International Journal of Commerce and Business Management
e ISSN–0976–7940 Volume **8** | Issue 1 | April, 2015 | 28-35
DOI: 10.15740/HAS/IJCBM/8.1/28-35
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RESEARCH PAPER

External benefit and external cost in the economics agroforestry systems in north western parts of Tamil Nadu

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Received : *01.10.2014;* **Revised :** *10.02.2015;* **Accepted :** *25.02.2015*

ABSTRACT

Agroforestry is defined as a dynamic, ecologically based, natural resource management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels (Leakey, 1996). Agroforestry has considerable potential to contribute towards solving some of these problems. Nitrogen-fixing trees, as substitutes or complements for chemical fertilizer, can increase smallholder incomes, conserve foreign exchange and improve regional food security. By providing a supply of fuelwood from the farm, agroforestry can help reduce pressure on forests and communal woodlands. Moreover, agroforestry trees can supply farm households with a wide range of other products, including food, medicine, livestock feed, and timber for home use and sale. Other services that trees provide, such as boundary markers, windbreaks, soil erosion barriers, beauty and shade, are difficult to quantify but are none the less of substantial importance to farm families and for natural resource protection.The present study is the outcome of socio-economic diagnosis of traditional as well as commercial agroforestry practices followed by farmers in north western parts of Tamil Nadu. Tree species like *Texctona grandis*, *Tamarindius indicus*, *Casuarina equestifolia* and *Eucalyptus* spp. were dominant species in traditional system whereas, *Texctona grandis* and *Tamarindius indicus* were the main species of commercial agroforestry. The net return from tree produce ha^{-1} per annum in commercial agroforestry system was Rs. 432773, Rs. 886711, Rs. 457998 and Rs. 908226, respectively for Teak growers, Tamarind growers, teak + maize and tamarind + sorghum, respectively. In commercial agroforestry, B:C ratio has been found higher (6.59) for tree based crop than tree crop (5.90). Although traditional agroforestry seems less promising as compared to commercial agroforestry, but it is also relevant to the farmers livelihood.

KEY WORDS : Agroforestry, Social cost, Social benefit, Socio-economic analysis

How to cite this paper : Sangeetha, R. and Shanmugam, T.R. (2015). External benefit and external cost in the economics agroforestry systems in north western parts of Tamil Nadu. *Internat. J. Com. & Bus. Manage*, **8**(1) : 28-35.

The tree component introduced in an agroforestry system is in a way to substitute for fuel, timber, fodder obtained from commons in many subsistence economies and which has scope to improve farm household food security and nutrition in the following ways. First, its contribution through green manures to increased productivity of agricultural field crops and the associated reduction in the cost of chemicals. Second, as animal feed in increasing the livestock production which could be directly used as food or sold in the market to purchase other consumer goods. Third, by increasing the availability of fuelwood and hence reducing the time and energy involved in collecting fuelwood and the cost of purchased cooking fuel. In addition increased income from timber production help to earn more income and enable them to purchase consumer goods. Finally, by providing fruits and vegetables directly for improving the nutritional status of the household members. Besides, the economic rationale

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of agroforestry lies in cushioning the impact of crop failures especially under unirrigated farming (Kumar and Ramasamy, 1996).

Farmers manage trees as an integral part of their farming system, within a given ecological and social setting. The pattern and intensity of management of trees in terms of resource allocation, protection, upkeep and usage depend on the importance of trees or tree based biomass in the functioning of the system (Jodha, 1997). For most rural people foods derived from trees they maintain in their farming system, add variety to diets, improve palatability and provide essential vitamins, proteins and calories (Falconer, 1989). In addition, trees have a counter seasonal quality and role in livelihoods. For many resource poor farmers trees are key components in the farming systems and stabilise and supplement their subsistence and income (Chambers *et al.*, 1991), support strategies filling in slack seasons and reducing the need to migrate (Chambers and Longhurst, 1986) and provide security and self respect (Chambers and Leach, 1987). Thus, trees play a vital role in the farm household economy.

