Land-use Strategies, Economic Options and Stakeholder Preferences: A Study of Tribal Communities in Forest Peripheries

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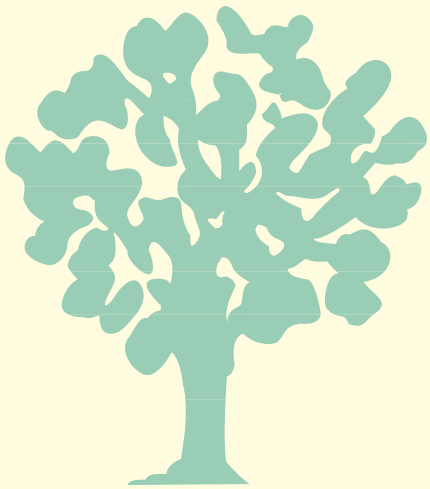
Seema Purushothaman



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Abstract

In the Anaikatty region of the southern Western Ghats in India, land-use in forest peripheries is characterized by low productivity and extended fallows. Land alienation, soil degradation, drought, wild animal attacks, and declining access to forests have debilitated the livelihood base of a tribal community known as *Irulas*. This study seeks to identify alternate land-use and management strategies to strengthen and diversify the livelihood options that are confronted by these extremely poor marginal farmers. Benefit-cost analysis in combination with stakeholder discussions reveal that alternative land-use strategies such as millet-based dry-farming along with the adoption of soil conservation or growth of perennials on field bunds are economically efficient relative to current dry-farming and that these enjoy acceptance among farmers. Adoption of such systems would result in a nearly 300 percent increase in the annual income from their land. Other economically superior alternative land-uses are not acceptable to farmers, indicating the care with which tribal development policies need to be made. The tribals in this region are caught up in an almost insurmountable poverty and environment trap. This study offers suggestions that may enable them to move away from the grim reality that currently faces them.

Key Words: Tribals, land-use, forest peripheries, dry-farming, benefit-cost analysis,western ghats

Land-use Strategies, Economic Options and Stakeholder Preferences: A Study of Tribal Communities in Forest Peripheries

Seema Purushothaman

1. Introduction

Of India's 84 million tribals (2001 census), approximately 55 percent live in and around the dry tropical deciduous forests of central and southern India. These rural poor are unfortunately 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). But conservation and development efforts can come to naught if careful analyses of stakeholder preferences do not accompany the economic implications of projects, (Kothari *et al.*, 1988; Johnson, 1993). This study is an attempt to highlight the importance of socio-ecological and economic analyses when it comes to land-use planning for forest-dependent tribal farmers.

In this paper 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 "ecologically superior" land-use strategies were feasible. We wanted to gauge whether ecologically more sensitive land-use strategies made economic and financial sense and *vice versa*. Thus, the objective of the study was to identify economic and socially acceptable land-uses in the region that could serve as alternatives to current unsustainable land-use practices.

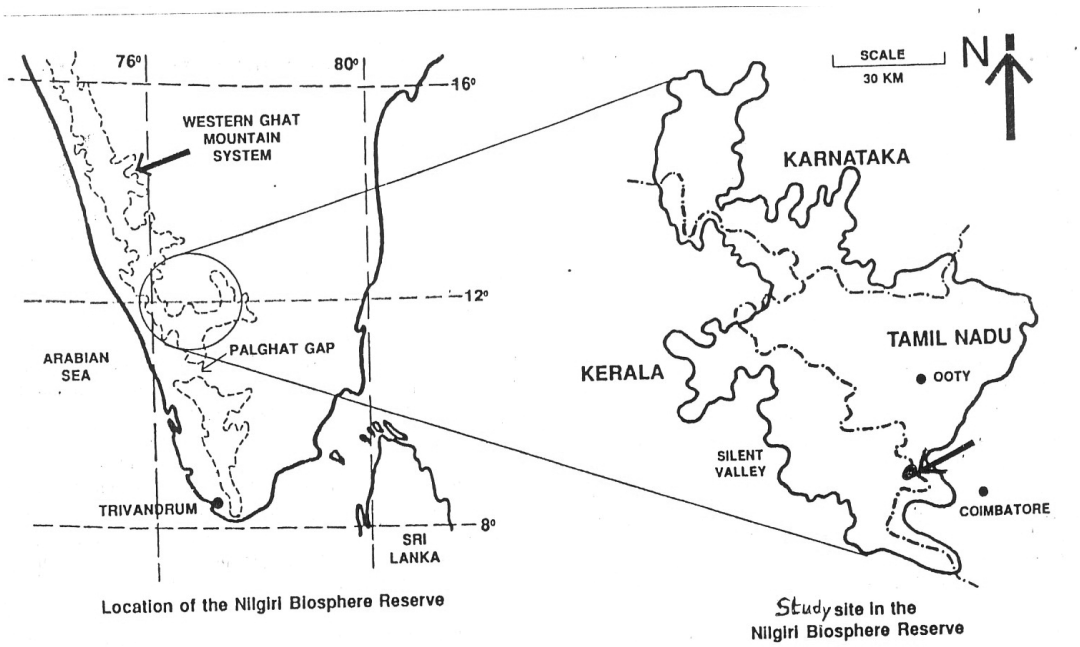
In order to meet these goals, we first identified and elicited farmer and expert opinions on current and potential land-uses that were considered feasible in areas bordering forests. We then undertook a benefit-cost analysis of 14 feasible land-use systems. Financial and economic benefit-cost analyses 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 in 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 sapling choice and availability. Equitable access to ground water is another important requirement.

In the following section, we first present a brief description of the study area, data collection efforts, and current livelihood linkages. Alternate and feasible land-uses that would expand the choices facing farmers are identified in section III. Section IV presents methodological issues and section V presents the benefit-cost analysis of different land-use systems. The paper concludes with recommendations for improving land-use in the region.

2. Study Area and Data Collection

Our 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 the Nilgiri Biosphere Reserve.

Figure 1: The Study Area near Anaikatty



The study area 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. *Adivasi*s form the majority (45.4 % or 2105 out of 4637) in 24 Veerapandi and 44.8% (7591 out of 16941) in Sholayur panchayats as per the 1991 census of population. This tribal area has seen many ecological and economic changes over the years. A description of some of these changes is presented in appendix 1.

2.1 Data Collection

The main objective of this study was to understand whether there were economic alternatives to the current, rather unsustainable, land-use practices in the Anaikatty forest peripheries. To meet this objective, a series of tasks were undertaken. 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 (Details in Appendix 2).

Expert interviews: The next phase of this research involved discussions with researchers attached to institutes located in the area: ecologists from the Salim Ali Center for Ornithology and Natural History (SACON, Anaikatty); forestry scientists from the Institute of Forest Genetics and Tree Breeding (IFGTB, Coimbatore); staff members of Attappady Hill Area Development Society (AHADS, Agali) and state 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 (see Appendix 3) for interviewing the households was prepared, pre-tested, finalized and translated into the local languages (Tamil and Malayalam). Since variation with respect to livelihood and landholding patterns 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 therefore identified 62 hamlets and 120 households (4% sample) for a detailed survey. Formal education is almost nil among the heads of households with whom most of the interactions were to be held. The household survey, undertaken with the help of local investigators, elicited data on farm and livelihood characteristics. We also gathered data about perceptions and preferences regarding land-use options. Transect and field walks helped assess the impacts of prevailing land-use practices. On-farm discussions helped to trace the potential of land-use practices on local livelihood systems. Local markets were visited to obtain price data. Data collected from this survey are discussed in sections three and four.

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 (SACON, IFGTB and AHADS) in order to develop a final list of potential land-uses. The identified and current uses were then subjected to benefit-cost analysis (BCA). Section five 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 sub-sample of respondents before making recommendations. Section six discusses results of this comparative analysis and the implications.

2.2. 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 the 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 utilize their own traditional skills for sustained livelihood for people of the area (the history of land use in the area is discussed in Appendix 1). 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 for these lands.

Tables 1 and 2 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 percent 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 percent of annual household income, which includes the value of crop consumed and marketed farm produce (Table 3).

Table 1: 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 2: Other Characteristics of Farm Holdings

Average distance to reserve forests (km)	0.81
No of people given titles recently (land distribution ceremonies)	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	51 %

*Source: Household Survey

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 the farmers thus of crucial draft power for the next cropping season. This trend is a pointer to a vicious cycle: first ecological degradation leads to poor bio-mass production (both on and off farm) that in turn leads to fodder scarcity and thereby to a paucity of draft power and other resources for cultivation; this makes the farmer more impoverished and dependant on foraging, ultimately leading to more degradation.

Excess land acquired via state land reforms is periodically distributed to the landless, most of which is cleared forest area. Nearly 10 percent 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 received rights to 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. Instead, these beneficiaries of land reforms continue to lease 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 are not being managed for long-term productivity.

The survey reveals that more than 31 percent of respondents had incurred crop losses due to drought in the year 2001-2002. About 24 percent of the respondents had not attempted cultivation in the second crop season, predicting crop failures due to soil moisture deficit. Rainfall data from the Government Horticultural Farm in Anaikatty for the last 12 years showing a decline in the number of rainy days as well as in the total rainfall received supports this decision.

Wild animals inflict a mean loss in yield of about 51 percent to the native farms in any season. Crop raids occur in places where settlers grew sugarcane 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 cultivation of species known to be favorites among wild pachyderms. Certain crops such as dolichos beans (*Dolichos lablab*) and horse gram (*Dolichos uniflorus*) that are not much relished by elephants are gaining acreage in the fields.

Table 3 shows that *Irulas* are highly dependent on non-farm income. Wages from casual labour is the most important source of non-farm income. Wage income constitutes nearly 64 percent of the annual household income of natives (Table 3). Labour opportunities are generally confined to seasonal planting activities undertaken by the forest department. Sale of stock in times of liquidity crisis formed the income from livestock to the tribal. Other sources of income include income from NTFPs (12%). Agricultural income constitutes approximately 20% of the annual household income. Our paper focuses on improving the productivity of land because it appears to be the only productive asset with a household. Other livelihood options such as migration in search of employment or provision of better and reliable employment facilities in these inaccessible areas seem a remote possibility.

Table 3: Annual Household Income of Respondents (2001-2002)

	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	0.20	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

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

3. Identification of Feasible Land-use Options for Economic Analysis

The major challenge facing us before attempting an evaluation of different land-uses was to select the land uses to be evaluated. Our fear was that evaluating just the existing ones or options suggested for other similar areas in literature may exclude many locally accepted and feasible uses. As noted in section 2, we therefore first identified existing land-use practices in the study area through a preliminary survey and rapid appraisal. A survey of experts also helped identify potential alternative land-use practices and their characteristics. Further, in order to understand farmer preferences, we asked a series of questions from the households regarding different land-uses and farmer preferences. This section reflects the attitudes of respondents on various land-uses as well as expert opinion on them.

Table 4 identifies the major land-use alternatives in the area. The seven 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, and fallowing or non-use of land for agriculture. Columns 2 and 3 of Table 4 present the reasons as to why farmers preferred certain systems of land-uses and the risks they saw in adopting these systems. General reasons for preferring a particular land-use appear to be immediate benefit when it comes to supplementing food and fuel-wood. Perceived risks include that of crop failures, uncertainty over harvest rights, and unavailability of inputs.

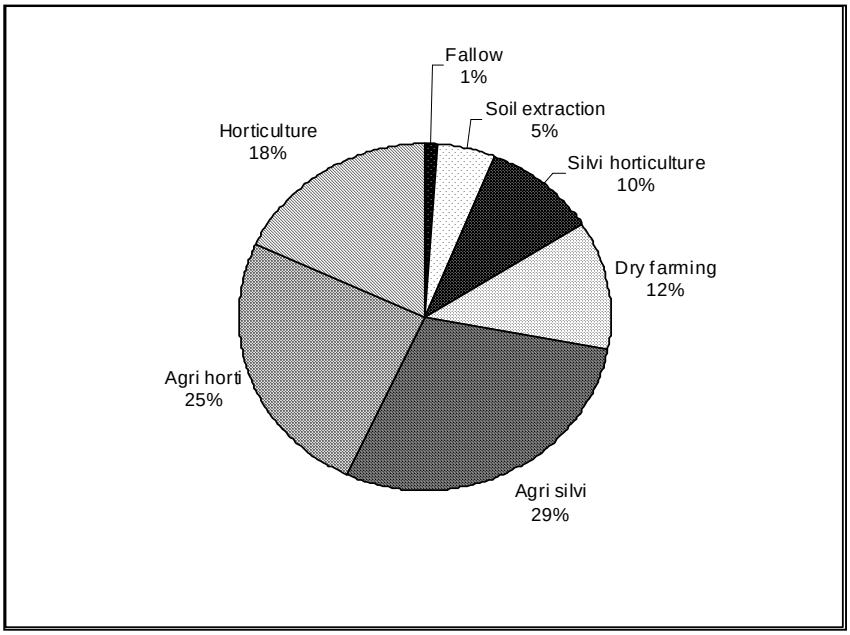
Table 4: Land-based Livelihood Strategies in Anaikatty Region: Reasons for Local Preference and Perceived Risks

	Land-use options	Reasons for preference	Risks perceived
1	**Dry-farming (Seasonal field crops)**	For subsistence. Traditional occupation Millets and coarse grain s form staple diet No other employment	Drought Wild animals Soil degradation
2	**Agri-silvicultural systems (Field crops with forest trees on bunds)**	Supplement firewood where either the access to forests is low or forests are highly degraded. While seasonal crops are affected by exogenous factors, timber provides income security	Availability of planting material in time Tree shade may reduce crop yield Apprehensions about rights to harvest, transport and sell timber
3	**Agro-horticultural systems (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 Tree shade may reduce crop yield Apprehensions about rights to harvest, transport and sell timber Attract elephants
4	**Horticulture (Plantations of fruit trees)**	Supplement diet and meet other needs for wood when there is enough land left for millets. Prefers species with low water requirement	Availability of planting material in time Apprehensions about rights to harvest, transport and sell Attract elephants
5	**Silviculture (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 Apprehensions about rights to harvest, transport and sell
6	**Silvipasture and natural regeneration**	For people dependant on grazing	Very few depend exclusively on grazing
7	**Leasing to the brick kilns for soil extraction**	Immediate income Wild life attack and drought make farming impossible Land leveling Feels that soil can be rejuvenated in few years	Land degradation and loss in crop production
8	**Fallowing**	Lowering productivity, lack of draft power and yield loss to drought and wild animals.	Subsistence affected

Source: Household survey

Figure 2 shows the distribution of farmer preferences for different land-uses. Nearly 12 percent of the households surveyed wanted to cultivate only millet crops as was the practice now. But most respondents (54%) wanted to continue with millet farming in an improved system (25 % opted for agri-horticulture and 29% for agri-silviculture systems). Thus, nearly 66 percent of the respondents want to continue with dry-farming either with (54%) or without (12%) modifications. Most of the respondents (54%) were willing to modify current land-use by planting trees on bunds. About 28 percent opted for plantations (10% for silvi-horticulture systems and 18% 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.

Figure 2: Tribal Preferences for Different Land-uses



4. Benefit-Cost Analysis (BCA) 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 5) were assessed by BCA and compared with the existing practice. The first six in the table are primarily farming options while the next five are plantations followed by two mixed stands with a fodder grass component. Two to five and 12 in Table 5 are newly suggested land-uses for the study area because the local community is not familiar with systems involving conservation measures, improved fallows and silvipasture recommended by scientists, though the vegetative components of these systems were common in the locality. Further details about these land-uses are presented in Annexure 2.

The first step in the benefit-cost analysis was to identify the benefits and costs in different land-uses for the selected time-period (section 4.2). Quantification of these costs and benefits followed next (see Appendix 4). Costs and benefits of each land-use are quantified with the assumption that general management strategies prevailing in dry-land agriculture in the area, with minimum application of inputs, is continued for the period of analysis in all the land-use options. The third step estimated the financial and economic net present values of land-uses (section 4.3 and Appendix 5) at selected discount rates. Thus, in the following sections, we discuss some of the methodological issues that need to be addressed in undertaking benefit-cost analyses.

Table 5: Selected Land-uses for Detailed Analysis

	Land-use
1	Dry-farming as practiced (DF1)
2	Dry-farming as practiced with some protection from animals and drought (DF)
3	Dry-farming as practiced 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 (*AnacardiumOccidentale*) plantation (CSW)
12	Unirrigated eucalyptus (*Eucalyptus Territricornis*) plantation (EU)
13	Silvipastoral system (SP)
14	Natural regeneration (NR)

4.1 Finding the Net Present Value (NPV) 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 therefore 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.

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

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_{n1t} Unused expenditure due to drought and/or crop raiding

CC_t Cost of soil conservation measures 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)[1] 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 a 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. For land-uses with shorter rotations, the number of possible rotations till 20 years is considered.

In light of the 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 eight percent was used to reflect individual time- preference. Considering the problem of sustainability of land-uses, a social discount rate of five percent was also applied. Benefits and costs are valued at constant prices prevailing in 2001 for the time-period till 2020 (details in Appendix 4) and the annual net-benefit flows are discounted to find the present value of land-use using Equation (1).

4.2 Costs and Benefits for Computing NPV

The first step in benefit-cost analyses is to identify the various costs and benefits associated with each alternate use. Table 6 presents the various costs and benefits quantified in each of the land-use options to calculate the NPV using Equation (1). Major benefits from many of the land-uses include food grains, 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

[1] Although it is generally the liquidation value that is taken as the realizable value in selling land, here both the existing official ban on transactions of tribal lands to non-tribals and the rarity of formal tribal-to-tribal land transactions make it unrealistic.

production function.[2] Costs are chiefly associated with a) labour and material inputs in protection, planting, cultivation and harvest; b) yield loss due to soil erosion and animal raids. Appendix 4 has more specific details on kind, quantity and price of each component.

Direct benefits in the form of bio-mass outputs were quantified and valued at farmgate, forest gate or nearest market price collected during survey. Growth pattern and bio-mass yields (hardwood, pulpwood, firewood, fodder and seeds) of trees are based on either information from rain-fed plantations of the specific species, or from published works, as indicated for relevant species in corresponding tables in Appendix 4. Current yield levels of tree species not available for the study area were collected from the volume tables of forest trees.

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[2] The 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 using a single factor Mitscherlich-Spillman production function as adopted by Gunathilake (1988) and Ananda, *et al.*, (2001). This production function relates crop yield to soil depth and is represented in the following manner:

$Y_t = a + b\,(1- R^{zt})$, 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 meter 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 (Govt of Kerala 1994; Biswas and Mukherjee 1987) and expert opinion from officials of the Agricultural Departments of Tamil Nadu and Kerala.

The production functions for relevant land-uses are as follows:
For DF1, DFC, DF, IF AF1 and AF2 (for details see table 6), 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 (SE):

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

Initial topsoil depth after excavation and soil reclamation activities was 20cm 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 resumed after soil excavation 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).

Table 6: Benefits and Costs Quantified for BCA of Land-uses

Land-use	Benefits	Costs
1. Dry-farming as practiced (DF1)	Food grains, fodder and soil carbon	Labour and material in cultivation and harvest; soil loss and animal raids
2 Dry-farming as practiced with protection (DF))	Food grains, fodder and soil carbon	Labour and material in fencing, planting, gapfilling, guarding, cultivation and harvest; soil loss and animal raids
3.Dry-farming as practiced with soil conservation measures (DFC)	Food grains, fodder and soil carbon	Labour and material in fencing, planting, gapfilling, guarding, soil conservation efforts, cultivation and harvest; reduced soil loss and animal raids
4. Multi purpose trees for 10 years and dry farming resumed by retaining some trees as in agro - forestry (AF1)	Food grains, fodder, timber, firewood and soil carbon	Labour and material in fencing, planting, gapfil ling, guarding, soil conservation efforts, cultivation and harvest; soil loss and animal raids
5 Agro-forestry (millet based) from now on with two tree species (AF2)	Food grains, fodder, timber, firewood, carbon in wood and soil	Labour and material in f encing, planting, gapfilling, guarding, soil conservation efforts, cultivation and harvest; soil loss and animal raids
6 Improved fallows with tree legumes for five years and dry farming resumed (IF)	Food grains, fodder, timber and firewood carbon in wood and soil	Labour and material in fencing, planting, gapfilling, guarding, soil conservation efforts, cultivation and harvest; soil loss and animal raids
7 Soil excavation, land reclamation and resumption of dry -farming (SE)	Extracted soil; grains and fodder after reclamation soil carbon	Labour and material in reclamation, fencing, planting, gapfilling, guarding, cultivation and harvest, soil loss and animal raids
8 Un-irrigated plantation of *Phyllanthus Emblica* (*Amla*/ Indian gooseberry) (EM)	Fodder, firewood, fruits and timber, soil conservation, soil and wood carbon	Labour and material in fencing, planting, gapfilling, guarding, and harvest
9 Un-irrigated neem (*Azadirachta Indica*) plantation (NM)	Fodder, firewood, fruits and timber, soil conservation, soil and wood carbon	Labour and material in fencing, planting, gapfilling, guarding, cultivation and harvest
10 Un-irrigated teak (*Tectona Grandis*) plantation (TK)	Firewood and timber, soil conservation, soil and wood carbon	Labour and mate rial in fencing, planting, gapfilling, guarding, and harvest
11 Un-irrigated cashew (*Anacardium Occidentale*) plantation (CSW)	Firewood, fruits and soft wood, soil conservation, soil carbon	Labour and material in fencing, planting, gapfilling, guarding, and harvest
12 Un-irrigated eucalyptus (*Eucalyptus Territricornis*) plantation (EU)	Firewood and soft wood	Labour and material in fencing, planting, gapfilling, guarding, and harvest
13 Silvipastoral system (SP)	Fodder, firewood and timber, soil conservation, soil and wood carbon	Labour and material in fencing, planting, gapfilling, guarding, and harvest
14 Natural regeneration (NR)	Fodder, firewood and timber, soil conservation, soil and wood carbon	Labour and material in fencing, guarding, and harvest

Source: Author's discussions with farmers and experts as in section 2.1. For quantification of these costs and benefits, see appendix 4.

