



Research Article

Agroforestry Practices Affecting Farm Income in Rural Khyber Pakhtunkhwa, Pakistan

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Abstract | Farm households in the rural areas are practicing agroforestry to generate their livelihood. To conduct this study, two districts namely Mardan and Swat of Khyber Pakhtunkhwa, Pakistan were purposively selected. In district Mardan, agroforestry is practiced as boundary line plantations; while in Swat intercropping is more common characteristics. A total of 390 households involved in agroforestry practices were interviewed. The study investigated the effect of agroforestry practices on farm income of rural households in KP. A Multiple linear regression model was used to find out the effect of area under agroforestry, number of fruit and wood trees on farm, schooling level of household head, number of farm labor and adopted agroforestry practices on farm income. It was found that the effect on annual farm income by a unit increase in area under agroforestry was Rs.44.379, number of fruit trees was Rs.0.344 and wood trees on farm was Rs. 0.240, quantity of crops under these systems was Rs.39.174 and education was Rs. 8.987 which were positive and statistically significant. It was found that intercropping practice in comparison to boundary line plus intercropping was statistically significant.

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Keywords | Agroforestry, Intercropping, Boundary line Plantation, farm income, livelihood



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Introduction

Agriculture sector is of vital importance for Khyber Pakhtunkhwa because over 75% of the population is at least partly dependent on agriculture for their livelihood. The one solution to poverty dilemma in rural areas can be to improve agricultural growth which will lead improve family income and farm output. In the province there are just over 1 million farms, in which 60% consist of less than 2.5 acres and 37% less than 1 acre (GoKP, 2010). Agroforestry is a dynamic natural resource management system in

which trees are integrated with crops on cultivated lands with socio economic benefits for all land users. As majority of farmers in Pakistan are small holders so agroforestry can be a better solution to improve their income (Anwar *et al.*, 2017). Linear tree planting method was found more adopted as compared to linear + interplanting and compact planting in district Chinot, Pakistan. Income, fodder and fuelwood were the motivation drivers behind agroforestry in area (Nawaz *et al.*, 2016). Majority of the farmers grew Eucalyptus camaldulensis (Sufeda) on their cultivated areas for economic benefits and their intentions to

increase number of Eucalyptus (Sufeda) trees on their farms is based on the economic outturn (Hassan *et al.*, 2014). Low quality crop-stand, unfavorable markets infrastructure, unavailability of plant nurseries, damage caused by animals and humans and lack of support were the constraints in adoption of agroforestry. The socio-economic factors also effect farmers perception about agroforestry such as large family size and high level of education support agroforestry to fulfill household demand for fuel wood timber and improve family income (Jamilu *et al.*, 2014). Indonesian farmers cultivate teak as one component in integrated multispecies agroforestry systems. Such systems enable farmers to diversify production. Besides supplying food for households, smallholder teak systems provide 40% of household income from agricultural and timber crops (Roshetko *et al.*, 2013). Farmers with the least land were found to allocate a higher percentage of their land to Mango-based agroforestry in Padma floodplain, Bangladesh to increase income from agroforestry (Rahman *et al.*, 2012). To manage the growing demand for timber and fuel wood and improving farm income Agroforestry is of much importance (Ali *et al.*, 2011). In areas where the livelihoods are completely dependent on natural forests can be diverted to planted forests in form of different agroforestry practices so lowering the pressure on natural forests and improving income by agroforestry (Paul, 2011). Compared with subsistence agriculture, an agroforestry system provides cash income generation from the marketing of multiple and a variety of outputs. In southern Africa, growing of different indigenous fruit tree species improve biodiversity and helped farm households in solving socio-economic issues (Kalaba *et al.*, 2010). Agroforestry is a livelihood choice that influences a household to grow trees with crops on their farms. It improves family income, a source for timber and fuel wood for the households. Agroforestry practice can minimize the gap between households with large land holding and those with relatively low land holding (Regmi, 2003).

Objectives of the study

The need for this research study has been felt because the previous studies on agroforestry conducted in Pakistan were mostly based on the adoption of agroforestry, attitude and perception towards agroforestry and ignored the effect of agroforestry practices on farm income rural Khyber Pakhtunkhwa.

Further, this study highlighted the significance of

agroforestry for rural livelihood in existing poverty, land management problems and government deaf ear towards agroforestry. The government's policies are generally made to improve monoculture i-e crop production or to protect and conserve existing forests but the agroforestry hardly come under limelight in policy corridors.