Though the agroforestry systems have considerable merit in environmental, ecological and socio-economic conditions of the people who are engaged in it, the existing and potential economic contributions of agroforestry have not been rigorously examined, making it difficult to set development and research agenda. Studies show that most economic studies have focussed in location specific assessment of financial returns from particular practices. Only a few studies (Poel and Dijk,1987; Stevenson, 1989; David, 1997; Shively, 1998 and Cooke, 1998) have examined agroforestry in the context of regional land use changes relative returns to productive factors or household decision making. The key requirements for more effective use of economic analysis in agroforestry development policy and program design include (i) development of a theoretical framework for analysing the economic role and potential of agroforestry in farming systems and (ii) development of better methods of incorporating agroforestry into models of household decision making process (Scherr, 1992). Household studies may also be used to evaluate the effects of price policy changes on the extent, mix and benefits from agroforestry practices.

Sampling framework :

The present study aims to examine the social cost and social benefit in the north western zone of Tamil Nadu. The north western zone was purposively selected as agroforestry enterprise is more prominent in this region as compared to other regions. Hence, to enable the study to deal with the private and social benefit and cost , the sampling design was carefully formulated. Further, the region practices highly differentiated agroforestry systems which has evolved over longer time. The agroforestry systems and practices in the region were examined. To examine the social cost and social benefit a sample of 240 tree growers were studied.

To fullfil the objectives of the study, Dharmapuri district of north western zone was selected purposively. Two block, where the practice is followed intensively was selected. Since the block wise details for area under agroforestry were not available, the selection of blocks was done based on the discussion with officials of Department of Agriculture and the Scientists of Tamil Nadu Agricultural University. Pennagram and Morappur block of Dharmapur district was selected purposively to represent Agrisilvicultural system. From the selected block, six revenue villages were selected randomly. This was done by listing out all the revenue villages in alphabetical order selecting randomly the villages.

For the present study, the land was considered as the major criterion to define resource poor farmers. Given the limited water resources in the study region, farm households with less than 2 hectares of land (small and marginal farmers) were considered as resource poor farm households. Two categories of respondents, namely, farmers who practice agroforestry (Teak + maize growers) and farmers who practice agroforestry (Tamarind + Sorghum) were studied in order to facilitate comparative analysis. To examine the role of agroforestry, 40 agroforestry farmers were selected from each of the six villages. Thus a sample of 240 tree growers were studied. Preliminary information relating to the study area were collected earlier to explore the possibility of conducting the study. Interview schedules were formulated and pretested. The needed information such as family labour force, number of workers and dependents, cropping pattern, land use, input use and cost of cultivation for different enterprises, details regarding tree husbandry, labour supply and consumption particulars were gathered personally administering the interview schedule.

Thus, a sample of 240 tree growers were studied. Preliminary information relating to the study area were collected earlier to explore the possibility of conducting the study. Interview schedules were formulated and pretested. The needed information such as family labour force, number of workers and dependents, cropping pattern, land use, input use and cost of cultivation for different enterprises, details regarding tree husbandry, labour supply and consumption particulars were gathered personally administering the interview schedule.

To address proposed objectives of the study, both primary and secondary data were used. The primary data on family composition, cropping pattern, income, cost of cultivation, farmer perception and technology adoption were collected through a well structured and pre tested interview schedule from 240 randomly selected sample farmers distributed equally at the rate of 120 sample farms in each blocks.

Agroforestry is a dynamic, ecologically based natural resource management system that, through which the integration of trees/woody perennials in farm and rangelands, diversifies and sustains production for increased social, economic and environmental benefits (Leakey, 1996).

Agroforestry can play a major role in bringing the desired level of diversification along with sustainability. The farm industry linkages have also helped the systems to be more sustainable than the traditional cropping systems (Kareemulla *et al.*, 2005; Saxena, 2000). The major objectives of the study were to document the agroforestry systems, identify the reasons of farmers to promote the systems, estimate the external benefit and external cost analysis and assessing the impact of agroforestry.