Incorporating soil productivity changes:

In this study, we incorporate the private financial costs of ecological damage due to specific land-uses by accounting for soil erosion over time and its impact on yield. Land-uses vary in their effect on soil, which in turn has an effect on crop yield and income. A land-use is considered to lead to excessive soil loss if erosion is more than

2.5 tons/ha/year (Biswas and Mukherjee, 1987). Accordingly, the 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) 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 were undertaken by using a single factor production function as adopted by Gunathilake (1988) and Ananda, *et al.*, (2001).[2]

4.3 Financial and Economic BCA

The financial analysis of a land-use estimates the profit to primary stakeholders while the economic analysis measures the impact of land-use on the economy as a whole. The 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. For a project to be economically viable, it has to be financially profitable and able to internalize the environmental externalities. The economic analysis measures the project's positive and negative social impacts through shadow prices.

In the economic benefit cost analyses, 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 sub-sections below are included in the economic NPV. The only traded and incremental component in any land-use is timber, where the shadow price can be calculated from the financial price using the domestic price numeraire. However, 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. The economic analysis takes into account the environmental benefit of sequestering carbon. Other externalities of land-uses (off-site impacts on other lands, rivers and dams) are not quantified because it is beyond the scope of the study. Thus, the differences between the Economic BCA and the Financial BCA in this analysis are three fold; they are to be seen in terms of the value of land, labour, and net carbon benefits.

Shadow price of land: When it comes to the opportunity cost of land, it is the rental value that is being used as shadow price of land. Actual rent foregone or the prevailing annual leasing rate was taken as the land rent for the Economic BCA. When it comes to the Financial BCA, the lease rate fixed by the revenue department is used as the land rent.

Economic wage rate: Wage rates prescribed by the government for the area are used in the Financial NPV while actual prevailing wage rates are used for the Economic Analysis. The labour wage rates for men and women for different jobs such as digging pits, weeding, harvesting, etc., were collected during the survey. If a job was confined to one's own farms, or if it was without a prevailing market, then the wage rate used for Economic BCA is:

Economic wage rate = Financial wage rate * Conversion factor.

The survey reveals that the average number of employed days per year per person (in casual wage labour) was 95 (the 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 the 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 the Economic NPV can be calculated based on a conversion factor from the financial wage rate.[3] The conversion factor is used to find the shadow cost of labour. The conversion factor estimated for the year 2000 from the Season and Crop Report of Tamil Nadu (Season and Crop Report 2001, Directorate of Economics and Statistics, Chennai) was 0.75. The conversion factor lowers the costs for labour inputs reflecting the surplus labour days available and presence of a weak labour market. If financial wage rates are not thus adjusted, the net benefits from a labour intensive land use will be underestimated.

Valuing carbon benefits: Carbon benefits enter benefit streams in the Economic BCA whenever there is an output of hardwood or if soil carbon increases as a result of the new land-use. In calculating carbon benefits, we account for: a) net carbon sequestered in woody parts of the vegetation that are used for long-lasting furniture or buildings (following Ravindranath and Somasekhar, 1995); and, b) net carbon sequestered in the soils attributable to the new land-use (following Biswas and Mukherjee, 1987). The World Bank's Prototype Carbon Fund (PCF) price of USD 10 per ton of carbon for 2001 (Prototype Carbon Fund, 2002) is adopted for valuation of the net carbon sequestered in soil and hardwood. By accounting for the values of carbon sequestered in the benefit stream, the Economic BCA provides an estimate of the worth of the project from the society's perspective.

5. Results of the BCA

Table 7 gives the net present values (NPV) and the incremental NPVs for selected land-uses at two discount rates under both the Financial and Economic BCA. The dominant trends in the relative performances of the land-uses remain the same between the economic and financial BCAs as well as between the two discount rates.

3 Owing to 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. The misinterpretation of crop management based on the unrealistically high cost of labour is made evident in Sen's analysis on peasant economies too (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. Realizing that co-existence of positive wage rate and surplus labour is the reality in a peasant economy, my approach was to highlight the relative NPV of land-uses, if we consider a shadow price for labour.

5.1 Financial Analysis

The financial analysis shows that unirrigated teak (TK) followed by dry-farming practiced 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: un-irrigated 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). Among the 13 land-uses compared with current practice DF1, 11 appeared better than DF1 at five percent and nine at eight percent**.** Land-uses such as natural regeneration (NR), unirrigated eucalyptus plantation (EU), and un-irrigated emblica plantation (EM) have positive individual NPV but their incremental NPV are not always positive.

At 8% discount rate, the incremental NPV ranges from Rs. 17,000 for soil excavation to Rs. 250,000 for teak. Figure 3 summarizes these results. The Financial BCA for different land uses indicate that unirrigated teak is the most profitable option because it would increase the NPV of land more than 10 times that of the current land use. The next best profitable land use among those analyzed -- dry-farming practiced with soil conservation measures-- increases the NPV to five times that of the current land-use.

5.2 Economic Analysis

Assessing incremental net benefits using shadow prices does not change the rankings of land-uses. The top two choices for alternate land-use --teak and dry farming with soil conservation-- are still the best alternatives to current practices. At 8% discount rate, the incremental NPV ranges from Rs. 2800 for soil excavation (SE) to Rs. 220, 000 for teak (TK). Figure 4 summarizes the results of the economic analysis.

At eight percent, in the Economic BCA, the current land use DF1 becomes better than SP (Silvipasture) and the economic worth of DF (current land-use with protection) becomes 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 the economic analysis at 8% discount rate. The economic BCA of different land-uses also indicate that unirrigated teak would increase the NPV of land more than 5 times that of the current land-use. The next best profitable land-use among those analyzed --dry-farming practiced with soil conservation measures-- increases the NPV three times to that of the current land-use.

A general pattern in incremental NPVs is that the economic values are lower than the financial worth for all land-uses except for DF (current land-use with protection) and for DFC (dry-farming practiced with soil conservation measures). Thus, in general, the financial differences between new and existing land-uses are greater than the economic differences for these land-use practices. For DF and DFC, however, the economic values of incremental NPVs were higher than their financial values. This is perhaps attributable more to the low crop yields (which means lower inputs and hence costs) than to a high social benefit in the form of ecological gains.

Table 7: Results of Benefit Cost Analysis
(Detailed BCA Tables of each land-use in Appendix 5)

Landuses		Financial (Rs)		Economic (Rs)	
		NPVs	Incremental NPVs	NPVs	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

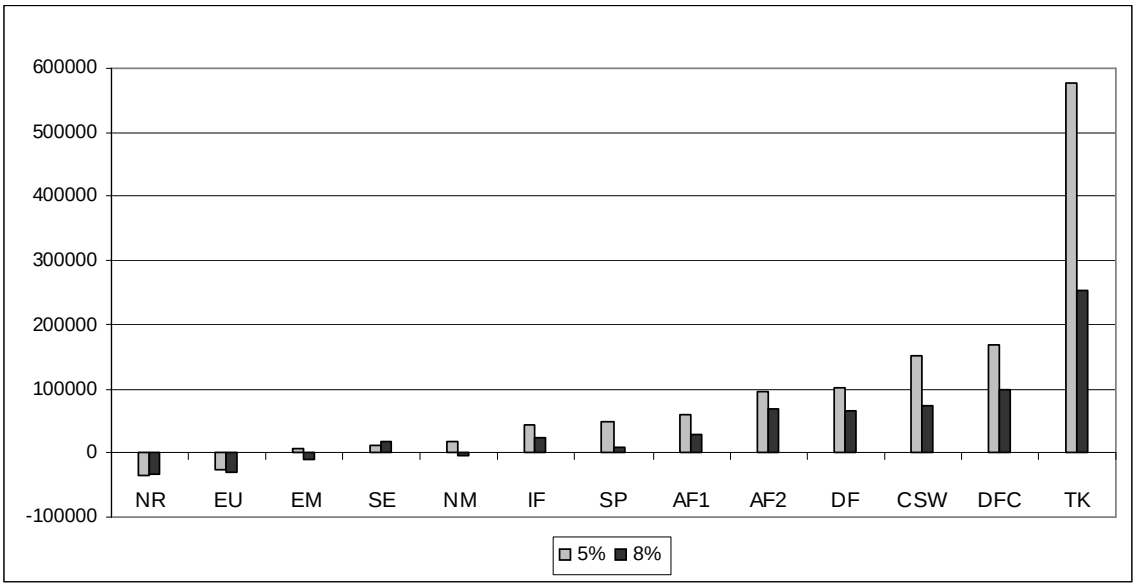
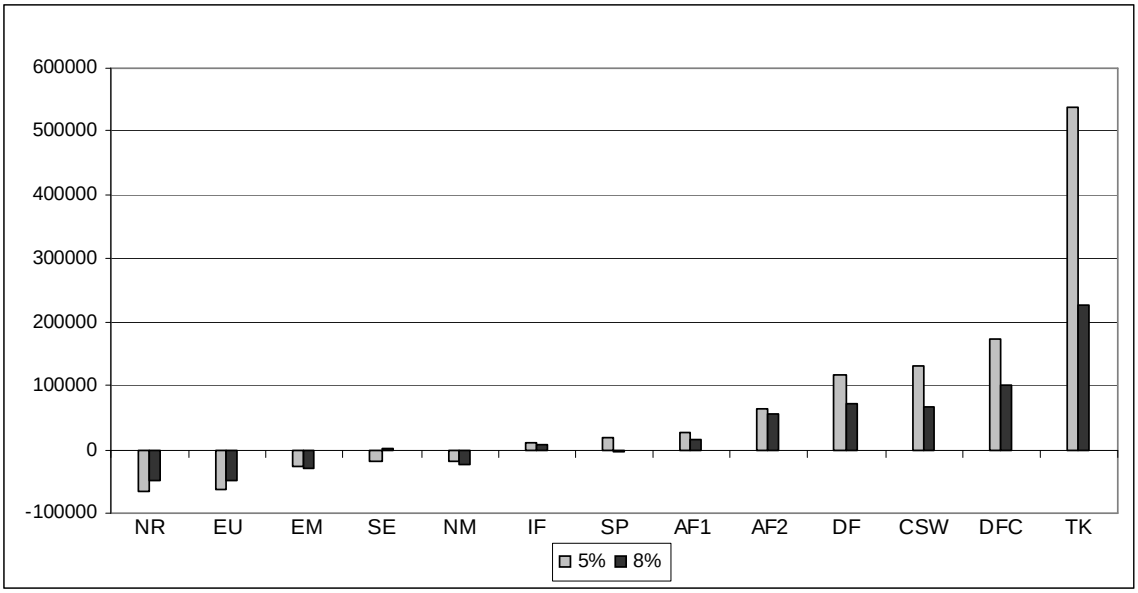


Figure 4: Incremental financial NPVs



5.3 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 the farmers' choice given the fact that none preferred a pure silvicultural plantation like teak as discussed in section 3. The land-uses perceived as most acceptable to respondents are Agro-forestry Systems with trees on bunds (AF2), which ranks fourth (after Teak, Dry-farming with Conservation, and Cashew) among the 13 land-uses that are compared with the current land use DF1. In other words, the best three land-uses from the BCA are not the farmers' preferred choices although they are economically superior as indicated by the high incremental NPVs.

The sustainability of any land-use, however, depends on local farmer acceptability (Tiwari, 2000). Household needs and household understanding of risks and returns determine the preferences of or acceptability by local stakeholders. Thus the final choice of land-uses should take into consideration these preferences as well. In order to understand how respondents may react to the BCA, the results were discussed with a subset of respondents. Table 8 shows the comparative ranking for superior land-uses emerging from the analysis.

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 practiced 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
Un-irrigated Cashew (CSW)	3	4
Dry-farming practiced with conservation (D FC)	2	2
Un-irrigated Teak (TK)	1	7

Source: Table 7 and Attitudinal Survey

Table 8 reflects an iterative process to identify the final set of potential land-uses that could be promoted in Anaikatty region[4]. First, all land-uses with a positive incremental NPV across all BCAs (at 5% and 8% discount rates in both the 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 7). 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 dry-farming with protection (DF). The land-use with the highest incremental NPV among these, i.e., DFC, is likely to be the most suited for the area. The remaining four land-uses (CSW, IF, AF1 and TK) with higher NPVs compared to the current practice reflect differences between stakeholder preference and economic efficiency. This discrepancy could be partially due to limiting the BCA to static analyses and unable to fully account for uncertainty and risk.

In order to compare the annual benefits to farmers from these land-uses, we calculated the equal annual equivalents (EAE) of NPVs*. The potential incremental annual

[4] It should be borne in mind that the species involved in the analysis are selected from the responses from the study area; however, the systems indicated by the land-uses can be practiced 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.

* EAE= NPV * CRF ; CRF = $[i (1+i)^n / (1+i)^n - 1]$ (Gittinger, 1984)

benefits to farmers from alternate land-uses range from Rs.5518 (244 %) for dry-farming practiced with protection to Rs.7295 (322 %) for dry-farming practiced with soil conservation, to Rs. 6861 (303%) for millet-based agro-forestry. Yet none of these superior options are used in Anaikatty as of now. The reasons are many-fold. Ignorance about the benefits and methods of simple soil conservation prevents these marginal farmers from undertaking conservation measures. Information gaps when it comes to tree-farming and availability of planting materials prevent the agro-forestry practices from being implemented. Moreover, paucity of resources discourages the practice of dry-farming protected from grazing by cattle and wild-life. Although cashew plantations are more acceptable than teak plantations, the lack of planting materials and technical know-how, and more importantly, of a market linkage when it comes to the sale of cashew products, make it less popular than agro-forestry methods. Lack of planting material and technical skills related to tree farming, along with fears about the rights of harvest, prevents stakeholders from planting teak.

6. Conclusions and Implications

The results indicate that there are land-uses superior to the current one when it comes to 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 animals have the highest twin advantages of economic viability and social sustainability. These land-uses are not too different from the current land-uses but result in between 244 to 322 percent increase in discounted annual income per hectare -- a huge increase in resources for the poor communities in this region. Thus, these are clearly land-uses that should be promoted, particularly since farmers seem willing to adopt them. This type of change would support and revitalize the millet-based land-use economy in the region and would not need dramatic adjustments that 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 new systems to be adopted, the land needs to be better protected with vegetative fencing, bunds and mulching. For such actions to be sustained in the long run, incentives as well as timely provision of saplings that have local adaptability are required. Other essential steps include assured rights over trees grown on farm, continuous technical support in the management of multi-purpose trees and appropriate soil-moisture management.

Though results of the benefit-cost analysis indicate the direction for desirable changes, the lacunae in policy cannot be overlooked. The three recommended land-uses are based on rain-fed millets. But the economic advantage suggested by the results may not come to pass if soil moisture levels continue to be depleted. Currently, access to ground water is skewed away from the marginal land holders. It was observed in the study area that while financial support for large-scale extraction, in the form of subsidies for 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 in Anaikatty to improve the productive potential of their land. Reduced self-reliance and

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Reliance on casual labour and developmental aid has not helped the native farmers in Anaikatty to improve the productive potential of their land. Reduced self-reliance and

high vulnerability to developmental aid also work in tandem with soil moisture stress to create a situation of land degradation. The link between poverty and degradation it appears is a result of historical factors, lack of empowerment and the limited assets of any kind. However, land continues to be the most important asset that the *Irulas* possess. Hence, increasing the productivity of dry-land agriculture would be an important step in bringing the tribals of Anaikatty out of this poverty trap.

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Appendix 1

History of Land-use and Land Rights in the Study Area

The current situation with regard to land-uses and livelihood patterns in the forest peripheral lands owned by the *Irulas* should be viewed in the light of many ecological and social changes that took place over a short span of time in this cohesive community, which was isolated from rest of the society till the latter part of the 20th century (Buchanan 1870; Bijoy 1999). The history of land-ownership and uses in the area depicted in the table below gives an interesting backdrop for the evolution of land-use problems in Anaikatty. This area, which was under different royalties till the 18th century, had dense forests although the economically backward practiced shifting cultivation and the well-to-do indulged in hunting. Timber extraction began on a commercial scale when the East India Company gained control of major parts of the area; the princely states and landlords owned the rest. Apart from shifting cultivation, *kumri** cultivation also became a common land-use among natives. Shifting and *kumri* cultivation were later banned from the forests but the extraction of timber continued while extraction of non-timber forest products (NTFP) too increased.

A Brief History of Land-uses in the Anaikatty 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 - 1970 (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

Towards the second half of the 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 the distribution of land to the landless. Excess land acquired from landlords who clear-

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

felled them prior to acquisition by the government were allotted to the landless. The rest of the private forests were nationalized.

*Irula*s of previous generations were generally not concerned with material wealth and hard labour to raise savings (Buchanan 1870). This seeming "indifference" triggered an alienation (rights shifting to non-natives) of their land in favor of settlers (mostly *gounders*) from the plains. Significant portions of relatively fertile lands distributed to the natives thus came to be alienated and farmers from the plains started settling in the area in large numbers. This paved the way for the entry of various institutions and commercial establishments. As a result, some of these areas, once populated mostly by natives, have now been reduced to *adivasi* minority areas. For example, in 1961, the population in the Attapady block in Kerala was 63 percent *adivasis*. By 1991, *adivasis* had been reduced to just 30 percent. A survey in 1977 by the Integrated Tribal Development Project under the Government of Kerala revealed that in Attapady block alone 10,107 acres of *adivasi* lands had been alienated (rights shifting to non *adivasis*). As a consequence, the majority of the native population were confined to the immediate periphery of forests.

The land that remained with the tribals derived its productivity from the adjacent forests and produced subsistence crops with minimum inputs. Lack of awareness about land conservation techniques in settled agriculture and dearth of monetary resources catalyzed a decline in productivity and subsequent indebtedness. While clear felling triggered ecological disturbances, curtailment of traditional forest rights and land alienation eroded the traditional base of livelihood. As a result, parts of adjacent state-owned forests were gradually 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 did try to integrate these communities into the 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.

The tribals of this region have thus become completely dependant on government programs or casual labour. Gradually, the native community has started living mostly on casual labour employment in the farms owned by settlers. Recurring drought conditions and wild animal intrusions have 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 into dry-land subsistence farmers, has now been reduced to the status of under-employed 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 characterized 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.

Appendix 2

Land-use Practices prevailing in the Anaikatty Area

1. Dry-farming

Dry-farming in this study refers to the traditional rain-fed mixed cultivation of millets, coarse grains and pulses. This largely is a subsistence activity and is at present threatened by drought and wild animals. Millet-based farming systems prevailing in the area are outlined below along with suggested improvements so as to sustain natural resources in the long run. Most farms had stands of millet and leguminous crops sown in mixed fashion without chemical inputs and irrigation. The first crop usually sown in June-July had *ragi* (*Eleusine Coracana*) as the major crop along with dolichos beans (*Dolichos Lablab*) and horse gram (*Dolichos Uniflorus*). The major cropping season starts after harvesting the first crop in October when *ragi* and *jowar* (*Sorghum Bicolor*) are sown along with cowpea (*Vigna Unguiculata*) and *sesamum* (*Sesamum Indicum*). Small areas are also sown with lesser millets (*Chama Setaria Itlaica*), *thenai* (*Panicum Miliaceae*) and vegetables. Since many crops are taken in a mixed sowing fashion, segregating the cost components for the BCA was difficult. For the BCA, the most popular crop combinations were assumed for all farms in common proportions for the area covered.

The major advantages of the system include catering to traditional dietary needs, the possession of traditional knowledge in cultivation, and low intensity of inputs (see 1 in Table 4). The disadvantages include susceptibility to drought, animals, and degradation. It was apparent from the survey that dry-farming in the land possessed by natives was abandoned only in dire situations like extreme drought or very frequent elephant raids (see 8 in Table 4). Otherwise, it was continued in whatever low scales possible within the resource limits. Farmers possessing marginal land holding and with low family income perceived dry-farming as a preferable land-use to fallows.

Two improvements over the existing system (DF1) were discussed with villagers. The first strategy would include actions to protect crops from wild life attack and grazing (DF) while the second, as suggested by experts, would incorporate soil conservation measures (DFC) such as contour bunding. These three systems, namely DF1, DF and DFC, are later assessed through the Economic and Financial BCA.

2. Millet based Agro-forestry systems

Agro-forestry systems were discussed in detail with scientists and other experts in the area because these were found to be the most popular practices. Though respondents preferred Agro-forestry practices, there seemed to be a lack of clarity regarding which tree-crop combination would be the most appropriate. Fears of trees shading millet crops and rights over harvest prevail among the respondents. Under the existing situation, no agro-forestry system is in vogue. This may also be due to the long co-existence of the community with forests.

Dwindling forest cover, increased population pressure and stringent forest laws rendered access to fodder, firewood and timber inside the forests increasingly difficult. This has led to the gradual realization of the need for an adequate flow of food, fruits and firewood from their own lands because this could make their livelihood drought-proof to a considerable extent. This is reflected in the farmers' perception of feasible land-uses. (see 2 in Table 4 as well as Figure 2). Respondents mentioned models incorporating fruit trees of guava, custard apple, lime, gooseberry and/or cashew trees. However, scientific opinion from the Division of Agro-forestry IFGTB (Institute of Forest Genetics and Tree Breeding), Coimbatore, was to confine to non-fruit-bearing trees on the field bunds considering the difficulty of establishing saplings without irrigation as well as the possibility of attracting wild animals.

While farmers focused on the nutritional benefits from trees in the agro-forestry systems, their ecological role is also noteworthy. When considering the cost of sequestering a ton of carbon in forestry options, Ravindranath and Somasekhar (1995) have shown that agro-forestry was among the least costly ones (with less than US$ 2.5/ton of C) under a demand driven scenario. Agro-forestry thus appears as a promising land-use option for the fallows of the *Irulas* of Anaikatty in terms of both on-site and off-site benefits. Research inputs into profitable combinations of millets and fruit trees for the area would pay off as socio-economic and ecological benefits of such systems have been proved elsewhere (Current and Scherr 1995). Suitable agro-forestry models could be visualized through discussions taking into account the stakeholders' twin objectives of continuing the tradition of dry-land agriculture while supplementing the bio-mass output. There can be many possible tree-crop/grass combinations suitable for the study site, which could be assessed for its economic and environmental impact. Taking the locally occurring trees suitable for agro-forestry in the area, the discussions as in section 2.1 elicited three potential agro-forestry systems for BCA:

AF1: Plantation of *Acacia nilotica* (*karuvelam*) in degraded fallows to replenish soil with fixed nitrogen and leaf litter while leaves and pods also provide fodder. After 10 years, dry-farming can be resumed in the reclaimed land as an agro-forestry system with *A nilotica* trees retained on bunds.

