
| Up to 18th century | Chera, Chola, Pandya, Vijayanagara, Mysore (Kongu) and Samoothiri (Malabar) kingdoms | Dense forests, shifting cultivation, hunting |
| 18th to 20th century | East India Company, kingdoms and "Janmis". | Dense forests, shifting cultivation, hunting and Timber extraction |
| 1950- 70 (After Tamil Nadu Preservation of Private Forests Act, 1949) | Adivasis, state departments of forest and revenue | Extraction of timber and NTFP; shifting and kumri cultivation |
| 1970 onwards (After Kerala Private Forests Vesting and Assignment Act, 1971) | Adivasis, gounders, state departments of forest and revenue, commercial establishments, institutions. | Degraded forests, Settled dry farming, plantations, fallows, brick kilns, buildings |

**Source*: Buchanan (1870) and Working Plan, Coimbatore Forest Division.

Wild animals inflicted a mean loss in yield of about 51 per cent to the native farms in any season. Crop raids occurred in places where settlers grew sugar cane and bananas on a large scale. Hamlets frequented by elephants were provided with power fencing by government or non-government agencies but most of the fences failed to serve the purpose on account of poor maintenance by the community or ingenious methods invented by elephants to transgress these barriers. In the absence of a preventive mechanism, native respondents were avoiding species known to be favourites of wild pachyderms. Certain crops like dolichos beans ("Dolichos lablab") and horse gram ("Dolichos uniflorus") not much relished by elephants, are gaining acreage in the fields.

Table 4 shows that Irulas are highly dependent on non-farm income. Wages for casual labour is the important source of non-farm income. Wage income constitutes nearly 64 per cent of annual household income of natives. Labour opportunities are generally confined to seasonal planting activities undertaken by the forest department. Sale of stock in liquidity crisis formed the income from livestock to the tribal. Other sources of income include income from NTFPs (12 per cent). Agricultural income constitutes approximately 20 per cent of the annual household income. Our paper focuses on improving the productivity of land because it is the only productive asset with a household and that other options like migration in search of employment or provision of better and reliable employment facilities in these inaccessible areas is a remote possibility.

State-sponsored social security schemes like subsidised distribution of grains and credit facilities seem to also influence land-uses of the study area. The above-mentioned factors in certain hamlets prevent distress activities like selling topsoil. Wherever social security schemes are not in place, like in the hamlets on the eastern side of the study area, degrading activities like selling topsoil to brick kilns, grazing as an occupation, etc, become integral part of survival strategies under liquidity crisis. Distribution of free rations also influence dietary habits and hence cultivation patterns. Millets, the conventional staple diet is gradually giving way to rice in daily intake, popularised by state-sponsored public distribution system though cropping of paddy is not agro-climatically feasible in the area.

**Table 4: Annual Household Income of Respondents (2001-02)***

| | Mean | (±) Std Error |
|---|---|---|
| Non-farm income (Rs '000) | 18.83 | 1.68 |
| Non-farm income/total | 0.64 | 0.03 |
| Agricultural income (Rs '000) | 5.45 | 0.46 |
| Agricultural income/total | 19.56 | 0.01 |
| Income from livestock (Rs '000) | 0.86 | 0.23 |
| Livestock income/total | 0.04 | 0.01 |
| Income from NTFP (Rs '000) | 2.72 | 0.44 |
| NTFP income/total | 0.12 | 0.01 |
| Annual household income (Rs '000) | 27.86 | 1.86 |

* *Source*: Household survey.

## IV
## Identification of Feasible Land-Use Options

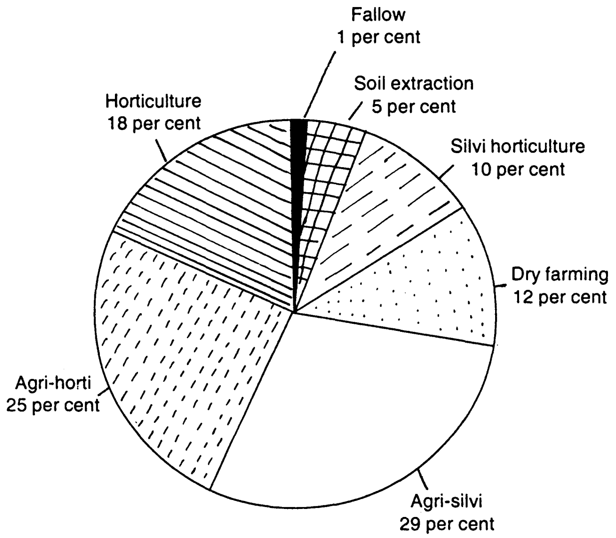
The major issue before attempting to value different land-uses was to select them for valuation. Valuing just the existing land-uses in the area and those suggested for other similar areas in literature may exclude many locally accepted and feasible uses. As noted in Section II, we first identified existing land-use practices in the study area through a preliminary survey and rapid appraisal. A survey of experts also helped identification of potential alternate land-use practices and their characteristics. Further, to understand farmer preferences, we asked a series of questions to the households about different land-uses and

