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Factors Affecting the Adoption and Intensity of Agroforestry in Tehsil Takht Bhai, Mardan

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This study was designed to determine the factors affecting agroforestry and the intensity of adoption in Tehsil Takht Bhai District Mardan Khyber Pakhtunkhwa. The data were collected by a well-structured questionnaire. The dependent variable of the study was a binary variable indicating whether a farmer adopted agroforestry or not. The study used the Probit and Logit models to calculate the odd ratio of the adoption of the agroforestry and to find out the factors affecting the adaption. One of main reasons for farmers adopting agroforestry could be better revenue compared to the traditional agricultural system. Therefore, the enterprise budgeting was performed first. The enterprise budget indicated that agroforestry adopters received more revenue as compared to non-adopters. The study also found that age of farmer, education of farmer, total land in acres, and revenues previously received from farming were positively contributing to the adoption of agroforestry and respective probabilities of intensities were 78 %, 1 %, 2%, and 43%. On the other hand, experience of farming, income from non-farm sources, expenditure incurred on farming were negatively affecting the adoption of agroforestry and the respective probabilities of intensities were 20%, 200%, and 13%. Family size of the farmers did not affect intensity of adoption which may be at odd with the general perception that availability of labor through own family members could be an important factor of adoption and intensity. The study also estimated the break-even prices for wheat and sugar cane crops. The study found that sugar cane was a more desirable crop compared to wheat. The current study found that if there were a decrease in the output prices of wheat (up to 11.21%) still the crop will generate positive revenue. On the other hand, the breakeven price analysis of the sugar cane showed

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that if there was a decrease in market price of the crop by 8.66% (from Rs. 180 to Rs.164.41), still it would generate positive revenues. Finally, trans log profit function was used to estimate the supply response function for wheat, sugar cane, hay and poplar. The results revealed that a 1% increase in the output prices of wheat and hay will increase the output by approximately 55%. Poplar trees take approximately 5 years rotation period, and 1% increase in the output prices of poplar will increase the production of poplar by approximately 20%. Increase in sugar cane prices by 1% will increase the production of the crop by approximately 35%. There has been a lack of revenue estimates for agroforestry in combination with various crops. It is recommended that the agricultural extension department should conduct some awareness sessions with local farmers to inform them of both revenue as well as non-market benefits. The limitations of the study included the reliability of the collected data as the data were collected for the five years and depended upon the recall by farmers as proper record of data was not kept. Lastly, we could not collect the data on the non-market benefits of agroforestry which could be significant in terms wind breakers, salinity control and many others. Based on the results from this study, it is recommended that training and extension services may be provided to inform the farmers of the benefits that the agroforestry system offers. Also, the farmers may be trained and encouraged for proper record keeping of the farm activities. Finally, the study could be extended to value the non-market benefits that the agroforestry system offers.

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Introduction

Agriculture is the mainstay of Pakistan's economy contributing about 21% to the total gross domestic product (GDP) and providing employment to 44 % inhabitants mostly living in rural areas (Government of Pakistan, 2016). Twenty-eight percent of rural population lives below poverty line earning Rs. 878.64 per adult equivalent per month (Government of Pakistan, 2005). Wheat is one of the most important cereal grains used in Pakistan. In Pakistan wheat is grown in combination with sugar cane for higher profitability. Majority of the farmers grow wheat and sugar cane for industrial production of flour and sugar respectively, while some of them grow it for domestic use and brown sugar (gurr). The prices of wheat and sugar cane for the fiscal year 2015-16 were approximately Rs. 1300 and Rs. 180 per 40 Kg respectively (GOP, 2016).

The agricultural sector, including livestock, is under great stress. In general, crop and animal yields are low. The sandstorms and gusts of wind emanating from the deserts in the country play havoc with agricultural crops and orchards (Mohammad and Hrenreich, 1993). Waterlogging and salinity have damaged much of the fertile agricultural land. In view of high man-land ratio and limited prospects of increasing arable land, increased production should be achieved through increased yield per hectare. The indiscriminate use of natural resources can lead to increasing difficulty in maintaining supply and lowering the standard of living (Akbar *et el.,* 1989). The farming community of the country is facing the problems of small and fragmented holdings as well. The existing small farm area holdings and traditional, age-old practices and ignorance about the modern approaches are responsible for the low incomes from farmland (Akbar *et et.,* 1989 and Baig *et al.,* 1995).

Agroforestry has been touted to compliment the revenue of the farmers and uplift the living standard in the rural areas in Pakistan. Although, there has been a lack of revenue estimates for the agroforestry in combination with various crops. Enterprise budgeting is

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one of the most popular techniques to investigate profitability of a specific enterprise. Enterprise budgeting is the listing of all the expenses and incomes associated with a single enterprise to assess the profitability of a particular enterprise (Sharp and Kaan, 2015). Enterprise Budgeting of any enterprise includes four basic steps vis-à-vis estimating total production and price, estimating variable cost involved in enterprise, estimating the fixed cost and finally estimating the net receipts (Rehman et al., 2012).

Breakeven analysis can be used for single enterprise or comparing two or more enterprises. Breakeven analysis of agricultural enterprise enables us to estimate the breakeven output, prices, variable cost, fixed cost, input requirement, specific input requirements etc. (Dillon, 1993). The study is designed to evaluate the enterprise budgets of wheat and sugar cane crops, as well as the study draw a comparison between two farming system practiced in the locality that are; growing traditional crops alone and the other with trees generally called agroforestry. The study also investigated the supply response function in the framework of multiple output production function.

Literature Review

Bradford and Debertin (1985) argue that most researchers and applied economists ignore the linkages of enterprise budgeting and economic theory of production and capital especially in agricultural products. The study critically analyzed the validity of farm enterprise budgeting in the light of complex economic theories. The study concluded that all the economic theories are based on continuous based solutions while enterprise budgeting is somehow discrete based. The study also elicited a few key problems like discrete output, time-period, accounting problems, inferences from data, etc. the study concluded that enterprise budgeting should be considered as a planning exercise rather than just a historical overview.

Dillon (1993) comprehensively presented the breakeven analysis of single enterprise, between enterprise and breakeven elasticities for four crops: rice, wheat, dry soya bean

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and irrigated soya bean. The breakeven equations for yield, piece, variable cost, fixed cost, input prices, input requirement are derived from basic profit function by mathematical manipulation. The technique was empirically tested by utilizing data from the University of Arkansas Cooperative Extension service. The empirical application of the technique revealed interesting results. The study found that rice and wheat are more desirable in the fluctuating environment of Arkansas Delta region.

