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CAN AGRICULTURAL SERVICES PROVIDERS (ASPS) PLAY ROLE FOR ENHANCING WHEAT PRODUCTIVITY? A CASE STUDY OF DISTRICT SARGODHA

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Agriculture supports a large proportion of rural people working either as farmers, casual laborers, traders or hire service suppliers. The agricultural services such as land preparation, drill sowing, transportation, harvesting, threshing and credit provision play a vibrant role in farm production. This study attempts to investigate the role of Agricultural Services Providers (ASPs) for increasing the productivity of crops in district Sargodha. The previous literature highly lacks the quantitative assessment of role of ASPs in the growth of agriculture. We used field survey data and the secondary data obtained from government sources. Generalized power production function was used to quantify the impact of agricultural services provided by ASPs to the farmers. Research findings revealed that ASPs have significant impact on wheat productivity. They can significantly improve the agricultural production by providing the quality farm services on judicious prices. Government must focus on strengthening the system of agricultural services provision for the growth and sustainability of agriculture sector. The farmers-ASPs cooperation should be encouraged among the community.
Keywords: Agricultural services, generalized power production function, productivity, crops.

INTRODUCTION

Agriculture is the mainstay of the economy of Pakistan since it contributes 18.5 percent in the GDP and endows 38.5 percent of labor force with employment. Agriculture sector experienced a small growth of 0.85 percent in 2018-19 as compared to 3.94 percent in the last year. The subdued growth rate in current year owes to the insufficient availability of water to the crops and high vulnerability of agriculture sector to damaging climate and weather variations (GOP, 2019). Agricultural farming serves as buttress for a large proportion of rural people working either as farmers, casual laborers, traders or hire service suppliers. Agricultural sector of Pakistan is operating far below its potential level despite the fact that Pakistan is an agrarian economy. The provision of quality agricultural services to the farmers is a key factor for the growth of agriculture sector of an economy. Sims and Kienzle (2006) reported that the provision of agricultural services such as land operations, modern farming guides, credit facilities, infrastructure and agriculture research facilities are required to overcome the problems of agriculture sector.

Efficiency and quality of agricultural services provision depend upon the level of education, knowledge, skills and experience attained by both of the agricultural services providers and gainers. ASPs include the people who provide the services of spraying, transportation, field work, ploughing, land leveling, drill sowing, harvesting, threshing, credit provision and many others. Agricultural services are also rendered through the farmers themselves who buy the farm implements after seeking the potential demand for farm services (Shetto *et al.,* 1999). These rental services are financially affordable and economical to the neighboring small and medium farmers (Sims and Kienzle, 2009; Rottger *et al.,* 2011). Farm power, that includes human efforts, animal traction, engine driven technologies and other implements, is usually supplied to the farmers through private entrepreneurs in developing countries (Sambrook, 2005).

In the present age, manual labor for agriculture sector is becoming extremely scarce due to some socioeconomic factors. Developed economies have managed the problem of labor shortage through adopting the farm mechanization at large scale. With the escalating demand for agricultural services in the context of farm power, the better management and timely availability of the farm implements is crucial for better crop productivity. To cope with the current demand of farm mechanization, it is imperative to use the existing farm mechanizing resources more efficiently. According to the official statistics, there were 45910 tractors, 17158 threshers, 2869 harvesters, 658 cutters, 40139 sprayers and 7737 sowing

Table 1. Number of agriculture machinery in Punjab and Sargodha division.

Implements	Tractors	Threshers	Harvesters	Cutters	Sprayers	Drills	Total
Punjab	456458	143133	37818	4077	684160	121131	1446777
Sargodha Div.	45910	17158	2869	658	40139	7737	114471
Sargodha	20644	6488	637	6	7937	957	36669
Khushab	6201	2044	118	18	1676	2962	13019
Mianwali	7461	2673	878	538	4761	1800	18111
Bhakkar	11604	5953	1236	96	25765	2018	46672

Source: (Punjab Development Statistics, 2014)

drills in Sargodha division during the year 2013-14. These implements are owned by the farmers as well as ASPs. Most of the large farmers use their own machinery on their lands. However, some small and medium farmers, in addition to their own farming, also provide the rental agricultural services like ploughing, planking, leveling, harvesting and threshing etc. The statistics of farm machinery are yet not updated officially. Table 1 represents the distribution of agricultural implements in Punjab during 2013-14.