Regardless of the constraints in adoption of agroforestry in Pakistan as highlighted by (Jamileu, *et al.*, 2014; Nouman *et al.*, 2016; Nawaz *et al.*, 2008) that agroforestry is commonly practiced in Khyber Pakhtunkhwa. Common problems like small land holding and large family size always compelled farm households to think about improvement in income. The farm households in such case finds agroforestry as solution to such problems but the question always arise that which agroforestry practice is the best suited and efficient one to create a significant effect on farm income of the household.

Materials and Methods

Universe of the study

Two districts of Khyber Pakhtunkhwa namely Mardan and Swat was purposively selected due to concentration of agroforestry in these districts. The total population of households involved in agroforestry based activities was 1950. In Mardan boundary plantations while in Swat intercropping is commonly practiced. The total population of district Mardan is 2.37 million, consisting 81.48% rural and 18.51% urban population while total population of district Swat is 2.31 million, consisting of 69.86% rural and 30.13% urban population (GoP, 2017).



Figure 1: Map of Khyber Pakhtunkhwa. The dotted lines shows District Mardan and Swat.

Source: Survey of Pakistan.

Sampling and sample size

Form the two purposively selected districts a total of 6 union councils with 3 villages from each union council were purposively selected. Since the population of total household in the study area is 1950, using proportion allocation method 20% of the total was taken as sample for this study which gives us a sample size of 390. The following Proportional allocation formula was used in the sampling.

$$n_i = n \frac{N_i}{N} \dots \dots (1)$$

Where;

N: Total population of AF farm households in all selected villages; N_i : Total population in i^{th} village; n_i : Sample size for i^{th} village; n: Selected sample in the study area.

Table 1: Sampled households in each union council.

Districts	Union Councils	Villages	Total HH*	Sampled HH**
Mardan	Babaini	Babaini	180	36
		Char Banda	130	26
	Katti Ghari	Shamsi	105	21
		Shiro	90	18
	Katakhat	Katakhat	230	46
		Barikab	120	24
Swat	Bar Thana	Bar thana	240	48
		Aghal	205	41
	Ashari	Ashari	210	42
		Kalakot	95	19
	Baydara	Baydara	110	22
		Sambat	235	47
All			1950	390

Source: * Field survey district Mardan and Swat, consultation with district forest officer; ** Self calculation.

Data collection

An interview schedule was used for collecting primary data regarding agroforestry practices, access to livelihood assets, income contributions of agroforestry practices to household income, livelihood strategies to cope income and food shocks and general characteristics of the sampled households. After collection of data, data analysis was conducted with the help of supporting software SPSS.

Data analysis

A multiple linear regression model was used to find the effect of different agroforestry practices on farm

income of the households. Maduka (2007) used multiple regression for agroforestry products effecting farm income. Safa (2005) used ordinary least square regression to find the effect of socio economic factors on farm income of small scale agro-foresters.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \alpha D_1 + \delta D_2 + \varepsilon_i$$

Where;

Y: Household Farm income (Thousand Rs/year); β_0 : Intercept; β_i : Co-efficient of explanatory variable; X_1 : Number of fruit trees on farm. It was hypothesized that more the number of fruit trees on farm, more it will contribute to farm income by selling fruits in the market; X_2 : Number of wood trees on farm. It was hypothesized that more the number of wood trees on farm. The farm households will not only sufficient in fuel wood but also sell fuel wood, timber and standing lots in market to generate more income; X_3 : Number of crops produced under agroforestry practice (per year). It was hypothesized that more the number of crops grown on farm, more it will contribute to farm income; X_4 : Education (No. of schooling years). It was hypothesized that more the number of schooling years of the head of the household. More efficiently he will apply agroforestry as farm management practice to improve farm income; X_5 : Area under Agroforestry Practice (*jerib*). It was hypothesized that more area under agroforestry will contribute more to farm income as it produces two products *i.e.* forest plus crop product from a single unit of land; X_6 : Household size (No.). It was hypothesized that larger the household size Less it will contribute to farm income as more land will be allocated to Ensure food security of the household more fuel wood will be consumed So less grains and fuel wood can be sale in the market; X_7 : Number of farm labor in HH. It was hypothesized that more farm labor in a household more it will contribute to farm income; $D_{1practice}$: 1 if the HH is practicing Boundary line Plantations otherwise zero; $D_{2practice}$: 1 if the HH is practicing Intercropping otherwise zero. Base is if the HH is practicing Boundary line plus Intercropping; ε_i : Error term.