Dillon and Casey (1990) introduced the concept of break-even elasticities between agricultural enterprises. They quoted Bender et al. and stated that break-even analysis involves decision making which includes several steps: problem identification, data collection, determining alternative solutions, plan execution, and implementation of decision. The study estimated the breakeven elasticities of corn and soybeans in East Texas. The data for 1988 was obtained from Texas Agricultural Extension Service for dryland corn and soybean on variables total output per hectare and cost per hectare. Breakeven analysis was used to estimate the prices and elasticities. The study found that dryland corn is more favorable to soybean in East taxes on the bases of return above the variable cost while soybean is favored over corn on bases of return above the total cost.

Rehman et al. (2012) conduct a survey in district Mansehra of Khyber Pakhtunkhwa to study the feasibility of green and black tea cultivation in the area. They used simple cost benefit analysis to estimate the net benefits received per hectare. the primary data was collected from National Tea Research Institute. The study found that tea processing units were working below its potential and that they cost an extra amount of approximately 226 per kilogram. The farmer's perceptions were asked about the cultivation of tea in the district. Because of the high initial investment, the farmers were not interested in cultivating tea. The net present value and Internal rate of return analysis states that there is a great opportunity for future investment in tea cultivation in the locality which would

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not only combat the increasing demand of black and green trees in the country, but would also provide employment opportunity to local labor.

Langemeier (2015) studied soybean and corn by using the total output, total cost and net benefits in Indiana. The study used the data on both crops in 2015 and perform the break-even analysis. The study found that corn will substantially contribute smaller resulting in a loss of 134 dollars per acre in 2016, while the breakeven price was calculated by adding overhead cost to variable cost, subtracting govt. receipts and dividing by total yield per acre, the breakeven price for corn was estimated approximately $4.6/bushel. For soybean, it is stated that it would loss $128/acre, while the breakeven price was estimated to be approximately $11/bushel.

Barnard and Nix (1979) presented the conceptual frameworks of farm planning and management. They argue that farm production should be considered as an organization and there must be planning and decision making. They provided a detail of principle, concepts and methods regarding agricultural enterprises. They contend that just like other production processes, agriculture production requires land, labor and machinery to produce a single commodity; thus, they believe that like other profit maximization problems, we need to optimize the production of agriculture commodities to overcome the increasing demand.

Singh et al. (2010) carried out research in Sonepat and Gurgaon districts in Haryana state on mushroom production. The study utilized the concepts of cost-benefit analysis, and break-even points for estimating the production of mushrooms in different farm levels; small, medium and large. For drawing the inferences from raw data, they used simple tubular, cost and benefit and price spread techniques to investigate the market efficiency in Haryana state. The study found that the fixed investment in large and medium farms is almost double as compared to the investment in small farms. Farm size is considered one of the essential components of farm production. The study found that farm production is

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positively related to farm size. The economies of scale argue that more production reduces the production cost, the study found that the production cost is less in large and medium farms as compared to small farms.

Baranchuluun et al. (2015) conducted research in Magoila on four different vegetables' production and irrigation techniques. The data is collected from Ulaangom soum in 2013-14. They used cost-benefit methods to investigate the production, cost and prices. They focus on the irrigation cost explicitly and argue that the cost on using the groundwater for farms is more as compare to surface water. Further, they argue that drip irrigation and sprinkler irrigation system require less labour and money compare to other irrigation systems, the production of vegetables in advanced irrigation system is more as compare to traditional irrigation system.

As far as multiple-output profit function is concerned, a study by Fulginiti and Perrin (1990) examined multiple dependent variables including Wheat, corn, soybean, linseed, sunflower, beef, sorghum – Multiple independent variables including prices of all products, labour wage, capital rent, and fertilizer input prices. Land and precipitation is taken as fixed input while time is taken fixed input as a proxy of technological change. The empirical estimation of multiple output and input trans-log profit function by utilized the time series data from 1940 to 1980. The study investigated the impacts of price policies on low growth rate of agriculture in Argentina. The study found that price policies affect the growth rate of agricultural activity in Argentina. The study also recommended that if, taxes on exports, imports restriction and other taxes are eliminated, there would be a tremendous increase the Argentine agricultural sector.

Liu, Ondrich and Ruggiero (2012) explore the effect of loans, investment, equity and net interest on income employee compensation, office expenses and other expenses. The nature of the research is theoretical as well as empirical testing of the model. The study utilized the multi-output and multi-input production framework for estimating the

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production function for US credit Union. The purpose of the study was to investigate the effectiveness of the National Credit Union Administration. The data on variables were collected from the annual call reports for the year 1998. In the empirical section of the study, authors estimated the aggregate production function and measured the distance non-parametrically to the end boundaries. They used canonical regression and developed a new two stage estimation model for estimating the multiple output production function.

Donnell et. al. (2004) empirically estimates the effect of labor, materials and capital on wheat, barley, canola, oats, grain sorghum and triticale The study used multi-input and multi-output profit maximization framework for investigating the degree of competition in Australian seed market. The data were taken from "Australian Bureau of Agricultural and Resource Economics" for financial years starting from 1989-1990 to 1999-2000. The study found that cereal food and wheat products manufacturing producers exert market power while purchasing wheat, oats, triticale, and barley. The authors confirm the findings of the study with Piggott et al. (2000) and Griffith (2000).

Whereas Kumbhakar (1996) analyzed hypothetical outputs and inputs theory. The study presented the efficiency measurement in the context of multiple output and multiple input cost and profit maximization framework. The study first modeled multi-output and multi-input cost minimization and then proceeded to multi-output and multi-input profit maximization. In the profit maximization approach, the author presented that a trans log profit function was an appropriate model to avoid model miss-specification.

Though, the study Weaver (1983) considers three distinct types of products including grains (wheat and rye), dairy products and feed grains (corn, barley, oil crops, oats, and hay). The study used capital services, labor, fertilizers, petroleum products and other materials as independent variables. The nature of the study was purely an empirical investigation of the theory. The study utilized data from various sources and estimated the expected future indices for both quantities and prices. The study employed the second

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order Taylor Approximation approach for estimating the multi-product profit function. The agricultural output was taken into share form. The empirical investigation confirmed that the multiple input and multiple output profit maximization approach was an appropriate technique.

Yet a study by Alam (1991) included high grade fish species, medium grade fish species and low-grade fish species. The independent variables used in study included labor, price of energy (petrol, lubricant, diesel etc.) and size of vessel.

