Socio-Economic Analysis of Agroforestry Systems in Western Uttar Pradesh

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ABSTRACT

The present study is the outcome of socio-economic diagnosis of traditional as well as commercial agroforestry practices followed by farmers in western Uttar Pradesh. Tree species like Azadirachta indica, Acacia nilotica, Dalbergia sissoo *and* Eucalyptus *spp. were dominant species in traditional system whereas,* Populus deltoides *and* Eucalyptus *spp. were the main species of commercial agroforestry. Fuel wood (50.6 %) was major driving force for agroforestry adoption followed by additional income (24.4 %) and shade (17.5 %) in traditional agroforestry region while, additional income (71.3 %) was the major factor in commercial agroforestry region. The net return from tree produce ha-1 per annum in traditional system was Rs. 989, 541 and 440 for marginal, small and medium farmers, respectively. In commercial region, B:C ratio has been found higher (3.00) for poplar based agrisilviculture than poplar (2.84) and eucalyptus (2.68) based bund system. Although traditional agroforestry seems less promising as compared to commercial agroforestry, but it is also relevant to the farmers' livelihood.*

Key Words : Agroforestry; Bund plantation; Socio-economic analysis

Agroforestry is a dynamic, ecologically based natural resource management system that, through which the integration of trees/woody perennials in farm and rangelands, diversifies and sustains production for increased social, economic and environmental benefits (Leakey, 1996). Therefore, efforts have been made by the farmers, corporates and researchers for introducing tree based farming systems in the green belt of U.P. in the past two decades. Uttar Pradesh (U.P.), where every sixth Indian lives, contributes to 20.37 percent of the country's agricultural production (GOI, 2005). If Indian agriculture has to prosper, the situation in Uttar Pradesh has to improve in all sectors including crop diversification. Agroforestry can play a major role in bringing the desired level of diversification along with sustainability. The farm-industry linkages have also helped the systems to be more sustainable than the traditional cropping systems (Kareemulla *et al*. 2005; Saxena, 2000). The major objectives of the study were to document the agroforestry systems, identify the reasons of farmers to promote the systems, estimate the cost-benefit analysis and assessing the impact of agroforestry.

METHODOLOGY

Agroforestry in different forms has been promoted in different parts of the country like southern Karnataka, parts of Andhra Pradesh and western Uttar Pradesh. Out of these regions, western Uttar Pradesh has been chosen for the study deliberately considering the organized linkages developed between the farmers and industry. Based on preliminary studies, the districts in the western Uttar Pradesh were divided into two regions: intensive (commercial) and traditional agroforestry region. Adopting multi-stage random sampling one district, two blocks and four villages per block were selected from each of these regions. In each of the selected villages, 20 farmers with some form of agroforestry were selected. From the commercial agroforestry region, Saharanpur district was selected, while from the other sub-region, Aligarh district was selected randomly. Thus, a total of two districts, four blocks and 16 villages and 320 farmers formed the sample units for the study. The farmers' data was post stratified to compare across the farm- holding size classes.

Since the trees are naturally growing especially in traditional agroforestry region and are just allowed to be thriving by the farmers, the costs associated with management of the trees are negligible except that of indirect costs associated with the shade and competition due to moisture and nutrient needs. Therefore, only the benefits from trees on account of harvest and sale of tree produce were accounted. Based on the data on harvest and sale collected for the past three years, the annual average production, consumption and sale of tree produce was estimated. Even though there were other agroforestry products besides tree products, only tree products that too wood harvested or trees sold were considered, since

the primary production from the predominant species of the district like Neem, Babool is wood. The data generated from the study was analyzed mainly using tabular analysis, benefit-cost analysis. The benefit cost ratio was worked out using the method adopted by Gittinger (1982) and Jain and Singh (2000).

RESULTS AND DISCUSSION

The results of the study are presented under two sections, the first section covering the results for the traditional agroforestry region, where Aligarh district was selected and the other section covering the Saharanpur district under the intensive/ commercial agroforestry region.

*Traditional Agroforestry Region :*This region is predominantly a Bajra (pearl millet)-Wheat cropping zone with adequate irrigation facilities. The multi-purpose trees are present in the farm fields on a scattered basis with greater concentration on the field bunds and boundaries. The results of the study in the selected district are presented below:

Characteristics of sample farmers : The study in the Aligarh district covered sample of 160 farmers and their composition by the category is indicated in Table 1.