AF2: Agro-forestry system with rain-fed millets in the field and trees of Neem (*Azadirachta indica*) and Acacia (*Acacia nilotica*) on bunds.

IF: Fast-growing tree legume species *Sesbania sesban* and *Leuceana leucocephala* are the major components of improved fallows. Dry-farming could be resumed on the reclaimed land when the top-soil is 50 cm deep and annual soil loss is reduced to one centimeter.

3. Plantations

Unirrigated plantations of teak (TK), cashew (CSW), neem (NM) and gooseberry (EM) were considered technically feasible and acceptable. Such plantations would be linked to market though each farm will be too small for efficient marketing. Also few can afford to allocate land away from raising subsistence crops. Rights of harvest and transport for sale may involve a transaction cost in acquiring permits. Plantations of

Eucalyptus (EU) were found mainly in forest plantations and absentee farms of non-native owners. These land-uses were found to be acceptable but not preferred like agro-forestry practices (see 4 and 5 in Table 4).

4. Silvipasture and Natural Regeneration

Forestry scientists (IFGTB, Coimbatore) felt that Silvipasture (SP) and Natural Regeneration (NR) systems are important in rejuvenating bio-mass productivity. Though respondents were not aware of silvipastoral systems, they were not averse to it. This system involving forest trees and fodder grass has proved successful in other dry parts of India (Pathak and Roy, 1994), especially on community lands. Individual incentives for opting for such land-uses is low in the study area, given the fact that few people live exclusively on grazing (see 6 in Table 4). In this context, efforts have been made at community level to protect degraded areas and to aid natural regeneration such as the one initiated by the Forest Department in the Joint Forest Management areas.

5. Soil Excavation

Low crop yields and lack of resources coupled with drought force many natives to sell the soil to brick kilns (SE) at times of liquidity crises in addition to working in the kilns as casual labourers. Profits accruing to the brick kilns were due to under-valuation of water and soil and resulted in rent-seeking behavior, deepening wells and a depleting layer of productive top soil. Brick kilns provide employment as well as credit to many. Selling the topsoil or working in a kiln against already advanced credit appear better than borrowing money from local traders on the prevailing terms (at 120% annual interest rates). However, once the cost of inputs shoot up as extraction of soil becomes difficult, brick kiln owners usually migrate in search of more suitable locations with the comparative advantage in soil availability (see 7 in Table 4). When this happens, those who sold the soil and thrived on jobs offered by the kilns will face the cost of reclamation and low yields if they revert to their land for livelihood. The situation could take a downward spiral to impoverishment as alternate employment for unskilled workers is hard to come by. Moreover, as observed from the survey, unlike many other communities, *Irula*s in the study area are reluctant to migrate. As shown in Table 4, fallowing and soil excavation are the options then left with a native respondent. Soil excavation is compared in the paper with the existing practice using BCA.

Appendix 3. Field Survey Schedule for the Economic Assessment of Land use Options

Seema, P. SANDEE Project, SACON, Coimbatore.

I Group discussions

1	**Settlement**	Distance to bus	Forest Range	Dist. to forest	Panchayat	Total area	Hamlet area			
1a										
1b	Population	Male	Female	Children	No: of HHs	No:of Pucca houses	Landless HH			
2	**Open access land**	Revenue poramboke		Degraded Forests		Private fallows (Total, Current & Permanent)			Village commons	
2a	Area and Current Use									
2b	Perceived feasible use									
2c	Management									
3	**Soil status**									
3a	TopSoil depth in the area	Low	Average	Highest						
3b	Crop	Best, likely and worst yields when there is no top soil left			Best, likely and worst yields when virgin soils are cultivated			A land with successive deeper top soil depth produces increased yields, but the rate of increase becomes smaller as the topsoil gets deeper. What do you think the increase in yield generated by each successive unit of top soil depth is likely to be 50%, 60%, 70%, 80%, 90%, 95% or other % less than 100% of the increase generated by the preceding unit of top soil depth?			
1										
2										
3										

4	**Wages prevailing in the area (Male and Female) for different activities**	
	Agrl labour	
	Brick Kiln	
	Construction	
	Estate	
	Others	

5	**Other details**	
	Land sale value(dry & irrigated)	
	Lease value of land (dry & irrigated)	
	Rules for land transactions	
	Status of forests around	
	Rules for extractions from forests	
	Drinking w ater source,status & distance	
	Other w ater bodies & status	
	Community initiatied activities	
	Any w orking NGO(explain)	
	Year of electrification	
	Vehicle ow ners in the settlement	
	Sanitation facilities	

II Individual Respondent

1	Name	Age	Female/Male	Address	Education	Occupation	Annual income	*Av. no: of earning days/month			

2	**Family members**									
	Age	F/M	Relation	Occupation	Place&distance	Annual inc	Formal edn	*Av. no: of earning days/month		
a										
b										
c										
d										
e										
f										
g										
h										
I										
j										
	*For w age labourers									
3	**Land details**									
		Area	Operated	Irrigated	Source of irrgn	Mode of irrigation	Land use			
a	Inherited									
b	Bought /year									
c	Allotted(year)									
d	Leased in									
e	Leased out									
f	Fallow area									
g	Period of fallow									
h	Reason for fallow									
I	Current use of fallow									

4	**Perceptions on possible land use in own fallows:**								
	Land use								
a	Silviculture plantation								
b	Silvo-pasture								
c	Silvo-herbal								
d	Fieldcrops								
e	Agri Silvi								
f	Coconut plantation								
g	Coconut & fruit trees								
h	Fruit trees								
I	Brick-kilns								
j	Others								
5	**Crop Yields (Last season)**								
	Kind.	Area	Production#	Consumption#	Qty Sold	Price	Qty Bhusa	Drought loss	No. of Wild animal attacks & loss
C1									
C2									
C3									
C4									
C5									
C6									
C7									

C8									
C9									
C10									
C11									
C12									
	Milk								
	Eggs								
	Stock								
	Dung								
	Others								
	# specify the conversion of units								
6	**Inputs in crop production**								
	Crop	C1	C2	C3	C4	C5	C6		
a	Qty of seeds & price								
b	FYM Qty & price								
c	Fertilizer Qty & price								
d	Pesticides Qty & price								
e	Total labour days (F,M&Ch)								
f	Transpt cost								
g	Others								

7	**Livestock**									
	Kind&no.	Free grazing					Stall fed fodder		Concentrates	Acquisitions and sale during th
		Place	season	Time	Person		Kind	Quantity		
					Age	F/M				
a										
b										
c										
d										
8	**Fuel**									
		Source	Distance	Qty/trip	Transport	Labour	Cost if bought	Lasts for		
a	LPG									
b	Kerosene									
c	Dung cake									
e	Fuelw ood									
9	**Grass & wood from the forests**									
			Species				Collection months/	total qty	Qty/day	Consumption
a	Fuel w ood trees									
b	Fuelw ood Shrubs									
c	Fodder grasses									
d	House maintenance									
e	Ploughs & props									

10	**Non-wood produce (Plants & Animals)**									
	Plant/Animal	Part	Source area	Processing	Use	Collection months/	Qty/yr	Qty/day	QtyConsumed	Price
a										
b										
c										
d										
e										
f										
g										

11	**Savings**	
a	A/c with a bank	
	From when	
b	Purpose	
c	Credit taken (year)	
d	Repayment status	
e	Bank interest rate	
f	Informal sources of credit	
g	Interest rate	

12	Other details :			
	Date:	Location:	Time:	Filled by:
	Others present:			

Appendix 4

Table 1. Annual cost and benefit flow (per hectare) from Dry Farming as practiced (DF1 [1])

Year	Total cost[2] (Rs)	Benefit[3] (Rs)	Net benefit (Rs)					
1	4075.00	7482.48	3407.48					
2	4103.00	7362.12	3259.12					
3	4131.00	7233.60	3102.60					
4	4159.00	7103.29	2944.29					
5	4187.00	6971.16	2784.16					
6	4215.00	6837.19	2622.19					
7	4243.00	6701.34	2458.34					
8	4271.00	6563.60	2292.60					
9	4299.00	6423.93	2124.93					
10	4327.00	6282.32	1955.32					
11	4355.00	6138.73	1783.73					
12	4383.00	5993.13	1610.13					
13	4411.00	5845.50	1434.50					
14	4439.00	5695.82	1256.82					
15	4467.00	5544.04	1077.04					
16	4495.00	5390.14	895.14					
17	4523.00	5234.09	711.09					
18	4551.00	5075.87	524.87					
19	4579.00	4915.44	336.44					
20	4607.00	4752.77	145.77					

[1] DF1: Two crops raised annually in a degraded dry land under dry farming (*Eleusine coracana* and *Sorghum bicolor* as the major crops in the first & second crop seasons respectively)

First Crop, sown in June-July: 40% area under ragi (*Eleusine coracana*), 20% under dolichos beans (*Doilcos lablab*) and 20% under horse gram (*Dolicos uniflorus*).

Second crop, sown in October: 30% area each under ragi and jowar (*Sorghum bicolor*), 20% under cow pea (*Vigna unguiculata*) and 20% under sesamum (*Sesamum indicum*)

[2] Costs include labour and material for crop cultivation and rent

[3] After deducting the 50% yield loss due to wild life attack, grazing and drought

First Crop yield in the first year = $506.67+1873.33*(1-0.5^{0.46})$

Second Crop yield for the first year = $600 + 1895 (1-0.5^{0.45})$

Annual soil loss = 2cm

Table 2. Annual cost and benefit flows (per hectare) from Dry Farming with protection (DF[1])

Year	Costs [2] (Rs)	Benefit [3] (Rs)	Net Benefit (Rs)
0	4500.00		-4500.00
1	7135.00	14964.97	7829.97
2	4403.00	14724.24	10321.24
3	4431.00	14467.21	10036.21
4	4459.00	14206.58	9747.58
5	4487.00	13942.32	9455.32
6	4515.00	13674.37	9159.37
7	4543.00	13402.68	8859.68
8	4571.00	13127.20	8556.20
9	4599.00	12847.87	8248.87
10	4627.00	12564.64	7937.64
11	4655.00	12277.46	7622.46
12	4683.00	11986.26	7303.26
13	4711.00	11691.01	6980.01
14	4739.00	11391.63	6652.63
15	4767.00	11088.07	6321.07
16	4795.00	10780.28	5985.28
17	4823.00	10468.19	5645.19
18	4851.00	10151.74	5300.74
19	4879.00	9830.87	4951.87
20	4907.00	9505.53	4598.53

[1]DF: Protecting the existing field (*Eleusine coracana* and *Sorghum bicolor* as the major crops in the first & second crop seasons respectively) with bunds and vegetative fencing to reduce wild animal attacks and grazing as also to add to the biomass production in the long run. This bio mass also helps to improve soil moisture and fertiltiy through operations like mulching.

[2] Includes labour and material for watch, ward and vegetative fencing in the first two years and crop cultivation from the third year along with rent

[3]Crop yields remain the same as DF1 (Table 1) but wild animal attacks, grazing and drought reduce due to protection

Annual soil loss = 2cm

Table 3. Annual cost and benefit flows (per hectare) from Dry Farming systems adopting soil Consevation measures (DFC [1])

Year	Total Cost [2]	Crop yield : 1st crop [3]	Crop Yield : 2nd crop [4]	Annual crop production[3]	Value of main product	Value of by-product	Total Revenue	Net benefits
		kg/ha/season	kg/ha/season	kg/ha/yr	Rs/ha/yr	Rs/ha/yr	Rs/ha/yr	Rs/ha/yr
0	6000.00							-6000.00
1	7285.00	1018.11	1117.36	2135.48	11232.60	3787.00	15019.60	7734.60
2	4355.00	1013.39	1112.58	2125.96	11182.58	3787.00	14969.58	10614.58
3	4335.00	1008.64	1107.78	2116.42	11132.37	3787.00	14919.37	10584.37
4	4315.00	1003.88	1102.96	2106.84	11082.00	3787.00	14869.00	10554.00
5	4295.00	999.10	1098.13	2097.23	11031.45	3787.00	14818.45	10523.45
6	4275.00	994.31	1093.28	2087.59	10980.72	3787.00	14767.72	10492.72
7	4255.00	989.50	1088.41	2077.91	10929.82	3787.00	14716.82	10461.82
8	4235.00	984.67	1083.53	2068.20	10878.74	3787.00	14665.74	10430.74
9	4215.00	979.83	1078.63	2058.46	10827.49	3787.00	14614.49	10399.49
10	4195.00	974.97	1073.71	2048.68	10776.05	3787.00	14563.05	10368.05
11	4175.00	970.09	1068.78	2038.87	10724.44	3787.00	14511.44	10336.44
12	4155.00	965.19	1063.83	2029.02	10672.65	3787.00	14459.65	10304.65
13	4135.00	960.28	1058.86	2019.14	10620.68	3787.00	14407.68	10272.68
14	4115.00	955.35	1053.87	2009.23	10568.52	3787.00	14355.52	10240.52
15	4095.00	950.41	1048.87	1999.28	10516.19	3787.00	14303.19	10208.19
16	4075.00	945.44	1043.85	1989.29	10463.68	3787.00	14250.68	10175.68
17	4055.00	940.46	1038.81	1979.27	10410.98	3787.00	14197.98	10142.98
18	4035.00	935.47	1033.76	1969.22	10358.10	3787.00	14145.10	10110.10
19	4015.00	930.45	1028.68	1959.13	10305.04	3787.00	14092.04	10077.04
20	3995.00	925.42	1023.59	1949.01	10251.79	3787.00	14038.79	10043.79

[1] Contour bunding with locally available rubbles and agave planted on sides; (*Eleusine coracana* and *Sorghum bicolor* as the major crops in the first & second crop seasons respectively)

[2] Includes labour and material for watch, ward and soil erosion in the first two years and crop cultivation from the third year, along with rent.

[3] First Crop yield in the first year = $506.67+1873.33*(1-0.5^{0.48})$

[4] Second Crop yield for the first year = $600 + 1895\ (1-0.5^{0.47})$

Average soil loss: 0.5 cm/annum.

Table 4. Annual cost and benefit flows (per hectare) from a degraded dry land under a multipurpose tree species *Acacia nilotica* (AF1[1])

Year	Costs									Benefits				Net Benefits
	Labour			Materials				Rent	Total cost					
	Categories	Person days	Cost	Kind	Quantity	Price	Cost			Kind	Quantity	Price	Revenue[2]	
		Number	Rs		Number	Rs/unit	Rs	Rs/anum	Rs		tons/ha	Rs/ton	Rs	Rs
0	Veg.fencing	8	600.00	Veg.fencing	200	0.50	100.00							
	Watch & ward	73	5475.00	Seedlings	200	6.00	1200.00							
	Pitting & planting	20	1500.00											
Total 0		101	7575.00				1300.00	500.00	9375.00				0.00	-9375.00
1	Watch & ward	73	5475.00	Veg.fencing	40	0.50	20.00							
	Pitting & planting	6	450.00	Seedlings[3]	60	6.00	360.00							
	Weeding	3	225.00											
Total 1		80	6150.00				380.00	500.00	7030.00				0.00	-7030.00
2	Watch & ward	7	525.00											
	Weeding	3	225.00											
Total 2			750.00					500.00	1250.00					-1250.00
3	Fodder grass[4]	2								Fodder	1.00	250.00	250.00	
Total 3			150.00				0.00	500.00	650.00				250.00	-400.00
4	Fodder grass	1								Fodder	0.50	250.00	125.00	
Total 4			75.00				0.00	500.00	575.00				125.00	-450.00
5	Grass fodder	2	150.00							Grass	1.00	250.00	250.00	
	Tree fodder[5] & firewood	10	750.00							Tree fodder	0.16	250.00	40.00	
										Firewood	0.64	1000.00	640.00	
Total 5		12	900.00				0.00	500.00	1400.00				930.00	-470.00
6	Grass fodder	2	150.00							Grass	1.00	250.00	250.00	
	Tree fodder & firewood	10	750.00							Tree fodder	0.16	250.00	40.00	
										Firewood	0.64	1000.00	640.00	
Total 6		12	900.00				0.00	500.00	1400.00				930.00	-470.00
7	Grass fodder	2	150.00							Grass	1.00	250.00	250.00	
	Tree fodder & firewood	10	750.00							Tree fodder	0.16	250.00	40.00	
										Firewood	0.64	1000.00	640.00	
Total 7		12	900.00				0.00	500.00	1400.00				930.00	-470.00
8	Grass fodder	2	150.00							Grass	1.00	250.00	250.00	
8	Tree fodder & firewood	10	750.00							Tree fodder	0.16	250.00	40.00	
										Firewood	0.64	1000.00	640.00	
Total 8		12	900.00				0.00	500.00	1400.00				930.00	-470.00

Table 4. AF1 continued..

Year	Costs									Benefits				Net Benefits
	Labour			Materials				Rent	Total cost	Kind	Quantity	Price	Revenue	
	Categories	Person days	Labour	Kind	Quantity		Cost							
		Number	Rs		Number		Rs	Ra/anum	Rs		tons/ha	Rs/ton	Rs	Rs/ha
9	Tree fodder & firewood	10	750.00							Tree fodder	0.16	250.00	40.00	
9										Firewood	0.64	1000.00	640.00	
Total 9		12	900.00					500.00	1400.00				930.00	-470.00
10	Grass fodder	2	150.00							Grass	1.00	250.00	250.00	
10	Tree fodder	10	750.00							Tree fodder	0.32	250.00	80.00	
10	Timber & firewood[6]	70	5250.00							Firewood	7.20		7200.00	
10										Timber	28 (m^3)	2500 / (m^3)	70000.00	
Total 10		82	6150.00					500.00	6650.00				77530.00	70880.00
										Carbon	8.00	450.00	3600.00	
11		47	3525.00				500.00	500.00	4525.00	Crop+tree			16114.91	11589.91
12		46.8	3510.00				500.00	500.00	4510.00	Crop+tree			15984.77	11474.77
13		46.6	3495.00				500.00	500.00	4495.00	Crop+tree			15853.73	11358.73
14		47.0	3525.00				500.00	500.00	4525.00	Crop+tree			15721.77	11196.77
15		47.0	3525.00				500.00	500.00	4525.00	Crop+tree			15588.90	11063.90
16		47.0	3525.00				500.00	500.00	4525.00	Crop+tree			15455.10	10930.10
17		46.0	3450.00				500.00	500.00	4450.00	Crop+tree			15320.37	10870.37
18		44.6	3420.00				500.00	500.00	4420.00	Crop+tree			15184.71	10764.71
19		45.6	3450.00				500.00	500.00	4450.00	Crop+tree			15048.10	10598.10
20		52.2	3915.00				500.00	500.00	4915.00	Crop+tree			27910.54	22995.54
										Soil carbon	2.5	450.00	1125	

[1]AF1:Plantation of *Acacia nilotica* (karuvelam) in degraded fallows 200/ha @ 5mx5m, replenishes soil with fixed nitrogen and leaf litter while leaves and pods provide fodder. After 10 years, dry farming is resumed as in DF (Table 2) on the reclaimed land as an agro forestry system.

[2] Carbon benefits included in the EBCA (Economic Benefit Cost Analysis)

[3] 70% survival. 30 % of 400 trees ie.,120 seedlings replanted

[4] Two cuttings/ year from grasses in between the trees

[5] Leaves and pods

[6] Six trees / man day including excavation of 280 trees with stumps leaving 40 trees on the bunds

Schroeder et al (1993)

Table 5. Annual cost and benefit flows (per hectare) from agroforestry system (AF2[1])

Year	Total cost[2] (Rs)	Annual income from crops (Rs)[3]	Benefits from trees (Rs)	Total benefits (Rs)[4]	Net benefits (Rs)						
0	10832.00				-10832.00						
1	9938.00	14964.97	0.00	14964.97	5026.97						
2	4900.00	14864.40	0.00	14864.40	9964.40						
3	4187.50	14763.13	37.50	14800.63	10613.13						
4	4176.25	14661.15	0.00	14661.15	10484.90						
5	4255.00	14558.47	113.25	14671.72	10416.72						
6	4266.25	14455.07	191.63	14646.70	10380.45						
7	4266.25	14350.95	262.50	14613.45	10347.20						
8	4277.50	14246.11	262.50	14508.61	10231.11						
9	4288.75	14140.54	312.75	14453.29	10164.54						
10	4288.75	14034.24	381.75	14415.99	10127.24						
11	4288.75	13927.19	381.75	14308.94	10020.19						
12	4288.75	13819.40	382.50	14201.90	9913.15						
13	4401.25	13722.84	7779.00	21501.84	17100.59						
14	4367.50	13601.57	539.25	14140.82	9773.32						
15	4367.50	13491.52	539.25	14030.77	9663.27						
16	4367.50	13380.70	539.25	13919.95	9552.45						
17	4367.50	13269.11	539.25	13808.36	9440.86						
18	4367.50	13156.74	539.25	13695.99	9328.49						
19	4367.50	13043.59	539.25	13582.84	9215.34						
20	4660.00	12929.66	16222.50	29152.16	24492.16						

1 AF2: with rainfed millets in the field and trees of neem (*Azadirachta indica*) and acacia (*Acacia nilotica*) on bunds. at 10m spacing, 40 trees planted on the outer bunds of a 1 ha plot. At 60% rate of survival, 24 trees grow till maturity.

[2] Material Cost of planting materials (seedlings, slips and seeds) and inputs in cultivation for the first two years and from 3rd year, only input cost in cultivation. Labour cost in fencing + tree planting (gap filling in the second year) + watch + crops. From 3rd year only labour cost in cultivation and harvest of tree products .

