

Profitability of Agroforestry System: The case of Udham Singh Nagar District of Uttarakhand State, India

Abstract

The paper has examined the profitability of the prevailing agroforestry system in Udham Singh Nagar district of Uttarakhand state.. Two blocks of Udham Singh Nagar district was selected for study purpose. In which it was found that two spacing of agroforestry was followed by sample farmers i.e. 7m x 3m and 5m x 4m. Study was conducted by taking in to account of sole cropping system and Agroforestry system for comparing the profit realised by both the systems. CACP (Commission for agricultural cost and prices) concept was used to determine the cost and return from both the spacing and with sole crop too. The result indicated that Agroforestry with spacing 7m x 3m is profitable in comparison to spacing 5m x 4m but with comparison to sole crop both spacing of Agroforestry system was found to be beneficial. The study has suggested that policy support in terms promotion of agroforestry system is MSP (Minimum Support Price) should be there for wood produce too as in case of crop produce so that more farmers will be encouraged towards practicing Agroforestry system.

Keywords: Agroforestry, spacing, sole crop, profitability, CACP, policy, MSP, Wood produce

Introduction

Agroforestry is a practice of agriculture and forestry in the same piece of land simultaneously. It is a dynamic, and natural resource management system that, through integration of woody perennials on farms and in the agricultural landscape, diversifies and sustains production and builds social institutions. They buffer against weather related production losses, enhancing resilience against climate impacts survival (Nair, 1993).

The inter-cropping with trees found to be beneficial as trees has the capacity to retain with all sort of problem i.e. drought, insects, pests, flood and it is economically viable too. Trees add more income to the farmer. Trees under agroforestry, improve soil productivity through

addition of organic matter in the soil. Trees also provide food, industrial raw materials, fuel wood, timber, fodder etc. **(National Agroforestry Policy, 2014)**. Broadly the plains and hills present different scenarios for agriculture in Uttarakhand. But in hills agroforestry is not practiced on commercial basis as in the plains. In view of shrinkage of agricultural land and operational holdings due to expansion of urbanization, change in food habit of people, increasing population, farmers were adopting the practices of including trees in their cropping system **(PHD chamber Uttarakhand, 2016)**.

Demography and Land Use Pattern

In Uttarakhand, only Udham Singh Nagar district occupies highest area (29.12 lakh ha) under cultivation followed by Haridwar district (23.60 lakh ha) respectively. In the demography and land use pattern it shown that the area under forest was (2.42%), Net Sown was (18.22%) and agroforestry area was found to be (61.6%).

Land holding pattern in Uttarakhand

The land holding pattern of the state is presented in the Table 1 for the year 2001 and 2016. The Table depicts that more than 74 per cent of the farmers belongs to marginal farm size group and about 17 per cent belongs to small farm size group. Thus about 74 per cent of the land holding is less than 1 hectare in size and covers only about 36 per cent of the total land holdings, while about 28 per cent of land holdings is between 1 to 2 hectare and 33 per cent of land holding is between 2 to 10 hectare in size covering about more than 50 per cent of the total cultivated land.

Table 1: Land holding pattern in Uttarakhand

S.No.	Farm size class	Number ('000)		Per cent change	Area ('000 ha)		Per cent change	Average Holding Size (ha)	
		2001	2016		2001	2016		2001	2014
1	Marginal	628 (71)	672 (74)	7.01	243 (29)	296 (36)	21.8	0.39	0.44
2	Small	158 (18)	157 (17)	-0.63	221 (26)	225 (28)	1.8	1.40	1.43
3	Semi Medium and Medium	102 (11)	82 (8.9)	-19.60	344 (41)	270 (33)	-21.51	4.11	2.64
4	Large	1 (0.1)	1 (0.1)	0.00	36 (4)	25 (3)	-30.56	36.00	25
	Total	889	912	2.59	844	816	-3.32	0.95	0.89

Note: Marginal=below 1 ha; Small=1 to less than 2 ha; Semi-medium and Medium = 2 to less than 10 ha; Large =10 ha and above

Note: Figures in parentheses indicate percentage to total farmers.

Source: Uttarakhand at a glance (2014), Directorate of Economics and Statistics, Dehradun.