Results and Discussion

Table 2 shows the agroforestry practices effecting farm income of the sampled farm households. The goodness of fit of the model with F-ratio is 203.205 with p-value (F)=.000. The R square (coefficient of determination) value= 0.843 which shows that 84% variation in farm income is explained by the in-

dependent variables like Area under Agroforestry, Number of fruit trees, Number of wood trees, number of farm labor in household, number of crops grown under agroforestry practices and type of agroforestry practice adopted.

Table 2: Empirical results of multiple regressions of households farm income and selected variables.

Variables	Estimated coeffi- cients	Standard error	t-ratio	p- val- ue
Area under agroforestry	44.379	4.737	9.369	.000
No. fruit trees on farm	.344	.033	10.298	.000
No. of wood trees on farm	.240	.054	4.466	.000
No. crops grown	39.174	12.599	3.109	.002
Household Size	7.647	7.661	.998	.319
No. Schooling years of household head.	8.987	2.709	3.318	.001
No. farm labor in house- hold	11.641	14.061	.828	.408
Agroforestry in practice as Boundary line plan- tations	-33.936	34.708	-.978	.329
Agroforestry in practice as Intercropping	72.073	14.324	5.029	.000
Constant	-383.794	74.564	-5.147	.000
R-square= 0.843, Adjusted R-square= 0.839, F-statistic=203.205, p-value= 0.000, N=390, (income in thousand PKR)				

Area under Agroforestry: The results of the study shows that the area under agroforestry has positive coefficient and statistically significant at 5% probability level. It shows that increasing the area under agroforestry by one *jerib** will increase farm income by Rs.44.379. Hussain and Khattak (2011) reported Rs.45550-54550 per acre (Rs.22775-27275/*jerib*) net revenue from different varieties of sugar cane grown under monoculture practices in KP while Khan (2014) reported that net income of a peach growing farm household was Rs.121,455 per acre (Rs.60727/*jerib*). The current study consists both the sugarcane growers with poplar trees and peach-fodder agroforestry combinations.

Number of fruit trees: The results of the study shows that the number of fruit trees on farm has positive coefficient and statistically significant at 5% probability level. It shows that increasing the number of fruit trees on farm will increase farm income by Rs. 0.344.

Maduka (2007) also reported positive influence of fruit trees on farm income in Tanzania.

Number of wood trees: The results of the study shows that the number of wood trees on farm has positive coefficient and statistically significant. It shows that increasing the number wood trees on farm will increase farm income by Rs. 0.240. Maduka (2007) also reported positive influence of fruit trees on farm income in Tanzania.

Number of crops grown: The results of the study shows that the number of crops cultivated under different agroforestry practices has positive coefficient and statistically significant. It shows that increasing the number of crops under agroforestry practices will increase farm income by Rs. 39.174. According to Maduka (2007) study it was reported that number of crops has significant positive effect on farm income.

Number of schooling years of household-head: The results of the study shows that Number of schooling years of household-head has positive coefficient and statistically significant. It shows that increasing the educational level by one year will increase farm income by Rs. 8.987. Mekoya *et al.* (2008) reported that agroforestry requires considerable educational level of farmers and farming households towards its adoption and practices because it is knowledge intensive. Adesina *et al.* (2000) reported that prospective new agroforestry technology adopters are more likely to be farmers with formal education as compared to farmers who have no formal education.

Agroforestry practice as Intercropping: the results of the study shows that intercropping in comparison to boundary line plus intercropping has positive coefficient and statistically significant. It shows that increasing intercropping will increase farm income in comparison boundary line plus intercropping by Rs.72.073.

The *jerib* is a traditional unit of land measurement in the Middle East and south east and western Asia. It is a unit of area used to measure land holdings (real property) in much the way that an acre or hectare area. 1 *Jerib* = 0.49 Acre (Rowlett, 1999).

Diagnostic Tests

Test for normality of the data: To check that data comes from a normal distribution the KS and Shap-

iro wilk tests were conducted. Null hypothesis for the test were given as:

H_0 : the data is normal or following a normal distribution; H_1 : the data is not normal or not following a normal distribution.

Table 3: Test statistics for households annual farm income.

	Kolmogoro Siemernov			Shapiro wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
HH Annual farm income	.014	390	.200	.998	390	.982

The results of both the tests showed that data followed a normal distribution showing reliability of the model.

Test for multicollinearity among the variables: The assumption of no multi collinearity was checked by variance inflation factor (VIF) and Tolerance test. Above-10 value of the VIF shows a problem (Myers, 1990). The following table shows that there is no multicollinearity among independent variables in the model.

