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Poplar Culture on Farmland: Farmer's Experience from Uttar Pradesh

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Introduction

The increasing pressure of growing population and demand for food and wood had resulted in conversion of large areas of forests to agriculture, industrial and urban development. This further led to scarcity of fuel wood, timber for construction and wood for many commercial uses. In order to save forests and trees for an important role that they play in climate change mitigation, prevention of soil erosion, etc., measures have been taken by several countries to conserve them and this has further reduced the supply of wood. The shortage of supply of timber is likely to increase in India making it difficult for the country to meet its requirements from both domestic and international front. Hence, partial solution to the above problems could be to increase area under tree cover by either growing trees on farm boundaries or by integrating them with agricultural crops on farmland. In other words, there is a need for wide scale adoption of agroforestry as land use.

Agroforestry is a land use system in which trees are grown with agricultural crops. The agroforestry, which has gained wide popularity in north-western India, is cultivation of poplar trees for timber along with other crops like wheat, sugarcane, turmeric, etc. Poplar is a major agroforestry tree species grown in Punjab, Haryana, western Uttar Pradesh (U.P.) and Uttarakhand due to its fast growth, profitable returns and high industrial demand. Poplar is one of the world's fastest growing industrial softwood and can be harvested at short rotations depending on the end use of its tree components. Its wood is light, homogenous, odorless and is excellent for manufacturing matches, pencils, plywood, light constructional timber, paper, and packaging cases. Poplar is deciduous in nature and therefore it adds leaf litter during winters thereby adding fertility to the soil. Its leaf shedding characteristic allows intercrops to be grown in winters. Wheat is the most preferred winter crop grown with poplar.

Poplar based agroforestry is not only economically very attractive but also beneficial to environment

According to Hara (2006), agroforestry has contributed immensely to society by way of providing good returns to farmers, supported wood industry thereby providing employment to millions, has given cheaper wood products to consumers and reduced India's dependence on wood imports.

Poplar Based Agroforestry (PBA) in the Terai Plains of Western Uttar Pradesh and Uttarakhand

As early as 1970s progressive farmers in the Terai region of U.P. started planting poplar with intercrops (Chandra, 2001). Since then there has been rapid adoption of poplar based agroforestry (PBA) in this region. The system adopted here is of taking sugarcane as intercrop for first two years followed by wheat as winter crop until the harvest of poplar trees.

Wood based industry in the region has been depended on the state forest departments for raw material until the late 1970s. Later on, the green felling was banned in state forests which meant that wood based industry had to go to farmers for their raw material needs (Chandra, 2003).

In 1976, an extensive publicity campaign was initiated by WIMCO to promote poplar cultivation. It decided to give farmers genetically superior quality poplar plants to grow, for them (Hara, 2006). WIMCO distributed 126,000 seedlings of poplar free of cost to farmers in the year 1983 in north-western India.

In 1984, WIMCO together with NABARD worked out a poplar refinance project. As per the project:

1. WIMCO supplied ETPs to the farmers.
2. It also transported the ETPs free of cost to the farmer's field.
3. It provided technical know-how to farmers for the entire growth period of the trees.
4. Damaged ETPs were replaced by WIMCO in the farmers' fields in the first two years.
5. Insurance cover for tree damage was arranged by the company.
6. WIMCO paid Rs. 500 or market price whichever was higher once the trees met the requisite parameters (during the first phase of the project period).

Extensive work done by WIMCO led to emergence of poplar based agroforestry as a major farming practice in North India which has made great strides in India in the last three decades.

Poplar Based Agroforestry at Our Farm

Chaudhary Farm is one of the leading well managed farms of the locality. The farm has all ingredients of modern agriculture that include intensive and mechanized farming with heavy inputs, farm site for testing and growing latest varieties in association with the leading agricultural university of the locality, organic farming with vermicompost and farmyard manure, diverse land use practices of horticultural crops like mango, litchi, guava; and agroforestry with poplar, eucalypts, teak, kadam, etc. The farm is located in Majhola belt of Pilibhit District of northern Uttar Pradesh. The locality falls in the Terai region with water table close to surface. The soils are loamy to clayey loam. It is one of the agriculturally productive belt of northern India known to grow wheat-paddy crop combination and sugarcane as annual crop.

