ADOPTION OF POPLAR-BASED AGROFORESTRY AS AN APPROACH FOR DIVERSIFIED AGRICULTURE IN PUNJAB

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Introduction

Punjab occupies only 1.5 per cent of country's geographical area but contributes 51 and 33 per cent of rice and wheat, respectively, to the central pool of food reserve. The excessive use of agro-chemicals in rice-wheat rotation has depleted and deteriorated soil health and water resources in the state (Sidhu, 1998). Diversification in rice-wheat crop rotation has strongly been advocated in irrigated agro-ecosystem (Aulakh, 2005a & b; Johl, 2005). Agroforestry is one of the land husbandry gaining importance as an approach for diversifying traditional agriculture. Progressive farmers of Punjab and adjoining states have adopted agroforestry but inspite of ecological and economic viability of the system, not even one per cent area of Punjab is under agroforestry system. 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. Jain and Singh (2000) found poplar-based agroforestry economically viable and more profitable than many other crop rotations. Sensitivity analysis indicates that this system is not risky. Dhillon et al. (2001)* reported economic benefits of poplar plantation in Yamunanagar, Haryana. The present study was planned to study the farmers perception towards poplar (Populus deltoides) based agroforestry system, identify the components and study yield potential of most prevalent poplar-wheat combination.

Material and Methods

For conceptual framework of awareness, a four phase awareness model with elements of identification, confirmation, support and problem solving alternatives (Krueger, 1989) was considered and conceptualised (Fig. 1) for the present study. Selection of the respondents (108 adopter and non-adopter each) was done following multistage sampling technique and data collected were suitably analysed. The primary data of adopters and non-adopters of poplar-based agroforestry were obtained from the State Forest and Agriculture Department. Based on the survey, a number of components in poplar-based agroforestry system were identified and the most common tree-crop (poplar-wheat) combination was studied for its

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productivity. Poplar (clone G-48) plantation of four ages were used for studying wheat (variety PBW-343) yield potential. Number of yield contributing parameters were recorded and results in term of grain yield are presented under poplar plantation of different ages raised along North-South direction at 4.5m x 3.0m m spacing. Crop yield was recorded using quadrates (1x1m²) analysis. Five quadrates per replication were used diagonally across the tree rows. The light intensity (x100 lux) was measured periodically twice a day using Digital Lux Meter (TES 1332A) during the crop growing season. Selected tree parameters at different age plantation were recorded randomly and the data were suitably analysed.
Results and Discussion

Apart from G-48 clone, S,C₆, S,C₁₅, S,C₂₀, 113324, Uday, WSL-22, WSL-32 and WSL-39 have become popular among the farmers. All the poplar-based agroforestry adopters are growing agricultural crops (including vegetable and flower crops) under poplar, whereas, 8.33 per cent farmers are integrating fruit plants, 15.74 per cent practice apiculture in poplar gardens and 37.96 per cent raise fodder crops. The adoption potential of different components vary in different agro-climatic zones of Punjab, and the component preference lies with the individual farmer. Central Punjab (main poplar growing area) is dominated by agricultural crops; wheat during rabi season, followed by fodder crops during kharif season. In the sub-montane zone, especially in Hoshiarpur, Nawanshahr and Ropar districts, fruit trees (mango, guava, pear, kinnoo, etc.) are grown with poplar particularly at the initial stage of orchard establishment.

The survey conducted in the prominent poplar growing areas of the state indicated that the poplar based agri-silviculture system is very popular among the farmers of north-western region. Crops like wheat, turmeric, colocasia, sugarcane, oats, berseem, bajra, sweet potato, mustard, etc., are being grown by the farmers in block plantations of poplar. Fruit tree species (mango, citrus, litchi, ber, guava, etc.) are also becoming popular, as the poplar is harvested by the time the fruit yield is available. It was observed that 53.70 per cent adopters in comparison to 10.19 per cent non-adopters has high awareness level about benefits of poplar-based agroforestry. None of the adopter has low awareness, even non-adopters (64.81 per cent) have medium level of awareness. Adopters as well as non-adopters have medium to high level of awareness about judicious use of resources, nutrient cycling, protective benefits, environmental benefits, socio-economic benefits, etc., of poplar in agroforestry system. But the non-adopters perceived more constraints than the adopters to non/less adoption of poplar-based agroforestry. At present, there are approximately 1.29 crore poplar trees in the state (FSI, 2006) covering less than 0.5 per cent geographical area under poplar-based agroforestry. The empirical model developed for the present study (Fig. 2) indicated that less favourable attitude, poor motivation, low awareness among the farmers may be the major causes for less adoption of poplar cultivation. Sharma and Kumar (2000) reported significantly higher socio-economic status, awareness, attitude and farm size for farmers adopting poplar-based agroforestry than those of non-adopters. Some progressive farmers of the state with intensive management of poplar, have earned Rs. 75,000 to 87,000/ha/yr from poplar-based agroforestry against approximately Rs. 30,000 to 37,000/ha/yr from rice-wheat rotation. Farmers have adopted poplar due to its short rotation, easy regeneration, availability of quality planting material, good market demand, handsome economic returns, restricted distribution of species in the country and its compatibility with the agricultural crops. Dhillon et al. (2001) reported annual net return of Rs. 55,390 and Rs. 73,330/ha without intercropping and with intercropping, respectively, over the entire rotation. The higher return in case of poplar with intercropping are mainly due to higher productivity of poplar with intercropping than poplar without intercropping.
Factors for the adoption and non-adoptions of poplar based agroforestry interventions