[3] Income from two crops/year based on yields derived from MS production function with reduced soil loss of 1 cm per year. Refer tables 1 to 3 for details of the production function.

[4] Carbon sequestered in 3.12 (m^3) of wood (1.2 (m^3) of acacia and 1.92 (m^3) of neem @ 0.4 tons/ m^3) and soil will be included in the EBCA

Table 6. Annual cost and benefit flows (per hectare) from Improved Fallows (IF[1])

Year	Costs									Benefits				Net Benefit
	Labour			Material				Rent	Total cost	Kind	Quantity	Price	Revenue	
	Categories	Person days	Labour	Kind	Quantity	Price	Cost							
		Number	Rs		Number	Rs/unit	Rs	Rs/anum	Rs		tons/ha	Rs/ton		Rs
0	Veg.fencing[2]	10	750.00	Agave	400	0.50	200.00							
	Watch & ward	73	5475.00	Gliricidia	40	6.00	240.00							
	Pitting & Planting	40	3000.00	Subabul	625		3750.00							
	Sowing	1	75.00	Sesbania seeds	2	150.00	300.00							
Total 0			9300.00				4490.00	500.00	14290.00				0.00	-14290.00
1	Watch & ward	73	5475.00	Agave slips	80	0.50	40.00							
	Gap filling	0.35	25.00	Gliricidia	8	6.00	48.00							
	Gap filling	5	375.00	Subabul	125	6.00	750.00							
Total 1			5875.00				838.00	500.00	7213.00				0.00	-7213.00
Total 2	Watch & ward	7	525.00					500.00	1025.00	Fodder[3]	0.75	250.00	187.00	-838.00
3	Fodder harvest	2	150.00											
Total 3	Fodder harvest	2	150.00				0.00	500.00	650.00	Fodder	0.75	250.00	187.00	-463.00
4			150.00											
Total 4	Fodder harvest	2	150.00				0.00	500.00	650.00	Fodder	0.875	250.00	218.00	-432.00
5	Firewood	12	900.00							Fodder	1.5	250.00	325.00	
	Fodder harvest	2	150.00							Firewood[4]	11	1000.00	11000.00	
Total 5			1050.00				0.00	500.00	1550.00				11325.00	9775.00
6	Dry farming[5]	46	3450.00				500.00	500.00	4450.00	Crop+by product	As in Table 2[5]		15514.91[7]	11064.91
7		45.8[6]	3435.00				500.00	500.00	4435.00	Crop+by product			15384.77	10949.77
8		45.6	3420.00				500.00	500.00	4420.00	Crop+by product			15253.73	10833.73
9		45.4	3405.00				500.00	500.00	4405.00	Crop+by product			15121.77	10716.77

Table 6. IF continued..

Year	Costs									Benefits				Net Benefit
	Labour			Material				Rent	Total cost	Kind	Quantity	Price	Revenue	
	Categories	Person days	Labour	Kind	Quantity	Price	Cost							
		Number	Rs		Number	Rs/unit	Rs	Rs/anum	Rs		tons/ha	Rs/ton		Rs
10		45.2	3390.00				500.00	500.00	4390.00	Crop+by product			14988.90	10598.90
11		45	3375.00				500.00	500.00	4375.00	Crop+by product			14855.10	10480.10
12		44.8	3360.00				500.00	500.00	4360.00	Crop+by product			14720.37	10360.37
13		44.6	3345.00				500.00	500.00	4345.00	Crop+by product			14584.71	10239.71
14		44.4	3330.00				500.00	500.00	4330.00	Crop+by product			14448.10	10118.10
15		44.2	3315.00				500.00	500.00	4315.00	Crop+by product			14310.54	9995.54
16		44	3300.00				500.00	500.00	4300.00	Crop+by product			14172.02	9872.02
17		43.8	3285.00				500.00	500.00	4285.00	Crop+by product			14032.54	9747.54
18		43.6	3270.00				500.00	500.00	4270.00	Crop+by product			13892.09	9622.09
19		43.4	3255.00				500.00	500.00	4255.00	Crop+by product			13750.67	9495.67
20		43.2	3240.00				500.00	500.00	4240.00	Crop+by product			13608.25	9368.25

[1]Fast growing tree legume species: *Sesbania sesban* (direct seeding) & *Leuceana leucocephala* (planted in rows 625 in number @ 2mx8m). Sesbania harvested fully in the 5th year and Leuceana in the 6th year. Replenishes soil with fixed nitrogen and leaf litter.

[2] Gliricidia planted among agave at 10 m intervals.

[3] 500 kg from 500 subabul trees and 250 kg from 1000 sesbania plants.

[4] 20 kg/tree of subabul and 1kg/ stump of sesbania.

[5] Production functions as in DF (Table 2) with initial soil depth at 50cm and annual loss at 1cm.

[6] Soil loss reduces harvest labour day every year be 20%.

[7] Main crop yields follw the footnote '5' and benefits include both main crop and by-product.

Table 7. Annual costs and benefits (per hectare) from soil excavated to be sold to brick kilns (SE)[1] and reclaimed for dry farming

Year	Cost					Benefits				Net benefits
	Categories	Labour	Material	Rent	Total Costs	Kind	Quantity	Price	Revenue	
		Rs	Rs	Rs/anum	Rs		tons/ha	Rs/ton	Rs	Rs
Total 0				500.00	500.00	Soil sold			50000	49500.00
Total 1				500.00	500.00				0	-500.00
2	Reclaimation	750	3075							
	Gap filling		40							
Total 2		750	3115	500.00	4365.00				0	-4365.00
Total 3	Reclamation	750	3825	500.00	5075.00				0	-5075.00
4	Reclamation	750	3825							
	Veg. Fence	800		500.00						
Total 4		1550	3825	500.00	5875.00				0	-5875.00
5	Dry farming [2]	4940.00	1235.00	500.00	6675.00				7192.13 [3]	517.13
6	Dry farming	4940.00	1235.00	500.00	6675.00				7192.13	517.13
7	Dry farming	4940.00	1235.00	500.00	6675.00				7185.93	510.93
8	Dry farming	4940.00	1235.00	500.00	6675.00				7185.93	510.93
9	Dry farming	4940.00	1235.00	500.00	6675.00				7176.64	501.64
10	Dry farming	4940.00	1235.00	500.00	6675.00				7176.64	501.64
11	Dry farming	4940.00	1235.00	500.00	6675.00				7161.13	486.13
12	Dry farming	4940.00	1235.00	500.00	6675.00				7161.13	486.13
13	Dry farming	4940.00	1235.00	500.00	6675.00				7145.61	470.61
14	Dry farming	4940.00	1235.00	500.00	6675.00				7145.61	470.61
15	Dry farming	4940.00	1235.00	500.00	6675.00				7130.08	455.08
16	Dry farming	4940.00	1235.00	500.00	6675.00				7130.08	455.08
17	Dry farming	4940.00	1235.00	500.00	6675.00				7098.99	423.99
18	Dry farming	4940.00	1235.00	500.00	6675.00				7067.84	392.84
19	Dry farming	4940.00	1235.00	500.00	6675.00				7036.64	361.64
20	Dry farming	4940.00	1235.00	500.00	6675.00				7005.39	330.39
						Soil Carbon	2	450	900.00	

[1] SE:excvation upto 3 feet and 20cm soil reclaimed after 3 years.

[2] Dry farming starts after reclamation during a 3 year fallow period; 50 % reduction from previous yield ;and increased labour & material cost in manure application.

[3] Main crop yields follw the footnote '2' and benefits include both main crop and by-product.

Crop yield (1st year) = 500+1500*(1-0.85 ^{xt}) Initial soil depth at (xt) 20cm and annual loss at 1cm

Table 8. Annual Cost and benefit flows (per hectare) from a degraded dry deciduous tract under *Emblica officinalis* (EM[1])

Year	Costs									Benefits				Net benefit
	Labour			Material				Rent	Total cost	Kind	Quantity	Price	Revenue	
	Categories	Person days	Labour	Kind	Quantity	Price	Cost							
		Number	Rs		Number	Rs/unit	Rs	Rs/anum	Rs		tons/ha	Rs/ton	Rs	Rs
0	Veg.fencing	8	600.00	Veg.fencing (slips)	400	0.50	200.00							
	Watch & ward	73	5475.00	Seedlings	200	10.00	2000.00							
	Pitting & planting	20	1500.00											
Total 0		101	7575.00				2200.00	500.00	10275.00				0.00	-10275.00
1	Watch & ward	73	5475.00	Seedlings (gaps)	60		600.00							
	Pitting & planting	2	150.00	Veg.fencing	80		40.00							
	Weeding & soil working	3	225.00											
Total 1		78	5850.00				640.00	500.00	6990.00				0.00	-6990.00
2	Watch & ward	35	2625.00											
	Fodder cutting	2	150.00											
Total 2		2	2775.00					500.00	3275.00				0.00	-3275.00
3	Fodder cutting	2	150.00							Fodder	1	250.00	250.00	
Total 3		2	150.00					500.00	650.00	Fodder	1	250.00	250.00	-400.00
4	Fodder cutting	3	225.00											
Total 4		3	225.00				0	500.00	725.00	Fodder	1.5	250.00	375.00	#REF!
5	Climbercutting & Fodder	3	225.00				0							
Total 5	Fodder		225.00				0	500.00	725.00	Fodder	1.5	250.00	375.00	-350.00
Total 6	Fodder	3	225.00				0	500.00	725.00	Fodder	1.5	250.00	375.00	-350.00
Total 7	Fodder	3	225.00				0	500.00	725.00	Fodder	1.5	250.00	375.00	-350.00
Total 8	Fodder	3	225.00				0	500.00	725.00	Fodder	1.5	250.00	375.00	-350.00
Total 9	Fodder	3	225.00				0	500.00	725.00	Fodder	1.5	250.00	375.00	-350.00
Total 10	Fodder	5	375.00				0	500.00	875.00	Fodder	1.5	250.00	375.00	-500.00
11	Fodder	5	375.00							Fodder	2	250.00	500.00	
11	Fruits & firewood[2]	7	525.00							Firewood[3]	0.5	1000.00	500.00	

Table 8. EM continued..

Year	Costs									Benefits				Net benefit
	Labour			Material				Rent	Total cost	Kind	Quantity	Price	Revenue	
	Categories	Person days	Labour	Kind	Quantity	Price	Cost							
		Number	Rs		Number	Rs/unit	Rs	Rs/anum	Rs		tons/ha	Rs/ton	Rs	Rs
Total 11		12	900.00				0	500.00	1400.00				4500.00	3100.00
12	Fodder	5								Fodder	2	250.00	500.00	
12	Firewood	2								Firewood	0.5	1000.00	500.00	
12	Fruits	10								Fruits	1	7000.00	7000.00	
Total 12		17	1275.00				0	500.00	1775.00				8000.00	6225.00
13	Fodder	5								Fodder	2	250.00	500.00	
	Firewood	2								Firewood	0.5	1000.00	500.00	
Total 13		7	525.00				0	500.00	1025.00				1000.00	-25.00
14	Fodder	5												
	Firewood	2								Fodder	2	250.00	500.00	
	Fruits	13								Firewood	0.5	1000.00	500.00	
										Fruits	2.85	7000.00	19950.00	
Total 14		20	1500.00				0	500.00	2000.00				20950.00	18950.00
15	Fodder	5												
	Firewood	2								Fodder	2	250.00	500.00	
										Firewood	0.5	1000.00	500.00	
Total 15		7	525.00				0	500.00	1025.00				1000.00	-25.00
16	Fodder	5								Fodder	2	250.00	500.00	
	Firewood	2								Firewood	0.5	1000.00	500.00	
Total 16		7	525.00					500.00	1025.00				1000.00	-25.00
17	Fodder	5								Fodder	2	250.00	500.00	
	Firewood	2								Firewood	0.5	1000.00	500.00	
	Fruits	20								Fruits	3.8	7000.00	26600.00	
Total 17		27	2025.00				0	500.00	2525.00				27600.00	25075.00
18	Fodder	5								Fodder	2	250.00	500.00	
	Firewood	3								Firewood	0.8	1000.00	800.00	
Total 18		8	600.00				0	500.00	1100.00				1300.00	200.00

Table 8. EM continued..

Year	Costs									Benefits				Net benefit
	Labour			Material				Rent	Total cost	Kind	Quantity	Price	Revenue	
	Categories	Person days	Labour	Kind	Quantity	Price	Cost							
		Number	Rs		Number	Rs/unit	Rs	Rs/anum	Rs		tons/ha	Rs/ton	Rs	Rs
19	Fodder	5								Fodder	2	250.00	500.00	
	Firewood	2								Firewood	0.6	1000.00	600.00	
	Fruits	20								Fruits	3.8	7000.00	26600.00	
Total 19		27	2025.00				0	500.00	2525.00				27700.00	25175.00
20	Fruits	18								Fodder	5	250.00	1250.00	
	Fodder									Firewood	5	1000.00	5000.00	
	Timber, small timber & firewood	100								Fruits	2085	7000	9975.00	
										Small timber	8	3490	27920.00	
Total 20		118	8850.00				0	500.00	9350.00				44145.00	34795.00
										Carbon	3.2	450	1440.00	
										Soil C	10	450	4500.00	

Crop yield (1st year) = 500+1500*(1-0.85^{xt}) Initial soil depth at 20cm and annual loss at 1cm

[1]200 seedlings planted at 7x7m : 80% rate of survival after gap filling in the second year

[2]100 bearing trees. 15 trees need one labour day; tree leaf fodder and firewood are also harvested along with fruits

[3] Fruits are harvested by cutting fruit laden branches which are sold as fire wood @ Rs.1/kg at site

[4] Yields every third year. Yield/ tree increases to a maximum of 20 kg/ tree by 16th year

Govt of Kerala(2002)

Table 9. Annual Cost and benefit flows (per hectare) in a degraded dry area under Neem (*Azadirachta indica*) (NM[1])

Year	Costs									Benefits				Net benefit
	Labour			Materials				Rent	Total cost	Kind	Quantity	Price	Revenue	
	Categories	Person days	Labour cost	Kind	Quantity	Price	Material cost							
		Number	Rs		Number	Rs	Rs	Rs/anum	Rs		tons/ha	Rs/ton	Rs	Rs
0	Veg.fencing	8	600.00	Veg.fencing	400	0.50	200.00							
	Watch & ward	73	5475.00	Seedlings	200	6.00	1200.00							
	Pitting & planting	20	1500.00											
Total 0			7575.00				1400.00	500.00	9475.00				0.00	-9475.00
1	Watch & ward	73	5475.00	Veg.fencing	80	0.50	40.00							
	Pitting & planting	2	150.00	Seedlings	60	6.00	360.00							
	Weeding	3	225.00											
Total 1			5850.00				400.00	500.00	6750.00				0.00	-6750.00
2	Fodder grass[2]	3	225.00											
	Watch & ward	15	1125											
Total 2			1350.00					500.00	1850.00				0.00	-1850.00
3														
	Fodder	3	225.00											
Total 3			225.00				0.00	500.00	725.00	Fodder	1.00	250.00	250.00	-475.00
4	Fodder	3	225.00							Fodder[3]	0.96	250.00	240.00	
Total 4			225.00				0.00	500.00	725.00				240.00	-485.00
5	Fodder, firewood & seeds	10	750.00											
										Seeds[4]	0.10	3000.00	300.00	
										Fodder	1.50	250.00	375.00	
										Firewood	0.08	1000.00	80.00	
Total 5			750.00				0.00	500.00	1250.00				755.00	-495.00
6	Fodder, firewood & seeds	10	750.00							Seeds	0.25	3000.00	750.00	
										Fodder	1.75	250.00	437.00	
										Firewood	0.09		90.00	
Total 6			750.00				0.00	500.00	1250.00				1277.00	27.00

Table 9. NM continued

Year	Costs									Benefits				Net benefit
	Labour			Materials				Rent	Total cost	Kind	Quantity	Price	Revenue	
	Categories	Person days	Labour cost	Kind	Quantity	Price	Material cost							
		Number	Rs		Number	Rs	Rs	Rs/anum	Rs		tons/ha	Rs/ton	Rs	Rs
7	Fodder, firewood & seeds	11	825.00							Seeds	0.4	3000	1200	
										Fodder	1.8	250	450	
										Firewood	0.1	1000	100	
Total 7			825.00				0.00	500.00	1325.00				1750	425.00
8	Fodder, firewood & seeds	11	825.00							Seeds	0.40	3000.00	1200.00	
										Fodder	1.80	250.00	450.00	
										Firewood	0.10	1000.00	100.00	
Total 8			825.00				0.00	500.00	1325.00				1750.00	425.00
9	Fodder, firewood & seeds	12	900.00							Seeds	0.50	3000.00	1500.00	
										Fodder	1.90	250.00	475.00	
										Firewood	0.11	1000.00	110.00	
Total 9			900.00				0.00	500.00	1400.00				2085.00	685.00
10	Fodder, firewood & seeds	13	975.00							Seeds	0.64	3000.00	1920.00	
										Fodder	2.00	250.00	500.00	
										Firewood	0.125	1000.00	125.00	
Total 10			975.00				0.00	500.00	1475.00				2545.00	1070.00
11	Fodder, firewood & seeds	13								Seeds	0.64	3000.00	1920.00	
										Fodder	2.00	250.00	500.00	
										Firewood	0.125	1000.00	125.00	
Total 11			975.00				0.00	500.00	1475.00				2545.00	1070.00
12	Fodder, firewood & seeds	13	975.00							Seeds	0.64	3000.00	1920.00	

Table.9. NM continued

Year	Costs									Benefits				Net benefit
	Labour			Materials				Rent	Total cost	Kind	Quantity	Price	Revenue	
	Categories	Person days	Labour cost	Kind	Quantity	Price	Material cost							
		Number	Rs		Number	Rs	Rs	Rs/anum	Rs		tons/ha	Rs/ton	Rs	Rs
										Fodder	2.00	250.00	500.00	
										Firewood	0.13	1000.00	130.00	
Total 12			975.00				0.00	500.00	1475.00				2550.00	1075.00
13	Timber [5]	8	600.00				0.00							
										Timber	12 (m^3)	4000.00	48000.00	
	Fodder, firewood & seeds	15	1125.00							Seeds	0.80	3000.00	2400.00	
										Fodder	2.40	250.00	600.00	
										Firewood	0.86	1000.00	860.00	
Total 13			1725.00				0.00	500.00	2225.00				51860.00	49635.00
										Carbon	0.48	450.00	*216.00*	
14	Fodder, firewood & seeds[6]	7	525.00							Seeds	0.40	3000.00	1200.00	
										Fodder	1.75	250.00	437.00	
										Firewood	0.16	1000.00	160.00	
Total 14			525.00				0.00	500.00	1025.00				1797.00	772.00
15	Fodder, firewood & seeds	7	525.00							Seeds	0.40	3000.00	1200.00	
										Fodder	1.75	250.00	437.00	
										Firewood	0.16	1000.00	160.00	
Total 15			525.00				0.00	500.00	1025.00				1797.00	772.00
16	Fodder, firewood & seeds	7	525.00							Seeds	0.40	3000.00	1200.00	
										Fodder	1.75	250.00	437.00	
										Firewood	0.16	1000.00	160.00	
Total 16			525.00				0.00	500.00	1025.00				1797.00	772.00

Table.9. NM continued

Year	Costs									Benefits				Net benefit
	Labour			Materials				Rent	Total cost	Kind	Quantity	Price	Revenue	
	Categories	Person days	Labour cost	Kind	Quantity	Price	Material cost							
		Number	Rs		Number	Rs	Rs	Rs/anum	Rs		tons/ha	Rs/ton	Rs	Rs
17	Fodder, firewood & seeds	7	525.00							Seeds	0.40	3000.00	1200.00	
										Fodder	1.75	250.00	437.00	
										Firewood	0.16	1000.00	160.00	
Total 17			525.00				0.00	500.00	1025.00				1797.00	772.00
18	Fodder, firewood & seeds	7	525.00							Seeds	0.40	3000.00	1200.00	
										Fodder	1.75	250.00	437.00	
										Firewood	0.16	1000.00	160.00	
Total 18			525.00				0.00	500.00	1025.00				1797.00	772.00
19	Fodder, firewood & seeds	7	525.00							Seeds	0.40	3000.00	1200.00	
										Fodder	1.75	250.00	437.00	
										Firewood	0.16	1000.00	160.00	
Total 19			525.00				0.00	500.00	1025.00				1797.00	772.00
20	Timber	12	900.00							Timber	12.8 (m^3)	4000.00	51200.00	
	Fodder, firewood & seeds	8	600.00							Seeds	0.48	3000.00	1440.00	
										Fodder	1.90	250.00	475.00	
										Firewood	0.96	1000.00	960.00	
Total 20			1500.00				0.00	500.00	2000.00				54075.00	52075.00
										Carbon	5.12	450.00	2304.00	
										Soil C	10.00	450.00	4500.00	

[1] Neem: 200 No/ha: @ 5mx10m; 80% survival after gapfilling.

