



Socioeconomic impact of agroforestry in Ludhiana (Punjab)

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ABSTRACT

The study was performed with the objective to study socio-economic impact of agroforestry on farmers in Ludhiana (Punjab), India. Two types of respondents were selected, viz. agroforestry adopters and non-agroforestry adopters from the Ludhiana district (52 agroforestry adopters and 52 non-agroforestry adopters) were selected for the purpose of the study. The social and economic profile of the farmers was evaluated by asking them to fill a questionnaire and personal interviews. The impacts of socio-economic factors were assessed adopting standard methodology. Results pertaining to adoption of agroforestry revealed that majority of adopters were a graduate (48.08%) and most of them had mass media exposure (82.69%). Among agroforestry adopters, the operational land holdings were also large (36.53%). The other social factors like family type, extension contacts, residential area, livestock and presence of physical assets also reported differences among agroforestry adopters and non-adopters. The economic status of farmers revealed that poplar based system was more economical than pure cropping system during 2012-2017 (when the price was ₹ 450/q or above) except 2016 when high fluctuation in the price of poplar was reported. Annuity value and benefit cost ratio (BCR) of agroforestry system were calculated to be higher than pure cropping system. During the year 2017, the BCR of agroforestry system was 4.32, whereas it was 3.31 for pure cropping system.

Key words: Adopters, Agroforestry, Benefit cost ratio (BCR), Non-adopters, Socio-economic factors

The Punjab state with a total geographical area of 5 036000 ha is predominantly an agricultural state having about 83% of its area under highly intensive technical and mechanical agriculture, whereas forests and tree outside forests occupy 3315 km², which is only 6.58% of the total geographical area of the state (ISFR 2015). During the green revolution era, increased productivity of agricultural crops brought socio-economic benefits to the farmers of Punjab. But in the post-green revolution era, cost of cultivation under high yielding varieties continued to increase while productivity stagnated in case of major crops. As a result, the majority of farmers came under debt. In long term, traditional agriculture led to sharp decline in net farm profitability with a passage of time-related to the continuous degradation of natural resources notably underground water and soil. Seeing the falling socio-economic condition of the farmers and negative effects of traditional agriculture system, there arises an urgent need to bring diversification in the prevailing agriculture system. Agroforestry can be a good alternative for diversification of agriculture in Punjab. Agroforestry will not only diversify the agriculture but will also improve the economic condition of the farmers and also conserve the depleting natural resources like soil and water. Moreover, throughout the Punjab, natural resources

degradation including rapid land deterioration is the most critical challenge due to which agricultural productivity exhibited decreasing trend. One way that appears suitable for providing a solution to the adverse effect of deforestation is the adoption of agroforestry as an approach to sustainable land use system. Agroforestry is a suitable farming system that imitates the structure and processes of natural forest vegetation. Such systems have high potential to increase the productivity of farming systems and sustain continuous crop production (Kalabisova and Kristkova 2010).

MATERIALS AND METHODS

The present study was conducted in Ludhiana district of Punjab state. The major agroforestry area in the Ludhiana district was identified. Out of the area identified, all types of respondents having small, medium and large operational land holding practising different types of agroforestry, viz. boundary plantation, tree block plantation and agrisilvicultural system were selected using simple random sampling. Similarly, non-agroforestry adopters were also selected. Data for the present study was collected by interviewing the selected farmers personally with the help of interview schedule. For the purpose of the study, data were collected from 52 agroforestry adopters and 52 non-agroforestry adopters. To compare the social profile of agroforestry adopters and non-adopters simple statistical tools were used, viz. frequency, percentage etc. Budgeting technique of analysis was used to work out the economics

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of poplar in block plantation along with intercrops and also that of wheat and paddy. In order to compare the income from poplar plantation plus inter-crops with the pure crops (rice-wheat) during the different study years (2013-17) in terms of productivity of capital over time, the concept of discounting was used while calculating the costs and returns from poplar based agroforestry. The costs and returns were discounted at the rate of 9%. The following efficiency measures are used: 1. Annuity value. 2. Benefit cost ratio.

