

Financial Evaluation of Short Rotation Tree Crop under Agroforestry System in Tamil Nadu

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Authors' contributions

This work was carried out in collaboration among all authors. Author RDB designed the study, performed the statistical analysis, wrote the protocol and the first draft of the manuscript. Authors VK and KC managed the above. All authors have read and approved the final manuscript.

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ABSTRACT

This paper presents the financial evaluation of short rotation tree crops under agroforestry system. Agroforestry involves the cultivation of two or more plant species with woody perennial in a single fragment of land. Multi-stage purposive sampling technique was employed in selection of the district, blocks and villages based on area under forest cover. Dharmapuri district of Tamil Nadu was taken for this study. Though there are many short rotation tree species grown in the study area, farmers prefer Malabar Neem (*Melia dubia*) for its multiple uses. The prominent agroforestry systems in the study region viz. Agri-Silviculture and Silviculture were selected. The primary data was collected from 80 sample farmers for the agricultural year 2018-19 and the sample respondents were surveyed from January to February, 2020. Financial analysis viz., Benefit-Cost Ratio (BCR), Net Present Worth (NPW) and Internal Rate of Return (IRR) were performed to check the feasibility of the investment in Agri- Silviculture and Silviculture system. The results indicate that additional income (68%) and meeting emergency cash requirement (67%) were the major reasons for adopting short rotation tree crops. The Net Present Worth per hectare in Agri-Silviculture and Silviculture system was Rs. 3,43,823 and Rs.1,97,909. BCR of Agri-Silviculture system has been found to be higher (2.01) than Silviculture system (1.66). Growing Malabar Neem with agricultural

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crops is more beneficial when comparing trees alone, it is capable of providing income round the year in a short span of time. Using tree crops as a contingency fund allows the farmer to meet the unforeseen expenses.

Keywords: Agri-silviculture; benefit cost ratio; net present worth; silviculture.

1. INTRODUCTION

“Agroforestry is a collective name for all land use systems and practices where woody perennials are deliberately grown on the same land management unit as agricultural crops or animals in some form of spatial arrangement or temporal sequence” [1]. Integrating trees with crops aids in amelioration of environmental problems, improves soil fertility, have wider environmental benefits which is on par with natural forest [2,3]. Researchers found that agroforestry has high potential to address current environmental and social concerns, such as climate change and food security. Agroforestry has enhanced diversity and reduced risk which can fulfill the needs of farmers at varying circumstances. The area under agroforestry in India is estimated as 25.32 Million hectare which is 8.2 % of the total geographical area of the country [4]. The forest cover in Tamil Nadu is 26,364.02 Sq.km i.e. 20.27 % of geographical area of the state [5]. In general, farmers willing to adopt fast-growing short-rotation tree crops with prospects of early financial return [6]. Demand for timber in India for 2025 is estimated to be 116 MCM (Million Cubic Metres), forest can meet about 12 MCM while agroforest and plantation can supply 90 MCM, leaving a deficit of 14 MCM [7]. The demand for wood-based products in Tamil Nadu is 8-10 lakh tonnes of wood pulp per year, while the availability is 4 lakh tonnes [8]. The major source of this wood pulp includes *Eucalyptus spp.* and *Casuarina spp* with poor productivity and long rotation period. To deal with these drawbacks indigenous trees like Malabar Neem (*Melia dubia*) can be potentially used as alternate sources of raw materials for pulp and paper industry [9]. The traditional agriculture has become less viable due to economic, environmental and social issues. In order to address these issues the farmers must opt for diversified agricultural practices. In this background the present study was conducted with the objective to work out the financial feasibility of the agroforestry system.

2. METHODOLOGY

2.1 Study Area

The study was conducted in Dharmapuri district of Tamil Nadu state, located approximately between 11° 47' and 12°33' of the North Latitude and between 77° 02' and 78°40' East longitude. The total geographical area of the district is 4497 Sq.km. The district accounts for 12.58 % (3,318.75 Sq.km) to the total forest cover in Tamil Nadu [5]. Two blocks namely Morappur and Pennagaram were selected purposively. The villages practicing agroforestry was collected from the Forest rangers of the respective blocks and the study villages were selected randomly. The prominent agroforestry systems followed in this region are Agri-Silviculture and Silviculture. In Agri-silviculture system Malabar Neem with maize is selected for the study. In Silviculture system Malabar Neem alone is taken as pure tree crop.