[2] Two cuttings /year

[3] Tree and grass fodder

[4] 80% survival of trees, 1.2 kg fresh fruits/ tree ie 100kg dry seeds/160 trees

[5] Thinning 50 % of the stand, ie; 80 trees

[6] From remaining 80 trees

Table 10. Annual cost and benefit flows (per hectare) from a degraded dry deciduous tract under rainfed Teak (*Tectona grandis*) (TK[1])

Year	Costs									Benefits				Net benefit
	Labour			Materials				Rent	Total cost	Kind	Quantity	Price	Revenue	
	Categories	Person days	Labour cost	Kind	Quantity	Price	Cost							
		Number	Rs		Number	Rs	Rs	Rs/anum	Rs		tons/ha	Rs/ton	Rs	Rs
0	Veg.fencing	8	600.00	Veg.fencing	400	0.50	200.00							
	Watch & ward	73	5475.00	Stumps	2500	2.00	5000.00							
	Stump Planting	6	450.00											
Total 0		87	6525.00				5200.00	500.00	12225.00				0.00	-12225.00
1	Watch & ward	73	5475.00	Stumps	625	2.00	1250.00							
	Planting	3	225.00	Veg.fencing	80	0.50	40.00							
	Weeding & soil working	10	750.00											
Total 1		86	6450.00				1290.00	500.00	8240.00				0.00	-8240.00
2	Watch & ward	35	2625.00											
	Weeding	10	750.00											
Total 2			3375.00					500.00	3875.00				0.00	-3875.00
3	Climbercutting & pruning	6	450.00											
Total 3			450.00				0.00	500.00	950.00				0.00	-950.00
4	Climbercutting & pruning	6	450.00											
Total 4			450.00				0.00	500.00	950.00	Firewood	0.435	1100.00	450.00	-500.00
5	Climbercutting & pruning	6	450.00											
Total 5			450.00				0.00	500.00	950.00	Firewood	0.44	1100.00	460.00	-490.00
6	Maintenance (fence & fireline)	5	375.00											
Total 6			375.00				0.00	500.00	875.00	Firewood	0.45	1100.00	540.00	-335.00
7	Maintenance	5	375.00											
Total 7			375.00				0.00	500.00	875.00				0.00	-875.00
8	Thinning,working &transport 875 trees[2]	43.7 (20 trees/man/day)	4375.00							Poles	875	90.00	78750.00	
										Firewood	0.795	1100.00	875.00	
Total 8			4375.00				0.00	500.00	4875.00				79625.00	74750.00

Table 10. TK contd..

Year	Costs									Benefits				Net benefit
	Labour			Materials				Rent	Total cost	Kind	Quantity	Price	Revenue	
	Categories	Person days	Labour cost	Kind	Quantity	Price	cost							
		Number	Rs		Number	Rs	Rs	Rs/anum	Rs		tons/ha	Rs/ton	Rs	Rs
9	Maintenance	5	375.00											
Total 9			375.00					500.00	875.00	Firewood	0.2	1100.00	220.00	-655.00
10	Maintenance	5	375.00											
Total 10			375.00				0.00	500.00	875.00	Firewood	0.2	1100.00	220.00	-655.00
11	Maintenance	5	375.00											
Total 11			375.00					500.00	875.00	Firewood	0.2	1100.00	220.00	-655.00
12	Maintenance	5	375.00											
Total 12			375.00				0.00	500.00	875.00	Firewood	0.2	1100.00	220.00	-655.00
13	Maintenance	5	375.00											
Total 13			375.00				0.00	500.00	875.00	Firewood	0.2	1100.00	220.00	-655.00
14	Maintenance	5	375.00											
Total 14			375.00				0.00	500.00	875.00				0.00	-875.00
15	Maintenance	5	375.00											
Total 15			375.00				0.00	500.00	875.00				0.00	-875.00
16	Maintenance	5	375.00											
Total 16			375.00				0.00	500.00	875.00	Firewood	0.227	1100.00	250.00	-625.00
17	Maintenance	5	375.00											
Total 17			375.00				0.00	500.00	875.00				0.00	-875.00
18	Maintenance	5	375.00											
Total 18			375.00				0.00	500.00	875.00				0.00	-875.00
19	Maintenance	5	375.00											
Total 19			375.00				0.00	500.00	875.00				0.00	-875.00
20	Harvest 788 trees (10% mortality)[3]	394	29550.00							Firewood	17.91	1100.00	19700.00	
							0.00			Timber[4]	97.71 (m^3)	10000.00	977100.00	
Total 20			29550.00				0.00	500.00	30050.00				996800.00	966750.00
										Carbon stored [5]	39.084	450.00	17588.16	
										Soil Carbon	10	450.00	4500.00	

[1] 2500 stumps/ha @ 2mx2m (before thinning), thinning for small timber & poles in 8th year;
70% survival after gapfilling in the second year; 90% after thinning in the 7th year

[2] 50% Thinning

[3] Harvest, working and transport

[4] Timber 0.124 m^3 per trer

[5] Carbon stored in timber 0.4 tons per m^3 of timber

Buvaneswaran et al (2001)

Table 11.Annual cost and benefit flows (per hectare) from a degraded dry land under Cashew (*Anacardium occidentale)* (CSW [1])

Year	Costs									Benefits				Net benefit
	Labour			Materials				Rent	Total cost	Kind	Quantity	Price	Revenue	
	Categories	Person days	Labour cost	Kind	Quantity	Price	Cost							
		Number	Rs		Number	Rs	Rs	Rs/anum	Rs		tons/ha	Rs/ton	Rs	Rs
0	Veg.fencing	8	600.00	Veg.fencing	400	0.50	200.00							
	Watch & ward	73	5475.00	Grafts	400	20.00	8000.00							
	Pitting & planting	20	1500.00											
Total 0			7575.00				8200.00	500.00	16275.00		0.00		0.00	-16275.00
1	Watch & ward	73	5475.00	Gap filling	78		1560.00							
	Pitting & planting	6	450.00	Veg.fencing	80		40.00							
	Weeding	3	225.00											
Total 1			6150.00				1600.00	500.00	8250.00		0.00		0.00	-8250.00
2	Watch & ward	35	2625.00											
	Weeding	3	225.00											
Total 2		38	2850.00				0.00	500.00	3350.00				0.00	-3350.00
3	Watch, weed	50	3750.00				0.00	500.00	4250.00		0.00		0.00	-4250.00
4	Weed & prune	50	3750.00				0.00	500.00	4250.00		0.00		0.00	-4250.00
5	Weed & harvest	20	1500.00				0.00	500.00	2000.00	Nuts	0.08	3500.00	2800.00	800.00
6	Weed & harvest	21	1575.00				0.00	500.00	2075.00	Nuts	1.00	3500.00	3500.00	1425.00
7	Weed & harvest	38	2850.00				0.00	500.00	3350.00	Nuts	2.00	3500.00	7000.00	3650.00
8	Weed & harvest	55	4125.00				0.00	500.00	4625.00	Nuts	4.00	3500.00	14000.00	9375.00
9	Weed & harvest	75	5625.00				0.00	500.00	6125.00	Nuts	6.00	3500.00	21000.00	14875.00
10	Weed & harvest	90	6750.00				0.00	500.00	7250.00	Nuts	9.00	3500.00	31500.00	24250.00
11	Weed & harvest	90	6750.00				0.00	500.00	7250.00	Nuts	9.00	3500.00	31500.00	24250.00
12	Weed & harvest	90	6750.00				0.00	500.00	7250.00	Nuts	9.00	3500.00	31500.00	24250.00
13	Weed & harvest	90	6750.00				0.00	500.00	7250.00	Nuts	9.00	3500.00	31500.00	24250.00
14	Prune & harvest	90	6750.00				0.00	500.00	7250.00	Nuts	9.00	3500.00	31500.00	24250.00
15	Weed & harvest	90	6750.00				0.00	500.00	7250.00	Nuts	9.00	3500.00	31500.00	24250.00
16	Harvest	90	6750.00				0.00	500.00	7250.00	Nuts	9.00	3500.00	31500.00	24250.00
17	Harvest	90	6750.00				0.00	500.00	7250.00	Nuts	9.00	3500.00	31500.00	24250.00
18	Harvest	90	6750.00				0.00	500.00	7250.00	Nuts	9.00	3500.00	31500.00	24250.00
19	Harvest	90	6750.00				0.00	500.00	7250.00	Nuts	9.00	3500.00	31500.00	24250.00
20	Harvest	90	6750.00				0.00			Nuts	9.00	3500.00	31500.00	
	Firewood + Timber	120	9000.00				0.00			Firewood	3.12	4000.00	12480.00	
										Timber	31.2 (m^3)	3000.00	93600.00	
Total 20			15750.00					500.00	16250.00				137580.00	121330.00
										C in wood	12.48	450.00	5616.00	
										Soil C	10.00	450.00	4500.00	

[1] High density planting at 8mx4m; 312 grafts/ha

Table 12. Annual cost and benefit flows (per hectare) from a degraded dry deciduous tract planted with *Eucalyptus territicornis* (EU[1])

Year	Costs									Benefits				Net benefit
	Labour			Materials				Rent	Total cost	Kind	Quantity	Price	Revenue	
	Categories	Person days	Labour cost	Kind	Quantity	Price	Cost							
		Number	Rs		Number	Rs	Rs	Rs/anum	Rs		tons/ha	Rs/ton	Rs	Rs
0	Veg.fencing	8	600.00	Veg.fencing (slips)	400.00	0.50	200.00							
	Watch & ward	73	5475.00	Seedlings	2222.00	3.00	6666.00							
	Pitting & planting	100	7500.00											
Total 0		181	13575.00				6866.00	500.00	20941.00				0.00	-20941.00
1														
	Gapfilling	10	750.00	Seedlings	450	3.00	1350.00							
	Weeding & fire line	20	1500.00	Veg.fencing	80	0.50	40.00							
Total 1		30	2250.00				1390.00	500.00	4140.00				0.00	-4140.00
2	Weeding & fire line	20	1500.00											
	Watch & ward	15	1125.00											
Total 2			2625.00					500.00	3125.00				0.00	-3125.00
3								500.00	500.00				0.00	-500.00
4								500.00	500.00				0.00	-500.00
5								500.00	500.00				0.00	-500.00
6								500.00	500.00				0.00	-500.00
7	First harvest [2]	110	8250.00							Pulpwood [3]	25	1000.00	25000.00	
										Firewood	1.6	500.00	800.00	
Total 7			8250.00					500.00	8750.00				25800.00	17050.00
8								500.00	500.00				0.00	-500.00
9								500.00	500.00				0.00	-500.00
10								500.00	500.00				0.00	-500.00
11								500.00	500.00				0.00	-500.00
12								500.00	500.00				0.00	-500.00
13								500.00	500.00				0.00	-500.00
14	Second harvest	88.66	6650.00							Pulp wood	30	1000.00	30000.00	
										Firewood	1.76	500.00	800.00	
Total 14			6650.00					500.00	7150.00				30800.00	23650.00
15								500.00	500.00				0.00	-500.00
16								500.00	500.00				0.00	-500.00
17								500.00	500.00				0.00	-500.00
18								500.00	500.00				0.00	-500.00
19								500.00	500.00				0.00	-500.00
20	Final harvest	66	4950.00							Pulp wood	20	1000.00	20000.00	
										Firewood	1.2	500.00	600.00	
Total 20			4950.00					500.00	5450.00				20600.00	15150.00

[1] 1.5m x 3 m spacing and 2222 trees; 20% mortality at first coppice (14 th year) and 40% mortality at the second coppice (20th year)

[2] Cutting, cleaning, transporting of 20 trees/day

[3] Price received for harvested wood

Table 13. Annual Ccst and benefit flows (per hectare) from a degraded dry land under silvipastoral system (SP [1])

Year	Costs									Benefits				Net benefit
	Labour			Materials				Rent	Total cost	Kind	Quantity	Price	Revenue	
	Categories	Person days	Labour cost	Kind	Quantity	Price	Cost							
		Number	Rs		Number	Rs	Rs	Rs/anum	Rs		tons/ha	Rs/ton	Rs	Rs
0	Veg.fencing	8	600.00	Veg.fencing	400	0.50	200.00							
	Watch & ward	73	5475.00	Seedlings [2]	500	6.00	3000.00							
	Pitting & planting	25	1875.00											
	Grasses [3]	10	750.00	Seeds	6 kg	30.00	180.00							
Total 0		116	8700.00				3380.00	500.00	12580				0	-12580.00
1	Watch & ward	73	5475.00	Seedlings (gaps)	100	6.00	600.00							
	Pitting & planting	6	450.00	Veg.fencing	80	0.50	40.00							
	Weeding	3	225.00											
	Grasses [5]	10	750.00	Seeds	1	30.00	30.00			Fodder [4]	1.00	250		
Total 1		92	6900.00				670.00	500.00	8070				250	-7820.00
2	Watch & ward	35	2625.00											
	Weeding	3	225.00							Fodder	3.50	250		
			2850.00					500.00	3350				875	-2475.00
3	Fodder	8								Fodder	3.50	250		
Total 3		8	600.00				0.00	500.00	1100				875	-225.00
4	Fodder	8								Fodder	4.00	250		
Total 4			600.00				0.00	500.00	1100				1000	-100.00
5	Fodder	6								Fodder	3.00	250	750	
	Firewood	5								Firewood	1.25	500	625	
Total 5		11	825.00				0.00	500.00	1325				1375	50.00
6	Fodder	8	600.00											
										Fodder	4.00	250		
Total 6		8	600.00				0.00	500.00	1100				1000	-100.00
7	Fodder [6]	10	750.00	Seeds	1	30.00	30.00							
										Fodder	5.00	250		
Total 7			750.00				30.00	500.00	1280				1250	-30.00

Table 13.SP continued..

Year	Costs									Benefits				Net benefit
	Labour			Materials				Rent	Total cost	Kind	Quantity	Price	Revenue	
	Categories	Person days	Labour cost	Kind	Quantity	Price	Cost							
		Number	Rs		Number	Rs	Rs	Rs/anum	Rs		tons/ha	Rs/ton	Rs	Rs
8	Fodder	7								Fodder	5.00	250		
Total 8			525.00				0.00	500.00	1025				1250	225.00
9	Fodder	7								Fodder	5.00	250		
Total 9			525.00				0.00	500.00	1025				1250	225.00
10	Fodder	10								Fodder	6.00	250		
Total 10			750.00				0.00	500.00	1250				1500	250.00
11	Fodder	9		Seeds	1	30.00	30.00			Fodder	8.00	250	2000	
	Firewood	10								Firewood	2.50	500	1250	
Total 11		19	1425.00				30.00	500.00	1955				3250	1295.00
12	Fodder	7								Fodder	4.00	250		
Total 12			525.00				0.00	500.00	1025				1000	-25.00
13	Fodder	7								Fodder	4.00	250		
Total 13			525.00				0.00	500.00	1025				1000	-25.00
14	Fodder	7	525.00							Fodder	8.00	250	2000	
							0.00	500.00		Firewood	2.60	500	1300	
										Small timber [7]	28 (m^3)	3000	84000	
Total 14			525.00					500.00	1025				87300	86275.00
										Carbon	7.00	470	3290	
15	Fodder	10	750.00											
	Firewood	13	975.00											
	Timber & others	50	3750.00											
Total 15		73	5475.00				0.00	500.00	5975	Fodder	6.00	250	1500	-4475.00
										Fodder	8.00	250	2000	
16	Fodder	10		Seeds	1	30.00	30.00			Firewood	2.50	500	1250	
Total 16			750.00				30.00	500.00	1280				3250	1970.00
17	Fodder	9												
	Firewood	10												
Total 17		19	1425.00				0.00	500.00	1925	Fodder	4.00	250	1000	-925.00

Table 13.SP continued..

Year	Costs									Benefits				Net benefit
	Labour			Materials				Rent	Total cost	Kind	Quantity	Price	Revenue	
	Categories	Person days	Labour cost	Kind	Quantity	Price	Cost							
		Number	Rs		Number	Rs	Rs	Rs/anum	Rs		tons/ha	Rs/ton	Rs	Rs
18	Fodder	7												
Total 18			525.00				0.00	500.00	1025	Fodder	4.00	250	1000	-25.00
19	Fodder	7												
Total 19			525.00				0.00	500.00	1025	Fodder	8.00	250	2000	975.00
20	Fodder	7								Fodder	4.00	250	1000	
	Firewood	15								Firewood	3.20	500	1600	
	Timber	52	3900.00							Timber [8]	32 (m^3)	3000	96000	
Total 20		74	5550.00				0.00	500.00	6050				98600	92550.00
										Carbon stored	6.40	450	2880	
										Soil Carbon	10.00	450	4500	

[1] Trees: 490 /ha @ 4.5m x 4.5m spacing with grass-legume mixture in between. Survival rate: 80% after gap filling in the second year

Stylosanthese hamata + *Gmelina arborea* /*Azadirachta indica* + *Dichanthium annulatum* can yield 3.4 tons DM leaves/ha /yr from 440 trees at 4.5x4.5m tree spacing (Pathak and Roy 1994 & Hegde and Daniel. 1994)

These can also give tree fodder at 1kg/ tree and fire wood at 10 kg/tree when 10 years old.

[2] *Gmelina arborea* and *Azadirachta indica*

[3] A mixture of legume and grass; labour cost includes sowing and one harvest

[4] Single cut in the first year

[5] Since the fodder grass mixture includes a perennially spreading grass like penisetum (Dinanath), after first year seeding cost is less. But harvest cost @2.5 days/harvest for

[6] Including tree fodder & pods from 7th year onwards

[7] (0.14 m^3/tree) and 200 trees

[8] 0.16 m^3/tree from 200 trees

Grado et al (2001) and Pathak and Roy (1994)

Table 14: Annual Cost and Benefit Flows (per hectare) from a Degraded Dry Deciduous Tract under Protection for Natural Regeneration (NR[1])

Year	Costs									Benefits				Net Benefit
	Labour			Materials				Rent	Total cost	Kind	Quantity	Price	Revenue	
	Categories	Person days	Cost	Kind	Quantity	Price	Cost							
		Number	Rs		Number	Rs	Rs	Rs/anum	Rs		tons/ha	Rs/ton	Rs	Rs
0	Veg.fencing	8	600.00	Veg.fencing	400	0.5	200.00		800.00					
	Watch & ward	73 [2]	5475.00						5475.00					
Total 0			6075.00				200.00	500.00	6775.00				0.00	-6775
1	Watch & ward	73	5475.00		80	0.5	40.00		5515.00					
Total 1			5475.00				40.00	500.00	6015.00				0.00	-6015
Total 2	Watch & ward	35	2625.00					500.00	3125.00				0.00	-3125
3	Climbercutting & pruning	10	750.00											
Total 3			750.00				0.00	500.00	1250.00				0.00	-1250
4														
	Climbercutting & pruning	10	750.00											
Total 4			750.00				0.00	500.00	1250.00				0.00	-1250
5	Climbercutting & pruning	5	375.00											
Total 5			375.00				0.00	500.00	875.00				0.00	-875
6	Fodder (only for stall feeding)	2.5								Fodder [3]	0.2	250.00	50.00	
	Firewood	2.5								Firewood	1	500.00	500.00	
Total 6		5	375.00				0.00	500.00	875.00				550.00	-325
7	Fodder (only for stall feeding)	2.5								Fodder	0.2	250.00	50.00	
	Firewood	2.5								Firewood	1	500.00	500.00	
Total 7		5	375.00				0.00	500.00	875.00				550.00	-325
8	Fodder	2.5								Fodder	0.2	250.00	50.00	
	Firewood	2.5								Firewood	1	500.00	500.00	
Total 8		5	375.00				0.00	500.00	875.00				550.00	-325
9	Fodder	2.5								Fodder	0.24	250.00	60.00	
	Firewood	2.5								Firewood	1.04	500.00	520.00	
Total 9		5	375.00				0.00	500.00	875.00				580.00	-295
10	Fodder	2.5								Fodder	0.24	250.00	60.00	
	Firewood	2.5								Firewood	1.04	500.00	520.00	
Totl 10		5	375.00				0.00	500.00	875.00				580.00	-295

Table 14. NR contd..

Year	Costs									Benefits				Net Benefit
	Labour			Materials				Rent	Total cost	Kind	Quantity	Price	Revenue	
	Categories	Person days	Cost	Kind	Quantity	Price	Cost							
		Number	Rs		Number	Rs	Rs	Rs/anum	Rs		tons/ha	Rs/ton	Rs	Rs
11	Fodder	2.5								Fodder	0.24	250.00	60.00	
	Firewood	2.5								Firewood	1.04	500.00	520.00	
Totl 11		5	375.00				0.00	500.00	875.00				580.00	-295
12	Fodder	2.5								Fodder	0.28	250.00	70.00	
	Firewood	2.5								Firewood	1.1	500.00	550.00	
Total 12		5	375.00				0.00	500.00	875.00				620.00	-255
13	Fodder	5	375.00							Fodder	1.313	250.00	328.00	
	Thinning, working & transport 200 poles and firewood	16	1200.00							Poles	200 poles	90.00	18000.00	
										Firewood	4.812	500.00	2406.00	
Total 13		21	1575.00				0.00	500.00	2075.00				20734.00	18659
14	Fodder	2.5	0.00											
	Firewood	2.5												
Total 14		5	375.00					500.00	875.00				0.00	-875
15	Fodder	2.5								Fodder	1.5	250.00	375.00	
	Firewood	2.5								Firewood	1	500.00	500.00	
Total 15		5	375.00				0.00	500.00	875.00				875.00	0
16	Fodder	2.5								Fodder	1.5	250.00	375.00	
	Firewood	2.5								Firewood	1	500.00	500.00	
Total 16		5	375.00				0.00	500.00	875.00				875.00	0
17	Fodder	2.5								Fodder	1.5	250.00	375.00	
	Firewood	2.5								Firewood	1	500.00	500.00	
Total 17		5	375.00				0.00	500.00	875.00				875.00	0
18	Fodder	2.5								Fodder	1.5	250.00	375.00	
	Firewood	2.5								Firewood	1	500.00	500.00	
Total 18		5	375.00				0.00	500.00	875.00				875.00	0
19	Fodder	2.5								Fodder	1.5	250.00	375.00	
	Firewood	2.5								Firewood	1.97	500.00	985.00	
Total 19		5	375.00				0.00	500.00	875.00				1360.00	485
										Fodder	1.593	250.00	398.00	
20	Harvest	5 tree/4men								Firewood	5.912	500.00	2956.00	
										Poles	200 poles	90.00	18000.00	
Total 20		213	16000.00					500.00	16500.00				21354.00	4854
										Carbon	12	450.00	5400.00	
										Soil C	15	450.00	6750.00	

[1] One third of the area harvested for fodder and firewood every year from 6th year.