Annuity value (AV) is the equalized yearly value over the life of project which discounted at a given rate will generate the present net value (PNV) equal to that generated by the project at the same discount rate. Annuity value can be expressed as follows:

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

Benefit cost ratio (BCR) is the ratio of the sum of discounted benefits to the sum of discounted costs. Benefit cost ratio can be expressed as:

$$BCR = \frac{\sum_{i=1}^n \frac{B_i}{(1+r)^i}}{\sum_{i=1}^n \frac{C_i}{(1+r)^i}}$$

RESULTS AND DISCUSSION

Socio-personal profile of agroforestry adopters and non-agroforestry adopters

It relates to the information regarding socio-personal

characteristics of respondents which included family type, education, operational land holding, residential area, mass media exposure and extension contacts. Data pertaining to the profile of the farmers according to their socio-personal characteristics have been presented in Table 1. In case of family type majority of both agroforestry adopters and non-agroforestry adopters belonged to nuclear family that is 73.08% and 69.23%, respectively. Whereas only 26.92% agroforestry adopters and 30.77% non-agroforestry adopters belongs to the joint family. The percentage of a joint family in case of agroforestry was found little lower. The educational qualification was categorized into five categories as presented in Table 1, which revealed that majority (48.08%) of agroforestry adopters were graduate or above whereas only 23.08% non-agroforestry respondents fall in this category. About 32.69% agroforestry adopters and 46.15% non-agroforestry adopters were matric pass. Only 19.23% of agroforestry adopters were found in the categories of illiterate, primary and middle, whereas the share of non-agroforestry respondents was high (38.46%) in these categories. This data clearly showed that agroforestry adopter respondents were higher qualified farmers than the non-agroforestry adopter respondents. Similar findings were reported by Himshika (2016) and Maleknia *et al.* (2013) regarding the education level of agroforestry adopters. Among agroforestry adopters operational land holding of the respondents was categorized into five categories. The study findings revealed that respondents operational land holding ranged from 1 to 300 acres. It can be inferred from data given in Table 1 that 36.53% agroforestry adopters had large operational land holding with respect to 23.08% in case of non-agroforestry adopters. Whereas 34.61%

Table 1 Distribution of respondents on the basis of socio-personal characteristics

| Socio-personal characteristic | Scores/range | Agroforestry adopters | | Non-agroforestry adopters | |
|-------------------------------|-------------------|-----------------------|------------|---------------------------|------------|
| | | Frequency | Percentage | Frequency | Percentage |
| Family type | Joint | 14 | 26.92 | 16 | 30.77 |
| | Nuclear | 38 | 73.08 | 36 | 69.23 |
| Education | Illiterate | 4 | 7.69 | 6 | 11.54 |
| | Primary | 4 | 7.69 | 5 | 9.61 |
| | Middle | 2 | 3.85 | 9 | 17.31 |
| | Matric | 17 | 32.69 | 24 | 46.15 |
| | Graduate or above | 25 | 48.08 | 12 | 23.08 |
| Operational land holding | Marginal | 2 | 3.85 | 1 | 1.92 |
| | Small | 3 | 5.77 | 10 | 19.23 |
| | Semi-medium | 10 | 19.23 | 14 | 26.92 |
| | Medium | 18 | 34.61 | 15 | 28.85 |
| | Large | 19 | 36.53 | 12 | 23.08 |
| Mass media exposure | Low | 9 | 17.31 | 18 | 34.61 |
| | Medium | 35 | 67.31 | 22 | 42.31 |
| | High | 8 | 15.38 | 12 | 23.08 |
| Extension contacts | Low | 46 | 88.46 | 43 | 82.69 |
| | Medium | 6 | 11.54 | 9 | 17.31 |
| | High | 0 | 0 | 0 | 0 |

agroforestry adopters had medium land holding, i.e. 10-25 acres which are 28.85% in case of non-adopters. In case of semi-medium land holding, i.e. 5-10 acres, 19.32% respondents were agroforestry adopters and 26.92% non-agroforestry adopters. Only few agroforestry adopters fall in the category of small (5.77%) and marginal farmers (3.85%). But in case of non-agroforestry adopters, the share of small (19.23%) and marginal farmers (1.92%) is high. These results showed that most of the agroforestry adopters belong to the medium (10-25 acres) and large (25 or more acres) operational land holding categories. Results of Borremans *et al* (2016) are in accordance with our study.