The nature of the research was empirical. The study used the data through survey and the observations included were 42. The study utilized the duality theory and formulated a second order Taylor series approximation (trans log profit function) for investigating the output-input separability, production optimization and profit maximization behavior of the fisherman. The study estimated the share equation for each category of output and found that the production of each category was a non-joint in required inputs as well as output and input association was separable.

Whereas the study by Ball (1988) empirical tested the underlying assumptions of the duality theory using five food products including oil seeds, food and feed grains, milk and livestock on durable equipment flows, building and land, hired labor, farm produced durables, energy, and intermediate inputs for the period of 1948-1979. The research modeled the supply response function in the agriculture sector. The study incorporated the second order Taylor series approximation and model a restricted trans log profit function, by applying Hoteling lemma. The study estimated the product shares and tested the assumptions of the theory.

The study by Squires (1987) examined the round fish, flat fish and all other kinds with their energy prices and capital was taken as fixed input. The study was an attempt of long-run restricted multi-product profit function backed by empirical investigation. The study developed the long-run restricted profit function. The long run multiple production

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profit function was modeled as second order Taylor series approximation. The data on variables used in the study was collected from 42 otter travel vessels for two years (1980 and 1981). The study included two dummy variables as a proxy for technological progress. The study concluded that supply elasticities were inelastic; input demand elasticities were complimentary. Finally, the industry exhibited decreasing return to scale.

The previous literature identified the potential benefits associated with agroforestry system. These benefits included an increase in farm-based income, the production of fuel wood, fodder for cattle, timber for industrial use, increase in soil fertility by producing the green manure, and decrease in the cost of fertilizer by using the organic fertilizers produced by the trees. Previous literature also provided a list of factors which influence the adoption of agroforestry. These factors included education level, off-farm income, age, gender, farm size, hired labor, family labor, tree species, maturity level of tree, experience of farmer etc. Moreover, the previous literature on the multi-outputs trans log profit function identified that the price of relevant inputs and outputs should be included in estimating the profit function

Materials and Methods

The study was conducted in district Mardan, Khyber Pakhtunkhwa. In the district Mardan, there are plane farmlands, majority of the farmers in the district grow two crops; wheat and sugar cane. Sugar cane crops are sold out to the nearby Premier Sugar mills, while wheat is either kept for personal use or sold out in the market. The farmers practice two types of farming systems; conventional farming and agroforestry. The study used data from both farming systems. The data were collected in 2016 in Tehsil Takht Bhai of district Mardan through a well-designed questionnaire. The questionnaire included all the questions regarding variable cost, fixed cost, total cost, production, prices, labor input, education, family size, farms size, equipment and machinery etc. The data were collected from 138 farmers face to face in person interviews. We calculated the sample size to 138

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farmers by choosing a desired confidence level 95% and a margin of error 5% (Walpole, 1984). Further, we divide the sample size into two groups based on the agricultural farming system. The traditional farming system is practiced by 62 farmers in current study while the remaining 78 farmers practiced agroforestry.

The study utilizes the cost-benefit analysis methods to estimate the enterprise budgets of each crop for the farming system. The study used the concept of present value and discounting. The farm's nominal revenues and costs do not depict the actual situation because cash flows are occurring in different time periods (Bright, 2001). Hence, the present value of each cash flow (the cost is incurred in earlier period and the revenues are received in latter period) is discounted by applying appropriate formula, the formula is given as follows;

$$Present\ Value = \frac{V_0}{(1+r)}$$

In the above equation, present value represents the value in any base period, V_0 the current period value, and (1+r) represent the discount factor.

The study follows breakeven analysis technique of assessing the profitability of a single enterprise and intra enterprises as in Dillon (1992). The breakeven equations are derived from profit function given as follows.

$$\pi_i = P_i Y_i - VC_i - FC_i \quad ---------- (1)$$

Where, π is the profit generated by commodity i, P is the price of community i, Y is the produced output of commodity i, VC is the variable cost incurred in the production of commodity i, and FC is the fixed cost incurred in the production of commodity i. The breakeven equations can be derived from equation (1) by simple mathematical manipulation. The breakeven equation of single enterprise for output price, output, variable cost, fixed cost, and total cost are as follows.

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$$P_i = \frac{\pi_i + VC_i + FC_i}{Y_i} \text{ ----------(Price)}$$

$$Y_i = \frac{\pi_i + VC_i + FC_i}{P_i} \text{ ----------(output)}$$

$$VC_i = P_i Y_i - FC_i - \pi_i \text{ ----------(varaible cost)}$$

$$VC_i = P_i Y_i - VC_i - \pi_i \text{ ----------(Fixed cost)}$$

$$TC_i = P_i Y_i - \pi_i \text{ ----------(total cost)}$$

Breakeven points between enterprises can be conducted by equating the profit equations of different enterprises. It is given as follows.

$$P_i Y_i - VC_i - FC_i = P_j Y_j - VC_j - FC_j \text{ ----------(2)}$$

Where, in equation (2) all the variables are explained earlier except subscript j, which demonstrate commodity *j*. By mathematical manipulation and solving for the desired variable enables us to estimate the break-even points between enterprises. The desired break-even points are given as follows.

As we know; net return can be calculated for commodity *j,* subtracting variable cost and fixed cost from the revenues generated by commodity *j*, it is given as follows;

$$P_j Y_j - VC_j - FC_j = NR_j \text{ ----------(2.1)}$$

In the above equation (2.1) *NR* stands for the net returns from commodity *j*, putting equation (2.1) in equation (2) and solving for desired variables P_i , Y_i , VC_i , and FC_i we will be left with the following equation;

$$P_i = \frac{VC_i + FC_i + NR_j}{Y_i} \text{ ----------(Price)}$$

$$Y_i = \frac{VC_i + FC_i + NR_j}{P_i} \text{ ----------(output)}$$

$$VC_i = P_i Y_i - FC_i - NR_j \text{ ----------(varaible cost)}$$

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$$FC_i = P_i Y_i - VC_i - NR_j \text{----------} (varaible\ cost)$$

Supply Response Function

The problem maximization of multiple products has remained a key issue to the researchers in recent years. Generally, the duality theory has been overlooked for coming up with a better solution. The problem of join-inputs posed more complication in the optimization problem. Hence, it has remained a key issue for the researcher not only to be modeled but also subject to empirical investigation. In recent years, there have been attempts to model and test the duality theory in case of multiple inputs and multiple output {Squires (1987), Ball (1988), and Weaver (1983)}. The methodology for the current study has been borrowed from Ball (1988); the study used the restricted profit function approach to model the multiple product profit function.