We at Chaudhary Farm have been planting poplar since 1987 and there is no denying that a well-managed farm gives economic returns much more than the conventional crops and this will be shown by comparison that we have made through our calculations. Our poplar plantations have been giving returns in excess of Rs. one hundred thousand per acre per annum consistently since last 3-4 yrs, whereas paddy-wheat rotation gives us a return of about Rs. 25,000 per acre per annum. Clearly, returns from poplar are four times higher than that of paddy-wheat rotation. This is studied in detail in later sections.

There are other benefits of poplar based agroforestry over paddy-wheat rotation. We have found that the soil health improves under poplar plantations, whereas repeated practice of rice-wheat rotation depletes the soil health. The crop yields taken after the harvest of poplar have been much higher than those taken on plots where poplar was not planted.

We have 12,000 poplar trees of high genetic quality planted at our farm. Spacing pattern of 4m x 5m, 4m x 4m and 7m x 3m are being followed and plantations are harvested in seven years yielding about 1,000 q of timber per acre on harvest.

We first came to know of poplar from WIMCO. In the face of acute shortage of timber in late 1970s WIMCO took steps to promote poplar based agroforestry on commercial scale in the Terai districts of U.P., many of which are now part of Uttarakhand. High yielding clones of poplar were introduced and farmers were encouraged to plant them.

Poplar was planted at our farm for the first time in the year 1987. We purchased 800 ETPs of D-121 clone from WIMCO at buy back arrangement and we were promised Rs. 500 per tree after 8 years provided certain parameters specified by WIMCO were met. The important parameter was that the trees should attain a girth size of 90 cm at a height of four and a half feet from ground level. The supervisors from WIMCO prescribed farmers the standard package of practices to be followed for the maintenance of poplar plantations and the farmers who didn't comply with the right techniques and failed to achieve the expected girth size were not paid the full amount.

Once we purchased poplar seedlings from WIMCO, supervisors used to visit our farm every 15 days to see the progress of our poplar and tell us how and what can be done to grow poplar successfully. We were updated with all the latest techniques of managing these trees. Because of WIMCO's support, timely guidance and advice we have been able to raise good plantations. Hence, WIMCO's role has been immense in enabling us to earn remunerative returns from PBA. It has played a significant role in popularizing poplar among farmers and is largely responsible for the adoption of PBA in north-western India.

D-121 was the first variety that we planted on our farm. This variety had a strong root system and lodging was little, however, its growth was slow. Then we shifted to G-3 clone. It gave very good volume of wood, grew fast and tapering was less. However, after few years the clone became susceptible to leaf spot disease (which caused premature defoliation in case of heavy attack) and this disease was difficult to control through chemical sprays, WIMCO stopped producing this variety and came up with new disease resistant clones. L-49 was another clone that we planted on our farm. It grew very fast and gave very good volume of timber in a shorter period but had a weak root system. Hence, damage due to winds was high. Once, 50 per cent trees of a block of L-49 clone were lodged in the winds and rains in September. This variety was also phased out from our farm. Then we shifted to clones like Kranti, G-48, S7C8 and S7C15. G-48 proved to be the most successful variety on our farm. Presently, we are planting new varieties developed by WIMCO seedlings - WIMCO-39, WIMCO-81 and WIMCO-110 and these are showing promising results in clay loam and clay type soil of our farm.

Our Package of Practices

Our raising of poplar plantations involves intensive investment and care in plant nutrition, plant protection, pruning, irrigation and other aspects of plant management to attain high rates of timber growth. We have been planting 200 to 250 trees per acre.