**Table 5: Land Based Livelihood Strategies in Anaikatty Region: Reasons for Local Preference and Perceived Risks***

| Land-Use Options | Reasons for Preference | Risks Perceived |
|---|---|---|
| Dry farming (seasonal field crops) | For subsistence.<br>Traditional occupation<br>Millets and coarse grains form staple diet<br>No other employment | Drought<br>Wild animals<br>Soil degradation |
| Agri-silvicultural systems<br>(field crops with forest trees on bunds) | Supplement firewood where either the access to forests is low or forests are highly degraded.<br>While seasonal crops are affected by exogenous factors, timber provides income security | Availability of planting material in time<br>Tree shade may reduce crop yield<br>Apprehensions about rights to harvest, transport and sell timber |
| Agro-horticultural systems<br>(field crops with fruit trees on the bunds) | Felt need to supplement the diet (especially when there are growing children) without compromising on field crops when forests no longer supply fruits and tubers. | Availability of planting material in time<br>Tree shade may reduce crop yield<br>Apprehensions about rights to harvest, transport and selling timber<br>Attract elephants |
| Horticulture<br>(plantations of fruit trees) | Supplement diet and meet other needs for wood when there is enough land left for millets.<br>Prefers species with low water requirement | Availability of planting material in time<br>Apprehensions about rights to harvest, transport and selling<br>Attract elephants |
| Silviculture<br>(plantations of forest trees) | Households with enough land apart from field crops or where wild life attack and drought make cultivation difficult or those who are more dependant on NTFPs | Availability of planting material in time<br>Apprehensions about rights to harvest, transport and selling |
| Silvi-pasture and natural regeneration | For people dependant on grazing | Very few depends exclusively on grazing |
| Leasing to the brick kilns for soil extraction | Immediate income<br>Wildlife attack and drought make farming impossible<br>Land levelling<br>Feels that soil can be rejuvenated in few years | Land degradation and loss in crop production |
| Fallowing | Lowering productivity, lack of draft power and yield loss to drought and wild animals. | Subsistence affected |

* *Source*: Household survey.

Figure 2: Tribal Preferences for Different Land-Uses




which farmers may prefer. This section reflects the attitudes of respondents on various land-uses as well as expert opinion on them.

Table 5 identifies the major land-use alternatives in the area. The broad categories of land-uses that currently prevail or are feasible include: dry farming, agri-silvicultural systems, agro-horticultural systems, silviculture, horticulture, silvi-pasture, natural regeneration, soil excavation for brick kilns, fallowing or non-use of land for agriculture. Columns 2 and 3 of Table 5 present the reasons why farmers preferred certain systems of land-uses and the risks they saw in adopting these use systems. General reasons for preferring a land-use appear to be immediate benefit of supplementing food and fuel-wood. Perceived risks include that of crop failures, uncertainty over harvest rights, and unavailability of inputs.

Figure 2 shows the distribution of farmer preferences for different land-uses. Nearly 12 per cent of the households surveyed wanted to cultivate only millet crops as it is now being done. But most respondents (54 per cent) wanted to do millet farming in an improved system (25 per cent opted for agri-horticulture and 29 per cent for agri-silviculture systems). Thus, nearly 66 per cent of the respondents want to continue with dry farming either with (54 per cent) or without (12 per cent) modifications. Most of the respondents (54 per cent) were willing to modify current land-use by planting trees on bunds. About 28 per cent opted for plantations (10 per cent for silvi-horticulture systems and 18 per cent for pure horticultural plantations). A very small number of households showed a preference for soil extraction for brick kilns. None of the respondent households were interested in pure silviculture, though the system is prevalent in large farms or forestlands.

## V
## Benefit Cost Analysis of Land-Uses

After identifying potentially feasible alternate land-uses in the region, we were interested in establishing whether these land-use systems were economically feasible. From the major categories of land-use systems identified in the previous section, a set of 13 specific practices (listed in Table 6) were assessed by BCA and compared with the existing practice. First six in the table are primarily farming options and the next five plantations followed by two mixed stands with fodder grass component. Two to five and 12 in Table 5 have been newly suggested for the study area. The local community is not familiar with systems involving conservation measures, improved fallows and silvi-pasture (2, 5 and 12 in Table 6) recommended by scientists, though the vegetative components of these systems were common in the locality.

The first step in benefit cost analysis was to identify the benefits and costs in different land-uses for the selected time period. Quantification of these costs and benefits followed next. Costs and benefits of each land-use are quantified with the assumption that general management strategies prevailing in dryland agriculture in the area, with minimum application of inputs is continued for the entire period of analysis in all the options. The third step estimated the financial and economic net present values of land-uses at selected discount rates. Thus in the next section (VI) we report and discuss the results of BCA of individual land-use as compared to the current system of dry-farming (DF1). In the sections below we discuss some of the methodological issues that need to be addressed in undertaking benefit cost analyses.