Table 1. Composition of sample farmers in Aligarh district

Farmer's Category	Number (%)	Average holding size (ha)
Marginal (=1 ha)	81 (50.6)	0.71
Small (1-2 ha)	41 (25.6)	1.34
Medium / Large (>2 ha)	38 (23.8)	3.46
Total	160 (100.0)	1.52

The sample farmers were post-stratified into three categories as per the total land holding of these farmers. The marginal farmers had an average land holding of 0.71 ha, the small farmers had a land holding of 1.34 ha while the medium to large farmers' holding size was 3.46 ha. Thus, the overall holding size of the sample farmers in Aligarh district was 1.52 ha.

Agroforestry in Aligarh district : Aligarh district is dominated by forest and horticultural tree species in the agricultural lands, as forests cover a meager 0.65 per cent of the district's geographical area. Another 0.66 per cent area of the district is under grasslands and miscellaneous tree coverage. Therefore, primarily supplies from trees in the farmlands and supplies from outside the district meet the requirements of households for timber, fuel wood and other minor forest produce. The mode of agroforestry and the tree stock in the agricultural lands as observed in the survey in the district are presented below:

The net sown area of the district accounts for almost 80 per cent (DESO, 2001). The agriculture in the district is predominantly irrigated with almost 99 percent area under irrigation. The cropping intensity was 166 per cent in the district. Under these conditions there is absolutely any agriculture area, which is under systematic agroforestry except the bunds and boundaries of the agricultural fields. Almost all the sample farm households had some trees or the other only on the farm bunds or boundaries. The tree stock in the homestead was negligible.

Tree stock with farmers : The particulars of tree stock of the farmers on the field bund/ boundary are presented in Table-2. The average tree stock per farmer works out to 15.6. Among the farmer categories, the highest tree stock was with the large farmers. The total tree stock was directly proportional to the land holding size. Almost all the trees were naturally growing trees. The contribution of the farmers is that they only nurture and protect them. In order to understand the dependence and the role of farm trees on the livelihoods of the farmers, the tree density was estimated. Such an analysis indicated that marginal farmers had higher tree density as compared to the other two categories of farmers. It is therefore noted that there exists an inverse relationship between land holding size and tree density in farmlands. The dominant tree species observed in the farmlands of the study households were Azadirachta indica (Neem), Acacia nilotica (Babool), Dalbergia sissoo (Shisham) and Eucalyptus spp.

Table 2. Tree stock with farmers in Aligarh district

Farm Size Category	No. of Trees/farm family	Tree stock density (ha-1)
Marginal (= 1 ha)	9.5	13.4
Small (1-2 ha)	17.0	12.7
Medium/large (> 2 ha)	27.2	7.9
Overall	15.6	10.3

*Determinants of agroforestry :*Although the agroforestry system followed in Aligarh district is mostly traditional i.e. the farmers nurture the naturally growing trees rather than planting, the reasons for even doing so were elicited. The compiled status of the determinants of agroforestry is presented in the Table-3. For majority of the farmers (50.6 %), farm trees were a prime source of fuel wood and hence they protected the same. The other major reason (24.4 %) of agroforestry for the farmers was additional income from the tree component. A few farmers viewed that trees provided the much-needed resting place especially during summer. For a very few farmers the farm trees contributed small timber for making farm implements, bullock carts and household furniture.

Table 3. Determinants of agroforestry in Aligarh district

Determinant	Percentage
Fuel wood	50.6
Additional income	24.4
Shade	17.5
Timber	3.8
Others	3.8

*Costs and benefits of agroforestry :*The mean wood harvested either by pruning or by clear felling or through sale of trees per farmers on an average per year worked out to 4.24 q (Table-4). Across the farm-size categories, the highest wood production was in case of large farmers with 4.68 q. The net realization by farmers on account of sale of tree produce was Rs. 751 per annum. Across the farm-size categories it ranged between Rs.702 (marginal farmers) to Rs.881 (large farmers) on an average. On the basis of per ha returns from tree produce, the marginal and small farmers were getting higher as compared to their large counterparts. This could be due to more on-farm supervision and care besides frequent harvest by the former group of farmers.

Table 4. Annual production of tree produce

Farm Size Category	Estimated production of average annual tree produce (wood in q)	Estimated average annual net income from tree produce (Rs.)	Net returns from tree produce per ha per year (Rs.)
Marginal (=1 ha)	3.94	702	989
Small (1-2 ha)	4.40	725	541
Medium/large (>2 ha)	4.68	881	255
Overall	4.24	751	440

Intensive Agroforestry Region : The commercial agroforestry region mostly comprises the northern districts of western Uttar Pradesh, which falls in the tarai and adjoining areas with plenty of ground water, canal irrigation and fertile lands. The cropping pattern in the district is Paddy/Sugarcane - Wheat based. This region is characterized by trees in close association with crops either on farm bunds/ boundaries or within the fields. From the commercial agroforestry region, one district viz. Saharanpur was selected at random for studying the agroforestry practices of this region.