METHODOLOGY

Theoretical frame work :

When farmers make decisions about what and how much to produce, they normally take in to account the price of what they will produce and the cost of items for which they will have to pay such as labour, raw materials and energy use. These are called as the private costs of the farm. But there is another type of costs, that which representing a true cost to society, does not show up in the farms profit and loss statement. For example, when farmers grown a tree crop, neighboring farms have to take on the additional burden of bird scaring. Although this activity might represent a real cost to some members of society; farmers do not normally take it into account when deciding whether to cultivate the tree or not. Thus, even though these costs are external to the farm, they are internal to the society as a whole, which means that the cost of the agroforestry activities includes private as well as social costs as shown below :

Total cost = Private cost + Social cost

If, on the other hand, a farmer adopts a specific agroforestry activity and sells the products he grows, the income he generates becomes private. Yet, the trees that he grows produce other benefits to society such as nitrogen fixation, bird habitats, honey production, and scenic values. These benefits, while internalized by the society, are external was not possible to value the environmental effects by using market or surrogate – market techniques (Dixon *et al.*, 1994) for the agroforestry projects examined in the study. Hence, the study asked open – ended questions regarding people's willingness to pay (WTP) for a benefit, or their willingness to accept (WTA) by way of compensation to tolerate a cost, or both. The respondents had the full freedom to state any value.

In case of agro-forestry non-use value such as bequest value and existence value do not exist and option value also does not come in the case of agroforestry economic valuation. So tangible and intangible costs and benefits associated with agroforestry system included in this study area are :

Table A : Tangible and intangible costs and benefits from agroforestry

Intangible costs	Cost of birds scaring
Intangible benefits	Soil and water conservation
	Agricultural productivity
	Nitrogen fixxation
	Carbon store
	Waste assimilation
Tangible costs	Cost of cultivation
Tangible benefits	Firewood
	Timber
	Non-timber forest products

This study invoved survey of agro forestry adopters and extension officiala with agro-forestry projects. For the present study Dharmapuri district of Tamil Nadu state has been selected considering its lead in agro forestry. In total 240 farmers were interviewed in different agroforestry systems taken for this study. The agro forestry systems adopted by the farmers of the study regions are Agrisilviculture and Silviculture.

Agri-silviculture :

Teak and Tamarind were grown in the farmers field along with agricultural crops like maize, sorghum and groundnut as intercrops.

Silviculture :

Teak and tamarind were grown as pure tree crops :

In each category 120 farmers have been surveyed and thus, in the total sample 240 farmers were interviewed. The data were collected during the year 2012.The financial measures used for analyzing the economics of agroforestry systems were the benefit-cost ratio (BCR), net present value (NPV) and internal rate of return (IRR). These concepts are explained below.

A benefit-cost ratio (BCR) is an indicator, used in the formal discipline of cost-benefit analysis that attempts to summarize the overall value for money of a project. All benefits and costs should be expressed in discounted present values. Benefit cost ratio (BCR) takes into account the amount of monetary gain realized by performing a project versus the amount it costs to execute the project. The benefit cost ratio of an investment is the ratio of the discounted value of all cash inflows to the discounted value of all cash outflows during the life of mango production period. It is calculated by using following formula. The higher the BCR better the investment.

$$\text{Benefit cost ratio} = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+i)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+i)^t}}$$

where,

B_t = benefits in each year,

C_t = costs in each year,

n = number of year,

i = interest rate.

If BCR > 1, then the total revenue is greater than the total cost, if BCR = 1 then the total revenue is equal to the total cost and if BCR < 1 then the revenue is less than the total cost. The discount rate or interest rate should be equal to the opportunity cost of capital, the rate of interest on borrowed capital. It was assumed as 12 per cent for the analysis of the present study.

Net present worth (NPW) :

It is believed to be a more meaningful measure of the long-term investment proposal and useful in comparing the other investment proposal. Net present value is the discounted value of all cash inflows, net of all cash outflows of the project during its life period. Generally, higher the net present value better would be the preference.

The consensus in the investment literature is that if the objective of a firm is the maximization of profit or wealth of a business, then the NPW is the appropriate procedure to evaluate investment decisions (Tauer, 2002). The NPW is the total present value of future revenue and cost of an activity (Castle *et al*., 1987). Moreover, the NPW offers the better measure of project worth among the measures of investment returns over time (Swinton *et al*., 1997). In calculating the net present value, the present value of benefits was considered at a discount rate of 12 per cent. The discount rate or 12 per cent chosen since the prevailing rate of interest for long term commercial banks is around 12 per cent. Net present value was computed using the following formula :

$$\text{Net present worth} = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t}$$

where, notations are explained as

B_t = benefits in each year

C_t = costs in each year

n = number of year

i = interest rate.

