

Enhancing Farm Profitability through Boundary Plantation of Poplar and Eucalyptus in Punjab

Preet Kamal Singh Bhangu, Namami Gohain and Manjeet Kaur

Department of Economics and Sociology, Punjab Agricultural University, Ludhiana

Abstract

Punjab is an agricultural state having 5.93 per cent area under forest cover during 2021 as against the recommendation of 20 per cent. To increase the area under forests, the only feasible solution would be the adoption of different agroforestry practices. The present study is an attempt to examine the financial viability of boundary plantation of poplar and eucalyptus. The study is based on a primary survey of 100 farmers selected from two major agroforestry-based districts namely Ludhiana and Hoshiarpur. It was found that boundary plantation of both poplar and eucalyptus was financially viable as it provided extra income to the farmers at negligible cost. Moreover, poplar was more profitable as compared to eucalyptus owing to its short gestation period.

Keywords: Agro-Forestry, Poplar, Eucalyptus, Net Present Value, Annuity Value

JEL classification: L73, O13, Q13, Q23

Introduction

The National Forest Policy of India, 1988 envisaged a goal of achieving 33 per cent of the geographical area of the country under forest and tree cover, yet only 24.3 per cent of country's geographical area has been reported to be under forest cover in the year 2020 (India State of Forest Report 2021). In India, the gap between demand and supply of fuel wood, timber and raw material for wood-based industries is widening which has led to an increase in the pressure on existing forest resources. To reduce this pressure, Gera and Bhojvaid 2013, emphasized on afforestation programs as well as exploring plantation options outside forests. Hence, tree species which grow rapidly like poplar and eucalyptus etc are being planted for afforestation of farm and community lands through farm forestry and social forestry programs (Dhanda 1999). Poplar (*Populus deltoids*) and Eucalyptus have become important tree components of the agro-forestry systems in north-western part of the country due to high returns, short gestation period, compatibility with farming systems and good market demand (Dhiman 2013).

Punjab being an agricultural state has contributed significantly in food-grain production of India. Wheat and paddy occupy more than 80 per cent of the cropped area of the state and only 5.93 per cent area is under forests as against the recommendation of 20 per cent. In recent times, the excessive use of chemicals in rice-wheat rotation has led to a

depletion and deterioration of soil health and water resources of the state. At the same time, the state has also witnessed a surge in the demand for timber, fuel and other tree-based products. As a result, the Agriculture Diversification Policy prepared by state government has envisaged removing 12 lakh hectares of land from paddy cultivation and bringing 1.4 lakh hectares under tree plantation besides the area allocation under other crops. Additionally, the state government has also decided to abolish the rural development fee being levied on the purchase of wood from the wood market yard in the state to boost timber trade (The Tribune, September 15, 2013). However, it is not possible to divert the fertile arable lands to forests and the only feasible alternative would be adoption of agro-forestry practice.

Eucalyptus is grown on water logged or sub soils in Punjab and the agro-forestry system in which eucalyptus has been grown may have adverse effects on environment like soil degradation, decline of groundwater level and decrease of biodiversity. Moreover, industries have taken up poplar and eucalyptus for commercial agroforestry due to their wide acceptance and great market potential. Genetically improved clonal planting stocks of poplar and eucalyptus have transformed the average productivity (nearly 20-25 times higher compared to the average productivity of forests in India) and profitability of plantations. Almost 50 million plants of improved eucalyptus are being planted every year (Dhyani et al 2013). Although, the progressive farmers of Punjab and adjoining states have adopted agroforestry yet,

less than one per cent area of the state is under the system. This situation reflects the difficulty faced by a new system (agro-forestry) to enter the traditional system (rice-wheat rotation). The adoption of any new system depends upon the user's awareness level, attitudinal behaviour, positive perception and above all the capacity to take risk and overcome the constraints.

Proper blending of forestry with ongoing agriculture is the right way to increase the area under agroforestry in Punjab. In Punjab, farmers carry out two types of eucalyptus and poplar plantations namely block and boundary plantation. A study conducted by Kumar (2005) found that the profitability of any agroforestry system is plagued with many problems at the production stage which increases the costs and lower the productivity of trees. Hence in this backdrop the present study has been conducted to analyse the cost and return structure of boundary plantation of poplar and eucalyptus; to study the extent of yield reduction in case of boundary plantation and to check the financial viability of both types of trees in relation to the state's agro-ecosystem.