High quality poplar ETPs purchased from WIMCO Ltd. are planted in January and sugarcane is sown as intercrop in first week of February. In first two years sugarcane is grown and after the ratoon has been harvested, wheat is taken in winter until the harvest of poplar.

ETPs are lifted during the last week of December and on their receipt on the farm site these are immediately placed horizontally in pits filled with fresh water to prevent dehydration and then the transplanting begins in the first week of January. We store ETPs in fresh water for a minimum of 3 days. ETPs can be safely stored under fresh water for 10 to 12 days before transplanting.

Pretreatment of ETPs

All thick long and damaged roots of ETPs are pruned. Those thick roots that are likely to interfere with normal placing of ETPs in the pits are trimmed. All small, fine roots are left untouched. ETPs are then treated with an insecticide and a systemic fungicide by dipping the roots in the solution containing chlorpyrifos 20 per cent EC (insecticide) and carbendazim 50 per cent WP (fungicide). For every 100 ETPs, a solution of 100 l of water mixed with 200 ml of chlorpyrifos and 200 g carbendazim is prepared. These ETPs are kept for about 10 minutes in this solution.

Transplanting of ETPs into Pits

About one meter deep pits are dug with augurs having a diameter of 15 cms. The ETP is then placed vertically into the pit which is then filled with the mixture of top soil, 5 kg. FYM, 25 g MOP, 200 g SSP, 25 g micronutrients (zinc, iron, copper, etc.) and *Trichoderma*. One month before transplanting, we mix farmyard manure with *Trichoderma* and keep it in shade in a way that the moisture is maintained in the mixture. In this one month, *Trichoderma* multiplies itself. The pits should not be filled completely and the top 15 cm is left unfilled to allow maximum availability of water to the plant for their better survival and soil should not be compacted at this stage. However, before second irrigation, we fill the pits and again water the filled soil.

Post Transplanting

After ETPs have been transplanted flood irrigation of the field is done. Sugarcane sowing is done in the first week of February. Water channels along the trees are maintained to ensure timely irrigation of trees without flooding the entire field.

During first two years trees are prone to wind damage especially during monsoon and, therefore, a lot of care has to be taken to maintain right balance of branches along the main trunk and has to be assured that the top of the trees are light so that the wind damage is minimized. Tree roots are susceptible to fungal attack in the first two years, hence, are regularly treated with a systemic fungicide - carbendazim and an insecticide chlorpyrifos.

Irrigation and Fertilizers

Regular irrigation (2-3 per month) during summer months is very important for optimal growth of poplar trees. During winters, irrigation is done once a month.

Our poplar trees are regularly provided with recommended doses of nitrogen, phosphorus, potash, zinc, iron, calcium and boron along with FYM and bone-meal. From third year different doses of fertilizers are given per acre per year (Table 1).

Table 1. Nutrient application to poplar plantation (kg per acre) from third year onward

Fertiliser/Month	April	May	June	July	August	September
Single super phosphate	500	-	-	-	-	-
MOP	50					
Urea	-	-	50	50	50	50
Zinc sulphate	-	-	10	-	-	-
Ferrous sulphate	-	-	10	-	-	-
Calcium	25					
Boron	2					
Bone-meal			100			

In late April, after intercropped wheat has been harvested, full doses of phosphorous, potash, calcium and boron are added and mixed in soil by harrowing at zero cut. Field is then irrigated followed by 2-3 irrigations per month until arrival of monsoon. To maintain soil health and fertility, we add sufficient quantities of dairy manure in our soil. Bone-meal has also been found to be very beneficial for overall growth of poplars.

Pruning

It is very important to judiciously follow the practice of pruning of branches along the main trunk of the tree to attain maximum volume and quality wood production. It is very important that timely pruning of branches is done. In the first year of growth debudding is carried out in the lowest one third part of the stem during June-July and leader training is simultaneously done. We prune all the competing branches of the leading shoot during winter.