Specifically, in the production technology there are M number of outputs and M variable inputs; $Y_i = Y_1, Y_2, Y_3, \ldots. Y_M$ is the set of outputs and $X_i = X_1, X_2, X_3, \ldots. X_M$ is the set of variable inputs and a vector of fixed inputs $S = S_1, S_2, S_3, \ldots. S_N$. However, the fixed inputs are no longer fixed in the long run. Suppose, T be a set of a feasible combination of all inputs and outputs. T should follow certain assumption including a) T is non-empty, b) T is a convex and compact set, and c) T is a cone, in other words, the technology of T exhibits constant return to scale. Let, P_i represents the prices of outputs and W_i is the input prices then the profit function associated with T can be written as follows.

$$\pi(P,W) = \underset{Y}{Max}\{P' Y : (Y, -W) \in T\} \text{----------} (1)$$

Where, π is profit and a function of output and input prices. Following the assumption of T, the profit function should follow certain assumption including a) the profit function is homogeneous of degree 1 in output and input prices, b) concave in quantities and c)

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convex in prices. Following the study of Diewert (1973), if the profit function is differentiable, it must satisfy the Hotelling Lemma; given as follows.

$$\frac{\partial \pi(P,W)}{\partial P_i} = Y_i(P, W), \quad i=1, 2, 3, \ldots M \text{----------(2)}$$

$$\frac{\partial \pi(P,W)}{\partial W_i} = -X_i(P, W), \quad i=1, 2, 3, \ldots M \text{----------(3)}$$

Where; $Y_i(P, W)$ is the profit maximizing output and $\frac{\partial \pi(P,W)}{\partial W_i}$ is the profit maximizing input. Therefore, it is assumed that profit function $\pi(P,W)$ is twice differentiable.

Following the study of Ball (1988) profit function given in equation 1 can be written in the form of second order Tylor series; with arguments of the current study including output prices (P_i) labour wage (LW_j) capital rent (CR_k), Fertilizers prices (FP_n), others input prices (OP_l) along with dummy variables for time change. The long-term profit function is given as follows.

$$\ln \pi(p,w) = \beta_0 + \beta_T D + \sum_{i=1}^{M} \beta_i lnP_i + \sum_{j=1}^{M} \beta_j lnLW_j + \sum_{k=1}^{M} \beta_k lnCR_k + \sum_{l=1}^{M} \beta_l lnOP_l + \sum_{n=1}^{M} \beta_l lnFP_n + \sum_{i=1}^{M} \sum_{i1=1}^{M} \beta_{i\,i}$$

Where, in equation (4), D stands for time dummy and takes values; 1, 2, 3, 4 and 5 for 2011, 2012, 2013, 2014 and 2015 respectively. Equation (4) is a trans-log profit function. It is assumed that $\beta_{ii1}=\beta_{i1\,i}$ for $i \neq i_1$, $\beta_{jj1}=\beta_{j1\,j}$ for all $j \neq j_1$, $\beta_{kk1}=\beta_{k1\,k}$ for all $k \neq k_1$, $\beta_{ll1}=\beta_{l1\,l}$ for all $l \neq l_1$ and $\beta_{nn1}=\beta_{n1\,n}$ for all $n \neq n_1$. Further, without the loss of generality symmetry is imposed on other variables' parameters as well; $\beta_{ij}=\beta_{ji}$ for $i \neq j$, $\beta_{ik}=\beta_{ki}$ for $i \neq k$, $\beta_{il}=\beta_{li}$ for $i \neq l$, $\beta_{jk}=\beta_{kj}$ for $i \neq j$, $\beta_{jl}=\beta_{lj}$ for $l \neq j$, $\beta_{kl}=\beta_{lk}$ for $k \neq l$. Conditional revenues shares could be estimated from the total profit function by applying the Hotelling lemma.

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$$\frac{\partial \ln \pi(p,w)}{\partial lnP_i} = \frac{P_i Y_i}{\pi(p,w)} = \beta_i + \sum_{i1=1}^{M} \beta_{i\,i1}\, lnP_{i1} + \sum_{j=1}^{M} \beta_{ij}\, lnLW_j + \sum_{k=1}^{M} \beta_{ik}\, lnCR_k + \sum_{l=1}^{M} \beta_{il}\, lnOP_l + \sum_{n=1}^{M} \beta_{in}\, lnFP_n +$$

Where, equation (5) is a conditional revenues function for i[th] commodity, which is positive in all outputs and negative in all inputs. Homogeneity in prices are imposed on the above multiple product profit equation. Specifically, the restrictions are given as follows.

$$\sum_{i}^{M} \beta_i = 1 \text{----------} (HOD-1)$$

$$\sum_{i1}^{M} \beta_{i1\,i} = \sum_{j=1}^{M} \beta_{ij} = \sum_{k=1}^{M} \beta_{ik} = \sum_{l=1}^{M} \beta_{il} = \sum_{n=1}^{M} \beta_{in} = 0 \text{----} (HOD-0)$$

Specifically, in the current study, there are four different outputs: wheat, sugar cane, hay and poplar (M = 4), five variable inputs (M = 5) output prices, labor wage, capital rent, fertilizer price (DAP, Urea and Manure) and all other input prices (including site preparation per hour price, harrow price, spade price and other farm input). Short run profit is the revenues less the opportunity cost of labor, opportunity cost of capital employed and the cost of all other variable inputs. D_T is a dummy variable, and T takes the value 1 for 2011, 2 for 2012, 3 for 2013, 4 for 2014 and 5 for 2015. Balanced panel data has been used for 138 observations for five years. The data has been collected through a questionnaire. Long run profit function in equation (4) is estimated along with revenues shares given in equation (5). All the restrictions of symmetry and linear homogeneity are directly imposed.

For estimating the supply response function, the multiple output trans log profit function is differentiated with respect to the respective output prices.

Results and Discussion

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This section of the study presents the detail year-wise enterprise budgets of wheat and sugar cane for both farming systems that are agroforestry and traditional farming systems. The details are given in the following tables. Followed by enterprise budget of poplar, comparison of both farming systems and breakeven analysis.