Data Sources and Methodology

The study is based on primary survey conducted in two districts of Punjab namely Ludhiana and Hoshiarpur from June- August, 2023. Both these districts are among the main hub of agroforestry plantation of poplar and eucalyptus. To study the financial viability of boundary plantation of both poplar and eucalyptus, 50 farmers from each district were selected thus making the total sample size to 100 farmers. Data on both establishment cost of both poplar and eucalyptus (cost of sapling, fertilizer and manure, pesticide usage, transplantation) and operational cost of pruning in poplar was recorded. Likewise, the returns from both the selected crops were collected. In Punjab boundary plantation of poplar and eucalyptus is done in three ways namely one-side, two-side and four-side plantations where the number of trees varied with the size of plot and location of land. Most commonly, farmers opted for boundary plantation of poplar and eucalyptus either road side or along water channels. Moreover, four-side plantation was very rare and it was usually practised in plots where farmers cultivated shade loving crops like turmeric and around the newly established orchards. The number of trees grown in boundary plantation ranged from 35 to 400 plants where the spacing between two plants ranged from 5.5 to 8 feet. For ease of calculation, the economics of 100 plants were calculated. To achieve the objectives of the study, simple tabular analysis and various statistical techniques have been used which are discussed as under.

- 1. Cost and Returns from poplar and eucalyptus:** Simple average method was applied to calculate cost and return structure of poplar and eucalyptus cultivation.
- 2. Financial viability of agro-forestry:** To assess the

financial viability of poplar and eucalyptus, the following techniques were used:

- i) Net Present Value (NPV):** It is the present value of net benefits that the project will generate over and above that would be available, if the amount proposed to be invested in the project is invested at the current rate of interest elsewhere. In NPV, each item of the costs and benefits is discounted to its present value over the life of the project and then summed up to find out the net value. The formula of NPV is as:

$$NPV = \sum_{i=1}^n \frac{Bi-Ci}{(1+r)^i}$$

- ii) Annuity Value (AV):** It is the equalized yearly value over the life of the project which discounted at a given rate will generate the NPV equal to that generated by the project at the same discount rate. Again, using the same notations as earlier, annuity value can be expressed as:

$$AV = \frac{NPV}{\sum_{i=1}^n \frac{1}{(1+r)^i}}$$

Results and Discussion

Growing poplar and eucalyptus on the boundaries of a field is a common practice followed by farmers in Punjab. Thus an attempt has also been made to analyze the economics of these trees planted on the boundary of farmer's field. Most of the farmers grew trees as boundary plantation to get some extra income. Although the trees worked as a wind break yet at the same time also reduced the yield of crops due to their shading effect. Along with other trees, poplar and eucalyptus are very popular as boundary plants as they give good returns and have negligible operational cost. The farmers planted varied number of trees on the boundary side; either on one side, two side and four sides of the field.

Boundary Plantation of Poplar and Eucalyptus

In this study the economics of 100 plants were worked out as one side, two and four sides plantation. Similarly establishment cost of 100 plants was calculated and operational cost of pruning of poplar plantation up to three years was incorporated in the study. The estimates of yield reduction were taken from farmers and financial viability was calculated after including the cost of yield reduction. It was observed that these trees affect the crops up to 10 to 12 meters of distance.