Land utilization pattern in Uttarakhand

Like other hill state, the people of Uttarakhand practice integrated systems of farming including forestry, horticulture, livestock and off-farm activities. Most of the area of state is under forests and wastelands thus leaving only a small amount of land for cultivation. Table 2 presents the land use pattern in 2000-01 and in 2015-16. From the Table 2 it is clear that a mild change has been recorded in case of total reported area. Forest area increased only by 0.57 per cent. Total cultivable waste land declined by 19.17 per cent, while fallow land increased by 96.34 per cent. Land under non-agricultural uses and land under miscellaneous, tree crop and

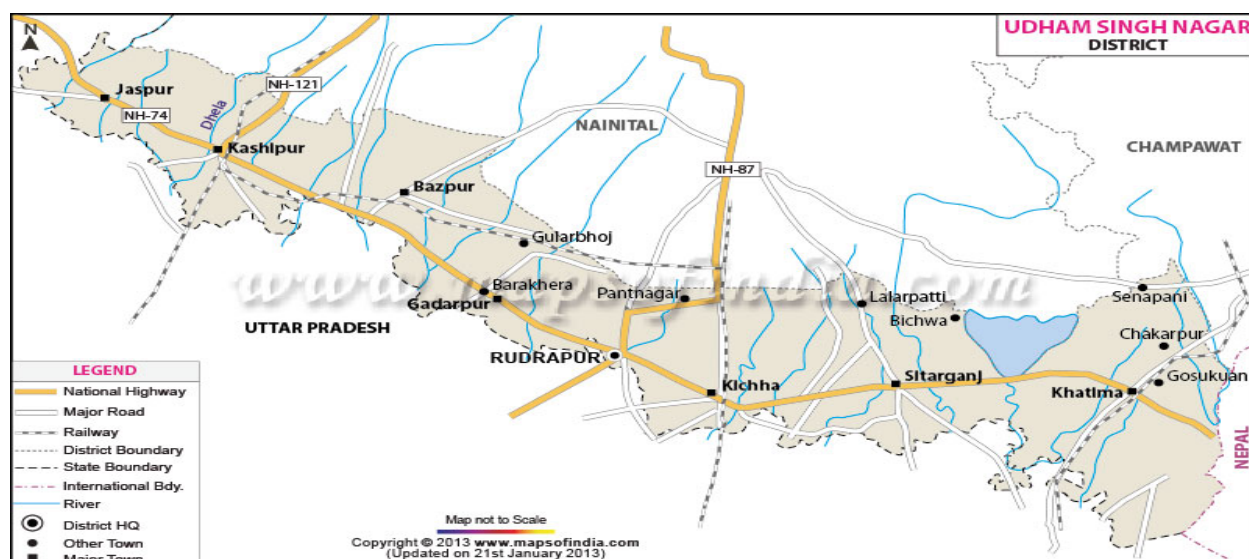
groves not included in net area sown increased by 43.21 and 52.84 per cent, respectively. Net sown area showed a decline of 7.24 per cent during the period from 2000-01 to 2015-16.

Table 2: Land utilization pattern in Uttarakhand

Sl. No.	Land use	Area(ha)		Percentage change in 2015-16 over 2000-01
		(2000-01)	(2015-16)	
1	Total reported area	5671698	5672636	0.01
2	Forest area	3465057	3484803	0.57
3	Culturable waste land	384928	311124	-19.17
4	Fallow land	68965	135412	96.34
5	Barren and unculturable land	310244	224851	-27.52
6	Land under non-agricultural uses	152247	218034	43.21
7	Permanent pasture & other grazing land	229481	198524	-13.50
8	Land under miscellaneous, tree crop and groves not included in net area sown	252351	385699	52.84
9	Net Area Sown	769944	714189	-7.24

Source: Uttarakhand at a glance (2013-14), Directorate of Economics and Statistics, Dehradun

Maps of the study area



Data and Methodology: -

Out of total 7 blocks in the Udhm Singh Nagar district, Rudrapur and Gadarpur blocks were selected randomly to represent the district. From the list of the villages in the selected blocks, one village was selected randomly then three adjoined villages were selected to form a cluster from each block. Secondly a list of all the farmers practicing agroforestry was prepared. It was found that farmers are planting both poplar and eucalyptus in blocks as well as on boundary. The number and percentage of farmers practicing these plantations in agroforestry is given in Table 3 Majority (67.39 per cent) of farmers found planting poplar based agroforestry, therefore, poplar based agroforestry was selected for the study purpose. Among block and boundary plantations with poplar it was observed that majority of farmers (52.53 per cent) are practicing block plantation.

Table 3: Major Agro- forestry systems in U. S. Nagar district

Major tree species	Agroforestry Systems	No. of farmers

Poplar	Bund/Boundary plantation	41 (14.85%)
	Agrisilviculture (Crop + Poplar Trees within the same field)	145 (52.53%)
Total number of farmers in poplar system		186{67.39}
Eucalyptus	Bund/Boundary plantation	55 (19.92%)
	Agrisilviculture (Crop + Eucalyptus Trees within the same field)	35 (12.68%)
Total number of farmers in eucalyptus system		90{32.60}
Overall number of farmer in Agroforestry system		276 {100}

Therefore, only block plantation of poplar based agroforestry has been considered for this study. In poplar block plantation it was found that two types of spacing viz., 7m x 3m and 5m x 4m are being followed in general in the selected villages. On the basis of these spacing farmers were divided into different strata (year wise). In the preliminary enquiry about the expenditure incurred in different years of poplar plantation it was found that none of the sample farmers recalled the years back expenditure incurred in the agroforestry plantation. Even most of them were unable to tell the selling prices of their produce from the agroforestry system.