Observations on tree parameters indicated significant but gradual increase up to the fourth year (Table 1). Poplar growth during second year was maximum and thereafter the growth progressed with age but at the decreasing rate. The mean monthly height and diameter at breast height were 0.58 m and 0.49 cm, respectively, during second year of planting and 0.22 m and 0.32 cm, respectively, during fourth year of planting. Dhanda and Verma (2001) also reported increase in tree height growth with age more than 5.5 m/yr during first two years, 4-5 m/yr at 3-5 year age and decrease to 3.1-3.4 m/yr at 6 to 9 year age. The wheat grain yield showed a decreasing
Table 1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Age of poplar tree (year)</th>
<th>CD 5%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Height (m)</td>
<td>4.9300</td>
<td>11.9800</td>
</tr>
<tr>
<td>DBH (cm)</td>
<td>5.3700</td>
<td>11.2900</td>
</tr>
<tr>
<td>Crown spread m²</td>
<td>8.3800</td>
<td>26.3100</td>
</tr>
<tr>
<td>Volume under bark (m³)*</td>
<td>0.0073</td>
<td>0.0445</td>
</tr>
<tr>
<td>Volume over bark (m³)*</td>
<td>0.0116</td>
<td>0.0562</td>
</tr>
<tr>
<td>Wheat crop yield (q/ha)</td>
<td>25.2900</td>
<td>17.2500</td>
</tr>
<tr>
<td>Light intensity (x100 lux)</td>
<td>752.8400</td>
<td>642.7300</td>
</tr>
</tbody>
</table>

*Standing volume was estimated using regression equation \( v = a + b \cdot DBH \cdot H \), where:
\( v \) = standing tree volume (m³), \( DBH \) = diameter at breast height (m), \( H \) = tree height (m); \( a \) & \( b \) are constants.
Open = without poplar trees.

Trend, however, the rate of decrease during third to fourth year was negligible and non-significant. The wheat grain yield reduced to 50 per cent during third year (Table 1). The decrease in grain yield was 11, 39, 50 and 54 per cent at one, two, three and four year age of poplar plantation, respectively, than the control (without poplar). Light intensity at different ages also decreased at the rate of 23, 35, 46 and 47 per cent (one to four year old poplar, respectively) than the control, indicating that the light becomes limiting factor after third year of tree growth (Fig. 3). However, winter cereals are well-suited to deciduous trees like poplar and grow profusely in autumn and early spring. By the time poplar develops foliages, the cereal crops virtually mature. The decrease in grain yield under one year old poplar is mainly due to reduction in space for crop on unit basis. Ralphan et al. (1992) reported 23.3 per cent decline in wheat grain yield (variety HD 2329) with poplar (clone G-3) at three years age, whereas reduction in grain yield during first year was nine per cent only.

Studies examining resource sharing ability of trees in an intercropping system (Farrell, 1990; Kessler, 1992) indicate that due to competition for light, crop growth
and yield are depressed under tree crown, where soil nutrient pool and their availability and soil moisture are adequate. In the present study also under irrigated agro-ecosystem, the soil moisture and nutrients were not noticed as the limiting factors but light intensity decreased with increase in age of poplar due to increase in crown spread (Table 1). Since reduction in cultivable space is normally uniform during complete rotation, light becomes limiting factor during March onwards when new flush of leaves appear. The harvesting of wheat is delayed by 10-15 days under tree canopy than the open space.

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SUMMARY

Agroforestry that envisages integration of trees, herbaceous crops and/or animals on the same land unit, holds promising potential in Punjab to diversify traditional rice-wheat rotation. On the basis of information provided by the respondents, it was realized that the farmers with low awareness, unfavourable attitude and constraints (land, technical, financial, legal, social, etc.) are not able to adopt poplar (Populus deltoides)-based agroforestry successfully. In poplar-wheat agroforestry system, growing condition of wheat are modified due to presence of tree and, thus, response of wheat differs than that of tree-less agricultural system. Age of poplar trees is recorded as most important factor influencing wheat grain (var. PBW 343) yield. On an average, reduction in grain yield was 20.10 per cent under one year old poplar plantation, which increased to 54 per cent under four year old plantation. Under irrigated poplar-based agro-ecosystem, light is the major limiting factor for reduction in grain yield.

Key words: Poplar-Based Agroforestry, Diversified Agriculture, Punjab.
References