Cost Structure of Poplar and Eucalyptus under Boundary Plantation in Punjab

Establishment cost is the major component in case of boundary plantation of both poplar and eucalyptus and is presented in Table 1. The cost of sapling of 100 plants of poplar was calculated to be Rs 2725 followed

Table 1. Establishment cost of poplar and eucalyptus in boundary plantation in Punjab, 2022-23

Particulars	Poplar		Eucalyptus	
	Cost (Rs)	Percentage	Cost (Rs)	Percentage
Sapling cost	2725	49.78	2200	60.46
Transportation	269	4.91	51	1.4
Transplanting	1540	28.13	930	25.56
Manures & Fertilizers	511	9.34	206	5.66
Plant protection	429	7.84	252	6.92
Total	5474	100.00	3639	100

by transplanting, manure and fertilizer, plant protection chemicals and transportation cost which were Rs 1540, Rs 511, Rs 429 and Rs 269 respectively. The total cost of establishing 100 plants of poplar was Rs 5474. It was observed that 49.78 per cent of expenditure was incurred on sapling cost followed by 28.13 per cent, 9.34 per cent, 7.84 per cent and 4.91 per cent on transplanting, fertilizers and manure, plant protection chemicals and transportation cost respectively. In case of eucalyptus, the cost of sapling of 100 plants were Rs 2200 followed by transplanting (Rs 930), plant protection chemicals (Rs 252), fertilizer & manure (Rs 206) and transportation (Rs 51). The total cost of establishing 100 plants of eucalyptus was Rs 3639. It was found that sapling and transplanting was the major expenditure in case of eucalyptus plantation. The establishment cost of poplar was more than eucalyptus plantation.

Operational cost of poplar is presented in Table 2. Only pruning cost was included as operational cost as there was no other inter-culture operations in boundary plantation. It was found that pruning cost increased with increase in the age of plant. The total operational cost for 100 plants of poplar was Rs 1268 in three years. An amount of Rs 350, Rs 430 and Rs 488 were spent on pruning operation in first, second and third year respectively. The expenditure incurred on pruning was 27.60, 33.92 and 38.49 per cent of the total operational cost in first, second and third year respectively. In case of eucalyptus, pruning was not required.

Table 2. Operational cost of poplar plantation in Punjab, 2022-23

Year	Pruning	Percentage
1	350	27.60
2	430	33.92
3	488	38.49
Total	1268	100.00

Undiscounted Returns from Boundary Plantation of Poplar and Eucalyptus in Punjab

Table 3 depicts the undiscounted returns from poplar and eucalyptus in case of boundary plantation. Selected farmers started harvesting trees from fourth year and continued up to sixth year in case of poplar whereas in case of eucalyptus, farmers started harvesting trees from fifth year and continued up to ninth year. The total returns from poplar plantation were Rs 253577, Rs 332887, Rs 398995 in fourth, fifth and sixth year respectively. Similarly the total returns from eucalyptus were Rs 196510, Rs 244900, Rs 300553, Rs 377125 and Rs 420539 in fifth, sixth, seventh, eighth and ninth year respectively. The total cost was same at different age of harvesting because there was no expenditure on poplar after attaining the age of three years whereas there was no variable cost in case of eucalyptus plantation. The net returns from poplar plantation was Rs 246835, Rs 326145 and Rs 392253 in fourth, fifth and sixth year respectively whereas in case of eucalyptus it was Rs 192871, Rs 241261, Rs 296914, Rs 373486 and Rs 416900 in fifth, sixth, seventh, eighth and ninth year respectively. Poplar plantation gave maximum incremental returns in fifth year (Rs 79310) whereas in case of eucalyptus it was (Rs 76572) in eighth year. It was found that poplar plantation gave more returns than eucalyptus plantation in short period. Similar results were obtained by Jain and Singh 2000 and Dhiman and Gandhi, 2017 where poplar based agroforestry system was found to be more profitable as compared to other agroforestry systems. The poplar plantation gave more benefit up to the tune of Rs 133274 and Rs 150992 than eucalyptus in fifth and sixth year respectively.

Farmers Perceptions Regarding Yield Reduction

The perception of farmers regarding the yield reduction of crops bounded by poplar and eucalyptus is incorporated in Table 4. The information has been compiled for one and two sides of plantation. The figures given in table are the average of the estimates on losses opined by farmers. For one and two side plantation there was no yield reduction of crops for the

Table 3. Returns from boundary plantation of Poplar and Eucalyptus in Punjab, 2022-23
(undiscounted) (100 plants)