2.2 Data Collection

Multistage purposive sampling adopted for the selection of district and two blocks. Preliminary information pertinent to the study area was collected to explore the possibility of conducting the study. To examine the role of agroforestry 80 sample farmers were interviewed randomly from ten selected villages, the sample was equally distributed in the agroforestry systems and the selected blocks. Using the structured and well defined questionnaire the primary data was collected for the year of 2018-19. The needed information such as family labour force, number of dependents, input use and cost of cultivation of agroforest enterprise, details regarding tree growing, labour supply and consumption were collected during primary survey.

2.3 Analytical Tools

The data generated from the study were analyzed using descriptive statistics viz., averages and percentages and financial feasibility analysis [10,11]. Economics of agroforestry is more complex because it involves

both trees and crops with a time lag between establishment and benefits harvested. For financial analysis farmers at different years of plantation were monitored at the same year as time between planting and harvesting benefits was too long [12]. Tree yields were recorded from farmers who have harvested the yields during the past three years. To study the subsistence oriented agroforestry system, Net Present Worth (NPW), Benefit Cost Ratio (BCR), and Internal Rate of Return (IRR) are the most important discounting measures and it has been used in this study [13]. The discount rate of 12 % was used for this study, and it is the lending rate of long term loans in commercial banks [14]

3. RESULTS AND DISCUSSION

Both social and economic factors have been considered on studying the agroforestry systems [15]. Socioeconomic characteristics of the sample respondents were investigated viz. age, education, family size, annual income, farm size, agroforest land size [16,17]. The descriptive statistics of the socio-economic variables were presented in Table 1.

3.1 Malabar Neem Cultivation in Sample Farms

In the study area Malabar Neem trees are planted at the spacing of 12x12 feet. As the tree grows the branches are pruned periodically to get straight pole. Farm Yard Manure is applied at 10kg/tree once a year up to 5 years. Weeding is

done twice the year while survival rate of the trees is 92 %. During fifth and sixth year 20 percent of the trees can be harvested, remaining trees are harvested during the seventh year. The total yield is the sum of all the yields from initial harvest to the final felling. Maize is grown as an intercrop for one season up to fifth year. The economic yield from trees is obtained from 5th year onwards and hence the output and returns were considered from the start of 5th year while income from maize is realized from first year itself.

Paired t test analysis (Table 2) showed that Cost and Returns for Silviculture and Agri-Silviculture systems were statistically different (P≤ 0.05) where the cost and returns for Agri-Silviculture system was higher than the Silviculture system.

$$Net\ Present\ Value = \sum_{t=1}^n \frac{(B_t - C_t)}{(1 + r)^t}$$

$$Benefit\ Cost\ Ratio = \frac{\sum_{t=1}^n \frac{(B_t)}{(1 + r)^t}}{\sum_{t=1}^n \frac{(C_t)}{(1 + r)^t}}$$

$$Internal\ Rate\ of\ Return = \sum_{t=1}^n \frac{(B_t - C_t)}{(1 + r)^t} = 0$$

B_t = Benefits in each year, *C_t* = Cost in each year, *r* = Discount rate, *t* = 1, 2, 3, *n*, *n* = number of years, *Rs* - Indian Rupees

Table 1. Socio-economic characteristics of the sample respondents

Characteristics	Measuring system	Observed range	Mean	Standard deviation
Age	Years	32 - 64	51.48	9.29
Education	Level of schooling	1 - 15	7.04	3.78
Family size	Numbers	3 - 8	4.92	1.27
Annual income	Indian Rupees	60,000 – 6,30,000	2,66,250	1,65,616.42
Farm size	Hectars	2 – 13.36	4.63	2.40
Agroforestry land size	Hectares	0.86 – 1.55	1.18	0.17

Table 2. Paired t – test analysis of cost and returns for silviculture and agri-silviculture model

Particulars	Model	Mean (Indian Rupees)	T - test	P - value
Cost	Silviculture	40508.47	-7.29	0.00001
	Agri-Silviculture	70565.76		
Returns	Silviculture	80058.88	-2.73	0.003
	Agri-Silviculture	156765.34		

From Table 3, it is observed that the total discounted cost for Agri-Silviculture system (Rs.2,99,437 per hectare) is higher than the Silviculture model (Rs.1,96,225 per hectare) because it involves two components i.e. trees and crops. The total discounted returns for Silviculture and Agri-Silviculture system was Rs.3,25,050 and Rs.6,00,872 per hectare, respectively. Total discounted returns obtained by growing tree with crop were comparatively higher than the discounted returns obtained by farmers who have grown trees alone.

3.1.1 Comparison of financial position of the Agroforestry systems

Net Present Worth (NPW) is the key criterion to choose the enterprise while IRR and BCR are ratios which can mislead the result, as it does not indicate the scale of investment or return [18]. The NPW for Silviculture and Agri-Silviculture system were Rs.1,97,909, and Rs.3,43,823 per hectare respectively. It was found that the value of NPW was positive indicating viability of both Silviculture and Agri-Silviculture system in the study area.

