Economics and Financial Feasibility of Major Pulpwood Trees Cultivation in Tamil Nadu

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The main raw material for manufacture of paper is wood pulp which are mainly obtained from the pulpwood trees like Casuarina, Eucalyptus and *Meliadubia*. In Tamil Nadu, the cultivation of these pulpwood trees was promoted by two leading paper manufacturing industries viz., Tamil Nadu Newsprint and Paper Limited (TNPL) and Seshasayee Paper and Boards Limited (SPB).This study aims at estimating the cost, returns and financial feasibility of major pulpwood tree species cultivated in Tamil Nadu. The study found that the cost of cultivation of casuarina, eucalyptus and *Meliadubia* were Rs.1,76,939, Rs.1,60,593 and Rs.1,52,672 and the net income obtained from these trees were Rs.1,58,473, Rs.1,37,028 and Rs.1,33,831 respectively. Among these trees, Casuarina is more profitable and the results of the study concluded that the cultivation of these three major pulpwood trees are profitable and financially viable.

Keywords: Cost of cultivation; Casuarina; Eucalyptus; Meliadubia; Pulpwood; financial feasibility.

1. INTRODUCTION

Pulpwood is timber with the principal use of making wood pulp for paper production. The wood pulp used for paper production is made from breaking down the fibrous part of plants, primarily trees, which are the main ingredients in the papermaking process. Pulp made from trees

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is the most common source of fibre for papermaking and the base for many paper and wood products. The global forest area has decreased from 4.28 billion ha in 1990 to 3.99 billion ha in 2015, however, the demand for timber and forest products is expected to have more than triple by 2050 due to the growing world population and changing patterns of consumption [1]. The anticipated production and demand of paper in India will be 39.7 and 43.9 million tonnes respectively during 2027 which creates huge gap in supply and demand [2].

Demand and supply of industrial wood is increased at higher pace after outlawing the harvesting of green timber from the reserved as well as private lands of India through the implementation of National Forest Policy 1988. Forest Survey of India (FSI, 2011) report states that as being 21 per cent of forest area contributes only 3 million cubic meter wood (approximately 6 percent) and remaining 44 million cubic meter wood comes from agroforestry sector of the country.

The demand for furniture, paper and fire wood has been rising between 8-12 percent annually [3]. This leads towards cultivating the various commercial tree species viz., poplar, eucalyptus, melia, dalbergia, teak, bamboo and casuarina trees outside the forest area through captive industrial plantation as well as agroforestry [4]. Among the cultivation of commercial tree species, Casuarina, Eucalyptus and *Meliadubia* are the major pulpwood trees extensively cultivated throughout the India [5].

There are around 39 paper mills in Tamil Nadu, out of which two paper mills viz., Tamil Nadu Newsprint and Papers Ltd, Karur and Seshasayee Paper and Boards Ltd, Erode are the wood based paper industries. The cultivation of pulpwood trees is being promoted by these two leading paper industries through the farmer-industry interface. The farmer-industry interface is in collaboration between two entities in order to share cultivation technology, costs, risks and benefits [6].

India is likely to face severe shortage of supply of timber to meet its requirement from both domestic and international front. Global demand for wood is increasing at an annual rate of 1.7% [7]. The demand for timber was increased from 58 million cubic meters in 2005 to 153 million cubic meters in 2020 [8]. The current supply of raw materials for pulpwood industries in the country is far behind the demand [9]. Thus, implementing tree farming outside the forest is a crucial need towards restoring the underutilized, deteriorated wastelands into green cover. Moreover, by establishing fresh pulpwood sources outside the forest area is important activity to preserve natural forest without being disturbed [10]. In addition to the commercial importance, this helps in preventing temperature rise and greenhouse gas emission into the atmosphere [11].

Hence, the present study has planned to estimate the economics of cost of cultivation and financial feasibility of major pulpwood tree species in Tamil Nadu.