It was quite clear from the data in Table 1 that agroforestry adopters had more mass media exposure than the non-agroforestry adopters. About 82.69% agroforestry adopters fall in the categories of medium and high mass media exposure and only 17.31% agroforestry adopters fall in the category of low mass media exposure. But in case of non-agroforestry adopters, only 65.39% respondents belonged to medium and high mass media exposure and more than 34% non-agroforestry respondents had low mass media exposure. A close examination of data given in Table 1 revealed that 88.46% agroforestry adopters and 82.69% non-agroforestry adopter respondents had low-level extension contacts. Only 11.54% agroforestry adopters and 17.31% non-agroforestry respondents had medium extension contacts.

Type of farming practised by agroforestry adopters and non-agroforestry adopters

Both types of respondents agroforestry adopters and nonadopters were investigated about the poplar with wheat as intercrop (agroforestry system) adopted by the agroforestry adopters and different crops grown by the non-agroforestry adopters. The data presented in the Table 2 revealed that majority (82.69%) of the agroforestry adopters were growing crops with block plantations. Only 5.77% of the respondents were found growing crops plus vegetables with agroforestry block plantations and 11.54% adopters were found growing agroforestry as boundary plantation.

In case of the non-agroforestry, rice and wheat were the main crops of respondents and out of them 79% respondents follow rice-wheat rotation (Table 3). It was observed that

Table 2 Type of agroforestry adopted by agroforestry adopters

| Type of farming | Frequency | Percentage |
|---|-----------|------------|
| Crops with boundary tree plantation | 6 | 11.54 |
| Crops plus vegetables with agroforestry | 3 | 5.77 |
| Crops with block plantation | 43 | 82.69 |

Table 3 Crop rotation practised by the non-agroforestry adopters

| Crop rotation | Frequency | Percentage |
|-------------------|-----------|------------|
| Rice-wheat | 41 | 78.85 |
| Rice-potato-wheat | 11 | 21.15 |

potato was also a popular crop among farmers of Ludhiana district. About 21.15% of the respondents were following a rice-potato-wheat rotation.

Economic status of agroforestry adopters and non-agroforestry adopters

The section deals with the economics of raising poplar block plantation with wheat as inter-crop among agroforestry adopters and rice-wheat crop rotation in case of non-agroforestry adopters. Cost structure and cost components of poplar in block plantation have been divided into two categories:

Establishment cost: It is incurred in the beginning considered to be zero year. According to the respondents of agroforestry adopters, the total establishment cost was ₹ 7820.56/acre. It includes the cost of planting material, transportation, land preparation, transplanting and plant protection. About 78.5% of total establishment cost was on planting material and transportation as depicted in Table 4.

Operational cost: Operational cost is the cost that is incurred during the period after establishment till the trees were marketed. The operational cost of plantation crop included cost incurred on irrigation, fertilizer application, harvesting etc. Irrigation cost was only for that period when there was no agricultural crop in the field, i.e. during the period after harvesting wheat unto the sowing of wheat. The operational costs for the agroforestry system are presented in Table 5. Data presented in Table 5, showed that ₹ 55680 was incurred only in the harvesting and marketing and the total operational costs were ₹ 70377/acre.

Yield reduction in wheat due to block plantation

Yield reduction was also calculated on the basis of information given by the selected farmers. According to the respondents inter-cultivation was only economical up to the fourth year. The data presented in Table 6 showed that yield reduction in wheat under poplar block plantation was positively related with age of poplar trees and tree density. As the space occupied by each plant, tree crown increases with age. Therefore, the yield reduction in the first year was due to only area reduction which is occupied by trees and irrigation channels. In case of wheat, the yield reduction was 16.32% in the first year and was increased to 41.62% during the fifth year. Similar finding was also reported by Singh and Mavi (2015). This increase in yield reduction may be due to tree-crop interactions becoming intense for