*Finding net present value of land-uses:* BCA is a tool that allows us to understand whether or not a given change will improve the welfare of specific households as well as the overall economy. Thus, we are interested in the incremental net present value (NPV) of different land-uses relative to the existing system of dry farming. Each land-use is compared with the existing practice of dry farming (DF1). The relative net benefits of each new system are assessed in terms of Financial and Economic NPV. Equation 1 gives NPV as the sum of discounted net benefits for 20 years.

$$NPV = \frac{\Sigma\ (t=1\ \text{to}\ 20)\ [\Sigma\ (P_{nt}Q_{nt} - P_{nt}Q_{n1t}) - \Sigma(C_{nt} - C_{nlt}) + CC_t) + LV_{20}]}{(1+r)^t} \quad [1]$$

where

$P_{nt}$ Price of $n^{th}$ output at time t

$Q_{nt}$ Estimated yield of $n^{th}$ output at time t

$Q_{n1t}$ Yield loss of $n^{th}$ output due to drought and/or crop raiding

$C_{nt}$ Input costs (labour, materials and land rent) for $n^{th}$ output at t

$C_{nlt}$ Any unspent cost due to loss in output n at time t

$CC_t$ Cost of conservation measures if any per hectare at time t

$LV_{20}$ Liquidation Value

For each land-use at both the discount rates, a final end value is worked out as liquidation value. This liquidation value $(LV)^2$ is added to the net benefits of the end year and then discounted. Assuming that the land will continue under the concerned land-use into perpetuity, annuity formulae are used to find liquidation value as shown below

LV for Annual crops = Net benefits in the end year/r [2]

LV for Perennial systems = Net benefits in the end year/$(1+r)^{20} - 1$ [3]

Equation (4) presents the incremental discounted net benefits from alternate land-use systems relative to the current practice of dry farming. This equation tells us whether farmer would consider any new land-uses superior to existing practices.

Incremental NPV = {NPV (alternate land-use practice) – NPV (dry farming)} [4]

Land-uses are evaluated for a suitable time horizon depending on the mean annual increment of biomass, which generally peaks around 20 years for perennial components in the selected land-uses. For land-uses with shorter rotations, possible number of rotations till 20 years has been taken.

In the light of literature surveyed [Barbier et al 1989; Dixon et al 1994; OECD 1995; Reddy et al 1997; Markandya and Murty 2000; Tiwari 2000; Neil 2001; Lele et al 2001 and Ninan and Lakshmikantamma 2001] and immediate concern for sustenance of major stakeholders, a discount rate of 8 per cent was used to reflect individual time preference. Considering the ecological linkage, a social discount rate of 5 per cent was also applied. Benefits and costs are valued at constant prices prevailing in 2001 for the time period till 2020 and the annual net benefit flows discounted to find the present value of land-use, using equation [1].

*Costs and benefits for computing NPV:* The first step in BCA is to identify the various costs and benefits associated with each alternate. Various costs and benefits in each of the land-use option were quantified to calculate NPV using equation [1]. Major benefits from many of the land-uses include foodgrains, fruits, fodder, firewood, timber, softwood, soil conservation and sequestered carbon. Some land-uses also have an impact on soil erosion and hence on crop productivity. This impact is quantified using a production function. Costs are chiefly associated with labour and material inputs in protection, planting, cultivation, and harvest; yield loss due to soil erosion and animal raids.

Direct benefit in the form of biomass outputs were quantified and valued at farmgate, forest gate or nearest market price collected during survey. Growth pattern and biomass yields (hardwood, pulpwood, firewood, fodder and seeds) of trees are based on information from rain-fed plantations of the specific species or from published works on the concerned species.

*Incorporating soil productivity changes:* In this study, we incorporate the private financial costs of ecological damage in specific land-uses by accounting for soil erosion over time and its impact on yield. Land-uses vary in their effect on soil and through that on crop yield and income. A land-use was considered to lead to excessive soil loss if erosion is more than 2.5 tonnes/ha/year [Biswas and Mukherjee 1987]. Accordingly, BCA of current land-use practice (DF1), dry farming with conservation (DFC), dry farming with protection (DF), improved fallows (IF), multipurpose trees followed by agro-forestry (AF1), millet-based agro-forestry (AF2) and soil excavation (SE) needs to incorporate the yield impact of soil loss. Detailed data on change in yield levels due to soil loss was not available for the study area and the crops concerned. Hence, the soil productivity analyses was undertaken by using a single factor Mitscherlich-Spillman production function (see Appendix) as adopted by Gunatilake (1998) and Ananda et al (2001).