Three farmers were selected from each of plantation year of agro forestry for complete rotation of each of the spacing. Hence, 21 farmers following spacing 7m x 3m and 21 farmers for spacing 5m x 4m were selected randomly from Rudrapur as well as from Gadarpur blocks making sample size from each block of 42 farmers.

Analysis of cost of and returns from agro forestry system

To estimate the cost of and returns from the agroforestry system cost concepts given by the Commission for Agricultural Costs & Prices (CACP), ministry of agriculture and farmers welfare, GOI have been used. The various cost concepts are summarized as follows:

Cost A₁: It is calculated by summing the following costs, as observed in the study area;

- a) Value of hired human labor (casual labor)
- b) Value of hired and owned machine labor
- c) Value of manures (owned and purchased Value of fertilizers)
- d) Value of seed (farm produced and purchased)
- e) Value of plant protection chemicals
- f) Irrigation charge
- g) Interest on working capital
- h) Depreciation on farm implements
- i) Land revenue
- j) Miscellaneous expenses

Cost A₂ = Cost A₁ + rent paid for leased-in land

Cost B₁ = Cost A₁ + Imputed interest on value of owned capital assets (excluding land)

Cost B₂ = Cost B₁ + Imputed rental value of owned land (net of land revenue) + Rent paid for Leased-in land

Cost C₁ = Cost B₁ + Imputed value of family labor

Cost C₂ = Cost B₂ + Imputed value of family labor.

Cost C₂* = Cost C₂ has been estimated by taking into account Statutory Minimum wage rate or actual wage rate, whichever was higher

Cost D = Cost C₂ * + 10% of Cost C₂* on account of managerial functions performed by the selected farmers.

Gross returns were calculated at the price to which the main and by products sold by the producers. Net returns were calculated by subtracting Costs A₁, A₂, B₁, B₂, C₁, C₂, C₂* and D from gross returns. To arrive at annual average cost and returns figures the total figure of entire poplar tree plantation period has been divided by 7.325. As the poplar trees have been found harvested on an average after 7.325 years of plantation.

RESULTS

The results of the study are presented under different sections, such as the results for the Major Agroforestry systems in Udham Singh Nagar district, Major tree species and clones, the economics of different plantation system of poplar and eucalyptus.

Major tree species and clones

In the Table 4 given below it is shown that the major tree species that was taken by number of farmers in different agroforestry system. The table given below is the major species and clones adopting by the farmers in study area.

Table 4 Major tree species and clones

SPECIES	PLANTATIONS	SPECIES/CLONES
Poplar	BLOCK & BOUNDARY	<i>Populus deltoides</i> Clones- G48, UDAI, W 3 ,WSL 22, WSL 32, WSL 39, S7C15, S7C8, ST 12, Pant Poplar 5

Cost of and Returns from the Agroforestry system of spacing 7m x 3m

(A) Operational Costs

It is evident from Table 5 that in overall the human labor plays an important role, since most of the operations were done manually. In the study area it was found that no one used the bullock labour. The human labor consist of family and hired labour was important item of operational cost which accounted for Rs.* 4182 and 31535 per ha annually. Whereas machine labor consists of transportation charges and other machinery charges for different operations i.e. charges of ploughing, sowing, digging etc. and stood at Rs. 9706 per ha annually .

(B) Material costs

It is further evident from the Table 5 that purchased input like fertilizers, manures, plant protection chemicals and plant growth protection chemical plays very important role in agroforestry cultivation. Seed material was an important item for agroforestry cultivation which stood at Rs. 13584 per ha of material cost. Whereas, values of manure, fertilizer, plant protection chemicals and irrigation were purchased at Rs. 13584, 2363, 1042 and 6424 per ha per year.

(C) Other costs

Other cost constitutes the rental value of owned land, depreciation and interest on value of owned capital assets. A perusal of the Table 5 indicates that the rental value of land was important item of fixed costs item. The rental value of land (net of land revenue) stood at Rs. 45335 per ha. Annual depreciation of capital assets and interest on the value of fixed assets were Rs. 813 and Rs. 1368, respectively.