Intercropping Pattern

For first two years, sugarcane is grown as intercrop. After the ratoon of sugarcane is harvested at the end of second year, wheat is sown. From beginning of third year onwards wheat is taken as intercrop during winter months as poplar shed their leaves and sunshine reaches the ground. During summer months the leaves of trees reduce sunshine and only shade tolerant crops can be grown. Where soils are sandy to sandy loam, turmeric and ginger are very remunerative shade bearing inter-crops. But, our soil being clay loam to clay it is not possible to plant them and we have been taking only wheat as intercrop. Recently, we have also started taking fodder oats and barseem as intercrops during winter months.

Economics of Poplar Based Agroforestry

Our period of study is seven year period from 2004 to 2011. We maintained records of year wise cost of cultivation for paddy, wheat, sugarcane and poplar separately from the farm during the given period. Year wise yields of these crops and respective sale prices for the same have been used to calculate the yearly returns. Annual net returns from PBA, paddy-wheat rotation and sugarcane crop for seven years from 2004-05 to 2010-11 are adjusted at a discount rate of 12 per cent to get the net present value for each farming option. The intercrops grown with poplar plantation under study, their yields, cost of production and returns are given in Table 2. The total returns from intercrops for the full rotation of seven years of trees have been worked out to be Rs. 118,799 with approximately Rs. 17,000 per acre per year at discounted rate of 12 per cent.

The details of wood yield and return, therefrom, are given in the following pages. Trees were harvested during January 2011 through a contractor and segregated to marketable lots of oversize logs, undersize logs, roots and firewood and sold to the local contractor at negotiated prices as per details given below.

Wood Sale Proceeds

Out of 250 saplings planted per acre, finally survived 238 trees were harvested. The girth of these trees varied between

Table 2. Discounted returns from intercrops 2004-2010 for one acre

Year	Intercrop	Yield of intercrop (q)		Price of intercrop (Rs.)		Returns from intercrop (Rs.)	Cost of intercrop (Rs.)	Net returns (Rs.)	NPV taking 12% discount rate (Rs.)
		wheat/sugarcane	straw	-	straw	straw			
2010-11	Wheat	14	10	1,120	2.5	18,180	10,722	7,458	7,458
2009-10	Wheat	15	11	1,100	2	18,700	9,501	9,199	10,303
2008-09	Wheat	15	11	1,080	2	17,200	8,639	8,561	10,701
2007-08	Wheat	17	11	1,000	1.5	18,950	8,193	10,757	15,060
2006-07	Wheat	18	14	750	1.5	15,600	7,453	8,147	12,791
2005-06	Sugarcane ratoon	175	NA	110	NA	19,250	7,500	11,750	20,680
2004-05	sugarcane	350	NA	110	NA	38,500	19,550	18,950	37,142
									114,135

75-90 cm at breast height. Trees yielded 940 q of timber (3.94 q per tree), out of which, 658 q was as oversize (>60 cm mid girth) and remaining 282 q as undersize (50-60 cm girth). We also got 58.6 q roots and 62 q firewood. Price that we received for oversize logs was Rs. 813 per q, Rs. 550 per q for undersize logs, Rs. 180 per q for roots and Rs. 200 per q for firewood. Total value realized was Rs. 713,000 out of which, Rs. 534,954 was for oversize logs, Rs. 155,100 for undersize logs, Rs. 10,546 for roots, and Rs. 12,400 for firewood. Based on money realized from the sale of wood logs, roots and firewood and that from the intercrops, Table 3 was drawn for the economical analysis for the PBA system for the full tree rotation period. Overall, the PBA gave us Rs. 700,455 per acre discounted value for seven years and a net returns of over Rs. one hundred thousand per acre per year. This realization is very high in comparison with other existing land use options from the similar fields and a motivational factor to continue with poplar based agroforestry.