**Table 6: Selected Land-Uses for Economic Analysis**

| | Land-Use |
|---|---|
| 1 | Dry farming as practised (DF1) |
| 2 | Dry farming as practised with some protection from animals and drought: (DF) |
| 3 | Dry farming as practised with soil conservation measures (DFC) |
| 4 | Multi-purpose trees for 10 years and dry farming resumed by retaining some trees as in agro-forestry (AF1) |
| 5 | Agro-forestry (millet-based) from now on with two tree species (AF2) |
| 6 | Improved fallows with legumes for five years and dry farming resumed (IF) |
| 7 | Soil excavation, land reclamation and resumption of dry farming (SE) |
| 8 | Unirrigated plantation of Phyllanthus emblica (Amla/Indian gooseberry) (EM) |
| 9 | Unirrigated neem (Azadirachta indica) plantation (NM) |
| 10 | Unirrigated teak (Tectona grandis) plantation (TK) |
| 11 | Unirrigated cashew (Anacardium occidentale) plantation (CSW) |
| 12 | Unirrigated eucalyptus (Eucalyptus territricornis) plantation (EU) |
| 13 | Silvipastoral system (SP) |
| 14 | Natural regeneration (NR) |

*Financial and economic BCA*: Financial analysis estimate profit to primary stakeholders from a land-use while economic analysis measures the impact of land-use on the economy as a whole. Financial analysis takes into account all expenditures incurred and revenues generated under a project in order to assess the ability of the project to meet its financial obligations and to assess the incentives to producers. Economic analysis measures the project's positive and negative social impacts through shadow prices.

In the economic BCA, we obtain the shadow prices of non-traded non-incremental inputs (land and labour) based on the supply price of the alternatives being displaced. This opportunity cost of land and value of unskilled surplus rural labour as described in the subsections below are included in economic NPV. The only traded and incremental component in any land-use is timber. Timber outputs from the study area (in terms of both quantity and quality) are not substitutes for imports to India, and hence timber is not shadow priced. Further, the environmental benefit of sequestering carbon in hardwood is taken into account to be described soon under. Other externalities of land-uses (off-site impacts on other lands, rivers and dams) are not quantified, being out of the scope for a study of short duration. Thus, the differences in economic BCA from financial BCA in this analysis are threefold: in terms of value of land, labour and net carbon benefits.

*Shadow price of land:* Opportunity cost of land in terms of the best alternative forgone will be the rent in economic analysis. Actual rent foregone or the prevailing annual leasing rate was taken as the land rent for economic BCA. For financial BCA, lease rate fixed by the revenue department is taken as the land rent.

*Economic wage rate*: Wage rates prescribed by the government for the area were taken in the financial NPV. Family labour was valued at prevailing rates for men and women for different jobs (taking pits, weeding, harvesting, etc). Survey reveals that, the average number of employed days per year per person (in casual wage labour) was 95 (highest employment was 250 days/year for brick kiln contract-labourers) and average labour deployment potential was 2.50 persons per family (old people get half wages in the locality). After taking annual per capita contribution of 28 days in own farms, 15 days in morbidity, and 35 days in religious, social and personal needs, there are 192 days available per person per year. This indicates that there are 470 surplus labour days available per household in an year. Thus the wage rate for economic NPV should be calculated based on a conversion factor from the financial wage rate.[3] If the financial wage rate is not actually in vogue, then the wage rate for economic BCA would be:

Economic wage rate = Financial wage rate * Conversion factor.

Conversion factor worked out for the year 2000 from Season and Crop Report of Tamil Nadu (Season and Crop Report 2001, Directorate of Economics and Statistics, Chennai) was 0.75.

*Valuing carbon benefits*: Carbon benefits enter benefit streams in economic BCA, whenever there is an output of hardwood or at the end of cycle as benefits in soil carbon attributable to the new land-use. Thus net carbon sequestered in woody parts of the vegetation entering long-term structural uses as well as net carbon sequestered in the soils [following Biswas and Mukherjee 1987] attributable to the new land-use were taken into account. The World Bank's Prototype Carbon Fund (PCF) price of USD 10 per tonne of carbon for 2001 (Prototype Carbon Fund 2002) is adopted for valuation of the net carbon sequestered in soil and hardwood. Accounting for the values of carbon sequestered in the benefit stream, economic BCA provided worthiness of the project from society's perspective.

## VI
## Results of BCA

Table 7 gives the NPV and the incremental NPVs for selected land-uses at two discount rates under both financial and economic BCA. Dominant trends in relative performance of land-uses remain the same between the economic and financial BCAs as well as between the two discount rates.