Table 4 Establishment cost of raising poplar in block plantation (₹/acre)

| Particulars | Cost in '0' year | Percentage |
|---|------------------|------------|
| Cost of planting material/ including transportation | 6140.84 | 78.5 |
| Land preparation | 850.71 | 10.5 |
| Manures and fertilizers | 250 | 3.19 |
| Plant protection | 579 | 7.4 |
| Total | 7820.56 | 100 |

Table 5 Stream of operational costs (per acre) for the poplar plantation in Ludhiana district

| Item | Cost of poplar plantation at differet age (₹/acre) | | | | | | Total |
|---|--|---------|---------|---------|---------|----------|----------|
| | 1 | 2 | 3 | 4 | 5 | 6 | |
| Irrigation | 550 | 525 | 500 | 450 | 400 | 350 | 2775 |
| Manures, fertilizers and plant protection | 1174.84 | 2119.5 | 2398.5 | 1687.9 | 1126.7 | 714.9 | 9222.33 |
| Harvesting and marketing charges | 0 | 0 | 0 | 0 | 0 | 55680.47 | 55680.47 |
| Misc. cost | 394.84 | 614.68 | 595.92 | 495.68 | 315.61 | 282.58 | 2699.21 |
| Total | 2119.57 | 3259.18 | 3414.42 | 2593.48 | 1842.31 | 57027.95 | 70377.01 |

Table 6 Yield reduction of wheat in poplar plantation in relation to age of the plantation

| Age (Year) | Per cent reduction in yield as compared to sole crop |
|------------|--|
| 1 | 16.32 |
| 2 | 22.57 |
| 3 | 28.62 |
| 4 | 38.24 |
| 5 | 41.62 |

light and soil moisture and nutrients etc (Singh *et al.* 1993).

Returns for poplar block plantation during 2012-2016

In this category returns over variable costs from the poplar block plantation of six-year rotation and intercrops grown under plantation was calculated on the basis of information given by the respondents. The establishment cost and the operational cost of poplar was discounted at 9% to calculate the net returns. Gross returns from the block plantations were calculated from the price prevailed in different years (2013-17) by taking the average yield of 850 q/acre. Similarly, returns from the intercrops were calculated by taking variable costs and minimum support price of wheat during different years (2012-17) into account.

The data presented in Table 7 for the returns over variable costs and price for poplar block plantation of six-year rotation and inter-crop (wheat) cleared that during 2013 when the price of Poplar was ₹ 625/q, farmers fetch the ₹ 531250/acre and the net returns is ₹ 453053 for poplar component. Additionally, the farmers earned net returns

Table 7 Returns over variable costs and price for poplar block plantation of six-year rotation and inter-crop (wheat) during 2013-2017 (₹/acre)

| Year | Price of poplar (₹/q) | Poplar based block plantation | | Wheat inter-cultivation | |
|------|-----------------------|-------------------------------|-------------|-------------------------|-------------|
| | | Gross returns | Net returns | Gross returns | Net returns |
| 2013 | 625 | 531250 | 453053 | 76977 | 53977 |
| 2014 | 475 | 403750 | 325553 | 85615 | 57615 |
| 2015 | 450 | 382500 | 317653 | 94215 | 61215 |
| 2016 | 375 | 318750 | 253903 | 102891 | 64891 |
| 2017 | 462 | 392700 | 314503 | 111552 | 68552 |

of ₹ 53977 from inter-cultivation of wheat in poplar block plantation. In the year 2016, when the price of poplar was lowest, farmers earned ₹ 253903 as net returns from poplar based block plantations and ₹ 64891 from inter-cultivation of wheat in the block plantation. In the year 2017, there was a slight rise in the price of poplar and the farmers who have harvested their plantation in this year got ₹ 314503 as net returns and ₹ 68552 from inter-cultivation of wheat in block plantation.

Returns over variable costs and price for wheat-paddy pure cropping system

Returns over variable costs and price for rice-wheat pure cropping system during 2012-17 was calculated from the information collected from the Department of Agricultural Economics and Sociology and from the selected farmers. The data presented in Table 8 clearly represented that in the last five years farmers from wheat-paddy pure cropping system earned ₹ 240892/acre on variable costs and price with an average of ₹ 48178/acre/year starting from 2012 to 2017.

