

## COMPARISON OF ECONOMIC RETURNS FROM POPLAR-WHEAT, FODDER MAIZE INTERCROPPING TO MONOCULTURE

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An agroforestry system comprising of Poplar (*Populus deltoides* clone AY-48), wheat and fodder maize crops was designed, in order to compare the economics of agroforestry system with conventional agricultural system. Poplar (*Populus deltoides* clone AY-48) was planted at a density of 455trees/ha, 305trees/ha, and 230trees/ha at the spacing of 3.66 x 6.10m (D1), 3.66 x 9.10m (D2) and 3.66 x 12.10m (D3) respectively. Agricultural crops namely, wheat (*Triticum aestivum*) variety Inqalab-91 and fodder maize (*Zea mays*) variety Neelum were sown alternately during "Rabi" and "Kharif" seasons each year throughout the entire study periods in poplar plots. To compare the differences between sole crop and intercropping the wheat and fodder-maize were also sown in separate plots (Dw/f). Highest net benefits (51495 Rs./ha) was observed in the treatment D2 while lowest net benefits (10904 Rs./ha) was observed in sole wheat, fodder maize treatment (Dw). The highest BCR (1.10) was recorded in treatment D2 and lowest BCR (0.65) was observed for sole poplar tree planting in treatment D4. The highest IRR was also (21.91%) observed in treatment D2 and lowest (0.78%) for treatment D4. In the dominance analysis it was that Treatments D4, D1 and D5 were dominated. The net benefit curve showed that net benefits were highest in treatment D2 while lowest in treatment D1 with the increase in cost. The marginal rate of return was highest in treatment D2 and lowest in treatment Dw. It was observed in the sensitivity analysis that if the future input prices increased by 10% or the future output prices decreased by 10% even then it was economical to recommend the treatment D2 and D3.

**Keywords:** Intercropping, poplar, wheat, fodder maize, economics

### INTRODUCTION

Pakistan is basically an agricultural country. Agriculture plays an important role in the economy of country. Its share in the GDP is 23.3% (Pakistan economic survey, 2003-2004)

In conventional agricultural cultivation, which involves only growing of crops, result only in depletion of organic matter and other nutrients from soil. Continuous growing of exhaustive crops, on a long run, can convert fertile land into desert. While on the other hand agroforestry system not only provides economic benefit but also improve the soil fertility (Mohsin *et al.* 1996). Pakistan has a long tradition of agroforestry. Farmers and landowners in different part of country integrate a variety of wood perennials in their crop and livestock production fields depending upon the agro climatic conditions and local needs. Quli (2001) reported that agroforestry has established itself as one of the most promising land management systems, helping in the expeditious enhancement of productivity per unit area on sustained basis. It was observed that the farmer's decisions of whether or not to plant trees had been based primarily on economic than ecological concerns. Properly managed homestead agroforestry can alleviate the poverty of rural people by increasing their overall house income Salam *et al.* (2000).

According to Hussain *et al.* (1999) almost all agroforestry system are being practiced in the province of Punjab. But most common system being practiced was "agrisilvicultural". Various efforts have recently been made at Govt. level to boost up the wood production and presently farm forestry is, therefore, being emphasized as pragmatic alternative. For this purpose the indigenous slow growing species are being replaced by some fast growing exotic species. Poplar (*Populus deltoides*) is one of the most popular amongst the species introduced recently. There are reports that poplar (*P. deltoides*) trees grow better under agroforestry conditions. (Singh *et al.*, 1998; Chaturvedi, 1992). Poplar based agroforestry system is economically more viable and more profitable than any of the crop rotations (Jain and Singh, 2000). To improve the biological productivity and economic return farmers plant poplar tree in view of its important contribution towards rural economy (Sodi and Ansari 1996).

The purpose of this study was to evaluate the economics of agroforestry system with the intercropping of wheat, fodder maize in the poplar. Hence an attempt has been made to determine the effect of intercropping on the net benefits.