*Financial analysis:* Financial analysis shows that unirrigated teak (TK) followed by dry farming practised with soil conservation measures (DFC) have the highest value of NPV and incremental NPV. Other land-uses that perform better than current land-use are: unirrigated cashew (CSW), multi-purpose trees for 10 years and dry farming resumed by retaining some trees in agro-forestry (AF1), millet-based agro-forestry with two tree species (AF2), and improved fallows with legumes for five years and dry farming resumed (IF). At 8 per cent, incremental NPV ranges from Rs 17,000 for soil excavation to Rs 2.5 lakh for teak. Figure 3 summarises these results. Financial BCA of different land-uses indicate that unirrigated teak is the most profitable option which would increase the NPV of land more than 10 times that of the current land-use. The next best profitable land-use among those analysed – dry farming practised with soil conservation measures – increases the NPV to four times that of the current land-use.

**Table 7: Results of Benefit Cost Analysis**

| Landuses | (Per Cent) | Financial (Rs) NPVs | Financial (Rs) Incremental NPVs | Economic (Rs) NPVs | Economic (Rs) Incremental NPVs |
|---|---|---|---|---|---|
| DF1 | 5 | 27389 | 0 | 73754 | 0 |
| | 8 | 22550 | 0 | 47670 | 0 |
| DF | 5 | 129918 | 102528 | 190235 | 116481 |
| | 8 | 88592 | 66043 | 120310 | 72640 |
| DFC | 5 | 196540 | 169151 | 246588 | 172834 |
| | 8 | 120615 | 98065 | 147017 | 99347 |
| AF1 | 5 | 86413 | 59024 | 99919 | 26166 |
| | 8 | 52411 | 29861 | 62744 | 15074 |
| AF2 | 5 | 124607 | 97218 | 138657 | 64903 |
| | 8 | 90864 | 68315 | 101918 | 54249 |
| IF | 5 | 71213 | 43824 | 84461 | 10707 |
| | 8 | 45419 | 22869 | 55640 | 7970 |
| SE | 5 | 40139 | 12750 | 54359 | -19394 |
| | 8 | 40081 | 17531 | 50504 | 2834 |
| EM | 5 | 34755 | 7366 | 45798 | -27956 |
| | 8 | 11005 | -11544 | 18669 | -29001 |
| NM | 5 | 44052 | 16663 | 54629 | -19125 |
| | 8 | 17625 | -4925 | 25134 | -22535 |
| TK | 5 | 605099 | 577710 | 611732 | 537979 |
| | 8 | 276274 | 253725 | 274383 | 226713 |
| CSW | 5 | 179938 | 152549 | 205839 | 132085 |
| | 8 | 97312 | 74762 | 114925 | 67255 |
| EU | 5 | 1002 | -26387 | 9284 | -64469 |
| | 8 | -8763 | -31313 | -1622 | -49291 |
| SP | 5 | 76850 | 49461 | 91279 | 17525 |
| | 8 | 32432 | 9883 | 42576 | -5094 |
| NR | 5 | -6930 | -34319 | 8370 | -65384 |
| | 8 | -10611 | -33161 | -1219 | -48889 |

**Figure 3: Incremental Financial NPVs**

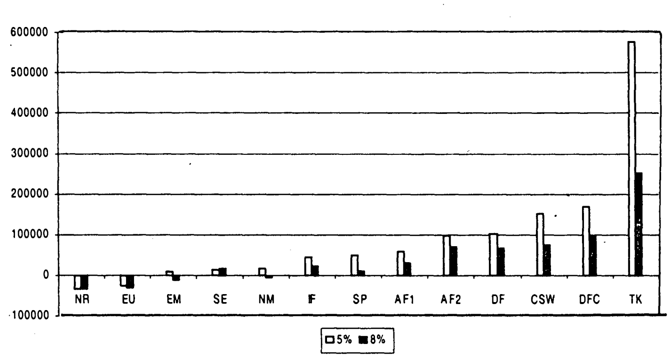
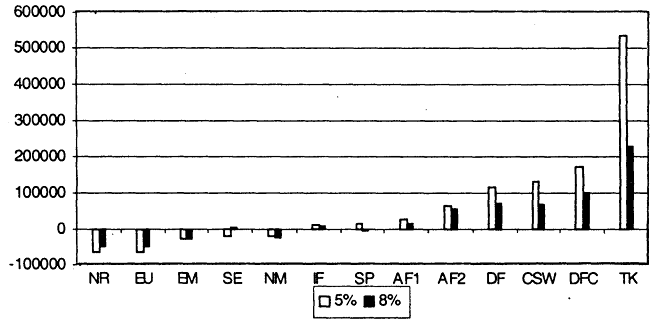



**Figure 4: Incremental Economic NPVs**




*Economic analysis:* Assessing incremental net benefits using shadow prices does not change the rankings of land-uses. Top two choices for alternate land-use – teak and dry farming with soil conservation – are still the best alternates to current practices. At 8 per cent incremental NPV ranges from Rs 2,800 for soil excavation (SE) to Rs 2.2 lakh for teak (TK). Figure 4 summarises these results of economic analysis.