[2] At 0.2 person /ha/day

[3] From 200 trees @1 kg leaves/ tree onwards

Appendix 5

Table 1 Current land use (Dry Farming - DF1)										
	Table 1.a Finanacial BCA					Table 1.b Economic BCA				
				Discounted net benefits*					Discounted net benefits*	
Year	Costs	Benefits	Net Benefits	(i=5%)	(i=8%)	Costs	Benefits	Net Benefits	(i=5%)	(i=8%)
0										
1	4075.00	7482.48	3407.48	3245.22	3155.08	2806.25	7482.48	4676.23	4453.56	4329.85
2	4103.00	7362.12	3259.12	2956.12	2794.17	2784.25	7362.12	4577.87	4152.26	3924.79
3	4131.00	7233.60	3102.60	2680.15	2462.95	2762.25	7233.60	4471.35	3862.52	3549.50
4	4159.00	7103.29	2944.29	2422.28	2164.14	2740.25	7103.29	4363.04	3589.49	3206.97
5	4187.00	6971.16	2784.16	2181.46	1894.85	2718.25	6971.16	4252.91	3332.27	2894.46
6	4215.00	6837.19	2622.19	1956.72	1652.42	2696.25	6837.19	4140.94	3090.03	2609.49
7	4243.00	6701.34	2458.34	1747.10	1434.42	2674.25	6701.34	4027.09	2861.98	2349.77
8	4271.00	6563.60	2292.60	1551.72	1238.62	2652.25	6563.60	3911.35	2647.35	2113.18
9	4299.00	6423.93	2124.93	1369.75	1063.00	2630.25	6423.93	3793.68	2445.44	1897.79
10	4327.00	6282.32	1955.32	1200.40	905.69	2608.25	6282.32	3674.07	2255.56	1701.80
11	4355.00	6138.73	1783.73	1042.91	765.01	2586.25	6138.73	3552.48	2077.06	1523.60
12	4383.00	5993.13	1610.13	896.58	639.41	2564.25	5993.13	3428.88	1909.33	1361.66
13	4411.00	5845.50	1434.50	760.75	527.46	2542.25	5845.50	3303.25	1751.79	1214.60
14	4439.00	5695.82	1256.82	634.78	427.90	2520.25	5695.82	3175.57	1603.88	1081.16
15	4467.00	5544.04	1077.04	518.07	339.53	2498.25	5544.04	3045.79	1465.08	960.16
16	4495.00	5390.14	895.14	410.07	261.28	2476.25	5390.14	2913.89	1334.89	850.54
17	4523.00	5234.09	711.09	310.25	192.19	2454.25	5234.09	2779.84	1212.84	751.31
18	4551.00	5075.87	524.87	218.09	131.35	2432.25	5075.87	2643.62	1098.48	661.56
19	4579.00	4915.44	336.44	133.14	77.96	2410.25	4915.44	2505.19	991.39	580.48
20	4607.00	4752.77	145.77	1153.68	422.19	2388.25	5877.77	3489.52	27618.39	10107.03
Sum of DNB (NPV)				27389.23	22549.61				73753.57	47669.68
*Includes Liquidation Value (LV) in the 20th year; LV at 20th year = Net benefits at 20th year / discount rate										
LV				2915.30	1822.06				69790.30	43618.94
Net Benefit (NB)				3061.07	1967.83				73279.82	47108.45
Discouned Net benefit (DNB)				1153.68	422.19				27618.39	10107.03

Table 2 Dryfarming with protection (DF) compared with the current land use (DF1) :																
	Table 2.a Finanacial BCA : Comparing DF with DF1							Table 2.b Economic BCA : Comparing DF with DF1								
				Discounted Net benefits*							Discounted Net benefits*				Discounted net benefits*	
Year	Costs	Benefits	Net Benefits	DF (i=5%)	DF (i=8%)	DF - DF1 (i=5%)	DF - DF1 (i=8%)	Costs	Benefits	Net Benefits	DF (i=5%)	DF (i=8%)	DF - DF1 (i=5%)	DF - DF1 (i=8%)	(i=5%)	(i=8%)
0	4500.00		-4500.00	-4500.00	-4500.00	-4500.00	-4500.00	3375.00		-3375.00	-3375.00	-3375.00	-3375.00	-3375.00		
1	7135.00	14964.97	7829.97	7457.11	7249.97	4211.89	4094.89	5116.25	14964.97	9848.72	9379.73	9119.18	4926.17	4789.34	4453.56	4329.85
2	4403.00	14724.24	10321.24	9361.67	8848.80	6405.55	6054.63	3009.25	14724.24	11714.99	10625.84	10043.72	6473.58	6118.93	4152.26	3924.79
3	4431.00	14467.21	10036.21	8669.65	7967.06	5989.51	5504.12	2987.25	14467.21	11479.96	9916.82	9113.16	6054.30	5563.66	3862.52	3549.50
4	4459.00	14206.58	9747.58	8019.36	7164.76	5597.09	5000.62	2965.25	14206.58	11241.33	9248.27	8262.72	5658.79	5055.75	3589.49	3206.97
5	4487.00	13942.32	9455.32	7408.49	6435.13	5227.03	4540.28	2943.25	13942.32	10999.07	8618.06	7485.78	5285.79	4591.32	3332.27	2894.46
6	4515.00	13674.37	9159.37	6834.86	5771.96	4878.15	4119.54	2921.25	13674.37	10753.12	8024.14	6776.29	4934.11	4166.80	3090.03	2609.49
7	4543.00	13402.68	8859.68	6296.41	5169.54	4549.31	3735.12	2899.25	13402.68	10503.43	7464.59	6128.65	4602.61	3778.88	2861.98	2349.77
8	4571.00	13127.20	8556.20	5791.17	4622.65	4239.45	3384.03	2877.25	13127.20	10249.95	6937.57	5537.73	4290.21	3424.55	2647.35	2113.18
9	4599.00	12847.87	8248.87	5317.29	4126.49	3947.54	3063.49	2855.25	12847.87	9992.62	6441.33	4998.80	3995.89	3101.01	2445.44	1897.79
10	4627.00	12564.64	7937.64	4873.02	3676.66	3672.62	2770.97	2833.25	12564.64	9731.39	5974.23	4507.52	3718.67	2805.71	2255.56	1701.80
11	4655.00	12277.46	7622.46	4456.69	3269.14	3413.78	2504.13	2811.25	12277.46	9466.21	5534.69	4059.89	3457.63	2536.30	2077.06	1523.60
12	4683.00	11986.26	7303.26	4066.73	2900.23	3170.15	2260.82	2789.25	11986.26	9197.01	5121.24	3652.26	3211.91	2290.60	1909.33	1361.66
13	4711.00	11691.01	6980.01	3701.65	2566.53	2940.90	2039.07	2767.25	11691.01	8923.76	4732.46	3281.25	2980.67	2066.65	1751.79	1214.60
14	4739.00	11391.63	6652.63	3360.03	2264.96	2725.25	1837.06	2745.25	11391.63	8646.38	4367.01	2943.76	2763.13	1862.60	1603.88	1081.16
15	4767.00	11088.07	6321.07	3040.54	1992.67	2522.47	1653.14	2723.25	11088.07	8364.82	4023.62	2636.94	2558.55	1676.78	1465.08	960.16
16	4795.00	10780.28	5985.28	2741.93	1747.05	2331.85	1485.76	2701.25	10780.28	8079.03	3701.10	2358.19	2366.21	1507.65	1334.89	850.54
17	4823.00	10468.19	5645.19	2462.98	1525.72	2152.73	1333.53	2679.25	10468.19	7788.94	3398.29	2105.11	2185.45	1353.80	1212.84	751.31
18	4851.00	10151.74	5300.74	2202.57	1326.50	1984.47	1195.16	2657.25	10151.74	7494.49	3114.12	1875.49	2015.64	1213.93	1098.48	661.56
19	4879.00	9830.87	4951.87	1959.62	1147.41	1826.49	1069.45	2635.25	9830.87	7195.62	2847.55	1667.31	1856.17	1086.83	991.39	580.48
20	4907.00	9505.53	4598.53	36395.89	13319.19	35242.21	12896.99	2613.25	11980.53	9367.28	74139.02	27131.40	46520.62	17024.36	27618.39	10107.03
Sum of DNB (NPV)				129917.68	88592.42	102528.44	66042.81				190234.69	120310.14	116481.12	72640.45		
*Includes Liquidation Value LV in the 20th year; LV at 20th year = NB20 / discount rate																
LV				91970.60	57481.63						187345.60	117091.00				
Net Benefit (NB)				96569.13	62080.16						196712.88	126458.28				
Discouned Net benefit (DNB)				36395.89	13319.19						74139.02	27131.40				

Table 3 Dryfarming with Soil Conservation (DFC) compared with current land use (DF1)																
	Table 3.a Finanacial BCA : Comparing DFC with DF1							Table 3.b Economic BCA : Comparing DFC with DF1								
				Discounted Net benefits*							Discounted Net benefits*				Discounted net benefits*	
Year	Costs	Benefits	Net Benefits	DFC (i=5%)	DF C (i=8%)	741 ,	DFC - DF1 (i=8%)	Costs	Benefits	Net Benefits	DFC (i=5%)	DF C (i=8%)	DFC - DF1 (i=5%)	DFC - DF1 (i=8%)	(i=5%)	(i=8%)
0	6000.00		-6000.00	-6000.00	-6000.00	-6000.00	-6000.00	4875.00		-4875.00	-4875.00	-4875.00	-4875.00	-4875.00		
1	7285.00	15019.60	7734.60	7366.29	7161.67	4121.07	4006.59	5228.75	15019.60	9790.85	9324.62	9065.60	4871.07	4735.76	4453.56	4329.85
2	4355.00	14969.58	10614.58	9627.73	9100.29	6671.61	6306.12	3011.25	14969.58	11958.33	10846.55	10252.34	6694.29	6327.55	4152.26	3924.79
3	4335.00	14919.37	10584.37	9143.18	8402.22	6463.03	5939.27	2991.25	14919.37	11928.12	10303.96	9468.93	6441.44	5919.43	3862.52	3549.50
4	4315.00	14869.00	10554.00	8682.80	7757.50	6260.52	5593.36	2971.25	14869.00	11897.75	9788.31	8745.20	6198.82	5538.23	3589.49	3206.97
5	4295.00	14818.45	10523.45	8245.40	7162.08	6063.93	5267.23	2951.25	14818.45	11867.20	9298.26	8076.62	5965.99	5182.16	3332.27	2894.46
6	4275.00	14767.72	10492.72	7829.83	6612.20	5873.12	4959.77	2931.25	14767.72	11836.47	8832.56	7458.99	5742.53	4849.49	3090.03	2609.49
7	4255.00	14716.82	10461.82	7435.02	6104.37	5687.92	4669.95	2911.25	14716.82	11805.57	8390.00	6888.44	5528.02	4538.67	2861.98	2349.77
8	4235.00	14665.74	10430.74	7059.94	5635.41	5508.22	4396.79	2891.25	14665.74	11774.49	7969.44	6361.39	5322.09	4248.21	2647.35	2113.18
9	4215.00	14614.49	10399.49	6703.60	5202.33	5333.85	4139.34	2871.25	14614.49	11743.24	7569.79	5874.54	5124.35	3976.76	2445.44	1897.79
10	4195.00	14563.05	10368.05	6365.08	4802.41	5164.69	3896.72	2851.25	14563.05	11711.80	7190.03	5424.83	4934.47	3723.03	2255.56	1701.80
11	4175.00	14511.44	10336.44	6043.50	4433.12	5000.59	3668.11	2831.25	14511.44	11680.19	6829.16	5009.43	4752.10	3485.84	2077.06	1523.60
12	4155.00	14459.65	10304.65	5738.01	4092.12	4841.43	3452.71	2811.25	14459.65	11648.40	6486.26	4625.74	4576.93	3264.08	1909.33	1361.66
13	4135.00	14407.68	10272.68	5447.82	3777.24	4687.07	3249.78	2791.25	14407.68	11616.43	6160.44	4271.34	4408.65	3056.74	1751.79	1214.60
14	4115.00	14355.52	10240.52	5172.16	3486.50	4537.38	3058.60	2771.25	14355.52	11584.27	5850.85	3943.99	4246.97	2862.84	1603.88	1081.16
15	4095.00	14303.19	10208.19	4910.31	3218.05	4392.24	2878.52	2751.25	14303.19	11551.94	5556.68	3641.65	4091.61	2681.49	1465.08	960.16
16	4075.00	14250.68	10175.68	4661.59	2970.18	4251.52	2708.90	2731.25	14250.68	11519.43	5277.18	3362.41	3942.30	2511.87	1334.89	850.54
17	4055.00	14197.98	10142.98	4425.35	2741.33	4115.10	2549.15	2711.25	14197.98	11486.73	5011.62	3104.51	3798.79	2353.20	1212.84	751.31
18	4035.00	14145.10	10110.10	4200.95	2530.04	3982.86	2398.69	2691.25	14145.10	11453.85	4759.31	2866.31	3660.83	2204.75	1098.48	661.56
19	4015.00	14092.04	10077.04	3987.83	2334.97	3854.69	2257.01	2671.25	14092.04	11420.79	4519.59	2646.33	3528.20	2065.85	991.39	580.48
20	3995.00	14038.79	10043.79	79493.36	29090.83	78339.67	28668.64	2651.25	16738.79	14087.54	111498.34	40803.16	83879.95	30696.12	27618.39	10107.03
Sum of DNB (NPV)				196539.76	120614.87	169150.53	98065.26				246587.97	147016.75	172834.40	99347.06		
*Includes Liquidation Value LV in the 20th year; LV at 20th year = NB20 year / discount rate																
LV				200875.75	125547.34						281750.75	176094.22				
Net Benefit (NB)				210919.54	135591.13						295838.29	190181.76				
Discouned Net benefit (DNB)				79493.36	29090.83						111498.34	40803.16				

Table 4 Dryfarming with multipurpose tree species (AF1) compared with current land use (DF1)															
	Table 4.a Finanacial BCA : Comparing AF1 with DF1							Table 4.b Economic BCA : Comparing AF1 with DF1						
				Discounted Net benefits*							Discounted Net benefits*			
Year	Costs	Benefits	Net Benefits	AF1 (i=5%)	AF1 (i=8%)	AF1 - DF1 (i=5%)	AF1 - DF1 (i=8%)	Costs	Benefits	Net Benefits	AF1 (i=5%)	AF1 (i=8%)	AF1 - DF1 (i=5%)	AF1 - DF1 (i=8%)
0	9375.00		-9375.00	-9375.00	-9375.00	-9375.00	-9375.00	7431.25		-7431.25	-7431.25	-7431.25	-7431.25	-7431.25
1	7030.00	0.00	-7030.00	-6695.24	-6509.26	-9940.46	-9664.34	5442.50	0.00	-5442.50	-5183.33	-5039.35	-9636.89	-9369.20
2	1250.00	0.00	-1250.00	-1133.79	-1071.67	-4089.91	-3865.84	1012.50	0.00	-1012.50	-918.37	-868.06	-5070.63	-4792.84
3	650.00	250.00	-400.00	-345.54	-317.53	-3025.68	-2780.48	562.50	250.00	-312.50	-269.95	-248.07	-4132.47	-3797.58
4	575.00	125.00	-450.00	-370.22	-330.76	-2792.49	-2494.91	506.25	125.00	-381.25	-313.66	-280.23	-3903.14	-3487.20
5	1400.00	930.00	-470.00	-368.26	-319.87	-2549.72	-2214.73	1125.00	930.00	-195.00	-152.79	-132.71	-3485.05	-3027.17
6	1400.00	930.00	-470.00	-350.72	-296.18	-2307.44	-1948.60	1125.00	930.00	-195.00	-145.51	-122.88	-3235.54	-2732.37
7	1400.00	930.00	-470.00	-334.02	-274.24	-2081.12	-1708.66	1125.00	930.00	-195.00	-138.58	-113.78	-3000.56	-2463.55
8	1400.00	930.00	-470.00	-318.11	-253.93	-1869.84	-1492.55	1125.00	930.00	-195.00	-131.98	-105.35	-2779.34	-2218.53
9	1400.00	930.00	-470.00	-302.97	-235.12	-1672.72	-1298.11	1125.00	930.00	-195.00	-125.70	-97.55	-2571.14	-1995.33
10	6650.00	77530.00	70880.00	43514.17	32831.15	42313.78	31925.46	5062.50	81130.00	76067.50	46698.85	35233.97	44443.29	33532.17
11	4525.00	16114.91	11589.91	6776.38	4970.72	5733.47	4205.71	3593.75	16114.91	12521.16	7320.87	5370.11	5243.81	3846.52
12	4510.00	15984.77	11474.77	6389.58	4556.79	5493.00	3917.39	3578.75	15984.77	12406.02	6908.14	4926.60	4998.81	3564.95
13	4495.00	15853.73	11358.73	6023.78	4176.58	5263.03	3649.12	3563.75	15853.73	12289.98	6517.64	4519.00	4765.85	3304.40
14	4525.00	15721.77	11196.77	5655.13	3812.07	5020.35	3384.17	3537.50	15721.77	12184.27	6153.89	4148.27	4550.01	3067.11
15	4525.00	15588.90	11063.90	5321.93	3487.80	4803.85	3148.28	3537.50	15588.90	12051.40	5796.93	3799.10	4331.85	2838.95
16	4525.00	15455.10	10930.10	5007.21	3190.39	4597.13	2929.11	3537.50	15455.10	11917.60	5459.59	3478.63	4124.70	2628.10
17	4450.00	15320.37	10870.37	4742.71	2937.92	4432.46	2745.74	3481.25	15320.37	11839.12	5165.37	3199.75	3952.53	2448.44
18	4420.00	15184.71	10764.71	4472.96	2693.86	4254.86	2562.51	3425.00	15184.71	11759.71	4886.40	2942.86	3787.92	2281.29
19	4450.00	15048.10	10598.10	4194.03	2455.71	4060.89	2377.75	3481.25	15048.10	11566.85	4577.39	2680.18	3586.01	2099.70
20	4915.00	27910.54	22995.54	13908.89	6281.29	12755.21	5859.10	3830.00	29035.00	25205.00	15245.29	6884.81	-12373.10	-3222.22
Sum of DNB (NPV)				86412.91	52410.72	59023.68	29861.11				99919.23	62744.05	26165.66	15074.37
	*Includes Liquidation Value LV in the 20th year; LV at 20th year = NB 20/((1+r)^20) -1													
LV				13908.89	6281.29						15245.29	6884.81		
Net Benefit (NB)				36904.43	29276.83						40450.29	32089.81		
Discouned Net benefit (DNB)				13908.89	6281.29						15245.29	6884.81		

Table 5 Agrfo forestry system (AF2) compared with current land use (DF1)

	Table 5.a Finanacial BCA : Comparing AF2 with DF1							Table 5b Economic BCA : Comparing AF2 with DF1						
				Discounted Net benefits*							Discounted Net benefits*			
Year	Costs	Benefits	Net Benefits	AF2 (i=5%)	AF2 (i=8%)	AF2 - DF1 (i=5%)	AF2 - DF1 (i=8%)	Costs	Benefits	Net Benefits	AF2 (i=5%)	AF2 (i=8%)	AF2 - DF1 (i=5%)	AF2 - DF1 (i=8%)
0	10832.00	0.00	-10832.00	-10832.00	-10832.00	-10832.00	-10832.00	8922.00	0.00	-8922.00	-8922.00	-8922.00	-8922.00	-8922.00
1	9938.00	14964.97	5026.97	4787.59	4654.60	1542.37	1499.52	7675.50	14964.97	7289.47	6942.35	6749.51	2488.79	2419.66
2	4900.00	14864.40	9964.40	9038.00	8542.86	6081.88	5748.69	3825.00	14864.40	11039.40	10013.06	9464.50	5860.79	5539.72
3	4187.50	14800.63	10613.13	9168.02	8425.04	6487.87	5962.10	3565.63	14800.63	11235.00	9705.22	8918.71	5842.69	5369.20
4	4176.25	14661.15	10484.90	8625.96	7706.72	6203.68	5542.57	3557.19	14661.15	11103.96	9135.26	8161.75	5545.77	4954.78
5	4255.00	14671.72	10416.72	8161.77	7089.44	5980.31	5194.59	3616.25	14671.72	11055.47	8662.25	7524.17	5329.98	4629.71
6	4266.25	14646.70	10380.45	7746.05	6541.44	5789.33	4889.02	3624.69	14646.70	11022.01	8224.79	6945.73	5134.76	4336.24
7	4266.25	14613.45	10347.20	7353.56	6037.49	5606.47	4603.08	3624.69	14613.45	10988.77	7809.51	6411.84	4947.53	4062.07
8	4277.50	14508.61	10231.11	6924.82	5527.55	5373.10	4288.93	3633.13	14508.61	10875.49	7360.96	5875.69	4713.60	3762.51
9	4288.75	14453.29	10164.54	6552.15	5084.80	5182.40	4021.81	3641.56	14453.29	10811.73	6969.34	5408.56	4523.89	3510.77
10	4288.75	14415.99	10127.24	6217.24	4690.87	5016.85	3785.18	3641.56	14415.99	10774.42	6614.56	4990.64	4359.00	3288.84
11	4288.75	14308.94	10020.19	5858.60	4297.49	4815.69	3532.48	3641.56	14308.94	10667.38	6237.00	4575.06	4159.94	3051.46
12	4288.75	14201.90	9913.15	5520.01	3936.65	4623.43	3297.24	3641.56	14201.90	10560.34	5880.39	4193.66	3971.06	2832.00
13	4401.25	21501.84	17100.59	9068.81	6287.85	8308.06	5760.39	3725.94	21501.84	17775.90	9426.94	6536.16	7675.15	5321.56
14	4367.50	14140.82	9773.32	4936.19	3327.44	4301.41	2899.54	3700.63	14140.82	10440.20	5273.01	3554.48	3669.13	2473.32
15	4367.50	14030.77	9663.27	4648.20	3046.27	4130.12	2706.74	3700.63	14030.77	10330.14	4968.98	3256.49	3503.90	2296.33
16	4367.50	13919.95	9552.45	4376.09	2788.27	3966.01	2526.99	3700.63	13919.95	10219.32	4681.59	2982.92	3346.70	2132.39
17	4367.50	13808.36	9440.86	4119.02	2551.57	3808.77	2359.38	3700.63	13808.36	10107.73	4409.97	2731.81	3197.13	1980.50
18	4367.50	13695.99	9328.49	3876.18	2334.45	3658.09	2203.10	3700.63	13695.99	9995.37	4153.28	2501.33	3054.80	1839.77
19	4367.50	13582.84	9215.34	3646.82	2135.31	3513.69	2057.35	3700.63	13582.84	9882.22	3910.73	2289.83	2919.34	1709.35
20	4660.00	29152.16	24492.16	14814.13	6690.10	13660.44	6267.90	3920.00	32356.16	28436.16	17199.66	7767.41	-10418.73	-2339.62
Sum of DNB (NPV)				124607.21	90864.20	97217.98	68314.60				138656.84	101918.24	64903.27	54248.56
*Includes Liquidation Value LV in the 20th year; LV at 20th year = NB 20/((1+r)^20) -1														
LV				14814.13	6690.10						17199.66	7767.41		
Net Benefit (NB)				39306.29	31182.26						45635.82	36203.57		
Discouned Net benefit (DNB)				14814.13	6690.10						17199.66	7767.41		