Characteristics of sample farmers : The study in the Saharanpur district covered a sample of 160 farmers and their composition by the category is indicated in Table-5. The sample farmers were post-stratified into three categories as per the total land holding of these farmers. The share of medium farmers was the highest (47.5 %) in the district, which owned a holding in the range of 2 to 5 ha. The other major category of farmers in the sample was small landholders who constituted about 35 per cent. The marginal farmers had an average land holding of 0.77 ha, while the small farmers had a land holding of 1.42 ha the land holding of medium and large farmers was 2.28 and 5.31 ha, respectively. Thus the overall holding size of the farmers worked out to 1.91 ha in Saharanpur district, significantly higher than that of Aligarh farmers, probably one of the reasons for commercial agroforestry intensity in this region.

Table 5. Composition of sample farmers in Saharanpur district

Farmer Category	No. (%)	Average Holding Size (ha)
Marginal (<1 ha)	12 (7.5)	0.77
Small (1-2 ha)	56 (35.0)	1.42
Medium (2-5 ha)	76 (47.5)	2.28
Large (>5 ha)	16 (10.0)	5.31
Total	160 (100.0)	1.91

Agroforestry in Saharanpur district : The adoption level of Agroforestry in the Saharanpur district is to the tune of 93 per cent (TERI, 2000). Hence the sample farmers were selected at random without any regard to whether they were practicing agroforestry or not. In this district, forest covers an area of only 9 percent and the net sown area is about 76.5 percent of which 69.6 per cent area is under irrigation. The cropping intensity of the district is 159 percent. The district is characterized by two modes of agroforestry viz. trees on field bunds or farm boundaries and the other being tree cultivation within the fields along with seasonal crops i.e. agrisilviculture. Two industry oriented tree species viz. Populus deltoides and Eucalyptus tereticornis hybrids. are most prevalent in this district. The other species observed under agroforestry on a few farmers' fields mostly on the field boundaries, were Mangifera indica (Mango), Dalbergia sissoo and Jamun either in combination with Poplar or with Eucalyptus or separately.

Based on the sample studies in 8 villages of two blocks of the district with interviews of 160 farmers, the various agroforestry systems practiced by the farmers are given in Table-6. It may be noted that majority of the farmers (78.1 %) were practicing bund/boundary plantation.

Table 6. Agroforestry systems practiced in Saharanpur district

Agroforestry Systems	No. of farmers	Major tree species
Bund/Boundary plantations	125 (78.1)	Poplar, Eucalyptus
Agrisilviculture (Crop + Trees within the same field)	35 (21.9)	Poplar

N.B.: Figures in parentheses are percentages

Area coverage and tree density under agroforestry : The average area covered under agroforestry in case of bund

system across the farm-size categories indicated that farmers who have adopted bund system of agroforestry, an average 67.4 per cent of their total holding is under agroforestry (Table-7). Similarly in case of farmers who have taken up agrisilviculture, the coverage of area under the system was 54 per cent on an average.

Table 7. Area coverage under agroforestry among the sample farmers

Farmer Category	Total Landholding	% area under agroforestry
Bund System		
Marginal/Small farmers	1.33	77.4
Medium farmers	2.73	67.0
Large farmers	5.51	56.6
All farmers	1.82	67.4
Agrisilviculture		
All farmers	2.83	54.0

The density of trees across the farm-size classes under bund system of plantation is given in fig-1. The overall tree density under bund plantations was 146 trees ha-1 on an average with 64 per cent of Poplar trees and another 33 per cent Eucalyptus. It is interesting to note that the tree density decreased as the land holding increased. The saplings under bund system are often planted in twin rows with at least 2 m spacing. The field bunds in the interior of the farm or the bunds on the boundary of common approach roads are planted with saplings to avoid complications with the neighbouring farmers. The farmers followed a rotation of eight years in case of bund/ boundary plantations.

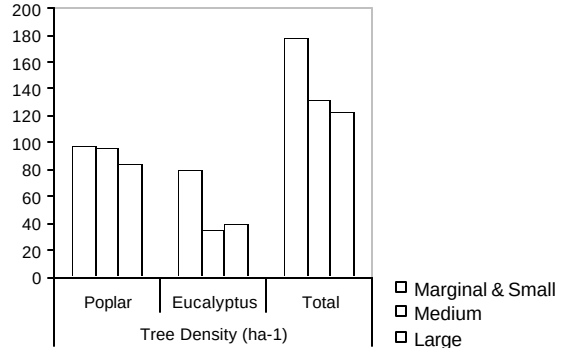

Fig 1. Tree density under bund system in Saharanpur district

In agrisilviculture, Poplar is the lone species. The average tree density in case of agrisilviculture worked out to 481 trees ha-1. The spacing followed is often 5 x 4 m, but due to slight inaccuracy in measurement and planting, the average tree population per ha among the 35 farmers, who were practicing agrisilviculture was slightly less than the recommended 500 trees ha-1. The normal rotation followed in the case of agrisilviculture is 7 years.