At 8 per cent, in economic BCA, DF1 (current land-use) became better than SP (silvi-pasture) and economic worth of DF (current land-use with protection) became larger than AF2 (millet-based agro-forestry) and CSW (unirrigated cashew). Unirrigated emblica (EM), soil excavation (SE) and unirrigated neem (NM) become inferior to current land-use (DF1) in economic analysis at 8 per cent. Economic BCA of different land-uses also indicate that unirrigated teak would increase the NPV of land more than 10 times that of the current land-use. The next best profitable land-use among those analysed – dry farming practised with soil conservation measures increases the NPV four times that of the current land-use.

A general pattern in incremental NPVs is that the economic values are lower than financial worth except for DF and DFC. Thus, in general, the financial differences between new and existing land-uses are better than the economic differences. For DF and DFC however, economic values of incremental NPVs were higher than their financial values. This is more attributable to the low crop yields (meaning lower inputs and hence costs) than to a high social benefit in the form of ecological gains.

*Benefit cost analyses and household perception:* Of the two land-uses always possessing the highest present worth, namely, teak (TK) and dry farming with soil conservation(DFC), DFC would be closer to farmers' choice given the fact none preferred a pure silvicultural plantation like teak as discussed in Section IV. The land-uses perceived to be most acceptable to respondents are agro-forestry systems with trees on bunds (AF2), which performs fourth (after teak, dry farming with conservation and cashew) among the 13 land-uses compared with the current land-use DF1. In other words the best three land-uses from BCA are not farmer's choices though their preference had economic rationality as shown by high incremental NPVs.

Sustainability of any land-use, however, depends on local farmer's acceptability [Tiwari 2000]. Household needs and household understanding of risks and returns determine farmer's acceptability. In order to understand how respondents may react to the choice of BCA, the results of BCA were discussed with a subset of respondents. We undertook an iterative process to identify the final set of potential land-uses that could be promoted in the Anaikatty region.[4] First, all land-uses with a positive incremental NPV across all BCAs (at 5 and 8 per cent discount rates in both financial and economic BCAs) were identified and ranked. This process elicited seven superior land-uses to the current one. These seven land-uses were again ranked based on an attitudinal survey among a random subset of 15 respondents (Table 8). Based on this iterative process, the top three choices for alternate land-uses in Anaikatty are: dry farming with conservation (DFC), millet-based agro-forestry AF2 and dryfarming with protection (DF). The land-use with highest incremental NPV among these i e, DFC, is likely to be most ideal for the area. Remaining four land-uses (CSW, IF, AF1 and TK) with higher NPVs compared to the current practice are symptomatic of the difference between stakeholder preference and economic efficiency. This discrepancy could also be because the CBA is limited to static analyses and is unable to account for uncertainty and risk.

In order to compare the annual benefits to farmers from these land-uses we calculated equal annual equivalents (EAE) of NPVs[5]. Potential incremental benefits to farmers in terms of annual financial returns per hectare at 8 per cent discount rate for the final choice of three land-uses are Rs 5,518 (244 per cent) for dry farming practised with protection (DF), Rs 7,295 (322 per cent) for dryfarming practised with soil conservation (DFC) and Rs 6,861 (303 per cent) for millet based agro-forestry (AF2). Yet none of the superior options, relative to the current land-use are in place in Anaikatty as of now. Reasons are many-fold. Ignorance about benefits and methods of soil conservation prevents them from going in for conservation measures. Information gaps in tree farming and availability of planting materials prevent the agro-forestry practices from being adopted. Paucity of resources discourages practising dry farming with adequate protection from wildlife and grazing also. Lack of planting material and technical skills in tree farming along with fears about the rights of harvest prevents stakeholders from planting teak. Cashew plantations (CSW) are better accepted than teak plantations (TK), but again lack of timely availability of planting materials and technical know-how and more importantly a need for market linkage for cashew products make it less popular than agro-forestry methods.

**Table 8: Land-Uses Ranked according to Incremental NPV and Stakeholder Attitude***

| Land-Use | Rank | |
|---|---|---|
| | BCA | Attitudinal |
| Improved fallows with tree legumes for five years and dry farming resumed (IF) | 7 | 5 |
| Dry farming practised with protection (DF) | 6 | 3 |
| Multi-purpose trees for 10 years and dry farming resumed by retaining some trees as in agro-forestry (AF1) | 5 | 6 |
| Agro-forestry (millet-based) from now on with two tree species (AF2) | 4 | 1 |
| Unirrigated cashew (CSW) | 3 | 4 |
| Dry farming practised with conservation (DFC) | 2 | 2 |
| Unirrigated teak (TK) | 1 | 7 |

* *Source*: BCA and survey.