Table 6 Dryfarming after improving the fallows by vegetative treatment (IF) compared with current land use (DF1)															
	Table 6.a Finanacial BCA : Comparing IF with DF1							Table 6.b Economic BCA : Comparing IF with DF1							
				Discounted Net benefits*							Discounted Net benefits*				
Year	Costs	Benefits	Net Benefits	IF (i=5%)	IF (i=8%)	IF - DF1 (i=5%)	IF - DF1 (i=8%)	Costs	Benefits	Net Benefits	IF (i=5%)	IF (i=8%)	IF - DF1 (i=5%)	IF - DF1 (i=8%)
0	14290.00	0.00	-14290.00	-14290.00	-14290.00	-14290.00	-14290.00	11915.00		-11915.00	-11915.00	-11915.00	-11915.00	-11915.00
1	7213.00	0.00	-7213.00	-6869.52	-6678.70	-10114.75	-9833.78	5677.75	0.00	-5677.75	-5407.38	-5257.18	-9860.94	-9587.02
2	1025.00	187.00	-838.00	-760.09	-718.45	-3716.21	-3512.62	843.75	187.00	-656.75	-595.69	-563.06	-4747.96	-4487.84
3	650.00	187.00	-463.00	-399.96	-367.54	-3080.10	-2830.49	562.50	187.00	-375.50	-324.37	-298.08	-4186.89	-3847.59
4	650.00	218.00	-432.00	-355.41	-317.53	-2777.68	-2481.68	562.50	218.00	-344.50	-283.42	-253.22	-3872.91	-3460.18
5	1550.00	11325.00	9775.00	7658.97	6652.70	5477.51	4757.85	1237.50	11325.00	10087.50	7903.82	6865.38	4571.55	3970.92
6	4450.00	15514.91	11064.91	8256.81	6972.77	6300.09	5320.35	3537.50	15514.91	11977.41	8937.73	7547.80	5847.70	4938.31
7	4435.00	15384.77	10949.77	7781.80	6389.09	6034.70	4954.67	3522.50	15384.77	11862.27	8430.30	6921.52	5568.32	4571.76
8	4420.00	15253.73	10833.73	7332.70	5853.13	5780.97	4614.51	3507.50	15253.73	11746.23	7950.31	6346.12	5302.96	4232.94
9	4405.00	15121.77	10716.77	6908.13	5361.06	5538.38	4298.06	3492.50	15121.77	11629.27	7496.33	5817.53	5050.89	3919.75
10	4390.00	14988.90	10598.90	6506.81	4909.34	5306.41	4003.65	3477.50	14988.90	11511.40	7067.00	5332.01	4811.44	3630.20
11	4375.00	14855.10	10480.10	6127.50	4494.74	5084.59	3729.73	3462.50	14855.10	11392.60	6661.02	4886.09	4583.96	3362.50
12	4360.00	14720.37	10360.37	5769.04	4114.25	4872.46	3474.84	3447.50	14720.37	11272.87	6277.16	4476.61	4367.83	3114.96
13	4345.00	14584.71	10239.71	5430.34	3765.12	4669.59	3237.66	3432.50	14584.71	11152.21	5914.25	4100.64	4162.47	2886.04
14	4330.00	14448.10	10118.10	5110.33	3444.82	4475.55	3016.92	3417.50	14448.10	11030.60	5571.20	3755.49	3967.33	2674.33
15	4315.00	14310.54	9995.54	4808.03	3151.01	4289.95	2811.48	3402.50	14310.54	10908.04	5246.95	3438.67	3781.88	2478.51
16	4300.00	14172.02	9872.02	4522.49	2881.55	4112.41	2620.27	3387.50	14172.02	10784.52	4940.51	3147.90	3605.63	2297.36
17	4285.00	14032.54	9747.54	4252.82	2634.46	3942.57	2442.27	3372.50	14032.54	10660.04	4650.94	2881.08	3438.10	2129.77
18	4270.00	13892.09	9622.09	3998.18	2407.92	3780.08	2276.57	3357.50	13892.09	10534.59	4377.34	2636.27	3278.86	1974.71
19	4255.00	13750.67	9495.67	3757.76	2200.26	3624.62	2122.30	3342.50	13750.67	10408.17	4118.86	2411.70	3127.48	1831.22
20	4240.00	13608.25	9368.25	5666.41	2558.96	4512.72	2136.77	3327.50	15633.25	12305.75	7443.16	3361.35	-20175.24	-6745.69
Sum of DNB (NPV)				71213.11	45418.94	43823.87	22869.33				84461.03	55639.64	10707.46	7969.95
*Includes Liquidation Value LV in the 20th year; LV at 20th year = NB 20/((1+r)^20) -1														
LV				5666.41	2558.96						7443.16	3361.35		
Net Benefit (NB)				15034.66	11927.22						19748.91	15667.10		
Discouned Net Benefit (DNB)				5666.41	2558.96						7443.16	3361.35		

Table 7 Dryfarming after soil excavation and reclaimation (SE) compared with current land use (DF1)

	Table 7.a Finanacial BCA : Comparing SE with DF1							Table 7.b Economic BCA : Comparing SE with DF1						
				Discounted Net benefits*							Discounted Net benefits*			
Year	Costs	Benefits	Net Benefits	SE (i=5%)	SE (i=8%)	SE - DF1 (i=5%)	SE - DF1 (i=8%)	Costs	Benefits	Net Benefits	SE (i=5%)	SE (i=8%)	SE - DF1 (i=5%)	SE - DF1 (i=8%)
0	500.00	50000.00	49500.00	49500.00	49500.00	49500.00	49500.00	450.00	50000.00	49550.00	49550.00	49550.00	49550.00	49550.00
1	500.00	0.00	-500.00	-476.19	-462.96	-3721.41	-3618.04	450.00	0.00	-450.00	-428.57	-416.67	-4882.13	-4746.51
2	4365.00	0.00	-4365.00	-3959.18	-3742.28	-6915.30	-6536.46	4315.00	0.00	-4315.00	-3913.83	-3699.42	-8066.10	-7624.20
3	5075.00	0.00	-5075.00	-4383.98	-4028.70	-7064.12	-6491.65	4837.50	0.00	-4837.50	-4178.81	-3840.16	-8041.34	-7389.67
4	5875.00	0.00	-5875.00	-4833.38	-4318.30	-7255.65	-6482.44	450.00	0.00	-450.00	-370.22	-330.76	-3959.70	-3537.73
5	6675.00	7192.13	517.13	405.18	351.95	-1776.28	-1542.90	9593.75	7192.13	-2401.62	-1881.73	-1634.50	-5214.00	-4528.96
6	6675.00	7192.13	517.13	385.89	325.88	-1570.82	-1326.54	5341.25	7192.13	1850.88	1381.16	1166.37	-1708.87	-1443.12
7	6675.00	7185.93	510.93	363.11	298.12	-1383.99	-1136.30	5341.25	7185.93	1844.68	1310.98	1076.35	-1551.00	-1273.42
8	6675.00	7185.93	510.93	345.82	276.04	-1205.90	-962.58	5341.25	7185.93	1844.68	1248.55	996.62	-1398.80	-1116.56
9	6675.00	7176.64	501.64	323.36	250.94	-1046.39	-812.05	5341.25	7176.64	1835.39	1183.11	918.15	-1262.33	-979.63
10	6675.00	7176.64	501.64	307.96	232.36	-892.43	-673.33	5341.25	7176.64	1835.39	1126.77	850.14	-1128.79	-851.66
11	6675.00	7161.13	486.13	284.23	208.49	-758.68	-556.52	5341.25	7161.13	1819.88	1064.05	780.52	-1013.01	-743.08
12	6675.00	7161.13	486.13	270.70	193.05	-625.89	-446.36	5341.25	7161.13	1819.88	1013.38	722.70	-895.95	-638.96
13	6675.00	7145.61	470.61	249.57	173.04	-511.17	-354.42	5341.25	7145.61	1804.36	956.89	663.46	-794.90	-551.14
14	6675.00	7145.61	470.61	237.69	160.22	-397.09	-267.67	5341.25	7145.61	1804.36	911.32	614.31	-692.55	-466.84
15	6675.00	7130.08	455.08	218.90	143.46	-299.17	-196.07	5341.25	7130.08	1788.83	860.46	563.91	-604.62	-396.25
16	6675.00	7130.08	455.08	208.48	132.83	-201.60	-128.45	5341.25	7130.08	1788.83	819.48	522.14	-515.40	-328.39
17	6675.00	7098.99	423.99	184.99	114.59	-125.26	-77.60	5341.25	7098.99	1757.74	766.90	475.06	-445.94	-276.24
18	6675.00	7067.84	392.84	163.23	98.31	-54.86	-33.04	5341.25	7067.84	1726.59	717.43	432.08	-381.04	-229.49
19	6675.00	7036.64	361.64	143.11	83.80	9.97	5.84	5341.25	7036.64	1695.39	670.92	392.84	-320.46	-187.64
20	6675.00	7005.39	330.39	199.83	90.25	-953.85	-331.95	5341.25	7905.39	2564.14	1550.92	700.40	-26067.47	-9406.63
Sum of DNB (NPV)				40139.33	40081.09	12750.10	17531.48				54359.15	50503.55	-19394.41	2833.87
*Includes Liquidation Value LV in the 20th year; LV at 20th year = NB 20/((1+r)^20) -1														
LV				199.83	90.25						1550.92	700.40		
Net Benefit (NB)				530.22	420.63						4115.06	3264.54		
Discouned Net benefit (DNB)				199.83	90.25						1550.92	700.40		

Table 8 Rainfed *Emblica officinalis* plantation (EM) compared with current land use (DF1)

	Table 8..a Finanacial BCA : Comparing EM with DF1							Table 8.b Economic BCA : Comparing EM with DF1						
				Discounted Net benefits*							Discounted Net benefits*			
Year	Costs	Benefits	Net Benefits	EM (i=5%)	EM (i=8%)	EM - DF1 (i=5%)	EM - DF1 (i=8%)	Costs	Benefits	Net Benefits	EM (i=5%)	EM (i=8%)	EM - DF1 (i=5%)	EM - DF1 (i=8%)
0	10275.00		-10275.00	-10275.00	-10275.00	-10275.00	-10275.00	8331.25		-8331.25	-8331.25	-8331.25	-8331.25	-8331.25
1	6990.00	0.00	-6990.00	-6657.14	-6472.22	-9902.37	-9627.30	5477.50	0.00	-5477.50	-5216.67	-5071.76	-9670.22	-9401.61
2	3275.00	0.00	-3275.00	-2970.52	-2807.78	-5926.64	-5601.96	2531.25	0.00	-2531.25	-2295.92	-2170.14	-6448.18	-6094.93
3	650.00	250.00	-400.00	-345.54	-317.53	-3025.68	-2780.48	562.50	250.00	-312.50	-269.95	-248.07	-4132.47	-3797.58
4	725.00	375.00	-350.00	-287.95	-257.26	-2710.22	-2421.40	618.75	375.00	-243.75	-200.53	-179.16	-3790.02	-3386.13
5	725.00	375.00	-350.00	-274.23	-238.20	-2455.70	-2133.06	618.75	375.00	-243.75	-190.98	-165.89	-3523.25	-3060.35
6	725.00	375.00	-350.00	-261.18	-220.56	-2217.89	-1872.98	618.75	375.00	-243.75	-181.89	-153.60	-3271.92	-2763.10
7	725.00	375.00	-350.00	-248.74	-204.22	-1995.83	-1638.64	618.75	375.00	-243.75	-173.23	-142.23	-3035.21	-2491.99
8	725.00	375.00	-350.00	-236.89	-189.09	-1788.61	-1427.71	618.75	375.00	-243.75	-164.98	-131.69	-2812.33	-2244.87
9	725.00	375.00	-350.00	-225.61	-175.09	-1595.36	-1238.08	618.75	375.00	-243.75	-157.12	-121.94	-2602.57	-2019.72
10	875.00	375.00	-500.00	-306.96	-231.60	-1507.35	-1137.29	731.25	375.00	-356.25	-218.71	-165.01	-2474.27	-1866.82
11	1400.00	4500.00	3100.00	1812.51	1329.54	769.60	564.53	1125.00	4500.00	3375.00	1973.29	1447.48	-103.77	-76.12
12	1775.00	8000.00	6225.00	3466.31	2472.03	2569.73	1832.63	1406.25	8000.00	6593.75	3671.65	2618.47	1762.32	1256.81
13	1025.00	1000.00	-25.00	-13.26	-9.19	-774.01	-536.66	843.75	1000.00	156.25	82.86	57.45	-1668.92	-1157.15
14	2000.00	20950.00	18950.00	9571.04	6451.74	8936.26	6023.84	1575.00	20950.00	19375.00	9785.69	6596.43	8181.82	5515.28
15	1025.00	1000.00	-25.00	-12.03	-7.88	-530.10	-347.41	843.75	1000.00	156.25	75.16	49.26	-1389.92	-910.90
16	1025.00	1000.00	-25.00	-11.45	-7.30	-421.53	-268.58	843.75	1000.00	156.25	71.58	45.61	-1263.31	-804.93
17	2525.00	27600.00	25075.00	10940.14	6776.99	10629.89	6584.81	1968.75	27600.00	25631.25	11182.83	6927.33	9969.99	6176.03
18	1100.00	1300.00	200.00	83.10	50.05	-134.99	-81.30	900.00	1300.00	400.00	166.21	100.10	-932.27	-561.46
19	2525.00	27700.00	25175.00	9962.60	5833.35	9829.46	5755.39	1968.75	27700.00	25731.25	10182.73	5962.24	9191.34	5381.76
20	9350.00	44145.00	34795.00	21045.82	9504.35	19892.13	9082.15	7087.50	50085.00	42997.50	26007.11	11744.88	-1611.28	1637.85
Sum of DNB (NPV)				34755.03	11005.11	7365.79	-11544.50				45797.88	18668.50	-27955.69	-29001.18
*Includes Liquidation Value LV in the 20th year; LV at 20th year = NB 20/((1+r)^20) -1														
LV				21045.82	9504.35						26007.11	11744.88		
Net Benefit (NB)				55840.82	44299.35						69004.61	54742.38		
Discouned Net benefit (DNB)				21045.82	9504.35						26007.11	11744.88		

Table 9 Neem (*Azadirachta indica*) plantation (NM) compared with current land use (DF1)

	Table 9.a Finanacial BCA : Comparing NM with DF1							Table 9.b Economic BCA : Comparing NM with DF1						
				Discounted Net benefits*							Discounted Net benefits*			
Year	Costs	Benefits	Net Benefits	NM (i=5%)	NM (i=8%)	NM - DF1 (i=5%)	NM - DF1 (i=8%)	Costs	Benefits	Net Benefits	NM (i=5%)	NM (i=8%)	NM - DF1 (i=5%)	NM - DF1 (i=8%)
0	9475.00		-9475.00	-9475.00	-9475.00	-9475.00	-9475.00	7531.25		-7531.25	-7531.25	-7531.25	-7531.25	-7531.25
1	6750.00	0.00	-6750.00	-6428.57	-6250.00	-9673.79	-9405.08	5237.50	0.00	-5237.50	-4988.10	-4849.54	-9441.65	-9179.38
2	1850.00	0.00	-1850.00	-1678.00	-1586.08	-4634.12	-4380.25	1462.50	0.00	-1462.50	-1326.53	-1253.86	-5478.79	-5178.64
3	725.00	250.00	-475.00	-410.32	-377.07	-3090.47	-2840.02	618.75	250.00	-368.75	-318.54	-292.73	-4181.06	-3842.23
4	725.00	240.00	-485.00	-399.01	-356.49	-2821.29	-2520.63	618.75	240.00	-378.75	-311.60	-278.39	-3901.08	-3485.36
5	1250.00	755.00	-495.00	-387.85	-336.89	-2569.31	-2231.74	1012.50	755.00	-257.50	-201.76	-175.25	-3534.02	-3069.71
6	1250.00	1277.00	27.00	20.15	17.01	-1936.57	-1635.41	1012.50	1277.00	264.50	197.37	166.68	-2892.66	-2442.81
7	1325.00	1750.00	425.00	302.04	247.98	-1445.06	-1186.43	1068.75	1750.00	681.25	484.15	397.50	-2377.83	-1952.27
8	1325.00	1750.00	425.00	287.66	229.61	-1264.06	-1009.01	1038.75	1750.00	711.25	481.40	384.27	-2165.95	-1728.91
9	1400.00	2085.00	685.00	441.56	342.67	-928.19	-720.33	1125.00	2085.00	960.00	618.82	480.24	-1826.62	-1417.55
10	1475.00	2545.00	1070.00	656.89	495.62	-543.51	-410.07	1181.25	2545.00	1363.75	837.22	631.68	-1418.34	-1070.12
11	1475.00	2545.00	1070.00	625.61	458.90	-417.30	-306.11	1181.25	2545.00	1363.75	797.36	584.89	-1279.70	-938.71
12	1475.00	2550.00	1075.00	598.60	426.90	-297.98	-212.51	1181.25	2550.00	1368.75	762.17	543.55	-1147.16	-818.11
13	2225.00	51860.00	49635.00	26322.50	18250.69	25561.75	17723.22	1743.75	52076.00	50332.25	26692.27	18507.06	24940.48	17292.46
14	1025.00	1797.00	772.00	389.91	262.84	-244.86	-165.06	843.75	1797.00	953.25	481.46	324.54	-1122.42	-756.61
15	1025.00	1797.00	772.00	371.35	243.37	-146.73	-96.16	843.75	1797.00	953.25	458.53	300.50	-1006.55	-659.65
16	1025.00	1797.00	772.00	353.66	225.34	-56.41	-35.94	843.75	1797.00	953.25	436.69	278.24	-898.19	-572.29
17	1025.00	1797.00	772.00	336.82	208.65	26.57	16.46	843.75	1797.00	953.25	415.90	257.63	-796.94	-493.67
18	1025.00	1797.00	772.00	320.78	193.19	102.69	61.84	843.75	1797.00	953.25	396.10	238.55	-702.38	-423.01
19	1025.00	1797.00	772.00	305.51	178.88	172.37	100.93	843.75	1797.00	953.25	377.23	220.88	-614.15	-359.60
20	2000.00	54075.00	52075.00	31497.65	14224.42	30343.97	13802.23	1575.00	60879.00	59304.00	35870.13	16199.04	8251.74	6092.01
Sum of DNB (NPV)				44051.92	17624.55	16662.69	-4925.06				54629.03	25134.26	-19124.53	-22535.43
	*Includes Liquidation Value LV in the 20th year; LV at 20th year = NB 20/((1+r)^20) -1													
LV				31497.65	14224.42						35870.13	16199.04		
Net Benefit (NB)				83572.65	66299.42						95174.13	75503.04		
Discouned Net benefit (DNB)				31497.65	14224.42						35870.13	16199.04		

Table 10 Rainfed Teak (*Tectona grandis*) plantation (TK) compared with current land use (DF1)