Note: Rs.*= Indian rupee

Table 5: Cost of production incurred in agroforestry system with spacing 7m x 3m (Rs/ha)

Cost items	I year		II year		III year		IV year		V year		VI year	VII year*	Annual average
	Sugarcane Planted	Tree	Sugarcane Ratoon	Tree	Wheat	Tree	Turmeric (Dry)	Tree	Ginger	Tree	Tree	Tree	
OPERATIONAL COST													
Family labour	3073	1541	1945	985	3535	1774	5250	1138	6172	1430	1745	2044	4182
Hired labour	34519	8959	31377	3615	10215	2726	48057	4862	46880	6670	9055	24056	31535
Machine hours	8965	2026	6553	2345	5051	951	5815	1330	5770	1710	2090	28490	9706
MATERIAL COST													
Seed	20675	8279	0	1120	4368	0	25915	0	39147	0	0	0	13584
Manure	2866	2786	0	1224	2830	0	3433	0	4172	0	0	0	2363
Fertilizer	6907	4928	5534	2307	5252	0	6325	0	6627	0	0	0	5171
PPC	1432	750	1148	568	1032	0	2432	0	270	0	0	0	1042
Irrigation	5253	5960	5606	2327	4547	0	11231	0	12131	0	0	0	6424
Total working capital	80617	33688	50218	13506	33295	3677	103208	6192	114997	8380	11145	52546	69825
OTHER COST													
Interest on working capital	2822	1179	1758	473	583	129	3612	217	4025	293	390	1839	2364
Depreciation	1459	457	1284	187	1367	146	254	178	165	113	117	227	813
Land revenue	0	175	0	175	0	175		175	0	175	175	175	167
Rental value of land	0	47200	0	47424	0	47915		47308	0	47308	47588	47333	45335
Interest on owned FCA	1735	391	1594	265	1854	270	1480	219	1403	241	227	343	1368
TOTAL COST AT													
Cost A1	84898	35499	53260	14341	35245	4127	107074	6762	119187	8961	11827	54787	73170
Cost A2	84898	35499	53260	14341	35245	4127	107074	6762	119187	8961	11827	54787	73170
Cost B1	86633	35890	54854	14606	37099	4397	108554	6981	120590	9202	12054	55130	74538
Cost B2	86633	82915	54854	61855	37099	52137	108554	54113	120590	56335	59467	102288	119705
Cost C1	89706	37431	56799	15591	40634	6171	113804	8119	126762	10632	13799	57174	78720
Cost C2	89706	84456	56799	62840	40634	53911	113804	55251	126762	57765	61212	104332	123887
Cost C2*	89706	84456	56799	62840	40634	53911	113804	55251	126762	57765	61212	104332	123887
Cost D	98676	92902	62478	69124	44697	59302	125185	60777	139439	63541	67334	114766	136276
Unit cost of main product at Cost D (Rs/Q)	156	0	108	0	1233	0	2504	0	762	0	0	81	727

Note: Figure has been rounded off to the nearest rupee, PPC=Plant Protection Chemicals, FCA=Fixed Capital Asset, *VII year plus 0.325 of VIII year i.e. till harvest of poplar tree

Table 6: Returns from agroforestry system with spacing 7m x 3m

Returns items	I year	II year	III year		IV year		V year		VI year	VII year*	Annual average
	Sugarcane Planted	Sugarcane Ratoon	Wheat	Tree	Turmeric (dry)	Tree	Ginger	Tree	Tree	Tree	
Yield of MP (Q/ha)	591	542	28	0	50	0	183	0	0	1288	376
Yield of BP (Q/ha)	118	108	24	13	0	16	0	22	33	682	139
Selling price of MP (Rs/Q)	280	280	1585	0	3723	0	3045	0	0	430	1276
Selling price of BP (Rs/Q)	96	97	545	52	0	52	0	55	53	78	140
GROSS RETURNS	176808	162236	57460	676	186150	832	557235	1166	1749	607036	239092
NET RETURNS OVER											
Cost A1	91910	108976	22215	-3451	79076	-5930	438048	-7795	-10078	552249	165922
Cost A2	91910	108976	22215	-3451	79076	-5930	438048	-7795	-10078	552249	165922
Cost B1	90175	107382	20361	-3721	77596	-6149	436645	-8036	-10305	551906	164554
Cost B2	90175	107382	20361	-51461	77596	-53282	436645	-55169	-57718	504748	119387
Cost C1	87102	105437	16826	-5495	72346	-7287	430473	-9466	-12050	549862	160372
Cost C2	87102	105437	16826	-53235	72346	-54420	430473	-56599	-59463	502704	115205
Cost C2*	87102	105437	16826	-53235	72346	-54420	430473	-56599	-59463	502704	115205
Cost D	78132	99758	12763	-58626	60965	-59945	417797	-62375	-65585	492270	102816
Net Return per rupee invested at Cost D	0.79	1.60	0.29	-0.99	0.49	-0.99	3.00	-0.98	-0.97	4.29	0.75

Note: Figure has been rounded off to the nearest rupee.

MP=Main product, BP=By Product

*VII year plus 0.325 of VIII year i.e. till harvest of poplar tree

Comparison of costs and returns

Cost A_1 which is also known owners expenses was found to be Rs. 73170 per hectare annually, which include costs of hired human labor, machine, seed material, plant protection chemicals, manures, fertilizers, irrigation charges, plant protection chemicals, depreciation on farm building and implements, interest on working capital.