## MATERIALS AND METHODS

This study was conducted at the research garden, Punjab Forestry Research Institutes, Faisalabad. The site is well-drained, alluvial and fine loamy soil. It is located in arid moisture regime with 300mm precipitation having longitude 73.11°E, Latitude 31.28°N and elevation 183m from sea level.

Poplar (*Populus deltoides* clone AY-48) was planted at a density of 455 trees/ha, 305 trees/ha, and 230 trees/ha at the spacing of 3.66 x 6.10m (D1), 3.66 x 9.10m (D2) and 3.66 x 12.10m (D3) respectively, by digging 75cm deep and 30cm wide pits during first week of February, 1999.

The soil was prepared by using mechanical means before planting of poplar. It was ploughed 4-5 times with tractor-mounted cultivator, followed by planking and leveling. Planting was done by using one year old, bare rooted entire nursery plants of uniform size. Good compaction and ramming of the plants was done after planting. First irrigation with canal water was given immediately after planting. After 24 hours of irrigation the leaning and wind fallen plants were straightened by adding and compacting more soil. Average height and diameter of plants was 4.5m and 5cm respectively at the time of planting. There were four rows of poplar under each treatment. The orientation of rows was south-east to north-west. The study was replicated three times.

**Table 1. Net benefits, benefit cost ratio (BCR) and internal rate of return (IRR) as influenced by intercropping system at various poplar tree densities**

Poplar trees density	Intercropping system	Income (Rs./ha)			Expenditure (Rs./ha)			Net benefits (Rs./ha)	BCR	IRR (%)
		Wheat-Fodder maize	Poplar trees alone	Total	Wheat-fodder maize	Poplar trees alone	Total			
D1	Tree+Crop	321343	247950	569293	190856	351794	542650	26643	1.05	17.60
D2	Tree+Crop	36149	219825	581320	190856	338969	529825	51495	1.10	21.91
D3	Tree+Crop	377421	181125	558546	190856	329109	519965	38581	1.07	21.04
D4	Poplar trees alone	-	259200	259200	-	400892	400892	-141692	0.65	0.78
D5	Tree+Crop	174241	335475	509716	190856	384376	575232	-65516	0.89	7.28
Dw/f	Wheat- fodder maize	444608	-	444608	455512	-	455512	-10904	0.98	6.86

Agricultural crops namely, wheat (*Triticum aestivum*) variety Inqalab-91 and fodder maize (*Zea mays*) variety Neelum were sown alternately during "Rabi" and "Kharif" seasons each year throughout the entire study periods in poplar plots. To compare the differences among sole crop and intercropping the wheat and fodder-maize were also sown in separate plots (Dw/f). Wheat was sown during third week of November through broad cast method using 125kg seed per hectare each year. Fertilizers (Urea, Di-ammonium phosphate (DAP) and Sulphate of potash (SOP) were applied at the rate of 125kg/ha.

DAP and SOP were applied at the time of sowing while urea was applied at the time of first and third irrigation in equal doses. Similarly fodder maize was sown during third week of July through broadcast method using 100kg seed per hectare. Fertilizer (Urea) was applied at the rate of 125 kg/ha at the time of first and fourth irrigation. The economic analysis of all the treatments was carried out. The data was analyzed by using the methodology described in CIMMYT (1988). The net benefit, benefit cost ratio (BCR) and the internal rate of return (IRR) were calculated using 14% discount rate. The purpose of this analysis was to evaluate the differences in costs and benefits, benefits to cost ratio and internal rate of return for different treatments. This analysis was conducted in three steps i.e., net field benefits, marginal analysis and sensitivity analysis.

## RESULTS AND DISCUSSION

### **Net Benefits**

The data regarding the monetary gain along with all relevant calculations and interpretations are given in Table 1. In this economic analysis total monetary benefits and cost involved during project periods of 8 years were used and for discounting 14% rate of interest was adopted. The net benefit values showed that all the intercropping systems gave substantially higher net income per hectare than sole wheat, fodder maize and poplar tree planting. Within intercropping systems, wheat, fodder maize with poplar trees in treatment D2 gave the highest net benefits of Rs.51495/ha followed by poplar trees intercropped in treatment D3 giving a net benefit of Rs.38581/ha and Rs.26643/ha by the poplar trees intercropped in treatment D1. Net benefit from sole poplar trees was Rs.141692/ha whereas it was Rs.10904/ha from sole wheat, fodder maize crops. These results are in lined with (Chaturvedi and Pandey, 2001).