		Table 10.a Finanacial BCA : Comparing TK with DF1							Table 10.b Economic BCA : Comparing TK with DF1						
					Discounted Net benefits*							Discounted Net benefits*			
Year	(i=8%)	Costs	Benefits	Net Benefits	TK (i=5%)	TK (i=8%)	TK - DF1 (i=5%)	TK - DF1 (i=8%)	Costs	Benefits	Net Benefits	TK (i=5%)	TK (i=8%)	TK - DF1 (i=5%)	TK - DF1 (i=8%)
0		12225.00	0.00	-12225.00	-12225.00	-12225.00	-12225.00	-12225.00	10543.75	0.00	-10543.75	-10543.75	-10543.75	-10543.75	-10543.75
1	3155.08	8240.00	0.00	-8240.00	-7847.62	-7629.63	-11092.84	-10784.71	6577.50	0.00	-6577.50	-6264.29	-6090.28	-10717.84	-10420.12
2	2794.17	3875.00	0.00	-3875.00	-3514.74	-3322.19	-6470.86	-6116.36	2981.25	0.00	-2981.25	-2704.08	-2555.94	-6856.35	-6480.73
3	2462.95	950.00	0.00	-950.00	-820.65	-754.14	-3500.79	-3217.09	7875.00	0.00	-7875.00	-6802.72	-6251.43	-10665.24	-9800.93
4	2164.14	950.00	450.00	-500.00	-411.35	-367.51	-2833.63	-2531.66	7875.00	450.00	-7425.00	-6108.57	-5457.60	-9698.05	-8664.56
5	1894.85	950.00	460.00	-490.00	-383.93	-333.49	-2565.39	-2228.34	7875.00	460.00	-7415.00	-5809.85	-5046.52	-9142.11	-7940.98
6	1652.42	875.00	540.00	-335.00	-249.98	-211.11	-2206.70	-1863.53	731.25	540.00	-191.25	-142.71	-120.52	-3232.74	-2730.01
7	1434.42	875.00	0.00	-875.00	-621.85	-510.55	-2368.94	-1944.97	731.25	0.00	-731.25	-519.69	-426.68	-3381.66	-2776.45
8	1238.62	4875.00	79625.00	74750.00	50593.74	40385.10	49042.02	39146.48	3712.50	79625.00	75912.50	51380.57	41013.16	48733.21	38899.98
9	1063.00	875.00	220.00	-655.00	-422.22	-327.66	-1791.97	-1390.66	731.25	220.00	-511.25	-329.56	-255.75	-2775.00	-2153.54
10	905.69	875.00	220.00	-655.00	-402.11	-303.39	-1602.51	-1209.08	731.25	220.00	-511.25	-313.86	-236.81	-2569.42	-1938.61
11	765.01	875.00	220.00	-655.00	-382.96	-280.92	-1425.87	-1045.93	731.25	220.00	-511.25	-298.92	-219.27	-2375.98	-1742.86
12	639.41	875.00	220.00	-655.00	-364.73	-260.11	-1261.31	-899.52	731.25	220.00	-511.25	-284.68	-203.02	-2194.01	-1564.68
13	527.46	875.00	220.00	-655.00	-347.36	-240.84	-1108.11	-768.31	731.25	220.00	-511.25	-271.13	-187.99	-2022.91	-1402.59
14	427.90	875.00	0.00	-875.00	-441.93	-297.90	-1076.71	-725.80	731.25	0.00	-731.25	-369.33	-248.96	-1973.21	-1330.12
15	339.53	875.00	0.00	-875.00	-420.89	-275.84	-938.96	-615.36	731.25	0.00	-731.25	-351.74	-230.52	-1816.82	-1190.68
16	261.28	875.00	250.00	-625.00	-286.32	-182.43	-696.39	-443.71	731.25	250.00	-481.25	-220.47	-140.47	-1555.35	-991.01
17	192.19	875.00	0.00	-875.00	-381.76	-236.49	-692.01	-428.67	731.25	0.00	-731.25	-319.04	-197.63	-1531.88	-948.94
18	131.35	875.00	0.00	-875.00	-363.58	-218.97	-581.67	-350.32	731.25	0.00	-731.25	-303.85	-182.99	-1402.33	-844.56
19	77.96	875.00	0.00	-875.00	-346.27	-202.75	-479.41	-280.70	731.25	0.00	-731.25	-289.38	-169.44	-1280.77	-749.92
20	422.19	30050.00	996800.00	966750.00	584740.42	264070.29	583586.74	263648.09	22612.50	1018888.25	996275.75	602599.12	272135.32	574980.73	262028.29
Sum of DNB (NPV)	22549.61				605098.92	276274.47	577709.68	253724.86				611732.08	274382.91	537978.51	226713.22
		*Includes Liquidation Value LV in the 20th year; LV at 20th year = NB 20/((1+r)^20) -1													
LV					584740.42	264070.29						602599.12	272135.32		
Net Benefit (NB)					1551490.42	1230820.29						1598874.87	1268411.07		
Discouned Net benefit (DNB)					584740.42	264070.29						602599.12	272135.32		

Table 11 Rainfed Cashew (*Anacardium occidentale*) plantation (CSW) compared with current land use (DF1)														
	Table 11.a Finanacial BCA : Comparing CSW with DF1							Table 11.b Economic BCA : Comparing CSW with DF1						
				Discounted Net benefits*							Discounted Net benefits*			
Year	Costs	Benefits	Net Benefits	CSW (i=5%)	CSW (i=8%)	CSW - DF1 (i=5%)	CSW - DF1 (i=8%)	Costs	Benefits	Net Benefits	CSW (i=5%)	CSW (i=8%)	CSW - DF1 (i=5%)	CSW - DF1 (i=8%)
0	16275.00	0.00	-16275.00	-16275.00	-16275.00	-16275.00	-16275.00	14331.25	0.00	-14331.25	-14331.25	-14331.25	-14331.25	-14331.25
1	8250.00	0.00	-8250.00	-7857.14	-7638.89	-11102.37	-10793.97	6662.50	0.00	-6662.50	-6345.24	-6168.98	-10798.79	-10498.83
2	3350.00	0.00	-3350.00	-3038.55	-2872.09	-5994.67	-5666.26	2587.50	0.00	-2587.50	-2346.94	-2218.36	-6499.20	-6143.15
3	4250.00	0.00	-4250.00	-3671.31	-3373.79	-6351.46	-5836.73	3262.50	0.00	-3262.50	-2818.27	-2589.88	-6680.79	-6139.38
4	4250.00	0.00	-4250.00	-3496.49	-3123.88	-5918.76	-5288.02	3262.50	0.00	-3262.50	-2684.07	-2398.03	-6273.55	-5605.00
5	2000.00	2800.00	800.00	626.82	544.47	-1554.64	-1350.39	1575.00	2800.00	1225.00	959.82	833.71	-2372.45	-2060.75
6	2075.00	3500.00	1425.00	1063.36	897.99	-893.36	-754.43	1631.25	3500.00	1868.75	1394.49	1177.63	-1695.54	-1431.86
7	3350.00	7000.00	3650.00	2593.99	2129.74	846.89	695.32	2587.50	7000.00	4412.50	3135.88	2574.65	273.90	224.88
8	4625.00	14000.00	9375.00	6345.37	5065.02	4793.65	3826.40	3543.75	14000.00	10456.25	7077.20	5649.19	4429.85	3536.01
9	6175.00	21000.00	14825.00	9556.33	7416.19	8186.58	6353.20	4668.75	21000.00	16331.25	10527.27	8169.69	8081.83	6271.90
10	7250.00	31500.00	24250.00	14887.40	11232.44	13687.00	10326.75	5512.50	31500.00	25987.50	15954.07	12037.24	13698.51	10335.44
11	7250.00	31500.00	24250.00	14178.47	10400.41	13135.56	9635.40	5512.50	31500.00	25987.50	15194.35	11145.59	13117.29	9622.00
12	7250.00	31500.00	24250.00	13503.31	9630.01	12606.73	8990.60	5512.50	31500.00	25987.50	14470.81	10319.99	12561.48	8958.34
13	7250.00	31500.00	24250.00	12860.29	8916.67	12099.54	8389.21	5512.50	31500.00	25987.50	13781.73	9555.55	12029.94	8340.95
14	7250.00	31500.00	24250.00	12247.90	8256.18	11613.12	7828.28	5512.50	31500.00	25987.50	13125.45	8847.73	11521.58	7766.58
15	7250.00	31500.00	24250.00	11664.66	7644.61	11146.59	7305.08	5512.50	31500.00	25987.50	12500.43	8192.34	11035.36	7232.18
16	7250.00	31500.00	24250.00	11109.20	7078.34	10699.13	6817.06	5512.50	31500.00	25987.50	11905.17	7585.50	10570.29	6734.97
17	7250.00	31500.00	24250.00	10580.19	6554.02	10269.95	6361.84	5512.50	31500.00	25987.50	11338.26	7023.61	10125.42	6272.31
18	7250.00	31500.00	24250.00	10076.38	6068.54	9858.28	5937.19	5512.50	31500.00	25987.50	10798.34	6503.35	9699.86	5841.78
19	7250.00	31500.00	24250.00	9596.55	5619.02	9463.41	5541.06	5512.50	31500.00	25987.50	10284.14	6021.62	9292.75	5441.14
20	16250.00	137580.00	121330.00	73386.66	33141.61	72232.98	32719.41	12262.50	147696.00	135433.50	81917.19	36994.01	54298.80	26886.98
Sum of DNB (NPV)				179938.39	97311.63	152549.16	74762.02				205838.85	114924.91	132085.28	67255.23
	*Includes Liquidation Value LV in the 20th year; LV at 20th year = NB 20/((1+r)^20) -1													
LV				73386.66	33141.61						81917.19	36994.01		
Net Benefit (NB)				194716.66	154471.61						217350.69	172427.51		
Discouned Net benefit (DNB)				73386.66	33141.61						81917.19	36994.01		

Table 12 Rainfed *Eucalyptus territicornis* plantation (EU) compared with current land use (DF1)														
	Table 12.a Finanacial BCA : Comparing EU with DF1							Table 12.b Economic BCA : Comparing EU with DF1						
				Discounted Net benefits*							Discounted Net benefits*			
Year	Costs	Benefits	Net Benefits	EU (i=5%)	EU (i=8%)	EU - DF1 (i=5%)	EU - DF1 (i=8%)	Costs	Benefits	Net Benefits	EU (i=5%)	EU (i=8%)	EU - DF1 (i=5%)	EU - DF1 (i=8%)
0	20941.00		-20941.00	-20941.00	-20941.00	-20941.00	-20941.00	17497.25		-17497.25	-17497.25	-17497.25	-17497.25	-17497.25
1	4140.00	0.00	-4140.00	-3942.86	-3833.33	-7188.08	-6988.41	3527.50	0.00	-3527.50	-3359.52	-3266.20	-7813.08	-7596.05
2	3125.00	0.00	-3125.00	-2834.47	-2679.18	-5790.59	-5473.36	2418.75	0.00	-2418.75	-2193.88	-2073.69	-6346.14	-5998.48
3	500.00	0.00	-500.00	-431.92	-396.92	-3112.06	-2859.86	450.00	0.00	-450.00	-388.73	-357.22	-4251.25	-3906.73
4	500.00	0.00	-500.00	-411.35	-367.51	-2833.63	-2531.66	450.00	0.00	-450.00	-370.22	-330.76	-3959.70	-3537.73
5	500.00	0.00	-500.00	-391.76	-340.29	-2573.23	-2235.14	450.00	0.00	-450.00	-352.59	-306.26	-3684.85	-3200.72
6	500.00	0.00	-500.00	-373.11	-315.08	-2329.82	-1967.51	450.00	0.00	-450.00	-335.80	-283.58	-3425.83	-2893.07
7	8750.00	25800.00	17050.00	12117.12	9948.51	10370.02	8514.09	6637.50	25800.00	19162.50	13618.43	11181.13	10756.45	8831.37
8	500.00	0.00	-500.00	-338.42	-270.13	-1890.14	-1508.75	450.00	0.00	-450.00	-304.58	-243.12	-2951.93	-2356.30
9	500.00	0.00	-500.00	-322.30	-250.12	-1692.06	-1313.12	450.00	0.00	-450.00	-290.07	-225.11	-2735.52	-2122.90
10	500.00	0.00	-500.00	-306.96	-231.60	-1507.35	-1137.29	450.00	0.00	-450.00	-276.26	-208.44	-2531.82	-1910.24
11	500.00	0.00	-500.00	-292.34	-214.44	-1335.25	-979.45	450.00	0.00	-450.00	-263.11	-193.00	-2340.17	-1716.59
12	500.00	0.00	-500.00	-278.42	-198.56	-1175.00	-837.96	450.00	0.00	-450.00	-250.58	-178.70	-2159.91	-1540.36
13	500.00	0.00	-500.00	-265.16	-183.85	-1025.91	-711.31	450.00	0.00	-450.00	-238.64	-165.46	-1990.43	-1380.06
14	7150.00	30800.00	23650.00	11944.86	8051.90	11310.08	7624.01	5400.00	30800.00	25400.00	12828.73	8647.71	11224.85	7566.55
15	500.00	0.00	-500.00	-240.51	-157.62	-758.58	-497.15	450.00	0.00	-450.00	-216.46	-141.86	-1681.53	-1102.02
16	500.00	0.00	-500.00	-229.06	-145.95	-639.13	-407.23	450.00	0.00	-450.00	-206.15	-131.35	-1541.04	-981.89
17	500.00	0.00	-500.00	-218.15	-135.13	-528.40	-327.32	450.00	0.00	-450.00	-196.33	-121.62	-1409.17	-872.93
18	500.00	0.00	-500.00	-207.76	-125.12	-425.85	-256.47	450.00	0.00	-450.00	-186.98	-112.61	-1285.46	-774.18
19	500.00	0.00	-500.00	-197.87	-115.86	-331.01	-193.81	450.00	0.00	-450.00	-178.08	-104.27	-1169.47	-684.75
20	5450.00	20600.00	15150.00	9163.50	4138.26	8009.82	3716.07	4162.50	20600.00	16437.50	9942.25	4489.95	-17676.14	-5617.09
Sum of DNB (NPV)				1002.07	-8763.03	-26387.16	-31312.64				9284.18	-1621.72	-64469.39	-49291.41
	*Includes Liquidation Value LV in the 20th year; LV at 20th year = NB 20/((1+r)^20) -1													
LV				9163.50	4138.26						9942.25	4489.95		
Net Benefit (NB)				24313.50	19288.26						26379.75	20927.45		
Discouned Net benefit (DNB)				9163.50	4138.26						9942.25	4489.95		

Table 13 Silvipastoral system (SP) compared with current land use (DF1)

	Table 13.a Finanacial BCA : Comparing SP with DF1							Table 13.b Economic BCA : Comparing SP with DF1						
				Discounted Net benefits*							Discounted Net benefits*			
Year	Costs	Benefits	Net Benefits	SP (i=5%)	SP (i=8%)	SP - DF1 (i=5%)	SP - DF1 (i=8%)	Costs	Benefits	Net Benefits	SP (i=5%)	SP (i=8%)	SP - DF1 (i=5%)	SP - DF1 (i=8%)
0	12580.00	0.00	-12580.00	-12580.00	-12580.00	-12580.00	-12580.00	10355.00	0.00	-10355.00	-10355.00	-10355.00	-10355.00	-10355.00
1	8070.00	250.00	-7820.00	-7447.62	-7240.74	-10692.84	-10395.82	6295.00	250.00	-6045.00	-5757.14	-5597.22	-10210.70	-9927.07
2	3350.00	875.00	-2475.00	-2244.90	-2121.91	-5201.02	-4916.08	2587.50	875.00	-1712.50	-1553.29	-1468.19	-5705.55	-5392.98
3	1100.00	875.00	-225.00	-194.36	-178.61	-2874.51	-2641.56	900.00	875.00	-25.00	-21.60	-19.85	-3884.12	-3569.35
4	1100.00	1000.00	-100.00	-82.27	-73.50	-2504.55	-2237.65	900.00	1000.00	100.00	82.27	73.50	-3507.22	-3133.46
5	1325.00	1375.00	50.00	39.18	34.03	-2142.29	-1860.82	1068.75	1375.00	306.25	239.95	208.43	-3092.31	-2686.03
6	1100.00	1000.00	-100.00	-74.62	-63.02	-2031.34	-1715.44	900.00	1000.00	100.00	74.62	63.02	-3015.41	-2546.47
7	1280.00	1250.00	-30.00	-21.32	-17.50	-1768.42	-1451.92	1042.50	1250.00	207.50	147.47	121.07	-2714.51	-2228.69
8	1025.00	1250.00	225.00	152.29	121.56	-1399.43	-1117.06	843.75	1250.00	406.25	274.97	219.48	-2372.39	-1893.70
9	1025.00	1250.00	225.00	145.04	112.56	-1224.71	-950.44	843.75	1250.00	406.25	261.87	203.23	-2183.57	-1694.56
10	1250.00	1500.00	250.00	153.48	115.80	-1046.92	-789.89	1012.50	1500.00	487.50	299.28	225.81	-1956.28	-1476.00
11	1955.00	3250.00	1295.00	757.16	555.40	-285.75	-209.61	1548.75	3250.00	1701.25	994.69	729.64	-1082.37	-793.96
12	1025.00	1000.00	-25.00	-13.92	-9.93	-910.50	-649.33	843.75	1000.00	156.25	87.01	62.05	-1822.32	-1299.61
13	1025.00	1000.00	-25.00	-13.26	-9.19	-774.01	-536.66	843.75	1000.00	156.25	82.86	57.45	-1668.92	-1157.15
14	1025.00	87300.00	86275.00	43574.74	29373.28	42939.96	28945.38	843.75	90450.00	89606.25	45257.25	30507.44	43653.37	29426.28
15	5975.00	1500.00	-4475.00	-2152.55	-1410.71	-2670.62	-1750.23	4556.25	1500.00	-3056.25	-1470.11	-963.46	-2935.18	-1923.62
16	1280.00	3250.00	1970.00	902.48	575.02	492.41	313.74	1012.50	3250.00	2237.50	1025.02	653.10	-309.86	-197.43
17	1925.00	1000.00	-925.00	-403.57	-250.00	-713.82	-442.19	1518.75	1000.00	-518.75	-226.33	-140.20	-1439.17	-891.51
18	1025.00	1000.00	-25.00	-10.39	-6.26	-228.48	-137.60	843.75	1000.00	156.25	64.93	39.10	-1033.55	-622.46
19	1025.00	2000.00	975.00	385.84	225.92	252.70	147.96	843.75	2000.00	1156.25	457.57	267.92	-533.82	-312.57
20	6050.00	98600.00	92550.00	55979.03	25280.27	54825.35	24858.08	4612.50	105980.00	101367.50	61312.31	27688.80	33693.92	17581.76
Sum of DNB (NPV)				76850.44	32432.47	49461.21	9882.86				91278.60	42576.12	17525.03	-5093.57
	*Includes Liquidation Value LV in the 20th year; LV at 20th year = NB 20/((1+r)^20) -1													
LV				55979.03	25280.27						61312.31	27688.80		
Net Benefit (NB)				148529.03	117830.27						162679.81	129056.30		
Discouned Net benefit (DNB)				55979.03	25280.27						61312.31	27688.80		

Table.14 Assisted Natural Regeneration (NR) compared with current landuse (DF1)

		Table 14.a Finanacial BCA : Comparing NR with DF1							Table 14.b Economic BCA : Comparing NR with Df1						
					Discounted Net benefits*							Discounted Net benefits*			
Year	(i=8%)	Costs	Benefits	Net Benefits	NR (i=5%)	NR (i=8%)	NR - DF1 (i=5%)	NR - DF1 (i=8%)	Costs	Benefits	Net Benefits	NR (i=5%)	NR (i=8%)	NR - DF1 (i=5%)	NR - DF1 (i=8%)
0		6775.00	0.00	-6775.00	-6775.00	-6775.00	-6775.00	-6775.00	5206.25	0.00	-5206.25	-5206.25	-5206.25	-5206.25	-5206.25
1	3155.08	6015.00	0.00	-6015.00	-5728.57	-5569.44	-8973.79	-8724.52	4596.25	0.00	-4596.25	-4377.38	-4255.79	-8830.94	-8585.63
2	2794.17	3125.00	0.00	-3125.00	-2834.47	-2679.18	-5790.59	-5473.36	2418.75	0.00	-2418.75	-2193.88	-2073.69	-6346.14	-5998.48
3	2462.95	1250.00	0.00	-1250.00	-1079.80	-992.29	-3759.94	-3455.24	1012.50	0.00	-1012.50	-874.64	-803.76	-4737.16	-4353.26
4	2164.14	1250.00	0.00	-1250.00	-1028.38	-918.79	-3450.65	-3082.93	1012.50	0.00	-1012.50	-832.99	-744.22	-4422.47	-3951.18
5	1894.85	875.00	0.00	-875.00	-685.59	-595.51	-2867.05	-2490.36	731.25	0.00	-731.25	-572.95	-497.68	-3905.22	-3392.14
6	1652.42	875.00	550.00	-325.00	-242.52	-204.81	-2199.24	-1857.23	731.25	550.00	-181.25	-135.25	-114.22	-3225.28	-2723.71
7	1434.42	875.00	550.00	-325.00	-230.97	-189.63	-1978.07	-1624.05	731.25	550.00	-181.25	-128.81	-105.76	-2990.79	-2455.53
8	1238.62	875.00	550.00	-325.00	-219.97	-175.59	-1771.69	-1414.21	731.25	550.00	-181.25	-122.68	-97.92	-2770.03	-2211.10
9	1063.00	875.00	580.00	-295.00	-190.16	-147.57	-1559.91	-1210.57	731.25	580.00	-151.25	-97.50	-75.66	-2542.94	-1973.45
10	905.69	875.00	580.00	-295.00	-181.10	-136.64	-1381.50	-1042.33	731.25	580.00	-151.25	-92.85	-70.06	-2348.41	-1771.86
11	765.01	875.00	580.00	-295.00	-172.48	-126.52	-1215.39	-891.53	731.25	580.00	-151.25	-88.43	-64.87	-2165.49	-1588.47
12	639.41	875.00	620.00	-255.00	-141.99	-101.26	-1038.58	-740.67	731.25	620.00	-111.25	-61.95	-44.18	-1971.28	-1405.84
13	527.46	2075.00	20734.00	18659.00	9895.27	6860.88	9134.52	6333.41	1631.25	20734.00	19102.75	10130.60	7024.04	8378.81	5809.44
14	427.90	875.00	0.00	-875.00	-441.93	-297.90	-1076.71	-725.80	450.00	0.00	-450.00	-227.28	-153.21	-1831.16	-1234.36
15	339.53	875.00	875.00	0.00	0.00	0.00	-518.07	-339.53	731.25	875.00	143.75	69.15	45.32	-1395.93	-914.84
16	261.28	875.00	875.00	0.00	0.00	0.00	-410.07	-261.28	731.25	875.00	143.75	65.85	41.96	-1269.03	-808.58
17	192.19	875.00	875.00	0.00	0.00	0.00	-310.25	-192.19	731.25	875.00	143.75	62.72	38.85	-1150.12	-712.45
18	131.35	875.00	875.00	0.00	0.00	0.00	-218.09	-131.35	731.25	875.00	143.75	59.73	35.97	-1038.75	-625.59
19	77.96	875.00	1360.00	485.00	191.93	112.38	58.79	34.42	731.25	1360.00	628.75	248.82	145.69	-742.57	-434.79
20	422.19	16500.00	21354.00	4854.00	2935.95	1325.88	1782.27	903.69	12431.25	33504.00	21072.75	12745.89	5756.08	-14872.50	-4350.96
Sum of DNB (NPV)	22549.61				-6929.79	-10611.01	-34319.02	-33160.62				8369.92	-1219.34	-65383.65	-48889.03
		*Includes Liquidation Value LV in the 20th year; LV at 20th year = NB 20/((1+r)^20) -1													
LV					2935.95	1325.88						12745.89	5756.08		
Net Benefit (NB)					7789.95	6179.88						33818.64	26828.83		
Discouned Net benefit (DNB)					2935.95	1325.88						12745.89	5756.08		

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