Table 4: Collinearity statistics of households farm income.

Variables	Collienearity statistics	
	VIF	Tolerance
Area under agroforestry	3.373	.296
No. fruit trees on farm	5.083	.219
No. of wood trees on farm	1.963	.509
No. crops grown	1.815	.551
Household Size	1.112	.899
No. Schooling years of household head.	1.339	.747
No. farm labor in household	1.420	.704
Agroforestry in practice as Boundary line plantations	3.962	.252
Agroforestry in practice as Intercropping	1.494	.669
Mean VIF	2.395	

Test for heteroscedasticity in the data: Ordinary least square (OLS) regression assumes that all residuals are drawn from a population that have constant variance. To satisfy the regression assumptions and to trust the results, the residuals should have a constant variance. Cross sectional studies often having very

large and small values are more likely to have heteroscedasticity. Breusch-Pagan tests were used to identify heteroskedasticity.

The results of Breusch-Pagan test shows that there is no issue of heteroskedasticity in the model. Thus, results of the estimated regression model are reliable.

Table 5: Statistics of Breusch-Pagan Tests for heteroskedasticity.

	Chi-square	sig
Breusch-Pagan test	1.192	0.275
H_0 : error term is homoscedastic; H_1 : error term is not homoscedastic		

Table 6: Distribution of the households by annual farm income.

Villages	Annual farm income in Rupees				Total
	Upto 5-lacs	5-10 lacs	10-15lacs	Above 15lacs	
Babaini	26(6.7)	7(1.8)	3(0.8)	0(0)	36(9.2)
Char Banda	24(6.2)	2(0.5)	0(0)	0(0)	26(6.7)
Shamsi	11(2.8)	9(2.3)	1(0.3)	0(0)	21(5.4)
Shiro	12(3.1)	3(0.8)	2(0.5)	1(0.3)	18(4.6)
Kattakhat	25(6.4)	21(5.4)	0(0)	0(0)	46(11.8)
Barikab	16(4.1)	8(2.1)	0(0)	0(0)	24(6.2)
Barthana	5(1.3)	12(3.1)	21(5.4)	10(2.6)	48(12.3)
Aghal	15(3.8)	19(4.9)	7(1.8)	0(0)	41(10.5)
Ashari	0(0)	13(3.3)	22(5.6)	7(1.8)	42(10.8)
Kalakot	0(0)	12(3.1)	7(1.8)	0(0)	19(4.9)
Baydara	6(1.5)	15(3.8)	1(0.3)	0(0)	22(5.6)
Sambat	17(4.4)	30(7.7)	0(0)	0(0)	47(12.1)
Total	157(40.3)	151(38.7)	64(16.4)	18(4.6)	390(100)

Source: Field survey 2018; Figures in parentheses are percentages.

Table 6 shows that majority 40.3 % of the households having annual farm income upto five lacs rupees. Majority of the households in this range belong to Mardan where the majority of the households were practicing boudaryline plantations with crop combination as sugar cane with poplar. The households having annual income ranges from 5 to 10 lacs were 38.7 %. Households with income 10-15 lacs were 16.4 % and only 4.6 % of the households reported their income more than 15 lacs.

Annual farm income with different tree and crop combination

Table 7 shows that 22.8 % of the households growing

Table 7: *Distribution of the households by annual farm income with respect to grown tree and crop combination.*

Trees and crop combination	Annual farm income in Rupees				Total
	Upto 5-lacs	5-10 lacs	10-15lacs	Above 15lacs	
Peach with fodder/cereal crop	19(4.9)	12(3.1)	21(5.4)	5(1.3)	57(14.6)
Apple with fodder/cereal crop	3(0.8)	1(0.3)	2(0.5)	0(0)	6(1.5)
Peach and apple with cereal	6(1.5)	13(3.3)	13(3.3)	4(1.0)	36(9.2)
Peach, and persimmon with cereal/fodder	1(0.3)	4(1.0)	1(0.3)	0(0)	6(1.5)
Peach, apple & parsimon with cereal/fodder	11(2.8)	34(8.7)	9(2.3)	2(0.5)	56(14.4)
Wheat/Maize/Sugarcane with Mulberry/bhakyani/Poplar	89(22.8)	7(1.8)	0(0)	0(0)	96(24.6)
Sugarcane/wheat/Maize/vegetables With Poplar	25(6.4)	22(5.6)	6(1.5)	1(0.3)	54(13.8)
Sugarcane/wheat/Maize/vegetables With Poplar, Peach/Loquat	0(0)	10(2.6)	0(0)	0(0)	10(2.6)
Peach-fodder and wheat/maize with Poplar/Kikar/Bhakyani	3(0.8)	48(12.3)	12(3.1)	6(1.5)	69(17.7)
Total	157(40.3)	51(38.7)	64(16.4)	18(4.6)	390(100)