Internal rate of return (IRR) :

The internal rate of return (IRR) is a rate of return used in financial analysis to measure and compare the profitability of investments. It is also called the discounted cash flow rate of return or the rate of return. In more specific terms, the IRR of an investment is the discount rate at which the net present value of costs (negative cash flows) of the investment equals the net present value of the benefits (positive cash flows) of the investment. Hence, the internal rate of return is that discounted rate at which the NPV is equal to zero. The internal rate of return is arrived at, through interpolation technique by using different discount rates so as to see that net present value is equated to zero. The higher a project's internal rate of return, the more desirable it is to undertake the project. Because the internal rate of return is a rate quantity, it is an indicator of the efficiency, quality, or yield of an investment. The IRR was estimated as follows :

$$\text{IRR} = \text{Lowest interest rate} + \text{Difference between the two discount rates} \left[\frac{\text{Present worth of cash flow at lower discount rate}}{\text{Sum of the absolute value of the two NPV's}} \right]$$

ANALYSIS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads :

General particulars of the firm :

The basic characteristics features of the sample are presented in Table 1. The average area under agro forestry per farm formed 26.48 per cent and 39.50 per cent in agri-silviculture. The average area, under agroforestry per farm formed 61.60 per cent 52.15 per cent in silviculture. This table also indicated that as the size of the farm increased the area under agro – forestry also increased. It could be seen that the farmers shifted from agri – silviculture to silviculture as farm size increased.

Family size of sample farm households :

The size of the family has important implications with respect to income realization of the sample households. The information on family size is presented in Table 2.

From the Table 3, it could be inferred that in the Pennagram block households, the family size group of 4 to 6 accounted for 72.00 per cent of total households, followed by family size group of less than 4 which accounted for 33.00 per cent and the family size group of more than 6 category

Table 1 : Agroforestry and allocation of area to its components in the study

Model	Crops	Area under agro-forestry (ha)	Farm size (ha)	% of agroforestry area to total operational area
Agri-silviculture	Teak intercropped with Sorghum + Ragi	1.12	4.23	26.48
Agri-silviculture	Tamarind intercropped with Sorghum + Ragi	1.43	3.62	39.50
Silviculture	Teak	3.24	5.26	61.60
Silviculture	Tamarind	2.67	5.12	52.15

accounted for 23.00 per cent.

In the Morappur block households, it was observed that the family size group of 4 to 6 accounted for 56.00 per cent of the total, followed by size group less than 4 which accounted for 36.00 per cent of the total and 28.00 per cent of the households belonged to more than 6 family size group.

In case of both the block farm households it could be seen from the table that among the tree growers medium sized family was highest with 53.33 per cent of the total households followed by small sized family with 28.75 per cent of the total households. Large size family was the lowest with 17.92 per cent of the total households.

Size of land holdings :

Size of land holdings would determine the income and employment generation. The land holding details are given in Table 4.

It could be seen from the Table 4 that medium farmers were highest with 40.42 per cent of total and as much as 27.50 per cent of the sample farmers were small farmers. The proportion of large farmers was lowest with 5.42 per cent to total. Hence, it could be concluded from the table that small farmers were predominant in the study area. This may be due to small sized holding, the farmers aimed at taking out as much income as possible from the farm. The area under agro forestry as the size of holding increased.

Teak cultivation in sample farms :

There are different operations in the management of a teak plantation such as site clearance, slash burning, land preparation, nursery raising, preparation of stumps, planting, maintenance, weeding, loranthus cutting, periodic thinning and final felling. The initial planting is done with a spacing of 2 × 2 m to reduce weed growth and to obtain a straight bole. As the canopy develops, some trees are removed to provide sunlight. There are two types of thinning - mechanical and silvicultural. The first two thinnings at 4^{th} and 8^{th} years are called mechanical thinnings where trees in the alternate diagonals are removed. The subsequent four thinnings are called silvicultural thinning where stunted and poorly grown trees are removed retaining a healthy crop. Yield obtained during thinning operations is termed as thinning yield.