Cost C_2^* was same as cost C_2 at Rs. 123887 per ha and cost D was Rs. 136276 per ha, which includes cost C_2^* and 10% of cost C_2^* . The unit cost of production of main product has been worked out to be Rs. 727 per quintal.

It is also evident from the Table 6 that average yield of agroforestry cultivation in the study area was 376 qt per ha (including average yields of tree log and crops) and average price received by the farmers was Rs. 1276/qt.

Further, per year the gross return received from the agroforestry system in the study area was Rs. 239092 per ha. The yield from by product which includes per hectare production of tree branches and roots and by products of crops was 139 qt /ha. Whereas, the net returns over cost C_2^* and D were Rs. 115205 and Rs. 102816, respectively.

And on spending 1 rupee, farmer got Rs. 0.75 net profit this indicates extent of profitability of agroforestry system in the study area.

Cost of and Returns from the Agroforestry system of spacing 5m x 4m

(A) Operational Costs

It is evident form Table 7 that in overall the human labor plays an important role and since most of the operations were done manually. The human labor consists of family and hired labour was important item of operational cost which was accounted for Rs. 3709 and 26871 per ha annually. Whereas machine labor consist of transportation charges and other machinery charges for different operations i.e. charges of ploughing, sowing, digging e.t.c. stood at Rs. 10347 per ha per year.

(B) Material costs

It is further evident from the Table 7 below that purchased input like fertilizers, manures, plant protection chemicals and plant growth protection chemical plays very important role in agroforestry cultivation. Seed and saplings was an important item for agroforestry cultivation which stood at Rs. 12069 per ha of material cost.

Whereas, values manure, fertilizer, plant protection chemicals and irrigation, were purchased at Rs. 2647, 5156, 1235 and 6133 per ha per annum.

(C) Other costs

Other cost constitutes the value of interest on working capital, rental value of owned land, depreciation and interest on value of owned capital assets. A perusal of the Table 7 indicated that the rental value of land was important item of fixed costs item. The rental value of land (net of land revenue) stood at Rs. 45398 per ha. Depreciation of capital assets and interest on the value of fixed assets was Rs. 1125 and Rs. 1113 per ha annually of agroforestry cultivation.

Table 7: Cost of production incurred in agroforestry system with spacing 5m x 4m (Rs/ha)

Cost items	I year		II year		III year		IV year		V year		VI year	VII year*	Annual average
	Wheat	Tree	Wheat	Tree	Wheat	Tree	Turmeric (Dry)	Tree	Ginger	Tree	Tree	Tree	
OPERATIONAL COST													
Family labour	3077	1738	2459	1455	2735	1773	4893	1045	3638	1475	1135	1748	3709
Hired labour	9207	10562	10413	10845	10828	4527	58527	4655	30623	8125	11465	27052	26871
Machine hours	5898	2790	5697	1860	5907	1330	6161	1959	5712	2470	2858	33150	10347
MATERIAL COST													
Seed	4060	8534	4292	2373	4172	0	26339	0	38636	0	0	0	12069
Manure	2430	3152	2316	1613	2270	0	3407	0	4200	0	0	0	2647
Fertilizer	5931	5095	5729	2539	5819	0	6281	0	6374	0	0	0	5156
PPC	1312	831	1403	907	1424	0	1690	0	1480	0	0	0	1235
Irrigation	4635	6418	4882	2516	4378	0	12036	0	10061	0	0	0	6133
Total working capital	33473	37382	34732	22653	34798	5857	114441	6614	97086	10595	14323	60202	64458
OTHER COST													
Interest on working capital	586	1308	608	793	609	205	4005	231	3398	371	501	2107	2010
Depreciation	1343	363	1343	104	1337	188	1285	162	1245	171	223	477	1125
Land revenue	0	175	0	175	0	175	0	175	0	175	175	175	167
Rental value of land	0	47563	0	47338	0	47378	0	47354	0	47591	47468	47851	45398
Interest on owned FCA	1512	280	1770	296	1090	187	1113	113	1294	115	178	205	1113
TOTAL COST AT													
Cost A1	35402	39228	36683	23725	36744	6425	119731	7182	101729	11312	15222	62961	67760
Cost A2	35402	39228	36683	23725	36744	6425	119731	7182	101729	11312	15222	62961	67760
Cost B1	36914	39508	38453	24021	37834	6612	120844	7295	103023	11427	15400	63166	68874
Cost B2	36914	86897	38453	71184	37834	53816	120844	54474	103023	58843	62693	110842	114105
Cost C1	39991	41246	40912	25476	40569	8385	125737	8340	106661	12902	16535	64914	72583
Cost C2	39991	88635	40912	72639	40569	55589	125737	55519	106661	60318	63828	112590	117814
Cost C2*	39991	88635	40912	72639	40569	55589	125737	55519	106661	60318	63828	112590	117814
Cost D	43990	97498	45003	79903	44626	61148	138311	61071	117327	66350	70211	123849	129595
Unit cost of main product at Cost D (Rs/Q)	941	0	1033	0	1124	0	4838	0	265	0	0	79	949

Note: Figure has been rounded off to the nearest rupee.