Table 2: Per Acre Enterprise Budgeting of Wheat Agroforestry System

	1st year	2nd year	3rd year	4th year	5th year	Total
Total cost in Rs.	14596.69	--	7711.04	--	8825.47	31133.20
Production (maunds)	30.62	--	29.18	--	22.27	82.07
Market price	1054.00	--	993.05	--	937.66	
Total revenues	32273.48	--	28977.14	--	20881.63	82132.26
Net benefits received	17676.79	--	21266.10	--	12056.17	50999.06

(Source: author's own calculation)

The farmers in the locality grow wheat and sugar cane in rotation. In the first year of wheat harvest the same crop of sugar cane is harvested for the second year also. In the second year, they don't grow wheat on the farms. Thus, the sugar cane rotation time is one and a half years. In table 2 we presented the year wise budgets of wheat of those farmers who adopted agroforestry as a farming system. The total cost is discounted for the base year of 2010 (the recall of data starts from this year as the trees are rotated after 5 years). From the discounted values, the study estimates the net benefits. Wheat grows every second year, while sugar cane crops are harvested for two years. In the first year, the total cost incurred on wheat crop accounts for Rs. 14596.69 per acre. The production in the same year is 30.62 maunds per acre. The total revenues received from one-acre accounts for Rs. 69229.41 from wheat. The net benefits received by farmers from one

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acre of land account for Rs. 32273.48. In the second year, the farmer did not grow wheat crops because of the previous year's sugar cane crop. In the third year, the cost is discounted for the base year; that is taken as the first year in survey data. The discounted cost incurred on wheat crop accounts for Rs. 7711.04 per acre. The production of wheat per acre is approximately 29.18 maunds. The total discounted revenues received by the farmer from one acre of land accounts for Rs. 28977.14. the net benefits received by farmer accounts for Rs. 21266.10 per acre of land. In the fourth year, the farmer did not grow wheat crops. In the fifth year, the total discount cost accounts for Rs. 8825.47 per acre. Production in fifth year accounts for 22.27 per acre. The total revenues generated by the one acre of land from wheat crop accounts for Rs. 20881.63 and the net benefits received by the farmer in fifth year account for Rs. 12056.17 per acre.

The total cost incurred by farmers on wheat crop accounts for Rs. 31133.20 per acre of land. The total production in five years accounts for 82.07 maunds. The total revenues generated by the wheat crop for a five-year account for Rs. 82132.26 and the net benefits received by the farmer from one acre of land in five years account for Rs. 50999.06.

TABLE 3: Per Acre Enterprise Budgeting of Sugar Cane Agroforestry System

	1st year	2nd year	3rd year	4th year	5th year	Total
Total cost in Rs.	32732.60	15674.13	28114.61	18411.74	19015.97	113949.05
Production (maunds)	400.17	501.27	383.00	493.80	286.75	2064.99
Market price	173.00	151.34	142.32	133.79	125.07	
Total revenues	69229.41	75863.36	54506.96	66065.75	35862.70	301528.18
Net benefits	36496.81	60189.23	26392.35	47654.02	16846.72	187579.13

(Source: (Source: author's own calculation from survey data (2016)

On the other hand, sugar cane is a crop which is harvested and maintained every year. In the first year, the total cost incurred on sugar cane crop accounts for Rs. 32732.60 per

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acre. Production from one-acre accounts for 400.17 maunds in the first year. Total revenues generated by the sugar cane crop accounts for Rs. 69229.41 per acre and the net benefits received by the farmer from one-acre accounts for Rs. 36496.81. in the second year, the farmer incurred a total cost of Rs. 15674.13 for sugar cane crops. The total production was 501.27 maunds per acre. Total revenues generated by one acre of sugar cane account for Rs. 75863.36 and the net benefits received by farmers from one acre of sugar cane account for Rs. 60189.23. In the third year, the total cost incurred for one acre of sugar cane crop accounts for Rs. 28114.61. One acre of sugar cane crop produces 383.00 maunds. The revenues generated by one acre of sugar cane accounts for Rs. 54506.96 and net benefits received by farmer accounts for Rs. 26392.35. In the fourth year, the cost incurred on sugar cane accounts for Rs. 18411.74 per acre. One acre of land produced 493.80 maunds of sugar cane. The crop generated total revenues Rs. 66065.75 per acre, and the net benefits received by farmer accounts for Rs. 47654.02 per acre. In the fifth year, the sugar cane crop consumed Rs. 19015.97 as total cost. Per acre production was recorded 286.75. The revenue generated by the crop was Rs. 35862.70 and net benefits received by farmer accounts for Rs. 16846.72.

Moreover, the total cost incurred in five years accounts for Rs. 113949.05 per acre. The total production in five years accounts for 2064.99 maunds per acre. The total revenue generated by one acre of land from sugar cane crop accounts for Rs. 301528.18 while the net benefits received from the sugar cane crop in 5 years accounts for Rs. 187579.13.

TABLE 4: *Per Acre Enterprise Budgeting of Wheat (Traditional)*

	1st year	**2nd year**	**3rd year**	**4th year**	**5th year**	**Total**
Total cost in Rs.	14492.87		7778.32		10503.63	32774.82
Production (maunds)	30.34		28.60		26.14	85.08

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Market price per maund	1054.00		993.05		937.66	
Total revenues	31978.36		28401.18		24510.37	84889.90
Net benefits received	17485.49		20622.86		14006.74	52115.09

Source: *Estimations from survey data (2016)*

In the traditional farming system, the farmers grow only crops alone. Table 4 and Table 5 presents the enterprise budgets of wheat and sugar cane crop respectively. In the first year of traditional farming, the total cost incurred by farmer per acre accounts for Rs. 14492.87. The total production of wheat from one acre of land accounts for 30.34 maunds. The total revenue generated by the crop accounts for Rs. 31978.36 while the net benefits received by farmer accounts for Rs. 17485.49 per acre. In the third year, total cost per acre accounts for Rs. 7778.32. in the same year, the total production was 28.60 maunds per acre. The crop generated revenues Rs. 28401.86 per acre and the net benefits received from one acre of land account for Rs. 20622.86. in the fifth year, total cost per acre on wheat crop was Rs. 10503.63. total production was 26.14 maunds per acre. The total revenues generated by wheat crop account for Rs. 24510.37 and the net profits received are Rs. 14006.74 per acre. In addition, the total cost in five years for wheat crop accounts for Rs. 32774.82. the total production accounts for 85.08 maunds per acre. Total revenues generated by the wheat crop in five years account for Rs. 84889.90 and the net profits received by the farmer account for Rs. 52115.09.