Rental service enterprises offer numerous services in the favor of small farmers to raise their farm incomes. Provision of agricultural services to the farmers lead to the reduction in production cost thereby rising income of both the farmers and the ASPs. This study analyzes the impact of ASPs on the productivity of wheat crop in Sargodha district of Punjab. Wheat is the staple food of Pakistan. It occupies the largest acreage and production over all other crops in Pakistan. Wheat productivity can be enhanced by following the appropriate production technology which includes the field operations from land preparation till the harvesting and threshing of crop (Hussain *et al.,* 2017). These field operations are closely related to the role of ASPs in agriculture. To follow the appropriate production technology, the cooperation among the ASPs and farmers is very important. The previous literature highly lacks the quantitative assessment of role of ASPs in the growth of agriculture. Therefore, the present study significantly contributes to the existing literature regarding the role of ASPs. It also needs further exploration, especially in developing countries.

The objectives of this study are: 1) to study the socio-economic characteristics of respondents, 2) to study the role of ASPs for enhancing the productivity of wheat crop, and 3) to suggest appropriate policy measures regarding the present system of agricultural services provision. The second section deals with data, variables and methods followed by the third section of results and discussion. The forth section concludes the paper.

MATERIALS AND METHODS

The study area was Sargodha district. Wheat is a major crop grown on large scale in district Sargodha. Random sampling technique was used for the selection of sample. The data were collected from 150 respondents through personal contact and interview using a comprehensive questionnaire. Out of 150 respondents, 100 were the farmers who were gaining the agricultural services and 50 were ASPs who were providing agricultural services. To make necessary corrections and modifications, the developed questionnaire was pre-tested before collecting the required information from study area. R-Software (v. 3.5.1) was used for data analysis.

The impact of farm services provided by ASPs has been quantified by using Generalized Power Production Function (GPPF) which was proposed by de Janvry in 1972. GPPF is a modified form of Cobb Douglas production function (Salam, 1981; Gujarati, 2009; Debertin, 2012). The GPPF included a dependent variable and three predictors in natural logarithmic form whereas the other nine predictors in simple form without log-transformation. In general form, the model can be written as:

$$Y_i = \beta_0 X_i^{f(x_{i,\dots,n})} e^{g(x_{i,\dots,n})}\mu \qquad (1)$$

Where, Y_i is the wheat productivity which is the dependent variable, X_i is the set of predictor variables, and e is the exponent (base of natural log). f and g are the functions of inputs. In our case,

$$f = \beta_i|_{i=1,2,3} \quad \text{and} \quad g = \beta_j|_{j=4,5,6,\dots,12}$$

The above model in specific form is,

$$\begin{aligned} ln\, Y_i = {} & ln\, \beta_0 + \beta_1 ln\, X_1 + \beta_2 ln\, X_2 + \beta_3 ln\, X_3 + \beta_4 X_4 \\ & + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 \\ & + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} \\ & + \varepsilon \qquad (2) \end{aligned}$$

Where the ε is the natural log of μ that is the residual term in our model.

In this model, we used the data of only those farmers who gained one or more agricultural services from ASPs in study area. The farmers who owned tractors but still gained at least one farm service on rent or took implements on rent were also included in model to assess the impact of tractor ownership. Furthermore, it is clear from the equation that dependent variable and first three predictors have natural log forms and the rest of predictors are in simple form. It is because, some predictor vectors from X_4 to X_{12} may have some zeros and the log of zero is a negative infinity which renders the regression process indeterminate. Moreover, some of these variables are at the nominal scale which do not require the log-transformation. For example, number of ploughings is always

a non-negative integer which may possess zero values. Therefore, these predictors are included in their original forms in the model. The variables' description is given in Table 2.