Source: *field survey 2018; Figures in parentheses are percentages.*

sugarcane, wheat, maize with poplar, mulberry or Bhakyani falls in upto-5 lacs annual income category. Growing sugarcane, wheat, maize with poplar under boundaryline system is a very traditional and common prevailing agroforestry practice in Mardan, Charsadda and Peshawar. Hussain and Khattak (2011) reported Rs.45550-54550 per acre net revenue from different varieties of sugar cane in KP. Some of the farm households only (1.8%) grown the same tree and crop combination reported annual income as 5-10 lacs. Majority of the farm households grown poplar trees sell it after 4-5 years and very few practice periodic or annual selling having a range of different age group trees on their farms. The farm households who sell timber/fuel wood use selective felling (cutting) technique and sell selected trees and earn annually from wood trees. As a result the farm households practicing agroforestry but sell only crop product like sugarcane or wheat earned less than those sold both crop and forest product (timber/fuel wood). About 12.3 % of the households grown peach with fodder and wheat, maize with poplar reported their annual farm income as 5-10 lacs.

Households with income 10-15 lacs were 16.4 % and only 4.6 % of the households reported their income more than 15 lacs. Villages like Barthana, Aghal, Ashari and Baydara are famous for orchard agroforestry grown peach with fodder under intercropping agroforestry practice. Previous studies in the area by Khan (2014) reported that net income of a peach growing farm household was Rs.121,455 per acre. Similarly, khalil (2014) also reported 33.3 % of the farm households earned 11-20 lacs annually from peach agroforestry in Barthana, Ashari and Baydara.

The above discussion shows that there is great diversity in the farm income of farm households growing sugarcane with cereals in comparison to those growing fruit trees with wheat, maize or fodder. The farm households growing both fruit and wood trees with cereal or fodder crop earned more annually than those grown sugarcane, wheat or maize with poplar or other wood trees. Which tree and crop combination is suitable and suits a farm household requirements of food, fuel wood and cash? It depends on farmers own choice. It was noticed during the study that lack of awareness among the farmers about different tree and crop combinations were the major reason that farm households grow 3-4 crops in rotation with wood trees on boundarylines of their farms lands.

Conclusions and Recommendations

This research study was conducted to investigate the effects of agroforestry practices on farm income of the households in two purposively selected districts of Khyber Pakhtunkhwa. The factors effecting farm household choice for different agroforestry practices and the sustainability of these livelihoods. A total of 390 agroforestry farm households were interviewed for this study through an interview schedule. The findings of the study shows that Area under agroforestry, number of fruit and wood trees on farm, number of crops grown and educational level show positive relationship with farm income. The contribution of boundary line practice in comparison to boundary line plus intercropping was statistically not significant. While, intercropping is statistically significant in comparison to boundary line plus intercropping.

The following recommendation are suggested on the basis of the main findings the study:

1. In light of the results of the current study it is necessary to motivate farm households to cultivate more area under agroforestry as area under agroforestry has positive effect on farm income.
2. The results of the study show a positive contribution of fruit trees to farm income. It is important to grow more fruits trees on farm as it is not only a source of income but also fulfill household food security needs.
3. It is recommended that farm households should grow wood trees with their crops because it provides not only fuel wood source for cooking purpose but also a good cash income source for the farm households.
4. A farm household should grow more crops under agroforestry practices as it contributes more to farm income. Besides the traditional three to four crops like sugarcane, wheat, maize and fodder with Poplar under boundary line plantations it is necessary to grow more crops under agroforestry practices.
5. The farm households practicing only boundary line plantations should adopt intercropping agroforestry practice with boundary line practice because the contribution of intercropping to farm income were Rs.72.073.

Novelty Statement

This study was conducted for the purpose to analyze the affect of agroforestry practices in farm income of the households and give a detail view to those who want to adopt or practice agroforestry in rural KP in future.

Author's Contribution

Najmul Saqib: Conducted research, collected data, made analysis and wrote this manuscript.

Himayathullah Khan: Guided and supervised the whole research study.

Conflict of interest

The authors have declared no conflict of interest.

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