Year of harvesting	Poplar				Eucalyptus			
	Total returns	Total costs	Net returns	Incremental returns	Total returns	Total costs	Net returns	Increment returns
4	253577	6742	246835	-	-	-	-	-
5	332887	6742	326145	79310	196510	3639	192871	
6	398995	6742	392253	66108	244900	3639	241261	48390
7	-	-	-	-	300553	3639	296914	55653
8	-	-	-	-	377125	3639	373486	76572
9	-	-	-	-	420539	3639	416900	43414

Note: Costs and returns are in terms of Rs.

first two years after which it started from third year onwards. But in case of eucalyptus, one side plantation had no effect on yield up to three years. In case of one side plantation of poplar, there was 1.45 per cent yield reduction in third year which further increased to 2.90, 3.81 and 5.93 per cent in fourth, fifth and sixth year respectively. Similarly for two side plantation of poplar, there was 1.79 per cent yield reduction in third year which further increased to 4.65, 7.30, and 10.22 per cent in fourth, fifth and sixth year of age respectively. In case of one side plantation of eucalyptus, yield reduction recorded in fourth year was 0.91 per cent which further increased to 1.92, 3.42, 4.97, 6.80 and 8.12 per cent in fifth, sixth, seventh and eighth year respectively. Similarly two side plantation of eucalyptus, the yield reduction was 0.78 per cent in third year which further increased to 3.50, 5.15, 7.16, 8.79, 10.50 and 11.17 per cent in fourth, fifth, sixth, seventh, eighth and ninth year respectively. Eucalyptus, being a slow grower, gave less yield reduction than poplar in similar years. These results are in line with the study of Dhiman and Gandhi, 2017 which indicated higher yield reduction in

poplar as compared to eucalyptus based agroforestry systems. After seven years of age, the yield reduction of eucalyptus increased at a faster rate.

Financial Viability of Boundary Plantation of Poplar and Eucalyptus in Punjab

The financial viability of poplar and eucalyptus boundary plantation of one side and two side is presented in table 5 and 6. NPV and annuity value was calculated at 10, 12 and 15 per cent discount rate to check the financial viability of boundary project and loss of crops was also incorporated in the costs. It was observed that NPV increased with the age of plant in the above two cases, but annuity value decreased with increase in age of plants in all cases, owing to loss of crops due to shade effect. It was found that one side and two side plantation gave almost equal returns in case of poplar. Likewise in case of eucalyptus, one side plantation was more profitable than two side plantation. Eucalyptus growers reaped maximum benefit the eighth year of harvesting. Poplar has short gestation period, hence more profitable than eucalyptus.

Table 4. Farmers perceptions regarding yield reduction of crops due to boundary plantation of poplar and Eucalyptus
(in per cent)

Age	Poplar		Eucalyptus	
	One Side	Two Sides	One Side	Two Sides
1	Nil	Nil	Nil	Nil
2	Nil	Nil	Nil	Nil
3	1.45	1.79	Nil	0.78
4	2.97	4.65	0.91	3.50
5	3.81	7.30	1.92	5.15
6	5.93	10.22	3.42	7.16
7	-	-	4.97	8.79
8	-	-	6.80	10.50
9	-	-	8.12	11.17

Table 5. Financial Viability of poplar plantation at different discount rates in Punjab, 2022-23

Year of harvesting	One Side						Two Side					
	NPV (Rs/100 plants)			Annuity Value (Rs/100plants)			NPV (Rs/100 plants)			Annuity Value (Rs/100plants)		
	10%	12%	15%	10%	12%	15%	10%	12%	15%	10%	12%	15%
4	163850	152024	136150	51687	50007	47688	162574	150833	135074	51285	49616	47311
5	195200	177795	154949	51504	49387	46253	191956	174806	152296	50648	48557	45461
6	210684	188320	159613	48433	45820	42225	205240	183355	155275	47181	44612	41078

Table 6. Financial Viability of eucalyptus plantation at different discount rates in Punjab, 2022-23