B-C Ratio for Malabar Neem with maize crop is 2.01% whereas 1.66 % in Malabar Neem alone. This shows that investment in agroforestry practices can be considered economically justifiable. This was in contrast to the result of Rani et al. [19], B:C ratio of Poplar (a short rotation tree with rotation period of 5 to 6 years) was higher than Poplar intercropped with agricultural crops.

IRR criterion is considered to be inferior to the NPW approach for profitability analysis; high IRR value does not ensure high profitability [20]. IRR of the plantations remains higher in shorter rotation [21]. Six years old poplar intercropped with paddy and wheat recorded an IRR of about 389 %, which is due to short rotation of agricultural crop [22]. The internal rate of return for Malabar Neem growers is 29.71 % whereas for Malabar Neem with maize growers the IRR was estimated at 140.46% respectively and such investment in the agroforestry is financially viable.

The result was in line with the study conducted by Khullar [23], in Punjab, trees intercropped with crops was the most economical than growing trees alone, but both land use systems were

more profitable than conventional cropping system.

3.2 Motives for Adopting Agroforestry

Adoption of agroforestry helps households to fulfill their subsistence and consumption needs in terms of energy and nutrition, so it is considered as efficient land use system. It also serves as a safety net at the times of crises i.e. provides income during crop failure [24]. The motivating factors for the adoption of agroforestry are higher production and income, risk proofing capability and self-sufficiency in terms of food, fodder, fuel and timber production [25]. In the study area majority of farmers (68%) reported that agroforestry as a source of additional income (Fig. 1). This is consistent with the findings of the study conducted by Mahmood and Zubair [26] in Indus River Basin, Pakistan. Another benefit from adoption of agroforestry is to fulfill the immediate emergency cash requirement (67%). The adoption of agroforestry requires less labour; this is another motivating factor expressed by 57 % of the respondents. The other reasons which are less common are agroforestry provides fuel wood and crops are affected by less pest and disease incidence (less than 20%).

3.3 Limitations in Adoption of Agroforestry

There are some limitations faced by the agroforestry adopters which influenced the other farmers' adoption. Poor technical knowhow faced by the farmers for growing tree crops lowers the effectiveness of agroforestry initiatives [27]. Non availability of quality seedlings and lack of irrigation water during early stages of tree establishment hamper the scaling up of agroforestry [25,28]. The study on challenges affecting the adoption of agroforestry in Kenya, Masibo et al. [29] highlighted that managerial problems, less availability of quality seedlings, damages by animals and human beings and natural calamities are the major issues. In this study over 95% of the respondents reported that drought was the major limitation in establishing Malabar Neem. The other issues perceived were lack of technical knowledge (54%), animal grazing (49%), unavailability of quality saplings (23%) and inadequacy of saplings (less than 10%). Some respondents also indicated that crop raiding by the wild animals is a critical issue unique to the study site near forest (Fig. 2)

Table 3. Financial analysis of Malabar Neem based agroforestry system

Age of the trees	Silviculture system (Malabar Neem)				Agri – Silviculture system (Malabar Neem + Maize)			
	Cost (Rs/ha)	Benefit (Rs/ha)	Discounted cost (Rs/ha)	Discounted benefit (Rs/ha)	Cost (Rs/ha)	Benefit (Rs/ha)	Discounted cost (Rs/ha)	Discounted Benefit (Rs/ha)
1	53625		47879	0	81474	75258	72744	67194
2	47434		37814	0	77182	73535	61529	58622
3	43466		30938	0	73969	77134	52650	54902
4	48208		30637	0	76331	77292	48510	49525
5	46164	117325	26194	66573	72686	197649	41244	112152
6	44924	140790	22760	71328	44924	140790	22760	71329
7	0	413725	0	187148	0	413725	0	187148
Total			196225	325050	Total		299437	600872
NPW (Rs/ha)			197909		NPW (Rs/ha)		343823	
BCR			1.66		BCR		2.01	
IRR (%)			29.71		IRR (%)		140.46	