The trees that remain after the different thinnings are felled at the rotation age in an operation called final felling. This is a clearfelling. The rotation age is the age of the plantation when it is finally felled. The total yield is the sum of all the yields from thinnings and the final felling yield. The mean annual increment (MAI) is an important measure of productivity used in forestry. MAI is obtained by dividing the total yield by the rotation age.

The dead seedlings in a plantation should be replaced Urea, DAP and potash fertilizers were applied as basal dose and top dressing. Teak thrives well only when they are free

Table 2 : Family size of sample farmers in the north western zone (in numbers)

Sr. No.	Family size (number)	Dharmapuri district		Total	Percentage
		Pennagram block	Morrapur block		
1.	Small (< 4)	33	36	69	28.75
2.	Medium(4 - 6)	72	56	128	53.33
3.	Large (> 6)	23	28	43	17.92
	Total	120.000	120.00	240.00	100.00

Table 3 : Experience in farming activities of sample farmers in the Dharmapuri district

Sr. No.	Farming experience	Districts		Total	Percentage
		Pennagram	Morrapur		
1.	Less than 10 years	31	30	61	25.42
2.	10-30 years	68	71	139	57.92
3.	More than 30 years	21	19	40	16.67
	Total	120.00	120.00	240.00	100.00

Table 4 : Size of land holdings of sample farmers in the Dharmapuri district

Sr. No.	Area (ha)	Blocks		Total	Percentage
		Pennagram	Morrapur		
1.	1 to 2	32	34	66	27.50
2.	2 to 5	45	52	97	40.42
3.	5 to 10	35	29	64	26.67
4.	> 10	8	5	13	5.42
	Total	120.00	120.00	240.00	100.00

from weeds and most sensitive to competition during the first year in a plantation, depending upon the intensity of weeds. Three or four weeding is to be taken up at least to keep the basin s free from weeds. Growth of teak could be doubled by giving irrigation during dry months. In the north western zone, intercropping under teak was practiced. From the study area, 26.48 per cent of sample farms could be practiced intercropping with teak and sorghum.

Tamarind cultivation in sample farms :

The tamarind planting was done during the onset of monsoon and harvested after 8 to 10 years. Tamarind is a tree of semi and tropical conditions. Tamarind can be grown in any areas where the temperature reaches 46°C maximum and 0°C minimum. The spacing is 10 × 10 m under intercropping. The weeding and ploughing are necessary in heavy soils. Watering is essential till the onset of monsoon especially in sandy tract. Early planting and establishment by end of monsoon makes the plant to survive till next monsoon. Watering once in 5 to 10 days is sufficient from December to next monsoon. Application of fertilizer boosts up growth immediately. At the end of first year or at the beginning of the third year pruning is essential. Thinning has to be done to get the larger size of straight poles, but farmers are not doing this operation. The trees are felled after felling. From the study area, 39.50 per cent of sample farms could be practiced intercropping with Tamarind and sorghum.

Output and returns were considered from the start of 6th year and onward because during that period, output was produced in such amount that could be marketed. Total discounted returns were derived with total output and price per unit of the product. From Table 5, it could be observed that the total discounted returns for Agri-silviculture I and II and Silviculture model I and II were Rs. 6,52,271.70, Rs. 1182879.00, Rs.5,35,666.80 and Rs. 1067686.00 per hectare, respectively. While comparing these attributes, Agri-silviculture (Both tree and crops) were attained higher amount of total returns than that of silviculture model. Total discounted returns obtained by tree with crops growers were comparatively higher than the discounted returns obtained by only tree alone growers.