Table 2. Endogenous Variables Included in Production Function.

Variables	(Units)
X1 = Area under wheat crop	Hectare
X2 = Fertilizer cost	PKR/ha
X3 = Chemical cost	PKR/ha
X4 = No. of ploughings done by ASPs	Numbers
X5 = No. of rotavator & disc ploughing done by ASPs	Numbers
X6 = No. of tube well irrigations on rent	Numbers
X7 = No of farm implements timely available by ASPs	Numbers
X8 = Implements repairing workshops in vicinity	Numbers
X9 = Tractor Ownership (Dummy)	Yes="1" , No= "0"
X10 = Loanee (Dummy)	Yes="1" , No= "0"
X11 = Harvesting method (Dummy)	Manual= "0", Machinery= "1"
X12 = Sowing method (Drill/Manual)	Manual= "0", Drill= "1"

The variables X_4 to X_{12} in the above table implicitly represent the role of ASPs in wheat productivity. X_9 variable shows whether the respondent farmer owns the tractor or not. If one owns a tractor (and implements), he/she will not be considered a service gainer. X_{11} and X_{12} variables show whether the harvesting and sowing are done through manual labor or through farm machinery and in this way, we can compare the wheat productivity of labor and farm machinery. The data collected through interview schedule mostly depend on farmers' will and memory, so the response might somewhat differ from the reality. The results thus reported in this study might be subject to these limitations. The regression coefficients were compared through t-test (Paternoster *et al.,* 1998), whereas the equality of variances was checked through Levene's test (Gastwirth *et al.,* 2009).

RESULTS AND DISCUSSIONS

This section interprets the results and tabulates the data collected from respondents. It includes the descriptive statistics of respondents, production technology of wheat crop in study area, the role of ASPs in wheat productivity and GPPF results and discussion.

Descriptive Statistics: The descriptive statistics tool generates a report of univariate statistics for data and provides information about the central tendency and variability of the data. We have classified the respondents into two groups; the wheat farmers and the ASPs. Based on socioeconomic characteristics, the data are summarized numerically in the Table 3 which shows that the difference in age is positive and significant indicating that the farmers are more aged than the ASPs on an average. The average education levels of farmers and ASPs are 8 and 9 schooling years, respectively. The difference of education level between farmers and ASPs is insignificant. Farmers have smaller average family size than ASPs, but the difference is insignificant. There is positive and significant difference in farming experience indicating that farmers are twice experienced in farming as compared to ASPs. The difference in the size of land holdings is positive and significant, indicating that mostly the ASPs have small land holdings. The results also indicate that the education has a positive impact on adoption of side-business together with farming as ASPs were relatively more educated, on an average. The educated farmers tend to be more innovative and efficient (Fakoya et al., 2007). The difference in income is negative that shows that the ASPs earn more than the farmers on an average. Here, agricultural income and income earned by provision of agricultural services are considered for farmers and ASPs, respectively.

Table 3. Summary of socioeconomic characteristics of farmers and ASPs.

Characteristics (average)	Farmers	ASPs	t-value
Age (years)	45	40	2.26*
Education (years)	8	9	-1.06
Family Size (nos.)	8	10	-1.47
Farming Experience (years)	24	11	7.91**
Size of Land Holding (ha)	3.24	2	0.02*
Income Per Year (PKR)	341286	367880	-0.53

Source: Author's own calculations

Use of Farms Inputs in Wheat Production: Farm inputs include land preparation, seed, fertilizers and chemicals and many others. Major inputs of our interest are shown in Table 4. Appropriate number of ploughings, seed rate, fertilizer and chemicals can increase the wheat productivity.

Table 4. Inputs used per hectare of wheat crop in Sargodha district.