### **Benefit-Cost Ratio (BCR)**

On the basis on Net income and net cost discounted at 14% interest rate, the BCR of 1.10 was recorded in wheat, fodder maize intercropping with poplar tree in treatment D2. The lowest BCR 0.65 was observed for sole poplar trees planting treatment D4. BCR for sole poplar tree crop was substantially lower than sole wheat, fodder maize crop.

It indicates that pure forestry practice with poplar tree is less beneficial than pure agriculture with wheat-fodder maize cultivation at 8 year rotation. (Singhal and Panwar, 1992) reported similar results.

### **Internal Rate of Return (IRR)**

The IRR was highest 21.91% for treatment D2 followed by D3 and D1 treatments. The IRR for monoculture of arable crops and trees was 6.86 and 0.78% respectively (Table 1). It indicates that intercropping of poplar trees with wheat, fodder maize is beneficial in all three treatments. These results are similar to the findings of Benjman *et al.* (2000).

### **Marginal Analysis**

To determine the most profitable cropping system marginal analysis was performed, by comparing a total cost with net benefit. Marginal analysis consisted of dominance analysis, net benefit curve, and marginal rate of return and sensitivity analysis.

### **Dominance analysis**

**Table 2. Dominance analysis of different wheat based intercropping systems at various poplar tree densities**

Treatments (Poplar tree density)	Intercropping system	Total cost (Rs./ha)	Net benefits (Rs./ha)
D4(3.05×3.05m)	Poplar trees alone	400892	-141692D
Dw/f	Wheat-Fodder maize	455512	-10904
D3(3.66×12.10m)	Tree+Crop	519965	38581
D2 (3.66×9.10m)	Tree+Crop	529825	51495
D1 (3.66×6.10m)	Tree+Crop	542650	26643D
D5(1.52×6.10m)	Tree+Crop	575232	-65516D

**Table 3. Marginal rate of return (MRR) as influenced by wheat based intercropping system at various poplar tree densities**

Treatments (Poplar tree density)	Intercropping system	Total cost (Rs./ha)	Marginal cost (Rs./ha)	Net Benefits (Rs./ha)	Marginal net benefits (Rs./ha)	MRR (%)
Dw/f	Wheat-Fodder maize alone	455512	54620	-10904	-	-
D3(3.66×12.10m)	Tree+Crop	519965	64453	38581	49485	76.78
D2 (3.66×9.10m)	Tree+Crop	529825	9860	51495	12914	130.97

Among the intercropping systems, treatments D4, D1 and D5 were dominated, as net benefits of each system did not increased with an increase in total cost of the corresponding intercropping system (Table 2).

### Net benefit Curve

It showed that benefits in all the intercropping systems did not increase with the increase in costs. As shown in figure 1, in treatment D3 net benefit was less at lower cost while in treatment D2 there was maximum benefit (Rs.51495) with an increase in costs that vary. However the net benefits in D1 decreased with an increase in costs that vary. From net benefit curve it is clear that treatment D2 should be recommended to the farmers for higher economic returns.