2. DATA AND SAMPLING DESIGN

The pulpwood trees are widely cultivated as a raw material for the paper industries in Tamil Nadu. For the present study, Erode and Villupuram districts are randomly selected to study the economics of production of Casuarina, Eucalyptus and *Meliadubia* in Tamil Nadu. Casuarina is widely grown in Villupuram district and Eucalyptus &*Meliadubia* are widely grown in Erode district. There are about 60 farmers for each tree species were randomly selected for the study. Totally, 180 farmers were selected and interviewed through personal interview method during the months of April 2022 to June 2022.

3. METHODOLOGY

The various tools of analysis used for the present study were discussed below.

3.1 Conventional Analysis

The conventional analysis such as percentage and average analysis were used to study the socio-economic profile status of sample farmers and cost of cultivation of pulpwood trees.

3.2 Cost of Cultivation

Cost of cultivation is the total expenditure incurred right from planting to harvesting the tree. It is worked out from cost of input materials such as seedlings, planting, fertilizers, insecticides, pesticides and labour cost and it is expressed in Rs./ha. The various costs taken into account for cost of cultivation were listed below.

a. Land preparation cost
b. Wages paid for engagement of human labour

c. Cost of seedlings and its transportation
d. Machinery cost (hired cost)
e. Cost of fertilizers, herbicides and plant protection chemicals
f. Irrigation cost
g. Cost for Pruning, Harvesting and transportation

3.3 Returns

Two types of returns were estimated:

a. Gross returns: Estimated based on the quantity of pulpwood harvested multiplied the price received by farmers.
b. Net returns: It is the difference between gross return and total cost.

3.4 Financial Feasibility Analysis

The financial feasibility of pulpwood tree plantations were measured through three discounted parameters namely, Net Present Value (NPV), Benefit - Cost Ratio (BCR) and Internal Rate of Return (IRR).

3.4.1 Net Present Value (NPV)

Net Present Value is the difference between the sum of discounted benefits and sum of discounted costs at given discount rate. The positive net present value indicates that the investment is financially viable. The formula to calculate NPV is given below:

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

Where,
B_t = benefits obtained by the farmers due to pulpwood tree cultivation in year 't'

C_t = costs in the pulpwood tree cultivation in year 't'
r = discount rate
t = number of years

3.4.2 Benefit Cost Ratio (BCR)

The benefit cost ratio is analyzed to determine whether the pulpwood tree cultivation is economically viable or not. BCR is the ratio of sum of discounted benefits to sum of discounted costs at given discount rate. If the benefit cost ratio is greater than one, then the cultivation of pulpwood trees is found to be economically feasible. The formula for B-C ratio is given below.

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

Where,
B_t = benefits of the farmers in pulpwood tree cultivation in the year t
C_t = costs of the farmers in pulpwood tree cultivation in the year t
r = Discount rate
t = number of time periods

3.4.3 Internal Rate of Return (IRR)

The internal rate of return is defined as the rate of discount which makes the net present worth of the cash flow equal to zero. The cultivation of pulpwood tree species is viable, if the calculated IRR is greater than the opportunity cost of capital i.e., the bank interest rate. The formula to calculate IRR is given below.

$$IRR = \left\{ \begin{array}{l} Lower \\ discount \\ rate \end{array} \right\} + \left\{ \begin{array}{l} Difference \\ between \quad two \\ discount \quad rates \end{array} \right\} \left\{ \frac{present \quad worth \quad at \quad lower \quad discount \quad rate}{Absolute \quad difference \quad between \quad networth \quad of \quad two \quad discount \quad rates} \right\}$$

4. RESULTS AND DISCUSSION

The details of socio-economic characteristics of sample respondents, analysis of costs, returns and financial feasibility for the cultivation of Casuarina, Eucalyptus and *Meliadubia* trees were worked out and the results are presented in the following section.

4.1 Socio-economic Profile Status of the Sample Respondents

The socio-economic profile status of the pulpwood tree sample respondents were furnished in Table 1. The age of the respondents is an important demographic factor and the sample farmers are grouped under four categories viz., age less than 35 years, 35 to 45 years, 45 to 55 years and more than 55 years. It could see from the Table 1 that the majority of sample pulpwood tree farmers (50 percent) were aged between 36 and 45 years followed by farmers with age between 46 and 55 years (26.1 percent) and 17.8 percent of the farmers were aged below 35 years. Only 6.1 percent of the farmers were aged above 55 years.

