Economic Analysis of Existing Agroforestry Systems Among Different Categories of Farmers in Tehsil Bangana of Una District of Himachal Pradesh, India

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Abstract

The present study was conducted to evaluate the existing agroforestry systems and their economic returns in Tehsil Bangana of Una district of Himachal Pradesh, India during the year 2019–2020. A total number of 324 farmers were selected randomly from three categories viz., marginal, small, and medium based on landholding capacity for survey and data collection. The data was collected through a pre-tested schedule for personal interviews with the head of each household and field sampling. The study revealed that five agroforestry system types prevalent among different categories of farmers namely: AS, AH, AHS, HP, and SP. The bioeconomic of the different systems was analyzed by calculating the cost of cultivation, gross returns per hectare, net returns per hectare, and benefit: cost ratio. The higher net returns of agroforestry systems among different farmers categories were observed in AS, small farmer's category (₹ 1,51761), and lowest were observed in SP, marginal farmer's category (₹ 5,999). Benefit: cost ratio of agroforestry systems among different farmers category was observed maximum in AH, medium farmer's category (1.89) whereas, minimum benefit: cost ratio was recorded in SP, marginal farmer's category (1.72). Irrespective of farmers category, maximum mean benefit: cost ratio (1.88) was recorded in AHS and minimum (1.72) was observed in the SP system. Hence the study represents the clear picture of economic analysis of existing agroforestry systems which will help the local peoples to fulfill their basic needs and the researchers to gain the benefit from the agroforestry.

1. Introduction

Agroforestry is not a new system or concept but traditionally been a way of life and livelihood in India for centuries Pandey, (2007). Existing agroforestry systems in any area are the result of farmer's innovation and experimentation over centuries Kaler et al. (2017). India has only 0.064 ha of forest area per capita as against 0.64 ha of the world average and the forest policy also aims at improved productivity to meet both local and national needs Parthiban et al. (2014). India became the first country in the World who adopted a special policy on agroforestry called the "National Agroforestry Policy, enacted in 2014. It is also realized that agroforestry is the only alternative to meet the target of increasing forest cover to 33% from the present level of less than 25% Anonymous, (2014). Agroforestry contributes to sustainable development and the enhancement of local people's livelihoods through their ecological, social, and economic benefits Khadka et al. (2021). At present, agroforestry meets near about 50% of the demand for fuelwood, 34% of the small timber, 70-80% of the wood for plywood, 60% of raw material for paper pulp, and 9-11% of the green fodder requirement of livestock, besides meeting the subsistence needs of households for food, fruit, fiber, medicine, etc. Handa et al. (2016). Agroforestry practices can provide food security, enhance soil fertility, provide fodder and generate income by ensuring a diversity of outputs Tsufac et al. (2021). As of today, agroforestry is considered as a problem-solving agroforestry system that can take an almost infinite number of different forms as they have the potential to include any of the crops, animals, and tree species used in agriculture and forestry. It provides an opportunity for diversification of existing land-use systems, beneficial environmental impacts, and higher returns as compared to the sole cropping system Kang and Akinnifesi (2000). Moreover, in rural areas, agroforestry improves socio-economic conditions by creating job opportunities and provides income, thereby reducing the scarcity of food production and improving the financial state Goudarzian and Yazdani (2015). Several researchers

noticed that agroforestry has potential for ecological benefits such as carbon sequestration, mitigation of climate change, enhancing soil fertility and water use efficiency, biodiversity conservation, biological pest control, sustainable land use, shelterbelt and windbreaks, microclimate amelioration, breaking the poverty and food insecurity circle, Caveats and clarifications Abbas et al. (2017); Udawatta et al. (2019); Tomar et al. (2021). Agroforestry is not a new concept in Himachal Pradesh and other Himalayan regions but it has been practiced traditionally since time immemorial Nautiyal et al. (1998). Traditional agroforestry systems *viz* Agri-Silviculture, Agri-Horticulture are prevalent in the Cold desert Region of Himachal Pradesh, India, that combines agriculture crops like Barley, Wheat, Buckwheat, Millets, Oat, Mustard, etc. with boundary plantations of multipurpose trees like *Morus alba*, *Salix* spp. and *Populus* spp. which are the main source of fodder and fuelwood Kaler et al. (2017). However, there is a need for improvement in agroforestry systems through scientific methods, research, etc. so that farmers can generate more economic benefits from agroforestry. Although various agroforestry systems exist in the sub-tropical low hill region of Himachal Pradesh, due to lack of scientific knowledge among the local people, these systems are not so productive and require improvement both in terms of structure as well as productivity. Therefore, the present study was undertaken to evaluate the economics of existing agroforestry systems among different categories of farmers in Tehsil Bangana of Una District of Himachal Pradesh.