## VII
## Conclusions and Implications

Results show that there are land-uses superior to the current one for private fallows in the forest peripheries of Anaikatty. From our analysis, millet-based rain-fed agro-forestry, dry farming with soil conservation, and dry farming with protection from wild animals and grazing emerge as those with the highest twin advantages of economic viability and social sustainability. These are not too different from the current land-use but result in 244 to 322 per cent increase in discounted annual income per hectare compared to the prevailing land-use yielding about 50 USD per hectare per year. Thus, these are land-uses that should be promoted – particularly since farmers seem willing to adopt them. This type of change would support and re-vitalise the millet-based land-use economy in the region and would not need dramatic changes, which might have social implications. To arrive at this conclusion, the paper brings together economic, ecological and social aspects of land-use dynamics.

In order for these systems to be adopted, the following actions need to be undertaken: protection of the land with vegetative fencing, bunds, mulching and bund planting. These actions to be initiated and sustained in the long run means initial incentives for constructing bunds and on-farm soil conservation measures as well as timely provision of saplings with local adaptability. Other essential steps include assured rights over trees grown on farm, continuous technical support in management of multipurpose trees and appropriate soil-moisture management.

Though results of benefit cost analysis imply the course of desirable changes, the lacunae in policy cannot be overlooked. The three recommended land-uses are based on rain-fed millets. The economic advantage suggested by the results may be uncertain if soil moisture levels continue to be depleted. Currently access to groundwater is skewed away from these marginal holders. The need to regulate extraction and use of natural resources (both in terms of formulation and enforcement) surface from this analysis. It was observed in the study area that while financial support for large-scale extraction in terms of subsidised electricity and water were in place, there was no incentive or support available to practice low-cost irrigation (e g, pot and wick) and soil conservation techniques (e g, soil mulching with dry leaves).

Reliance on casual labour and developmental aid has not helped the native farmers to improve the productive potential of land. Reduced self-reliance and high vulnerability to developmental aid also work in tandem with soil moisture stress to create a situation of poverty and land degradation. The link between poverty and degradation it appears is a result of historical factors, lack of empowerment and limited assets of any kind. Increasing the productivity of dryland agriculture would be an important step in bringing the tribals of Anaikatty out of this poverty trap. EPW

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## Appendix

Yields of different biomass products for different land-uses based on field crops were taken as estimated by the production function for each year depending on current yield, topsoil depth and annual soil loss. The soil productivity analysis was undertaken by using a single factor Mitscherlich-Spillman production function as adopted by Gunatilake (1998) and Ananda et al (2001). This production function relates crop yield to soil depth and is represented in the following fashion:

$Y_t = a + b\ (1 - R^{zt})$

where:

$Y_t$ is the crop yield per hectare at time t,

zt is the topsoil depth in time t

R is the marginal rate of change of y with respect to zt or constant ratio of marginal product at soil depths zt and zt+1

'a' corresponds to crop yield when soil is extremely eroded

'b' corresponds to incremental crop yield when topsoil depth does not limit yield levels.

a+b is the asymptotic value of crop yield when limit $zt \rightarrow \infty$.

For estimating this production function, a subset of respondents with good experience in farming was targeted. Their farms provided data on current yield levels at different soil depths. Mean yield levels of crops when topsoil is completely eroded (a) and when the crops are cultivated on rich virgin soils (a + b) were obtained from the responses of selected farmers. Current soil depth was obtained by physically measuring the topsoil depth from two soil profiles (one metre from surface) per acre. R was estimated from the responses regarding rate of change in yield levels with reduction in topsoil depth. The soil depth for the first year 'zt' was the current measured soil depth, which is expected to progressively decrease at the rate of erosion. Information on the rate of decline in 'zt' was obtained for each crop from scientific references (government of Kerala (1994); Biswas and Mukherjee (1987)) and expert opinion from officials of agricultural department, Tamil Nadu and Kerala.

The production functions for relevant land-uses are as follows:

For DF1, DFC, DF, IF AF1 and AF2, the production functions for the two annual crops are given below. Initial topsoil depth was zt in the first year and annual soil loss (zt – zt+1) through the period of rotation varies between land-uses.

First crop: $Y_t = 506.67 + 1873.33 *(1-0.5^{zt})$

Second crop: $Y_t = 600 + 1895 *(1-0.5^{zt})$

For dry farming after soil excavation:

$Y_t = 500 + 1500*(1-0.85^{zt})$

Initial topsoil depth after excavation and soil reclamation activities was 20 cm and annual soil loss for the first year after resumption of farming was 2.5 cm. Annual loss in soil decreased over the period from the time farming got resumed after SE due to careful land management.

For specific land-uses that result in topsoil loss, the value of $Y_t$ (crop yield/ha in the year t) obtained using the above production function is multiplied by the area under the crop to arrive at $Q_t$ (crop production from the farm in the year t) in equation [1].

## Notes

1 A system of agro-forestry where in the leaseholders inside forests take care of planted or regenerated saplings while cultivating the land in between.

2 Even though liquidation value is generally taken as the realisable value in selling the land, here existing official ban on transactions of tribal lands to non-tribals and rarity of formal tribal-to-tribal land transactions make it unrealistic.