TABLE 5: ***Per Acre Enterprise Budgeting of Sugar Cane (Traditional)***

	1st year	**2nd year**	**3rd year**	**4th year**	**5th year**	**Total**
Total cost in Rs.	29874.31	15155.51	26643.58	17958.66	21760.37	111392.43
Production (maunds)	487.71	558.84	493.86	575.36	447.97	2563.74

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Market price	173.00	151.34	142.32	133.79	125.07	
Total revenues	84373.83	84576.14	70284.09	76977.71	56025.85	372237.61
Net benefits	54499.52	69420.63	43640.51	59019.05	34265.47	260845.18

Source: *Estimation from survey data (2016)*

In the traditional farming system, in the first year, the total cost incurred by farmers for sugar cane accounts for Rs. 29874.31 per acre. The total production was 487.71 maunds per acre. The revenues received from production was Rs. 84373.83 per acre and the net benefits received from one acre of land account for Rs. 54499.52. In the second year, the total cost accounts for Rs. 15155.51 per acre. The total production is 558.84 maunds per acre. The revenue generated by produced output accounts for Rs. 84576.14 and net benefits received by farmers are Rs. 69420.63 per acre. In the third year, the total cost is Rs. 26643.58 per acre and the production accounts for 493.86 maunds per acre. The revenue generated by one acre of sugar cane crop accounts for Rs. 70284.09 and the net benefits received by the farmer from one acre of sugar cane account for Rs. 43640.51. in fourth year, the total cost is about Rs. 17958.66 per acre and total production is about 575.36 maunds. The total revenues generated account for Rs. 76977.71 and net benefits received are Rs. 59019.05 per acre. In the fifth year, the total cost on sugar cane crop is about Rs. 21760.37 and total production is 447.97 maunds per acre. The total revenue generated by the production of sugar cane in the year accounts for Rs. 56025.85 and the net benefits received accounts for Rs. 34265.47.

Furthermore, the total cost on sugar cane in five years accounts for Rs. 111392.43 per acre. The total production per acre is about 2563.74 maunds. The total revenues generated by total production in five-years are Rs. 372237.61 per acre and the net benefits received are Rs. 260845.18.

In the agroforestry farming system, the farmers planted the trees on the border of farmland. In most of the farmers plant the trees for cash. Almost all the farmers planted

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the poplar because of its rapid growth. In the current study, agroforestry practice farmers holding a land of 2233.5 acres and planted 27380 poplar trees on the border of farms. The detailed enterprise budgeting is given in Table 6.

Table 1.5: ***Enterprise Budgeting of Poplar***

	1st year	2nd year	3rd year	4th year	5th year
Number of trees	27380	27380	27380	27380	20075
Total cost in Rs.	649728	206948.22	383279.82	463955.88	374760.48
Per tree cost in Rs.	23.73	7.56	14.00	16.95	18.67
Fuel wood (maunds)	--	--	--	1655.00	7485
Price of fuel wood	--	--	--	131.60	121.69
Timber wood (maunds)	--	--	--	17930	68915
Price of timber wood	--	--	--	258.81	239.32
Total Revenues	--	--	--	4858261.30	17403587
Per Tree revenues	--	--	--	665.06	866.93
Total net Benefits	--	--	--	4403598.10	17028787
Per tree net benefits	--	--	--	602.82	848.26

Source: *Estimation from survey data (2016)*

The poplar trees are rotated at different rotation periods; some farmers rotate the trees at four years while some rotate it on five years period. The current study discounted all the values for year (the survey data start from fiscal year 2010) The total cost in first year of plantation including the cost of trees accounts for Rs. 649728 for a total number of 27380 trees. The cost per tree account Rs. 23.73. In the second year, the total cost accounted for Rs. 206948.22 and per tree incurred a cost about Rs. 7.56. In the third year, the total cost incurred by 27380 trees accounts for Rs. 383279.82 and per tree cost is about Rs. 14. In fourth year the total cost incurred is about Rs. 463955.88 while the per tree consumes about Rs. 16.95. In the fourth year, around 16 farmers rotated the total number of 7305

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poplar trees. The total production of fuel woods of 7305 trees accounts for 1655.00 maunds. The market price is about Rs. 180 which is equivalent to Rs. 131.60 in base year. The total number of trees 7305 produces timer wood of 17930 maunds after four years. The discounted price of timber wood accounts for Rs. 258.81. The total revenues generated by 7305 poplar trees are about Rs. 4858261.30 and per tree revenue accounts for Rs. 665.06. The net benefits received from 7305 trees are equal to Rs. 4403598.10 and per tree net benefits account for Rs. 602.82.

In the fifth year, the total cost incurred for 20075 trees accounts for Rs. 374760.48 and per tree costs about Rs. 18.67. The total trees produce fuel wood about 7485 maunds and timber wood about 68915 maunds. The price of fuel wood is around Rs. 121.69 and timber wood Rs. 239.32. the total revenues generated by both accounts for Rs. 17403587 while per tree generates around Rs. 866.93. The net benefits received from 20075 number of trees are around Rs. 17028787 and per tree net benefits received accounts for Rs. 848.26.

Furthermore, we compare the net benefits received from both farming systems. the agroforestry practicing farmers are holding a total of 233.5 acres of land. the farmers did devote a separate piece of land to the poplar, they planted the trees on the borders. Therefore, it is difficult to determine how much land is occupied by the trees. Hence, we estimate the net benefits received from a total land of 233.5 acres of land for both farming systems and made a comparison. The detailed comparison is given as in the following Table 7.

Table 7: ***Comparison of Traditional and Agroforestry***

	Traditional Farming	**Agroforestry**
Per acre net benefits (wheat) in Rs.	52115.09	50999.06
Per acre net benefits (sugar cane) in Rs.	260845.18	187579.13

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Net benefits from 233.5 Acres (wheat) in Rs	12168874	11908281
Net benefits from 233.5 Acres (sugar cane) in Rs.	60907350	43799727
Net benefits from tress in Rs.	--	21432385.1
Total benefits in Rs.	73076224	77140392

Source: *Estimations from survey data (2016)*

The study estimated the total net benefits received from 233.5 acres of land for both farming systems. The total net benefits received from both crops in the traditional farming system accounts for Rs. 73076224. On the other hand, the total net benefits received from agroforestry account for Rs. 77140392. The total net benefits of agroforestry include the benefits received from trees which account for Rs. 21432385.1. the agroforestry practicing farmers are receiving about Rs. 4064169 as compared to traditional farming for same land size of 233.5 acres of land.