PPC=Plant Protection Chemicals, FCA=Fixed Capital Asset , * VII year plus 0.325 of VIII year i.e. till harvest of poplar tree

Table 8: Returns from agroforestry system with spacing 5m x 4m (Rs/ha)

Return items	I year	II year	III year		IV year		V year		VI year	VII year*	Annual average
	Wheat	Wheat	Wheat	Tree	Turmeric (Dry)	Tree	Ginger	Tree	Tree	Tree	
Yield of MP (Q/ha)	32	30	27	0	44		175	0	0	1441	239
Yield of BP (Q/ha)	30	28	26	16	0	20	0	28	40	747	128
Selling price of MP (Rs/Q)	1520	1534	1527	0	3725		3047	0	0	453	1612
Selling price of BP (Rs/Q)	746	743	745	54	0	52	0	53	53	79	345
GROSS RETURNS	71020	66824	60599	864	163900	1040	533225	1484	2120	711786	220186
NET RETURNS OVER											
Cost A1	35618	30141	23855	-5561	44169	-6142	431496	-9828	-13102	648825	152426
Cost A2	35618	30141	23855	-5561	44169	-6142	431496	-9828	-13102	648825	152426
Cost B1	34106	28371	22765	-5748	43056	-6255	430202	-9943	-13280	648620	151312
Cost B2	34106	28371	22765	-52952	43056	-53434	430202	-57359	-60573	600944	106081
Cost C1	31029	25912	20030	-7521	38163	-7300	426564	-11418	-14415	646872	147603
Cost C2	31029	25912	20030	-54725	38163	-54479	426564	-58834	-61708	599196	102372
Cost C2*	31029	25912	20030	-54725	38163	-54479	426564	-58834	-61708	599196	102372
Cost D	27030	21821	15973	-60284	25589	-60031	415898	-64866	-68091	587937	90590
Net Return per rupee invested at Cost D	0.61	0.48	0.36	-0.99	0.19	-0.98	3.54	-0.98	-0.97	4.75	0.70

Note: Figure has been rounded off to the nearest number.

MP=Main product, BP=By product

*VII year and 0.325 of VIII year i.e. till harvest of poplar tree

Comparison of costs and returns

Cost A_1 which is also known as expenses incurred on owner's operated land, was found to be Rs. 67760 per hectare annually, which include costs of hired human labor, machine labor, seed material, plant protection chemicals, manures, purchased fertilizers, irrigation charges, plant protection chemicals, depreciation on farm building and implements, interest on working capital.

Cost C_2^* was same as cost C_2 was Rs. 117814 per ha and cost D was Rs. 129595 per ha. Which includes cost C_2^* and 10% of cost C_2^* on account of management functions performed by the farmer. The unit cost of production was Rs. 949 per quintal.

It is also evident from the Table 8 above that average yield of agroforestry cultivation (5m x 4m spacing) in the study area was 239 qt per ha and average price received by the farmers was Rs1612/qt. Further, the gross return received in the cultivation of agroforestry in the study area was Rs. 220186 per ha.

The yield from by product was 128 qt /ha. Whereas, the net returns over cost C_2^* and D have been found Rs. 102372 and Rs. 90590 per hectare respectively. On spending 1 rupee, farmer got Rs.0.70 net profit. Though this spacing under agroforestry has also been found profitable the extent of profitability has been found little less than that under the spacing 7m x 3m.

Cost of and Returns from sugarcane cultivation as a sole crop

The costs and returns from sugarcane planted and sugarcane ratoon cultivation have been computed considering the inputs used and output realized by the farmers for the Sugarcane planted and sugarcane ratoon to compare with the return from the agroforestry system. The total

costs and returns from sugarcane planted and sugarcane ratoon cultivation include three components i.e. operational cost, material cost and other costs. The profitability of sugarcane planted and sugarcane ratoon cultivation was worked on the basis CACP cost concepts and have been presented in the figure 1 and 2.

Component wise costs incurred in cultivation of sugarcane planted and sugarcane ratoon crops.

(A) Operational Costs

The table reveals that the operational cost contributes a major share in cultivation of Sugarcane planted and sugarcane ratoon cultivation. The use of fertilizers and plant protection chemicals were used in optimum quantity in study area.

The human labor consists of family and hired labour was important item of operational cost which was accounted for Rs. 3509 and 31448 per ha annually. Whereas, machine use consists of transportation charges and other machinery charges for different operations i.e. charges of ploughing, sowing, etc. stood at Rs. 7459 per ha per year.