We also tried to compare these returns from sole sugarcane production (Table 4) and wheat-paddy rotation from the adjoining fields which are the common crops grown in the locality. Detailed economical analysis for sugarcane alone is given in Table 4, and for wheat-paddy rotation in Table 5 to Table 7. There have been fluctuations in crop yields, input prices, sale prices and, therefore, in returns from sugarcane and wheat production during the study period. In general, fresh sugarcane crop gives better returns as yields are higher than the ratoon. The total returns of sugarcane cultivation have been worked out to be Rs. 188,684 for seven years with average returns of approximately 27,000 per acre per year.

In order to compare the economical analysis of PBA with the traditional paddy-wheat rotation separate costs and returns for these two crops were maintained and are presented in Table 6 and Table 7. Out of these two tables, Table 7 gives returns from paddy-wheat rotation.

The returns from paddy crop which is grown in summer season only is worked out to be Rs. 68,387 for the seven years of study period. To these values returns from wheat growing for the corresponding years (Table 7) was added.

The discounted benefits of paddy-wheat rotation at 12 per cent over 7 year period worked out to be Rs. 359,901 against the discounted costs of Rs. 187,863. Cost-benefit ratio turned out to be 1.92. The net returns from this crop production were Rs. 172,038 for seven years and approximately Rs. 24,500 per acre per year.

Table 3. Net present value (NPV) of poplar based agroforestry (in Rs.)

Year	t	Returns from intercrop	Cost of intercrop	Returns from poplar	Cost of poplar culture	Total returns poplar and intercrop = B	Total cost poplar and intercrop = C	Net returns B-C	$(1+r)^t$	NPV (B-C) $(1+r)^t$
Jan-11				713,000	61,170	7,13,000	61,170	651,830	1	651,830
2010-11	0	18,180	10,722		7,300	18,180	18,022	158	1	158
2009-10	1	18,700	9,501		5,442	18,700	14,943	3,757	1.12	4,208
2008-09	2	17,200	8,639	900	7,864	18,100	16,503	1,597	1.25	1,996
2007-08	3	18,950	8,193	700	7,066	19,650	15,259	4,391	1.4	6,147
2006-07	4	15,600	7,453	390	6,970	15,990	14,423	1,567	1.57	2,460
2005-06	5	19,250	7,500		3,588	19,250	11,088	8,162	1.76	14,365
2004-05	6	38,500	19,550		9,108	38,500	28,658	9,842	1.96	19,290
Total										**7,00,455**

Hence, returns per acre per year comes out to Rs. 100,065.

Table 4. Cost of production (per acre, r=12%) for sugarcane crop during the study period

Year	Crop (type)	Yield (q)	Price (Rs./q)	Returns (Rs.)	Cultivation cost (Rs.)	Net returns (Rs.)	NPV (Rs.)
2004	Fresh	350	110	38,500	19,450	18,950	37,142
2005	Ratoon	250	110	27,500	13,100	14,400	25,344
2006	Fresh	302	130	39,260	22,002	17,258	27,095
2007	Ratoon	150	130	19,500	11,708	7,792	10,909
2008	Fresh	330	140	46,200	26,134	20,066	25,083
2009	Ratoon	175	230	40,250	13,713	26,537	29,721
2010	Fresh	325	210	68,250	24,557	43,693	43,693
	Total						**188,684**

Table 5. Cost of production (per acre, r=12%) for wheat crop during the study period