The study used the data from the survey and estimate the enterprise budgets of each crops for both farming systems. The following table 8 presents statistics from the survey data on both crops (wheat and sugar cane) for both farming system (traditional and agroforestry). Table 9 presents the break-even points of single enterprise for output price per maund, yield per acre, variable cost per acre, fixed cost per acre, and total cost per acre of wheat and sugar cane for both farming system (traditional and agroforestry).

TABLE 8: ***Statistics of Wheat and Sugar***

	Traditional Farming		**Agroforestry**	
	Wheat	**Sugar Cane**	**Wheat**	**Sugar cane**
Harvested Land (acres)	172.25	172.25	233.5	233.5

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Output per acre in maunds	85.22	2567.46	82.07	2064.99
Output price per maund in Rs.	1383	180	1383	180
Variable Cost per acre Rs.	35404.18	100385.1	25831.98	101012.30
Fixed Cost Per acre in Rs.	13001.74	29681.53	12730.98	32195.89
Total cost per acre in Rs.	48406	130066	38562.96	133208.18
Returns above total cost per acre in Rs.	82455.08	361757.7	100771.83	342016.67
Returns above variable cost per acre Rs.	104857.52	432461.27	87670.83	271313.10
Returns above fixed cost per acre in Rs.	69453.26	332076.8	74939.85	241632.20

Source: *Estimation from the survey data (2016)*

Table 8 presents the data from enterprise budgeting of the data; the total area cultivated by 62 farmers is 172.25 acres. In traditional farming system, total yields per acre account for 85.22 and 2567.46 maunds of wheat and sugar cane respectively. Per maund market prices wheat and sugar cane account for Rs. 1383 and Rs. 180 respectively. Total costs of wheat and sugar cane per acre are Rs. 48406 and Rs. 130066 respectively. The net returns above the total costs received from wheat and sugar cane are Rs. 69453.26 and Rs. 322238 respectively. We consider the seeds, machinery and equipment's as fixed and the cost on that is a fixed cost, the fixed cost did not include the rent or any other cost of the land. The fixed costs per acre in traditional farming system account for Rs. 13001.74 and Rs. 29681.53 respectively. The variable per acre costs are Rs. 35404.18 and Rs. 100385.1 for wheat and sugar cane respectively.

In agroforestry practice, the total land under cultivation of sugar cane and wheat is 233.5 acres along with poplar on boarders. The total yields per acre of wheat and sugar cane are 82.07 and 2064.99 maunds respectively. The market prices of wheat and sugar cane are the same; Rs. 1383 and Rs. 180 for wheat and sugar cane respectively. The variable costs incurred for wheat and sugar cane are Rs. 25831.98 and Rs. 101012.30 per acre

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respectively. Fixed cost incurred on wheat is Rs. 12730.98 per acre while the fixed cost per acre of sugar cane accounts for Rs. 32195.89. Total cost on wheat per acre accounts Rs. 38562.96, while it accounts Rs. 133208.18 for sugar cane. The returns above the variable cost, fixed cost and total cost are also estimated and presented in the same table.

Table 9: ***Single Enterprise Breakeven Analysis***

	Traditional Farming		**Agroforestry**	
	Wheat	**Sugar Cane**	**Wheat**	**Sugar cane**
Output prices (Rs/50kg)	1230.33 (-11.04)	129.340 (-28.14)	1227.87 (-11.21)	164.41 (-8.66)
Yield per acre (50kg bag)	95.79 (-11.04)	3573.07 (-28.14)	92.44 (-11.21)	2260.82 (-8.66)
Variable cost (Rs. /Acre)	46100.46 (30.21)	381779.10 (280.31)	40171.32 (55.51005)	136261.4 (34.89)
Fixed cost (Rs. /Acre)	27626.10 (112.48)	311075.53 (948.04)	27070.32 (112.63)	67444.99 (109.4832)
Total cost (Rs. /Acre)	50028.54 (3.35)	411460.63 (216.34)	52902.30 (37.18)	168457.3 (26.46)

Note: *The values in parentheses show percentage change from the budgeted level.*

Table 9 presents the single enterprise breakeven analysis. In the traditional farming system, the breakeven price for wheat is approximately Rs. 1230 which is approximately 11.04 percent less than the existing market price, while the breakeven output price of sugar cane is Rs.129.34, which is approximately 28 percent less than the market price. The breakeven analysis of output prices per maund and yields per acre of both crops showed that even if the market price decreases up to the breakeven prices the crop will generate positive returns above the total cost. On the other hand, sugar cane is more favorable in the traditional farming system as compared to wheat; because of the fact it

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can withstand in a risky and highly unpredictable environment of the market (as the percentage decrease in price is more than that of wheat). Breakeven analysis of return above total cost indicate that wheat crop is more profitable crop as compared to sugar; where the percentage deviation of total cost from budgeted level of wheat is 3.35% while for sugar cane it is 216.34%. on the other hand, the breakeven analysis of return above the variable cost and fixed indicate that wheat crop is more profitable as the percentage increase in variable and fixed cost of wheat crop is less than sugar cane crop (see; table 1.8, the percentage increase in fixed cost and variable cost per acre of sugar cane is more than that of wheat).

In the agroforestry farming system, the breakeven price of wheat shows that if there is a decrease in the market price up to 11.21%, the crop will generate a non-negative revenue above the total cost. On the other hand, the breakeven price analysis of the sugar cane shows that if there is a decrease in market rice of the crop by 8.66% (from Rs. 180 to Rs.164.41), still it will generate positive revenues. breakeven analysis of returns above the total cost in agroforestry farming system showed that sugar cane is more profitable as the total cost per acre of wheat is approximately 37.2% as compared to sugar cane 26.5%. Breakeven analysis of variable cost and fixed cost also indicates that sugar cane is more profitable crop as compared to wheat crop (see; table 2, the percentage increase in fixed cost and variable cost per acre of wheat is more than that of sugar cane).

Supply Response Function

In this section, trans log profit function estimation results are presented, and the results are summarized in the table 10. In the table, results from estimation of the multiple-product profit function are presented. The results are obtained by applying seemingly unrelated regression (SUR) method. The marginal effects are estimated with respect to input prices and output prices. Specifically, we incorporated input prices including labor wage per day, DAP price per 50 kg bag, urea price per 50 kg bag, manure price per

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tractor container (Trali), site preparation price per hour, capital price per hour, and other input prices. The current study specifies four different profit functions for wheat, sugar cane, hay and poplar.