2. Materials and Methods

The present study was carried out in Bangana Tehsil of Una District of Himachal Pradesh (India) during the year 2019–20 and its coordinates lie between 31°18′ to 31°55′ N latitude and 75°55′ to 76°28′E longitude. The altitude of the study area varies from 650m-900 m above mean sea level. The climate of the study area is mostly sub-tropical and it receives an average annual rainfall of about 1253 mm, mostly from the southwest monsoon. The average temperature of the study site varies from 2°C in winter and 46°C in the summer season. May and June are the hottest months. The study site was selected through a multi-stage random sampling technique in which twelve panchayats were chosen (*viz.* Muchali, Dohgi, Dhundla, Malangar, Tanoh, Lathiani, Hatlikesru, Jasana, Piplu, Sihana, Thanakalan, Tihra) and from each selected panchayat as per classification of the government of Himachal Pradesh, three villages were selected. In each village, farmers were divided into three different categories based on their land holdings *i.e.,* marginal (<1 ha), small (1-2 ha) and medium (2-5 ha), and a random sample of three farmers from each category was taken as the ultimate unit of study. One hundred and eight farmers were falling in each category in selected panchayats. In total, 324 farmers were surveyed to know about agroforestry systems practiced in the area, and their economy was analyzed. The bio economics of the system was analyzed by calculating the cost of cultivation, gross and net returns per hectare. All the parameters were calculated based on market price prevailing at the time of completion of the experiment. The cost of cultivation was worked out on a per hectare basis as per the prevalent market rates. The prevailing local market price was used to convert the yield of all the crops plants into gross returns in rupees per hectare. Net returns were calculated by deducting total costs from the gross returns:

Net return= Gross return-total cost

Benefit/cost ratio=Total discounted costs ($₹$ ha^{-1})/Total discounted benefits ($₹$ ha^{-1})

2.1. Statistical analysis

The experiment was based on completely randomized design and further we use SPSS 16.0 software to carry out the multivariate general linear model to observe the difference. Further post hoc Tukey test was performed to identify the homogeneous subsets. All analyses are mean±standard deviation.

3. Results and Discussion

Among different categories of farmers, five agroforestry systems types *viz.* Agri-Silviculture (AS), Agri-horticulture (AH), Agri-horti-silviculture (AHS), Horti-pastoral (HP), and Silvi-pastoral (SP) were identified in the study area (Table 1). These system types may be familiar to agro-climatic conditions of the area and need of the farmers viz. fodder, food, fuelwood, timber, etc. A similar type of five agroforestry systems viz. Agri-silviculture; Agri-horticulture; Agri-Horti-silviculture; Agri-silvi-horticulture and Silvi-pasture were reported by Goswami (2009) in Kwaalkhad watershed in district Solan of Himachal Pradesh. Nayak et al. (2011) have also identified and categorized similar agroforestry systems in the Lahaul and Spiti districts of Himachal Pradesh.