Year	t	Wheat yield (Rs.)	Price (Rs.)	Value of produce (Rs.)	Yield of straw (q)	Net price of straw (Rs.)/kg	Value of straw (Rs.)	Total value of produce (Rs.)	Cost of production (Rs.)	Net Returns (Rs.), J	NPV = $J(1+r)^t$
2010-11	0	21	1,120	23,520	9	2.5	2,250	25,770	10,722	15,048	15,048
2009-10	1	21	1,100	23,100	9	2	1,800	24,900	9,501	15,399	17,247
2008-09	2	20	1,080	21,600	8	2	1,600	23,200	8,639	14,561	18,201
2007-08	3	20	1,000	20,000	8	1.5	1,200	21,200	8,193	13,007	18,210
2006-07	4	19	750	14,250	8	1.5	1,200	15,450	7,453	7,997	12,555
2005-06	5	19	650	12,350	8	1	800	13,150	7,323	5,827	10,256
2004-05	6	20	600	12,000	8	1	800	12,800	6,609	6,191	12,134
Jan-11											**$\Sigma J(1+r)^t$ 103,651**

Table 6. Cost of production (per acre, r=12%) for paddy crop during the study period

Year	t	Yield of paddy (q)	Price (Rs.)	Value of produce (Rs.)	Total cost (Rs.)	Net Returns (Rs.), G	NPV = $G(1+r)^t$
2010-11	0	25	1,100	27,500	13,489	14,011	14,011
2009-10	1	24	980	23,520	12,149	11,371	12,736
2008-09	2	23	880	20,240	11,262	8,978	11,223
2007-08	3	25	675	16,875	10,527	6,348	8,887
2006-07	4	23	610	14,030	10,042	3,988	6,261
2005-06	5	22	600	13,200	9,728	3,472	6,111
2004-05	6	23	600	13,800	9,127	4,673	9,159
Jan-11						**$\Sigma G(1+r)^t$**	**68,387**

Table 7. Cost of production (per acre, r=12%) for wheat-paddy rotation

Year	Returns from wheat	Returns from paddy	Benefits paddy+wheat	Cost of wheat	Cost of paddy	Total costs wheat+paddy
2010-11	25,770	27,500	53,270	10,722	13,489	24,211
2009-10	24,900	23,520	48,420	9501	12,149	21,650
2008-09	23,200	20,240	43,440	8,639	11,262	19,901
2007-08	21,200	16,875	38,075	8,193	10,527	18,720
2006-07	15,450	14,030	29,480	7,453	10,042	17,495
2005-06	13,150	13,200	26,350	7,323	9,728	17,051
2004-05	12,800	13,800	26,600	6,609	9,127	15,736

Table 8. Cost benefit ratio of wheat-paddy rotation

Year	t	$(1+r)^t$	Costs = C paddy + wheat	NPV of costs = $C_t(1+r)^t$	Benefits = B paddy+wheat	NPV of benefits = $B_t(1+r)^t$
2010-11	0	1	24,211	24,211	53,270	53,270
2009-10	1	1.12	21,650	24,248	48,420	54,230
2008-09	2	1.25	19,901	24,876	43,440	54,300
2007-08	3	1.4	18,720	26,208	38,075	53,305
2006-07	4	1.57	17,495	27,467	29,480	46,284
2005-06	5	1.76	17,051	30,010	26,350	46,376
2004-05	6	1.96	15,736	30,843	26,600	52,136
				187,863		**359,901**

Conclusion

From the above data the following conclusions are drawn. NPV of PBA for the seven years period turned out to be Rs. 700,455. Hence, returns are Rs. 100,065 per acre per year. Sugarcane crop gave returns of Rs. 188,684 for the corresponding period with net returns of approximately Rs. 27,000 per acre per year whereas, paddy-wheat rotation gave total returns of Rs. 172,038 for the corresponding period and Rs. 24,500 per acre per year. Net present value of returns

for PBA including intercrops is 4.07 times higher than the wheat paddy rotation and 3.71 times higher than the sugarcane crop farming for the corresponding period. Cost-benefit ratio for wheat-paddy rotation and for sugarcane are much below 3.96 for PBA for the corresponding period. Based on more than two decades of our experience with PBA, we can very confidently say that this farming practice is not only economically very attractive but also very beneficial to the environment. The wide adoption of PBA in north-west India is a positive development. This will not only save our forests but will also bridge the increasing gap in demand and supply of the wood.

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