Year of harvesting	One Side						Two Side					
	NPV (Rs/100 plants)			Annuity Value (Rs/100plants)			NPV (Rs/100 plants)			Annuity Value (Rs/100plants)		
	10%	12%	15%	10%	12%	15%	10%	12%	15%	10%	12%	15%
5	116730	106350	92721	30799	29541	27677	112768	102685	89450	29754	28523	26701
6	131199	117345	99554	30160	28551	26337	125318	111958	94815	28808	27240	25083
7	144873	127183	104969	29748	27891	25232	137212	120227	98924	28175	26365	23780
8	163691	141048	113243	30711	28379	25221	154462	132733	106100	28979	26706	23630
9	162980	137723	107406	28295	25839	22517	152576	128410	99475	26488	24091	20854

It was concluded from the above discussion that the 100 plants on boundary gave positive net returns and financially viable even after the incorporation of cost of crop losses due to shade effect of the trees. Similar views were expressed by Dogra 1984 that eucalyptus plantations on agricultural farms proved to be highly economical giving an internal rate of return of 35 per cent to 38 per cent without intercropping and 85 per cent with intercropping.

Conclusion and Policy Implications

Boundary plantation of both poplar and eucalyptus was beneficial in all the cases i.e. one side, two side and four side plantation. It gives extra income to the farmers at negligible cost and very few yield losses were recorded owing to shade effect. Both type of trees i.e. poplar and eucalyptus are profit giving. Poplar has short gestation period and gives more benefit to the farmers and moreover it adds manure to the soil. Whereas eucalyptus is more suitable in water logged soils and some farmers opted it as it gives sometimes premium price to the farmers. So, it is concluded that both the commercial trees were financial viable for the boundary. Further, govt intervention can enhance the area under agroforestry by giving technical knowledge to the farmers which can solve their production problems, spreading awareness through camps or expert lectures and giving free saplings of trees to farmers for trials etc. The state forest department can also play a crucial role to increase area under agroforestry and help to diversify some area under paddy-wheat rotation. This study could also act as a grassroot level example to farmer, policy-makers and other such stake holders to adopt this attractive, profitable and sustainable practice under changing climate scenarios.

References

- Dhanda R S 1999. Performance of farm forestry plantations in Punjab. Poplar case studies. In: Proc National Symposium on role of Agri-Business Enterprises in Agroforestry and Wasteland Development. *Association of Agri-plantation Companies in India*, New Delhi. pp. 48-60.
- Dhiman R C 2013. Status and impact of commercial agroforestry in India. *Indian Journal of Agroforestry* **15**: 55-67. <https://epubs.icar.org.in/index.php/IJA/article/view/103657>
- Dhiman R C and Gandhi J N 2017. Comparative performance of poplar, melia and eucalyptus based agroforestry systems. *Indian Journal of Agroforestry* **19**:1-7. <https://epubs.icar.org.in/index.php/IJA/article/view/102938>
- Dhyani S K, Handa A K and Uma 2013. Area under agroforestry in India: An assessment for present status and future perspective. *Indian Journal of Agroforestry* **15**: 1-11. <https://epubs.icar.org.in/index.php/IJA/article/view/103605>
- Gera N and Bhojvaid P P 2013. Promoting livelihood and economic growth through agroforestry: ICFRE endeavours. *Indian Journal of Agroforestry* **15**: 85-99. <https://epubs.icar.org.in/index.php/IJA/article/view/103660>
- Government of India 2021. *India State of Forest Report, Forest Survey of India*, Ministry of Environment Forest and Climate Change, Uttarakhand, India.
- Jain S K and Singh P 2000. Economic analysis of industrial agroforestry: Poplar (*Populus deltoides*) in Uttar Pradesh (India). *Agroforestry Systems* **49**: 255-273. <https://doi.org/10.1023/A:1006388128069>
- Kumar A 2005. An economic analysis of production and marketing of Poplar in Punjab. M.Sc. thesis, submitted to Punjab Agricultural University, Ludhiana, India.
- Mathur R S, Sharma K K and Ansari M Y 1984. Economics of Eucalyptus plantations under agroforestry. *Indian Forester* **110**: 171-201. DOI: [10.36808/if/1984/v110i2/10465](https://doi.org/10.36808/if/1984/v110i2/10465)
- Tribune News Service 2013. Govt abolishes fee to boost timber trade. pp 3 <https://www.tribuneindia.com/2013/20130915/punjab.htm#8>.

Received: November 07, 2023 Accepted: February 12, 2024