Table 1: Comparative status of agroforestry system types among different categories of farmers in Bangana Tehsil of Una District (HP)

Agroforestry system types	Farmers category		
	Marginal	Small	Medium
Agri-silviculture (AS)	+	+	+
Agri-horticulture (AH)	+	+	+
Agri-horti-silviculture (AHS)	+	+	+
Horti-pastoral (HP)	-	+	+
Silvi-pastoral (SP)	+	+	+

+: Agroforestry system existed; -: Agroforestry system not existed among farmer category

3.1. Total expenses of agroforestry systems among three farmers category

Data of farmers category-wise total expenses of agroforestry systems in Bangana Tehsil of Una District (HP) have been presented in Table 2. It is evident from the data that the total expenses were significantly influenced by farmers' category, agroforestry system and their interaction. The significant variations were recorded in the different agroforestry systems for total expenses. The maximum mean total expenses were noticed in AH system (₹ 1,71777.00) were lowed by HP (₹ 147357.50) while minimum mean expenses were recorded in the SP system (₹ 9151.30). The highest total expenses under the three farmers categories were observed in the small farmer category (₹ 1,32718.2) and minimum expenses were recorded in the medium farmer category (₹ 92,046.2). The highest mean total expenses in small farmers were due to higher use of fertilizers, seed cost, irrigation cost, equipment cost, etc. The interaction between agroforestry systems and three farmer categories reported significant variation in the total expenses. The higher total expenses were noticed in the AS, small farmer category (₹ 1,80795) while lower expenses were recorded in SP, marginal farmer category (₹ 8,349).

Table 2: Farmers category-wise total expenses (₹ ha⁻¹ yr⁻¹) of agroforestry systems in Bangana Tehsil of Una district (HP)

Sl. No.	AF system (s)	Farmers category			
		Marginal	Small	Medium	Mean
1.	AS	1,47,583	1,80,795	75,574	1,34,650.67
2.	AH	2,04,637	1,65,087	1,45,607	1,71,777.00
3.	AHS	1,25,906	1,60,469	82,470	1,22,948.33
4.	HP	-----	1,48,195	1,46,520	1,47,357.50
5.	SP	8,349	9,045	10,060	9,151.33
	Mean	1,21,618.75	1,32,718.2	92,046.2	

3.2. Gross return of agroforestry systems among the different categories of farmers

Results from Table 3 revealed that the gross return was significantly influenced by agroforestry systems, farmer's category, and their interaction. Mean Gross return was found significantly highest in the AH system (₹ 3,12,727.33) followed by HP (₹ 2,65,386.00) and AS (₹ 2,47,516.67) whereas on the other hand lowest mean gross return was found in the SP system (₹ 16,039.67). Among the three farmers categories, the highest mean gross return was reported in the small farmer category (₹ 2,42,393.60) while the lowest gross return was noticed in the medium farmer category (₹ 1,72,335.20). Interaction between agroforestry systems and three farmer categories significantly influenced the gross return. The maximum gross return was found in AH, marginal farmer category (₹ 3,55,089) and lowest gross return was indicated in SP, marginal farmer category (₹ 14,342) which was found statistically at par with the same agroforestry system, small farmer category (₹ 16,097). The gross returns were found more in the agri-horticulture system because agriculture and horticulture crops include cereals, pulses, vegetables, Mango, litchi, Guava, Citrus, Papaya, etc. are cultivated in a large area that fetches more capital to the farmers from the market.

Table 3: Farmers category wise gross return (₹ ha⁻¹ yr⁻¹) of agroforestry systems in Bangana Tehsil of Una district (HP)

Sl. No.	AF system (s)	Farmers category			
		Marginal	Small	Medium	Mean
1.	AS	2,73,132	3,32,556	1,36,862	2,47,516.67
2.	AH	3,55,089	3,08,084	2,75,009	3,12,727.33
3.	AHS	2,35,821	3,01,271	1,55,313	2,30,801.67
4.	HP	-	2,53,960	2,76,812	2,65,386.00
5.	SP	14,342	16,097	17,680	16,039.67
	Mean	2,19,596	2,42,393.60	1,72,335.20	

3.3. Net returns of agroforestry systems among three farmers category

Data tabulated in Table 4 revealed that the net returns were significantly influenced by agroforestry systems, farmer's category, and their interaction. The highest mean net returns among agroforestry systems were recorded in the AH system (₹ 1,40,950.33) followed by HP (₹ 1,18,028.50) and the lowest net return was recorded in the SP system (₹