Determinants of agroforestry : The factors influencing the agroforestry were ascertained from the sample farmers interviewed in Saharanpur district. The same are detailed in Table-8. Out of the total sample farmers, majority (71.3%) have indicated that agroforestry is a source of additional income. The other determinants of agroforestry as pointed out by farmers are emergency source for cash (17.5%), supplemental employment (4.4%), other reasons like soil conservation (4.4%) and fuel wood (2.5%).

Table 8. Determinants of agroforestry in Saharanpur district

Major Reason	Frequency	Percentage
Additional income	114	71.3
Source of money in emergency	28	17.5
Source of fuel wood	4	2.5
Source of employment	7	4.4
Others	7	4.4
Total	160	100.0

Cost benefit analysis of agroforestry : The system wise economic analysis of agroforestry considering the rotation period, cropping pattern and the actual number of farmers who have harvested the produce in the past three years was done for the bund/ boundary and agrisilviculture systems separately for the two major tree species. The farmers in general practiced bund planting with Poplar as well as Eucalyptus. For the sake of arriving at the comparative economics of exclusive Poplar and Eucalyptus based systems with the average population maintained per ha, the B:C was worked out. The cost benefit analysis of bund system of Poplar plantation with 8 year rotation for a tree density of 146 trees ha-1 is given in Table-9. Although the farmers followed different cropping sequences, for the sake of estimation the common cropping pattern was taken into account. The cropping pattern considered for the system was Sugarcane for the first two years and Paddy-Wheat system in the subsequent years. It may be noted that the B:C (discounted at 10 %) worked out to 2.84. The average annual net returns were to the tune of Rs.17282/- at current prices. On the other hand the comparative net returns from pure crop rotation were Rs.11734/- per annum.

Table 9. Cost-benefit analysis of Poplar based bund system in Saharanpur

Particulars	Value / amount (Rs/ha)
Input cost for trees	6569
Input cost for crops	67600
Total Costs	74169
Return from trees	60256
Return from crops	152170
Total returns	212426
Net returns for the rotation	138257
Annual average net return	17282
B:C ratio (discounted at 10 %)	2.84

Similarly the cost-benefit analysis of Eucalyptus based bund system of plantation was done (Table-10). For the eight years rotation, the B:C worked out to 2.68 and the annual average net return was Rs.16124 ha-1 at current prices. The B:C of Eucalyptus based system was slightly lower than that of Poplar based system.

Table 10. Cost-benefit analysis of Eucalyptus based Bund system

Particulars	Value/ amount (Rs)
Input cost for trees	8633
Input cost for crops	67600
Total Costs	76233
Return from trees	53058
Return from crops	152170
Total returns	205288
Net returns for the rotation	128995
Annual average net return	16124
B:C ratio (discounted at 10 %)	2.68

Table 11. Cost benefit analysis of Poplar based agrisilviculture in Saharanpur district

Particulars	Value/ amount (Rs)
Input cost for trees	19532
Input cost for crops	78493
Total Costs	98025
Return from trees	152605
Return from crops	176450
Total returns	329055
Net returns for the rotation	231030
Annual average net return	28879
B:C ratio (discounted at 10 %)	3.00

The cost benefit analysis of poplar based agrisilviculture with a tree density of 481 trees ha-1 and a seven year rotation under sugarcane (first two years) followed by only wheat in the next five years, as followed by the farmers was worked out (Table-11). The B:C worked out to 3.00 at a discount rate of 10 per cent. The average annual net returns worked out to Rs.28879/- whereas, pure crop rotation gave a net return of only Rs.11734/- per annum.

CONCLUSION

The major motivating factor for adoption of commercial agroforestry in western Uttar Pradesh was assured income whereas the availability of fuel wood was the prime reason for patronizing trees on farmlands under traditional agroforestry systems. Poplar and Eucalyptus based commercial agroforestry systems are comparatively profitable than both the traditional agroforestry systems and conventional cropping patterns in the western Uttar Pradesh. The contribution of the trees in the farming systems certainly added to the diversity dimension by way of income and employment to the farm households besides fulfilling the requirement of wood. Both forms of agroforestry have specific roles to play in the livelihoods and industrial development, which have to be carefully nurtured for their sustainability.

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