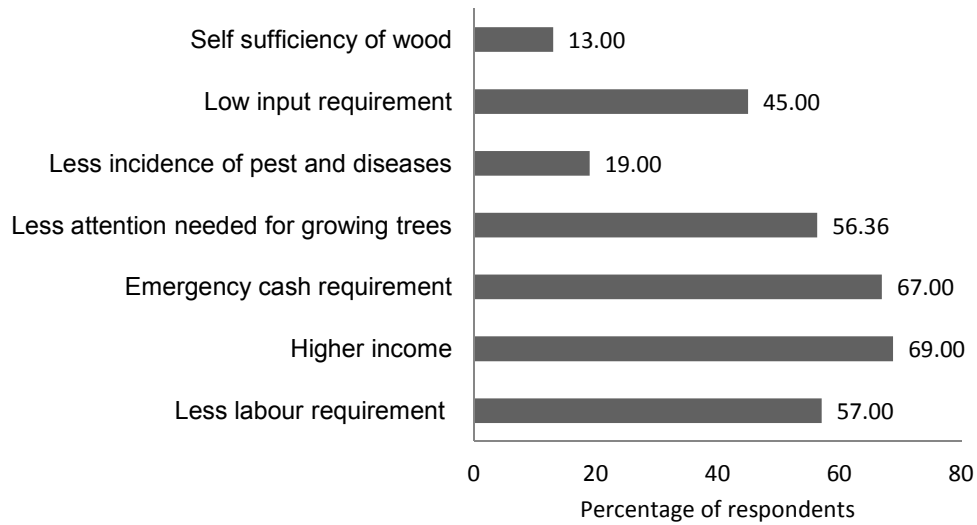


Fig. 1. Motives for adoption of agroforestry

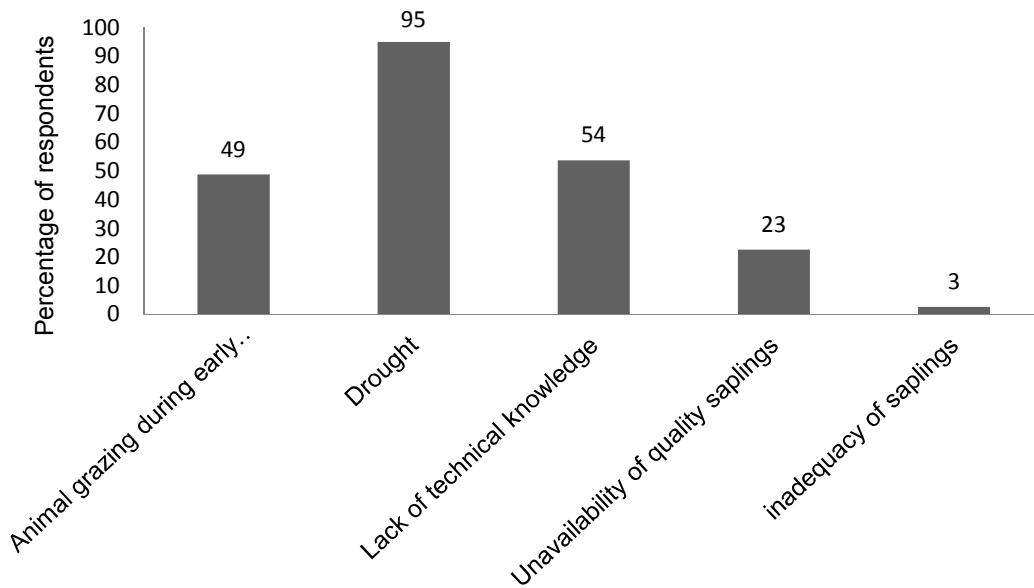


Fig. 2. Limitations in establishing Malabar Neem

4. CONCLUSION

To reduce deforestation and to meet the growing demand for timber, fuel wood and fodder, changes in land use system is needed to achieve the ecological and economic sustainability. On the other hand today's agriculture is characterized by reduced income due to, increase in cost of cultivation and increase in transportation cost. In order to address these issues, cultivation of trees with crops can be

undertaken. Malabar Neem based agroforestry systems play an important role in the socio-economic development of people and aids in preserving ecological system as well. The response of farmers to Malabar Neem based agroforestry in the study area on highly fertile land shows that need based, market oriented tree farming will be accepted by farmers. They are more concerned about their personal income than community benefit. *Melia dubia* inter cropped with maize shows maximum net returns

and improved monetary returns due to the additional advantage of value added products in the form of timber [30]. It is noted that in the study area, the average farm size of the farmers practicing agri-silviculture system is less when compared to the silviculture system, but the former is getting higher returns than latter; this may be due to the agri-silviculture farmers are more aimed at attaining higher income as possible from the available land. Thus agroforestry has evolved with sustainability.

Preannounced prices from wood-based industries can encourage the farmer to invest more in agroforestry. Further, strengthening of existing extension system is required to promote agroforestry. Finally, the farmers who have attained higher yields in agroforestry can be honored with awards as like Jaivik India Awards given for best organic farmers. This will enrich the competence among the states to promote agroforestry.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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