The gender of the sample respondents is an another important demographic factor and it could seen from the Table 1, that the majority of the sample pulpwood tree farmers are male (91.7 percent) and only 8.3 percent are female. The size of the family has important implications to realize the income and family labour availability of the sample households. It can be seen from the Table 1, that the family size of less than 4 members accounted for 46.7 percent of the sample farmers followed by the family size above 6 members (41.1 percent) and between 4 and 6 members (12.2 percent).

4.2 Costs of Cultivation for *Casuarina*

The total cost incurred for the cultivation of Casuarina trees per hectare were presented in the Table 2.

It could be seen from the Table 2, that the total cost of cultivation (per hectare) for Casuarina was Rs.1,76,939. Among the different costs incurred, the cost for harvesting and transportation of trees shares highest (42.51 percent) followed by pruning (9.78 percent), irrigation (9.72 percent), weeding (7.54 percent) and planting materials (6.82 percent). The lowest cost incurred among the cost of cultivation of Casuarina was gap filling (0.56 percent) followed by cost for transportation of planting materials (0.92 percent).

4.3 Cost of Cultivation for Eucalyptus

The total cost incurred for the cultivation of Eucalyptus trees were presented in the Table 3.

It could see from the Table 3, that the total cost of cultivation (per hectare) of Eucalyptus was Rs.

1,60,593. The results of the study indicated that the costs incurred for harvesting of trees shares highest (40.32 percent) followed by irrigation charges (11.79 percent), weeding (7.87 percent), pit and planting (7.18), land preparation (5.79) and cost of fertilizer application (5.69).

4.4 Costs of Cultivation for *Meliadubia*

The total cost incurred for the cultivation of *Meliadubia* trees were presented in the Table 4.

The year wise distribution of cost for the cultivation of *Meliadubia* is presented in Table 4. The study reveals that the cost incurred during the first year was Rs.51,760 which is mainly for the land preparation, seedlings, pit making and planting and irrigation purposes. The sample respondents also indicated that the high shares of costs incurred during the second year was mainly for pruning the side branches. Among the four years, the costs incurred for harvesting and transportation was Rs.63,541 which shares about 41.62 percent of the total cultivation.

4.5 Yield and Returns of *Casuarina*, *Eucalyptus* and *Meliadubia* Cultivation

The total yield and returns obtained from the cultivation of Casuarina, Eucalyptus and *Meliadubia* were compared and presented in Table 5. It could seen from the table 5, that the average yield of sample respondents obtained for Casuarina cultivation was 94 tonnes/ha. The paper industries paid Rs.3500 per tonne for the sale of wood which fetches the income of Rs.3,29,000/ha. Further, the sample farmers indicated that the sale of pruned materials, which are unfit for paper production are sold to other private parties which gives the income of Rs.6412/ha. Thus, the gross income obtained from Casuarina cultivation was Rs.3,35,412/ha. The net income earned by Casuarina farmers was Rs.1,58,473/ha. The results of the study indicated that the production of one tonne of Casuarina wood requires the cost of Rs.1882 and it gives the net income of Rs.52,824 per year from one hectare of Casuarina cultivation.