Table 4: Farmers category wise net return (₹ ha^{-1} yr^{-1}) of agroforestry systems in Bangana Tehsil of Una district (HP)

Sl. No.	AF system (s)	Farmers category			
		Marginal	Small	Medium	Mean
1.	AS	1,25,549	1,51,761	61,288	1,12,866
2.	AH	1,50,452	1,42,997	1,29,402	1,40,950.33
3.	AHS	1,09,915	1,40,802	72,843	1,07,853.33
4.	HP	-	1,05,765	1,30,292	1,18,028.50
5.	SP	5,993	7,052	7,620	6,888.33
	Mean	97,977.25	1,09,675.40	80,289	

6,888.33). Among the three farmers category, the highest mean net return was observed in the small farmer category (₹ 1,09,675.40) while the lowest net return was found in the medium farmer category (₹ 80,289). Interaction between agroforestry systems and three farmer's categories significantly influenced the net returns. The highest net returns in the interaction were occurred in AS, small farmer category (₹ 1,51,761), which was followed by AH, marginal farmer category (₹ 1,50,452), while the lowest amount of net return was recorded in SP, marginal farmer category (₹ 5,993) which was found statistically at par with same agroforestry system, small farmer category (₹ 7,052). Higher net returns were associated with financial variables including output prices, establishment cost, labor cost, and discount rate. It may also depend on management decisions such as the area planted to crops and trees Wise and Cacho (2002). The highest net returns in the AH system could be attributed to the reason that in this system, two main cash fetching components *viz.*, agriculture and tree components had contributed for significant share to the net returns. Kumar (1996) conducted a study on bio-economic appraisal of agroforestry systems in Himachal Pradesh and found that the agri-horticulture system gives the highest net return

followed by agri-silviculture and minimum in sole cropping.

3.4. Benefit-cost ratio of agroforestry systems among three farmers category

Data of Benefit: cost ratio of agroforestry systems among three farmers category in Bangana Tehsil of Una District in Himachal Pradesh has been presented in Table 5. It indicates that the benefit: cost ratio was significantly influenced by agroforestry systems, farmer's category, and their interaction. The maximum mean benefit: cost ratio among different agroforestry systems was recorded in the AHS system (1.88) followed by AS and AH (1.83) and the minimum benefit: cost ratio was recorded in the SP system (1.75). Among the three farmers category, the highest mean benefit: cost ratio (1.85) was recorded in the medium farmer category while on the other hand lowest benefit: cost ratio was found in the marginal farmer category (1.79). The interaction between agroforestry systems and three farmers categories showed significantly higher benefit: cost ratio in AH, medium farmer category (1.89) which were found statistically at par with HP, medium (1.89) whereas, the lowest benefit: cost ratio (1.71) was recorded in HP, small farmers category which was found statistically at par with SP, marginal farmer category (1.72).

Table 5: Farmers category wise benefit: cost ratio of (₹ ha^{-1} yr^{-1}) of agroforestry systems in Bangana Tehsil of Una district (HP)

Sl. No.	AF system (s)	Farmers category			
		Marginal	Small	Medium	Mean
1.	AS	1.85	1.84	1.81	1.83
2.	AH	1.74	1.87	1.89	1.83
3.	AHS	1.87	1.88	1.88	1.88
4.	HP	-	1.71	1.89	1.80
5.	SP	1.72	1.78	1.76	1.75
	Mean	1.79	1.82	1.85	

4. Conclusion

In the study area, five agroforestry system types were identified, where maximum mean net return (₹ 1, 40,950.33 ha^{-1} yr^{-1}) was obtained from AH and minimum (₹ 6, 888.33 ha^{-1} yr^{-1}) from SP System. The AH system was found most prevalent

and profitable agroforestry system in Bangana Tehsil (HP). Economic analysis of existing agroforestry systems in the study area will assist the researchers to understand their bio-economics to make further improvements and develop technologies that will help to increase returns.

5. References

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