### Marginal Rate of Return (MRR)

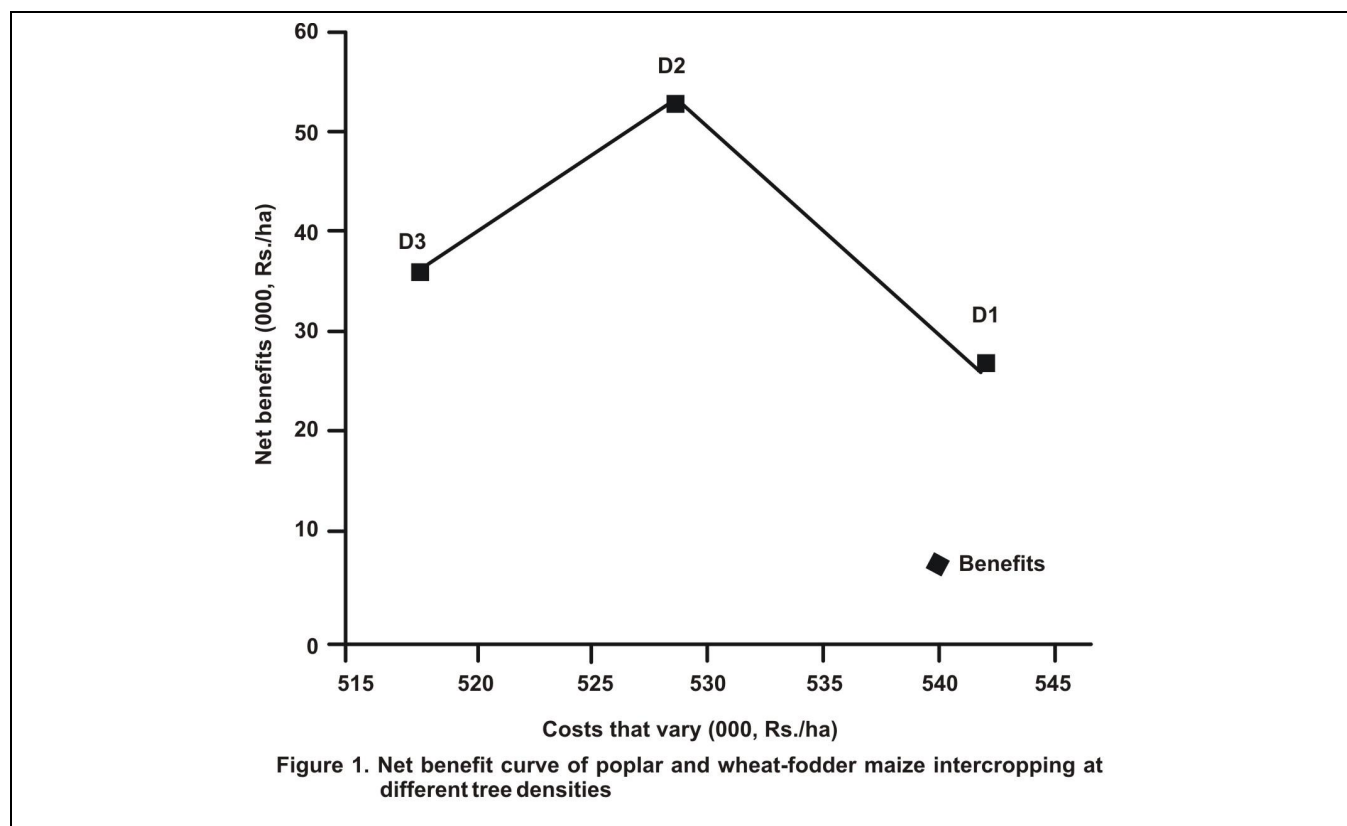
The MRR was the highest (130.97%) in intercropping system in treatment D2 followed by D3 having MRR of 76.78% (Table 3). This was mainly due to the differences in the poplar tree densities influencing the production of both arable crops as well as trees itself.

### Sensitivity Analysis

Sensitivity analysis was done with the following assumptions:

- Sensitivity analysis with constant output prices and input prices increased by 10%.
- Sensitivity analysis with constant input prices and output prices reduced by 10%.

### ***Sensitivity analysis with constant output prices and input prices increased by 10%***



The dominance analysis given in Table 4 indicates that the net benefits did not increase with even increase in output prices. The results clearly indicated that if the future input prices increased by 10% from the current prices, even then it was economical to recommend the treatments D2 and D3 as compared to other treatments. These results are in agreement with (Jain and Singh, 2000).