The average yield (Table 5) of sample respondents for Eucalyptus cultivation was 82 tonnes/ha and it was sold to paper industries for the amount of Rs.3500 per tonne which fetches the income of Rs.2,87,000/ha. Further, the sample farmers indicated that the income earned from the sale of pruned materials was

Table 1. Socio-economic profile of sample respondents

S. No	Category	Casuarina		Eucalyptus		Meliadubia		Total	
		No. of farmers	%	No. of farmers	%	No. of farmers	%	No. of farmers	%
Age (Years)									
1.	Below 35	12	20.00	11	18.30	9	15.00	32	17.80
2.	36 – 45	32	53.30	29	48.40	29	48.40	90	50.00
3.	46 – 55	12	20.00	17	28.30	18	30.00	47	26.10
4.	Above 55	4	6.70	3	5.00	4	6.60	11	6.10
Total		**60**	**100**	**60**	**100**	**60**	**100**	**180**	**100**
Type of Gender									
1.	Male	58	96.70	56	93.30	51	85.00	165	91.70
2.	Female	2	3.30	4	6.70	9	15.00	15	8.30
Total		**60**	**100**	**60**	**100**	**60**	**100**	**180**	**100**
Family size (Numbers)									
1.	Below 4	31	51.70	26	43.30	27	45.00	84	46.70
2.	4 to 6	9	15.00	9	15.00	4	6.70	22	12.20
3.	Above 6	20	33.30	25	41.70	29	48.30	74	41.10
Total		**60**	**100**	**60**	**100**	**60**	**100**	**180**	**100**

Table 2. Distribution of year wise costs incurred for Casuarina Cultivation (Rs./ha)

S. No	Particulars	Year I	Year II	Year III	Total Cost	Percentage share to total cost
1.	Land Preparation	9108			9108	5.15
2.	Planting materials	12062			12,062	6.82
3.	Seedling Transportation	1631			1631	0.92
4.	Pit &Planting	11715			11,715	6.62
5.	Gap Filling	956			956	0.56
6.	Irrigation	9657	7550		17,207	9.72
7.	Fertilizers	4550	4079		8629	4.87
8.	Weeding	7845	5505		13,350	7.54
9.	Pruning		8854	8466	17,320	9.78
10.	Plant Protection Chemicals	4959	4791		9750	5.51
11.	Harvesting & transportation			75,211	75,211	42.51
Cost of Cultivation		62,483	30,779	83,677	1,76,939	100.00

Table 3. Distribution of year wise costs incurred for *Eucalyptus* cultivation (Rs./ha)

S.No.	Particulars	Year I	Year II	Year III	Year IV	Total Costs	Percentage share to total cost
1.	Land Preparation	9300				9300	5.79
2.	Planting materials	6000				6000	3.74
3.	Transportation	1675				1675	1.04
4.	Pit &Planting	11528				11,528	7.18
5.	Gap filling	754				754	0.48
6.	Irrigation	10465	8480			18,945	11.79
7.	Fertilizers	4644	4359			9003	5.61
8.	Weeding	7408	5237			12,645	7.87
9.	Pruning		8649	8715		17,364	10.81
10.	Plant Protection Chemicals	4493	4132			8625	5.37
11.	Harvesting and transportation cost				64,754	64,754	40.32
	Cost of Cultivation	56,267	30,857	8715	64,754	1,60,593	100

Table 4. Distribution of year wise costs incurred for *Meliadubia* cultivation (Rs./ha)

S.No.	Particulars	YearI	Year II	Year III	YearIV	Total Costs	Percentage share to total cost
1.	Land Preparation	9125				9125	5.97
2.	Planting materials	6944				6944	4.55
3.	Transportation	1610				1610	1.05
4.	Pit &Planting	11868				11,868	7.77
5.	Gap filling	846				846	0.58
6.	Irrigation	8456	7553			16,009	10.48
7.	Fertilizers	4340	4069			8409	5.51
8.	Weeding	4546	4218			8764	5.74
9.	Pruning		8740	8659		17,399	11.39
10.	Plant Protection Chemicals	4025	4132			8157	5.34
11.	Harvesting & transportation Cost				63,541	63,541	41.62
	Cost of Cultivation	51,760	28,712	8659	63,541	1,52,672	100

Table 5. Comparison of yield and returns of *Casuarina, Eucalyptus* and *Meliadubia* cultivation (per ha)