In case of Agri-silviculture I and II and Silviculture I and II model, the estimated net present worth were Rs. 4,57,998.80, Rs. 886711.90, Rs. 457998.80and Rs. 908226.10 per hectare. In that study, it was found that the value of NPW was positive indicating viability of tree with crops and tree plantation in

Table 5 : Private benefit and private cost–agroforestry system (in rupees)

Sr. No.	Particulars	Silviculture model-I	Silviculture model-II	Agri-silviculture model – I	Agri-silviculture model- II
		Teak growers	Tamarind growers	Teak with maize growers	Tamarind with sorghum growers
1.	Total discounted costs (Rs./ha)	102893.00	180974.10	194272.90	274652.60
2.	Total discounted returns (Rs./ha)	535666.80	1067686.00	652271.70	1182879.00
3.	Net present worth (Rs./ha)	432773.90	886711.90	457998.80	908226.10
4.	B:C ratio	10.67	5.90	6.59	4.31
5.	Internal rate of return (%)	25%	22%	27%	23%

Table 6 : Social benefit and social cost (in rupees)

Sr. No.	Tree crops	Discounted benefit (12 %)	Discounted cost (12 %)	BCR	IRR
1.	Teak	47560	6044.358	7.86	23 %
2.	Tamarind	12719.9	3931.41	3.23	33 %
3.	Teak + maize	56313	6758	8.33	32 %
4.	Tamarind + sorghum	14246.28	4403.179	3.23	31 %

Table 7 : Intangible benefit and cost (in rupees)

Sr. No.	Composition	Teak	Tamarind	Teak + maize	Tamarind + sorghum
1.	**Intangible cost**				
	Cost of bird scaring	4453	5858	4898	6443
2.	**Intangible benefit**				
	Soil and water conservation	4457	7054	4902	7759
	Agricultural productivity	23804	9832	26184	10815
	Nitrogen fixation	2802	--	3082	-
	Waste assimilation	2469	997	2715	1096
	Carbon store	8547	1097	9401	1206

the study area. It is evident from Table 5 that BCR calculated at the highest value 10.67 for teak growers whereas in, Tamarind it was 5.90, teak with crop were 6.59 and tamarind with crop has 4.31, respectively. This had exhibited that investment in agroforestry practices can be considered substantial and economically justifiable. Internal rate of return was also derived from the above estimated cost and return particulars. IRR value for teak with crop growers were estimated at 27 per cent, whereas, it was 25 per cent, 23 per cent and 22 per cent for teak growers, tamarind with crop growers and tamarind growers respectively and as such the investment in agroforestry is financially viable.

Results of social benefits and social cost analysis are presented in Table 6. External benefit are higher in Teak + maize and Tamarind and hence these crops were topping in the social benefit and cost analysis.

From the Table 7, it could be seen that the intangible cost included cost of bird scaring only. It was higher in case of tamarindand tamarind + sorghum since these two crops provide shelter to birds, have a longer gestation period and being fruit crops, they attract more birds. Composition of intangible benefits is presented in Table 7. Intangible benefits are realized due to soil and water conservation, agricultural productivity of intercrops, nitrogen fixation, waste assimilation and carbon storage. Solanki *et al.* (2014) also worked on the performance of herbal medicinal crops under spota-jatropha based three-tier agroforestry system.

Conclusion :

The economic valuation of agroforestry system was dominated by intangible benefits (social benefits). In India the revenue from forests to government has declined heavily as a result of the introduction of various conservation measures during the last decade. Currently, the accounts in forestry sector show a net deficit. This may be fall out of increasing conservation activities. However, it may be noted that this estimate is mostly based on tangible benefits (timber and non-timber forest products), which is in most cases less than that of intangible benefits . The contribution of forests has to be looked into a wider perspective by considering both tangible and intangible benefits when analysing its benefits and costs.

This paper shows that the contribution of agroforestry to the economy should be viewed through a wider perspective and intangible benefit and cost measures should be incorporated when calculating total revenue. As the contribution of various intangible benefits of agroforestry systems are underestimated or ignored, the economic valuation of these projects has become increasingly important. A major difficulty in achieving this task is the lack of appropriate methods for assessing non-monetary benefits of agroforestry; therefore, it is essential to develop economic valuation methodologies for measuring, intangible benefits and improve methods such as contingent valuation. When social and sustainability aspects are incorporated in the economic analysis of agroforestry, it becomes profitable to the farming society and the country to invest in agroforestry systems.

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