(B) Material cost

It is further evident from the figure 1 that purchased input like fertilizers, manures, plant protection chemicals and plant growth protection chemical plays very important role in agroforestry cultivation. Seed setts was an important item for sugarcane cultivation which stood at Rs. 10238 per ha of material cost. Whereas, value of manure, fertilizer plant protection chemicals and irrigation were purchased at Rs. 1383, 6171, 1290 and 5430 per ha.

Figure 1: Cost of sugarcane cultivation as a sole crop

Cost items	Sugarcane Planted	Sugarcane Ratoon	Annual cost
OPERATIONAL COST			(Rs/ha)
Family labour	4073	2945	3509
Hired labour	32519	30377	31448
Machine hours	8565	6353	7459
MATERIAL COST			
Seed	20475	0	10238
Manure	2766	0	1383
Fertilizer	6807	5534	6171
Plant protection chemicals	1432	1148	1290
Irrigation	5253	5606	5430
Total working capital	77817	49018	63418
OTHER COST			
Interest on working capital	2724	1716	2220
Depreciation	1355	1284	1320
Land revenue	175	175	175
Rental value of land	47200	47424	47312
Interest on owned fixed capital asset	1735	1594	1665
TOTAL COST AT			
Cost A1	82071	52193	67132
Cost A2	82071	52193	67132
Cost B1	83806	53787	68796
Cost B2	130831	101036	115933
Cost C1	87879	56732	72305
Cost C2	134904	103981	119442
Cost C2*	134904	103981	119442
Cost D	148394	114379	131386
Unit cost of main product at Cost D (Rs./Q)	229	178	203

(c) Other costs

A perusal of the figure 1 indicates that the rental value of land was important item of fixed costs item. The rental value of land (net of land revenue) stood at Rs. 47312 per ha. Depreciation of capital assets and interest on the value of fixed assets was Rs. 1320 and Rs. 1665 annually of agroforestry cultivation.

Figure 2: Returns from sugarcane cultivation as a sole crop

Cost items	Sugarcane Planted	Sugarcane Ratoon	Annual Return
Yield of main product (Q/ha)	609	600	604
Yield of by product (Q/ha)	120	124	122
Selling price of main product (Rs./Q)	280	280	280
GROSS RETURNS (Rs/ha)	181819	179748	180784
NET RETURNS OVER			
Cost A1	99749	127556	113652
Cost A2	99749	127556	113652
Cost B1	98014	125962	111988
Cost B2	50989	78713	64851
Cost C1	93941	123017	108479
Cost C2	46916	75768	61342
Cost C2*	46916	75768	61342
Cost D	33425	65370	49397
Net Return per rupee invested at Cost D	0.23	0.57	0.38

Comparison of costs using CACP Cost concepts and returns

Cost A₁ was found to be Rs. 67132 per hectare, whereas, cost B₁ was Rs. 68796 per ha Cost C₂* was same as cost C₂ at Rs. 119442 per ha and cost C₃ was 131386 per ha. It is also evident from the figure 2 that average yield of sugarcane cultivation in the study area was 604 qt per ha and

average price received by the farmers was Rs. 280/qt. Further, the gross returns received in the cultivation of sugarcane in the study area was Rs. 180784 per ha. Whereas, the net returns (returns over cost C2* and D was Rs. 61342 and Rs. 49397, respectively. And on spending 1 rupee, farmer got Rs. 0.38 net profit in sugarcane cultivation which is quite low compared to that of agroforestry

Costs of and returns from paddy and wheat cultivation

Paddy and wheat rotation is found a common crop rotation followed in the study area. The costs and returns from paddy and wheat cultivation have been computed considering the inputs used and output realized by the farmers for the paddy and wheat cultivation as a one year crop rotation. The total costs and returns from paddy and wheat cultivation is also disused under three components i.e. operational cost, material cost and other costs. The profitability of paddy and wheat cultivation was worked out based on CACP cost concepts. The results of same have been presented in the figure 3. The purpose was to compare with the paddy - wheat crop rotation vis –a vis agroforestry system.

Component wise estimation of costs

(A) Operational Costs

The human labor consists of hired and family labour was important item of operational cost which accounted for Rs. 6580 and 22761 per ha annually per year respectively. Whereas, machine charges accounted for Rs. 10697 per ha per year.

(B) Material costs

It is evident from the figure 3 that purchased input like fertilizers, manures, plant protection chemicals and plant growth protection chemical plays very important role in paddy-wheat cultivation. Seed was an important item for paddy-wheat cultivation with an expenditure of Rs. 7424 per ha among the material costs. Whereas, manure, fertilizer, plant protection chemicals and irrigation chemicals, were accounted for at Rs. 4897, Rs. 10184, Rs. 2975 and Rs. 9679 per ha per year respectively.