S.No.	Particulars	Casuarina	Eucalyptus	Meliadubia
1.	Yield (tonnes)	94	82	80
2.	Price (Rs./tonne)	3500	3500	3500
3.	Income from sale of wood (Rs.)	3,29,000	2,87,000	2,80,000
4.	Income from pruned materials during II and III year (Rs.)	6412	6415	6503
5.	Gross Income(Rs.)	3,35,412	2,93,415	2,86,503
6.	Total Cost (Rs.)	1,76,939	1,60,593	1,52,672
7.	Cost of production (Rs./tonne)	1882	1958	1908
8.	Net Income (Rs.)	1,58,473	1,37,028	1,33,831
9.	Net income per year (Rs.)	52,824	34,257	33,458

Table 6. Financial Feasibility of *Casuarina, Eucalyptus* and *Meliadubia* cultivation

S.No.	Financial Indicators	*Casuarina*	*Eucalyptus*	*Meliadubia*
1.	Net Present Value (Rs.)	99,138	65,045	67,211
2.	Benefit Cost Ratio	1.71	1.53	1.58
3.	Internal Rate of Return (%)	79	41	44

Rs.6415/ha which are unfit for paper production. Thus the gross income obtained from Eucalyptus cultivation was Rs.2,93,415/ha. The net income earned by Eucalyptus farmers was Rs.1,37,028/ha. The results of the study indicated that the production of one tonne of Eucalyptus wood requires the cost of Rs.1958 and it gives the net income of Rs.34,257per year from one hectare of Eucalyptus cultivation.

The average yield (Table 5) of *Meliadubia* cultivation was 80 tonnes/ha and it was sold to Rs.3500 per tonne. The average gross income of sample respondents obtained from *Meliadubia* cultivation was Rs.2,86,503/ha which was from the sale of main pulp wood (Rs.2,80,000/ha) and the sale of pruned materials (Rs.6503/ha). The net income earned by *Meliadubia* farmers was Rs.1,33,831/ha. The results of the study indicated that the production of one tonne of *Meliadubia* wood requires the cost of Rs.1908 and it gives the net income of Rs.33,458 per year from one hectare.

4.6 Financial Feasibility

The financial feasibility of any long term investment is generally estimated through discounted measures namely Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR). In this study, a discount rate of 12 per cent is considered. The results of the financial feasibility of Casuarina, Eucalyptus, *Meliadubia* are presented in Table 6.

It could seen from the Table 6, that the net present value of Casuarina, Eucalyptus and *Meliadubia* cultivation was Rs.99,138, Rs.65,045 and Rs.67,211 respectively indicated the positive value implies that the investment made in the cultivation of above three pulpwood tree species are financially worthy. The benefit cost ratio was estimated to be 1.71, 1.53 and 1.58 for the cultivation of Casuarina, Eucalyptus and *Meliadubia* respectively and it shows above one indicates the financial viability of the pulp wood trees cultivation.

The IRR (Table 6) is another measure of financial viability of the investment estimated to be 79, 41 and 44 percent for the cultivation of Casuarina, Eucalyptus and *Meliadubia*. These IRR values are higher than the discount rate (12 percent) implying that the investment made in the Casuarina, Eucalyptus and *Meliadubia* cultivation is financially viable one.

5. CONCLUSION

Among these three pulpwood trees, Casuarina is the most profitable one than the others. Even though it is incurring more costs than the other two but due to its high yielding potential and less duration compared to other two pulpwood trees the financial viability for casuarina was comparatively high so the farmers are getting more profits from Casuarina compared to other pulp wood species. After Casuarina, Eucalyptus is the next highly profitable tree which is used as a dual purpose tree known for paper production and oil extraction. The average gross income of sample respondents obtained from *Meliadubia* cultivation was Rs.2,86,503/ha which was from the sale of main pulp wood and the sale of pruned materials. The financial feasibility measures namely Net Present Value, Benefit Cost Ratio and Internal Rate of Return indicated that the investment on cultivation of Casuarina, Eucalyptus and *Meliadubia* was financially viable. This study would help the policy makers to fix the price per tonne based on cost of production and the feasibility analysis would help to evaluate the financial viability of these pulpwood trees cultivation.

CONSENT

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

COMPETING INTERESTS

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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