3 Owing to a small farm size, the sole rain-fed crop raised and lack of full employment in the informal sector, the available days per individual for further employment is less than what is additionally required for suggested land-uses. So to take an opportunity cost of labour will actually diminish the NPV of labour-intensive and locally preferred land-use. Also the misinterpretation on crop management based on unrealistically high cost of labour is made evident in Sen's analysis on peasant economies [Sen 1984]. He showed that when there is a wage gap, the real cost of labour as the social opportunity cost (as alternative marginal productivity) or calculated as the optimal value of the dual variable corresponding to the labour supply constraint can be nil. Realising that a coexistence of positive wage rate and surplus labour is reality in a peasant economy, my approach was to highlight relative NPV of land-uses, if we consider a shadow price for labour.

4 It should be borne in mind that the species involved in the analysis are selected from the responses from the study area but the systems indicated by the land-uses could be practised with other suitable species in similar areas. For instance, teak represents a silvicultural plantation as cashew represents a horticultural plantation suited to the respondents and local conditions.

5 EAE = NPV * Capital Recovery Factor (CRF); CRF = $[i\ (1+i)^n / (1+i)^n - 1]$ [Gittinger 1984].

## References


Ananda, J, G Herath and A Chisholm (2001): 'Determination of Yield and Erosion Damage Functions Using Subjectively Elicited Data Application to Small Holder Tea in Sri Lanka', *Australian Journal of Agricultural and Resource Economics,* 45(2):98.

Bijoy, C R (1999): 'Adivasis Betrayed: Adivasi Land Rights in Kerala', *Economic and Political Weekly,* 34(22):140-45.

Barbier, E B, D W Pearce and A Markandya (1989): 'Environmental Sustainability and Cost Benefit Analysis', *Environmental Planning,* 1(22):1260.

Buchanan, F (1870): *A Journey from Madras through the Countries of Mysore, Canara and Malabar,* Vols 2 and 11, reprinted 1988, HB&Co.

Biswas, T D and S K Mukherjee (1987): *Textbook of Soil Science*, Tata McGraw Hill, New Delhi, pp 57-60.

Dixon, J A, F Scura, A Carpentar and P Sherman (1994): *Economic Analysis of the Environmental Impacts,* Earthscan, London.

Gittinger, J P (1984): *Economic Analysis of Agricultural Projects*, EDI series, World Bank, John Hopkins, Baltimore, p 433.

Gunatilake, H M (1998): *An Economic Analysis of Soil Conservation in the Upper Mahaweli Watershed of Sri Lanka*, PhD thesis, University of Hawaii, US.

Irvin, G (1978): *Modern Cost-Benefit Methods*, Macmillan Press, pp 1-239.

Lélé, S, V Srinivasan and K S Bawa (2001): 'Returns to Investment in Conservation: Disaggregated Benefit-Cost Analysis of the Creation of a Wildlife Sanctuary' in K N Ganeshaiah, R U Shaanker and K S Bawa (eds), *Proceedings of International Conference on Tropical Ecosystems: Structure, Diversity and Human Welfare*, Oxford-IBH Publishing Co, New Delhi, pp 31-33.

Markandya, A and M N Murty (2000): *Cleaning up the Ganges: A Cost-Benefit Analysis of the Ganga Action Plan*, Oxford University Press, New Delhi.

Mehta, L (2000): 'Drought Diagnosis Dryland Blindness of Planners', *Economic and Political Weekly,* 35(27):2439-41.

Nadkarni, M V (2000): 'Poverty, Environment and Development: A Many-Patterned Nexus', *Economic and Political Weekly,* 35(14):1184-90.

Neil, J (2001): 'Markets and the Environment: The Solution is the Problem', *Economic and Political Weekly,* 36 (21): 1868.

Ninan, K N and S Lakshmikantamma (2001): 'Social Cost-Benefit Analysis of a Watershed Development Project in Karnataka, India', *Ambio,* (30): 157-61.

OECD (1995): *The Economic Appraisal of Projects and Policies: A Practical Guide*, Organisation for Economic Co-operation and Development, Paris.

Reddy, B S, J K Parikh and K S Parikh (1997): 'Framework for Economic, Social and Natural Resource Accounting for Land Regeneration' in J K Parikh and B S Reddy (eds), *Sustainable Regeneration of Degraded Lands*, Tata McGraw Hill.

Sassone, P G and W A Schaffer (1978): *Cost-Benefit Analysis a Handbook: An Introduction to Financial, Economic and Social Appraisal of Development Projects,* Academic Press, New York, pp 1-179.

Sen, A K (1984): *Resources, Values and Development,* OUP, New Delhi, pp 33-37, 213-18.

– (2000): *Development as Freedom,* Knopf, New York, pp 87-92.

Tiwari, N D (2000): 'Sustainability Criteria and Cost-Benefit Analysis: An Analytical Framework for Environmental-Economic Decision-Making at the Project Level', *Environment and Development Economics,* 5:259-88.