(C) Other costs

Other costs constitute the value of interest on working capital, rental value of owned land, depreciation and interest on value of owned capital assets. A perusal of the figure 3 indicates that the rental value of land was important item of fixed costs item. The rental value of land (net of land revenue) stood at Rs. 36758 per ha. Depreciation of capital assets and interest on the value of fixed assets was Rs. 2221 and Rs. 2386 per year per ha for of paddy-wheat cultivation as a one year crop rotation.

Comparison of costs using CACP Cost concepts and returns

The figure 3 reveals that Cost A_1 was found to be Rs. 72300 per hectare annually, Cost C_2^* was same as cost C_2 at Rs. 117848 per ha and cost D was Rs. 129633 per ha, which includes Cost C_2^* plus 10 percent of cost C_2^* .

Figure 3: Cost of Paddy and Wheat cultivation

Cost items	Wheat	Paddy	Annual cost
OPERATIONAL COST			(Rs/ha)
Family labour	3535	3045	6580
Hired labour	10215	12546	22761
Machine hours	5451	5246	10697
MATERIAL COST			
Seed	4368	3056	7424
Manure	2830	2067	4897
Fertilizer	5252	4932	10184
Plant protection chemicals	1032	1943	2975
Irrigation	4547	5132	9679
Total working capital	33695	34922	68617
Interest on working capital	590	611	1287
Depreciation	1167	1054	2221
Land revenue	175	0	175
Rental value of land	18302	18456	36758
Interest on owned fixed capital asset	1154	1232	2386
TOTAL COST AT			
Cost A1	35627	36587	72300
Cost A2	35627	36587	72300
Cost B1	36781	37819	74686
Cost B2	54908	56275	111268
Cost C1	40316	40864	81266
Cost C2	58443	59320	117848
Cost C2*	58443	59320	117848
Cost D	64287	65252	129633
Unit cost of main product at Cost D (Rs./Q)	1047	1242	1137

It is also evident from the figure 4 that average yield of paddy-wheat cultivation in the study area was 67 qt per ha per year and average price received by the farmers was Rs. 1555/qt. Further, the gross return received in the cultivation of paddy-wheat rotation in the study area was Rs. 177333 per ha per year.

Figure 4: Return from paddy and wheat cultivation

Yield of main product (Q/ha)	36	31	66
Yield of by product (Q/ha)	35	30	65
Selling price of main product (Rs./Q)	1574	1536	1555
GROSS RETURNS (Rs./ha)	96619	80714	177333
NET RETURNS OVER (Rs. /ha)			
Cost A1	60992	44127	105033
Cost A2	60992	44127	105033
Cost B1	59838	42895	102647
Cost B2	41711	24439	66064
Cost C1	56303	39850	96067
Cost C2	38176	21394	59484
Cost C2*	38176	21394	59484
Cost D	32332	15462	47699
Net Return per rupee invested at Cost D	0.50	0.24	0.37

The yield from by product was 65 qt /ha per year. Whereas, the net returns over cost C2* and D have been Rs. 59484 and Rs. 47699, respectively. So we can say that there was profit in following paddy and wheat crop rotation. And on spending 1 rupee, farmer got Rs. 0.37 as net profit

CONCLUSION

Poplar based Agroforestry systems are comparatively profitable due to their fast growth and short rotation cycle. The trees component in the farming systems certainly add to the diversity dimension to the farm households besides providing increased and stable income. Agroforestry has specific role to play in the livelihoods and industrial development which have to be carefully nurtured for their sustainability.

From the above analysis it has been found that farmers obtained gross return of Rs. 239092 and Rs. 220186 per hectare per year from spacing's 7m x 3m and 5m x 4m of agroforestry system. Net return obtained over cost D from spacing 7m x 3m and 5m x 4m was Rs. 102816 and 90590 annually from agroforestry system. Net return per rupee invested at cost D was Rs. 0.75 and Rs. 0.70 for 7m x 3m and 5m x 4m spacing of agroforestry system. It means that on spending one rupee farmer got Rs. 0.75 and Rs. 0.70 of spacing 7m x 3m and 5m x 4m of agroforestry, respectively. On the basis of above analysis it can be said that spacing 7m x 3m of agroforestry is profitable than spacing 5m x 4m. For comparing the differences between the agroforestry and sole crops the annual costs and returns for sugarcane cultivation and paddy-wheat cultivation, it can be deduced from the table that in sugarcane and paddy-wheat cultivation farmer obtained gross return of Rs. 180784 and Rs. 177333, respectively and net returns obtained over cost D as Rs. 49397 and Rs. 47699. Hence, it can be concluded that agroforestry is much profitable in comparison to sole crops. From the results of this section it can be observed that the net returns over cost D in sugarcane cultivation per year is found slightly higher than that under paddy-wheat cultivation as one year crop rotation and were profitable. But the net profit per year over cost D from agroforestry system is found to be almost doubles than that of sole crop or crop rotation, besides other advantages.

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