**Table 4. Sensitivity analysis with input cost increased by 10 percent Marginal rate of return (MRR)**

Treatments (Poplar tree density)	Intercropping system	Total cost (Rs./ha)	Marginal cost (Rs./ha)	Net Benefits (Rs./ha)	Marginal net benefits (Rs./ha)	MRR (%)
Dw/f	Wheat-Fodder maize alone	501063	60082	-10904	-	-
D3(3.66×12.10m)	Tree+Crop	571961	70898	38581	49485	69.80
D2 (3.66×9.10m)	Tree+Crop	582807	10846	51495	12914	119.07

**Table 5. Sensitivity analysis with input cost reduced by 10 percent Marginal rate of return (MRR)**

Treatments (Poplar tree density)	Intercropping system	Total cost (Rs./ha)	Marginal cost (Rs./ha)	Net Benefits (Rs./ha)	Marginal net benefits (Rs./ha)	MRR (%)
Dw/f	Wheat-Fodder maize alone	455512	54620	-9810	-	-
D3(3.66×12.10m)	Tree+Crop	519965	64453	34723	44533	69.09
D2 (3.66×9.10m)	Tree+Crop	529825	9860	46346	11623	117.88

**Sensitivity analysis with constant input prices and output prices reduced by 10%**

The dominance analysis given in Table 5 indicated that the net benefits did not decrease with reduction in

output prices by 10%. The results clearly indicated that if the future output prices reduced by 10% from the

current prices, even then it was economical, to recommend the treatments D2 and D3 as compared to other systems. These results are in lined with (Jain and Singh, 2000).

#### LITERATUE CITED

- Benjamin, T.J., W.L. Hoover, J.R. Seifert and A.R. Gillespie. 2000. Defining competition vectors in a temperate alley cropping system in the Midwestern USA:4. The economic return of ecological knowledge. *Agroforestry Systems*, 48(1):79-93.
- Chaturvedi, A.N. 1992. Optimum rotation of harvest for poplars in farmlands under agroforestry. *Indian For.*, 118(2):81-88.
- Chaturvedi, O.P. and I.B. Pandey. 2001. Yield and economics of *Populus deltoides* G-3 marsh based intercropping system in eastern India. *Forests-trees and livelihoods*, 11(3):207-216.
- CIMMYT. 1988. An economic Training Handbook. Economic Programme, CIMMYT, Mexico.
- Hussain, R.W., A.K. Chaudhry and M.M. Khan. 1999. Review of existing agroforestry systems in the Punjab. *Agroforestry Research Series # 4*. Punjab Forestry Department (PFSDP & PFRI) and Hunting Technical Services UK.
- Jain, S.K and P. Singh. 2000. Economic analysis of industrial agroforestry: poplar (*Populs deltoids*) in Uttar Pradesh (India). *Agroforestry Systems*, 49(3):255-273.
- Mohsin, F., R.P. Singh and K. Singh. 1996. Nutrient cycling of poplar plantation in relation to stand age in agroforestry system. *Indian J. Forester.*, 19(4):302-310.
- Quli, S.M.S. 2001. Agroforestry for NTFPs conservation and economic upliftment of farmers. *Indian For.*, 127(11):1251-1261.
- Salam, M.A., T. Niguchi and M. Koike. 2000. Understanding why farmers plant trees in the homestead agroforestry in Bangladesh. *Agroforestry systems*, 50(1):77-93.
- Singh, H.P., R.K. Kohli and D. R. Batish. 1998. Effect of poplar (*Populus deltoides*) sheltered on the growth and yield of wheat in Punjab, India. *Agroforestry systems*, 40(2):207-213.
- Singhal, R.M. and B.P.S. Panwar. 1992. Commercial approach to poplar (*Populus deltoids* M.) based agroforestry systems in north-western Uttar Pradesh. *Van-Vigyan.*, 30(1): 29-38.
- Sodhi, H. and M.Y. Ansari. 1996. Economics of farm forestry in Harayana-An economically viable and ecologically sustainable system. *Indian For.*, 122(7):584-590.