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Variables	Wheat	Sugar Cane	Hay	Poplar	dy/dx (wheat)	dy/dx (sugar cane)	dy/dx (Hay)	dy/dx (Poplar)
Output Price/maund	0.47*** (0.13)	0.208 (0.589)	0.020*** (0.001)	0.501*** (0.168)	0.051*** (0.010)	0.192 (0690)	0.104*** (0.003)	0.423** (0.177)
Labour wage/day	-0.062 (0.87)	-0.062 (0.87)	-0.034** (0.017)	0.060 (0.062)	-0.039 (0.076)	-0.056 (0.199)	-0.129 (0.102)	0.057 (0.064)
DAP price/50 kg	-0.005*** (0.002)	-0.005*** (0.002)	-- --	-0.006*** (0.001)	0.002 (0.001)	-0.021*** (0.004)	-- --	-0.003** (0.001)
Urea Price/50 kg	-0.154 (0.218)	-0.154 (0.217)	-- --	-0.060 (0.183)	-0.310 (0.205)	-0.390 (0.484)	-- --	-0.006 (0.190)
Manure Price/trali	-0.002 (0.002)	0.007 (0.005)	-- --	-- --	-0.003* (0.002)	0.005 (0.004)	-- --	-- --
Site preparation /hour price	-0.006*** (0.002)	-0.006*** (0.002)	-- --	-0.426** (0.192)	-0.027*** (0.004)	-0.129*** (0.018)	-- --	0.002 (0.002)
Capital rent/hour	-.011 (.013)	-0.010 (0.012)	-0.003 (0.002)	-- --	-0.067*** (0.012)	-0.089*** (0.027)	-0.085*** (0.018)	-- --
Other input prices	-0.005 (0.004)	-0.005 (0.004)	-- --	-- --	0.002 (0.004)	-0.011 (0.010)	-- --	-- --

Table 10: ***Multi-Output Trans log Profit Function Estimation Results and Marginal Effects***

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Constant	0.571 (0.672)	1.480 (1.350)	0.063* (0.039)	0.071 (0.502)	-- --	-- --	--	-- --
R^2	0.89	0.70	0.90	0.88	--	--	--	--

Note: *Where; ***, **, * are representing the significance level at 1%, 5% and 10% respectively. The values in parenthesis are the standard error.*

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The R-Square values of the regression results are quite decent, and the values are 0.89, 0.70, 0.90 and 0.88 for wheat, sugar cane, hay and poplar share respectively. The results showed that when there is a 1% increase in the output prices of wheat, sugar cane, hay and timber it will increase the profit by 5.1%, 19.2%, 10.4% and 42.3% respectively. The results of wheat and hay are significant at 1% while the marginal effect parameter of poplar is significant at 5%. However, the parameter of sugar cane is insignificant for output price.

The input price of labor is found to be insignificant for all output shares. DAP price per 50 kg bag decreases the profit of sugar cane share by 2.1% when there is an increase in the DAP prices by 1%. The increase in DAP price by 1% will decrease the profit of poplar by 0.3%. DAP price is found insignificant for wheat. Urea prices are also found insignificant, however, the increase in urea prices by 1% will decrease the profit share of wheat, sugar cane and poplar by 31%, 39% and 0.6% respectively. Manuring price per tractor container is found significant in wheat at 10% while it is insignificant in wheat profit function. An increase in the manure price by 1% will decrease the profit share of wheat and sugar cane by 0.3% and 0.5% respectively.

Capital input prices are found strongly significant in all three categories of outputs (wheat, sugar cane and hay) at 1%. The increase in capital price per hour will decrease the profit of wheat, sugar cane and hay by 6.7%, 8.9% and 8.5% respectively. other input prices in the profit function are found insignificant, however, in sugar cane the sign of the other input prices is consistent with economic theory; a 1% increase in the other input prices will decrease the profit from sugar cane by 1.1%. Furthermore, the current study estimates the supply response function for wheat, sugarcane, hay and poplar and the results are given in table 11;

Table 11: ***Supply Response Function***

Variable	**Elasticity with respect to output price**
Wheat	0.55* (0.01)
Sugar Cane	0.35 (2.65)
Hay	0.55* (0.01)
Poplar	0.20* (0.001)

Note: *Where; the standard errors are given in parenthesis and * stands for significance level at 1%.*

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The elasticities are in accordance with the basic economic theory as a 1% increase in the output prices of wheat will increase the production of wheat by 55% and it is statistically significant too. The study found that the sugarcane elasticity is insignificant with respect to output price. Hay production is associated with the production of wheat. The current study revealed that 1% increase in hay output prices will increase the production of hay by 55%. On average, the farmers rotate the poplar tree after 5 years. Finally, the current study found that an increase in timber prices by 1% will increase the production of timber wood by 20 % and it is significant too.

Conclusions and Recommendations

The primary objectives of the study were to identify the factors affecting agroforestry in Takht Bhai and measure its intensity. The study used the data from the survey, which included 138 observations. The data was collected through a well-structured questionnaire. Majority of the farmers grew two crops in the study area. Out of a total of 138 farmers, 76 farmers had adopted agroforestry and had grown poplar in their fields on boarders. The study first presented the enterprise budgeting of two main crops: sugar cane and wheat followed by enterprise budgeting of poplar. The cost benefit analysis found that agroforestry adopters received higher revenues from fields as compared to traditional farmers. For achieving the first objective of the study we found that age of the farmer (AG), farming experience (EXP) income from other sources (IN), total land in acres (TL), total expenditures in five years (E) and total revenues received were significantly affecting the agroforestry adoption in the study area. Third we estimated the intensity of the agroforestry by using the Tobit model by decomposing the results in total change and specific change by an explanatory variable in the dependent variable. Furthermore, the intensity of agroforestry adoption was estimated.

The intensity of adoption revealed that income from other sources negatively affected the adoption of agroforestry in the locality. Age in years, education, total land in acres, revenues received from farming positively contributed in the adoption of agroforestry and the respective adoption intensities were found to be 78 %, 1 %, 2 % and 43 %. Experience is considered one of the essential components of the agricultural production sector. However, in the present study, the sign of experience in years variable in Tobit regression is negative. Family size farmers did not contribute in the agroforestry adoption as the intensity probability was found to be zero. Finally, elasticities were estimated by estimating a multiproduct production function.

It can be concluded that agroforestry provides extra revenue compared to traditional farming systems. The age of farmers, education, family size, income from other sources, total farm land,

expenditures and revenues received are significantly affecting the agroforestry and its intensity in the Tahsil Takht Bhai.

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