Comparative economics of poplar block plantation

Considering the total variable costs and price in different years for the both poplar plantation with wheat inter-cultivation and the paddy-wheat pure cropping system returns are calculated. By using the discount rate of 9% the BCR (Benefit cost ratio) and Annuity values were worked out on per acre basis and are given in Table 10. The prices of poplar varied in different years and it was found that there were high fluctuation in the price of poplar for the year 2012-16.

In the study period, the price of poplar was found

Table 8 Returns over variable costs and price for wheat and paddy during 2012-2017 (₹/acre)

| Year | Total variable costs | Gross returns | Returns over variable costs |
|---------|----------------------|---------------|-----------------------------|
| 2012-13 | 18703 | 62575 | 43872 |
| 2013-14 | 19294 | 65990 | 46696 |
| 2014-15 | 20660 | 68440 | 47780 |
| 2015-16 | 21199 | 71390 | 50191 |
| 2016-17 | 22777 | 75130 | 52353 |
| Total | | | 24082 |
| Average | | | 48178 |

Table 9 Comparison economics of poplar block plantation with wheat intercropping and wheat-paddy pure cropping system at 9% discount in agroforestry system

| Year | Agroforestry system | Pure cropping system |
|---------------------------------|---------------------|----------------------|
| <i>Annuity value (₹/acre)</i> | | |
| 2012-13 | 68509 | 43872 |
| 2013-14 | 51995 | 46696 |
| 2014-15 | 49717 | 47780 |
| 2015-16 | 41882 | 50191 |
| 2016-17 | 51987 | 52353 |
| <i>Benefit cost ratio (BCR)</i> | | |
| 2012-13 | 5.38 | 3.34 |
| 2013-14 | 4.19 | 3.42 |
| 2014-15 | 4.16 | 3.31 |
| 2015-16 | 3.66 | 3.37 |
| 2016-17 | 4.32 | 3.31 |

highest in 2013 and during this year, farmers who had harvested their plantation has the highest annuity and the BCR (Benefit cost ratio). Annuity value was ₹ 68509 and BCR was 5.38 at 9% rate of discount, respectively. In the same year annuity and the BCR of pure cropping system was ₹ 43872/acre and 3.34, respectively. This calculation clearly showed that the farmers who have adopted poplar based agroforestry with wheat as an intercrop were in benefit than the non-agroforestry farmers.

In the year 2014, agroforestry plantation was also found more economical than paddy-wheat pure cropping system with ₹ 51995/acre annuity and 4.19 BCR as compared to ₹ 46696/acre annuity value and 3.42 BCR, respectively.

In all the years of study BCR of poplar block plantation with wheat as an intercrop was found higher than the paddy-wheat cropping system (Table 9). The calculated annuity value of poplar block plantation with wheat as an intercrop showed that agroforestry was more economical than the pure cropping system of Punjab in all the years except 2016. Only in the year 2016, when the price of poplar was ₹ 375/q poplar plantation was found uneconomical than pure cropping system.

It is evident from the economic analysis that poplar based block plantation with wheat as an intercrop was more economical than the paddy-wheat crop rotation. Kumar (2005) also reported that annuity value and BCR of poplar block plantation is higher than the pure paddy-wheat crop rotation.

Chakraborty *et al.* (2015) reported the socioeconomic impact of cropland agroforestry on farmers was significant

and plant expansion of cropland agroforestry for overall socio-economic development of farmers was concluded in Bangladesh on the basis of five indicators, viz. housing pattern, level of education, land holdings and other physical assets. The mean annual income of household was significantly higher for cropland agroforestry than non-cropland agroforestry. The present study's findings are in line with the study reported above.

Conclusion

It was evident from the present study that literacy rate was higher in case of agroforestry adopters than the non-agroforestry adopters. The adoption of agroforestry was found higher among the farmers having a higher operational land holding. In the study area, farmers were found practising agroforestry as block plantation and only a few were found practising boundary plantations. Less number of agroforestry adopters was having physical assets (related to agriculture) as compared to non-agroforestry adopters. Poplar block plantations and wheat as intercrop were found more economical than the pure cropping (paddy-wheat) system when the price of poplar was ₹ 450/q or above.

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