Inputs	Quantity used	Quantity Recommended
Seed Rate (kg)	128.29	100-125
No. of Ploughs	5.83	4-5
DAP (No. of bags)	1.88	3.70
Urea (No. of bags)	3.56	5

Source: Author's own calculations

The recommended quantity of Urea is 5 bags and DAP is 3.7 bags per hectare in wheat crop for medium type of soil (Anwar *et al.,* 2016). Similarly, the recommended seed rate for wheat is 100 to 125 kg per hectare (Abbas *et al.,* 2005). The table shows average amounts of seed rate, number of ploughings and fertilizer used for wheat crop in the study area. Obviously the seed rate and land operations for wheat production in study area are at appropriate level. But the

fertilizer application is very low as compared to the recommended level. This is due to less purchasing power of the farmers. That is also a reason behind the low productivity of wheat crop than the potential level.

Comparison of Wheat Productivity under the Provision of Different Farm Services: Table 5 portrays the comparison of wheat yields for the farmers gaining more agricultural services with those who are gaining less services. We have classified the farmers in two groups with respect to each agricultural service gained from ASPs. The cultivator services up to 3 number of ploughings are classified as "less services gained", and "more services gained" otherwise. More than one rotavator and deep ploughing services are classified as "more services gained". The farmers who sowed uncertified wheat varieties and used broadcast method of sowing are considered as "no service gainers". The means are compared by simple t-test. The results show that the farmers gaining more services of cultivator, rotavator and deep ploughings from ASPs obtained significantly higher yields as compared to their counterparts gaining fewer services. Similarly, the use of certified wheat seed and drill sowing method yielded significantly higher than the conventional broadcast sowing method and uncertified wheat seed.

The implications of agricultural services indirectly show the role of ASPs for enhancing the productivity of wheat crop. The farmers can gain more agricultural services and hence the higher crop yield, if ASPs provide the timely and quality farm services at farms. The service convenience is a very important factor determining the number of services gained by the farmers. Many farmers showed grievances about the lack of cooperation by the ASPs regarding the prices, quality and timely availability of agricultural services. In certain areas, ASPs have the monopoly over the rents of farm services and they charge higher prices than the market rates.

Table 5. Wheat productivity under the provision of different farm services by ASPs.

Agricultural Services	Wheat Yield (kg/ha)	Yield Difference (kg/ha)	t-value
Cultivator up to 3	3072.94	703.74	5.74***
Cultivator > 3	3776.68		
Rotavator ploughings up to 1	3327.94	548.56	3.64***
Rotavator ploughings >1	3876.50		
Deep ploughings up to 1	3971.39	571.30	3.87***
Deep ploughings >1	4542.69		
Broadcast sowing	3740.11	111.69	0.55
Drill sowing	3851.79		
Seed uncertified	3516.73	269.83	1.75*
Seed certified	3786.56		

Source: Author's own calculations

Impact of Agricultural Services on Wheat Productivity: The impact of farm services rendered by ASPs has been quantified by using Generalized Power Production Function (GPPF). The regression results are presented in Table 6. The sign of the area under wheat crop was negative but insignificant. This inverse relation was due to the hazards of management and supervision for larger crop areas. The larger farms are generally difficult to manage. The results indicate that wheat yield increased significantly by use of more fertilizers, more number of ploughings, timely provision of farm services and owning a tractor. The farmers owning a tractor obtained higher yield per hectare than those who did not own, on an average. The appropriate use of chemicals, provision of loaning services by creditors and drill sowing of wheat also found productive. The negative sign of harvesting method of wheat shows that wheat harvesting by reaper or combined harvester had a negative effect on yield because the reaper or harvester causes the yield losses when the crop is flattened due to lodging. The wheat crop was lodged due to high rainfall and wind, in many areas in current year.

The findings of GPPF proved that the timely provision of appropriate farm services by ASPs including drill sowing, cultivator, rotavator and disc ploughing and loan services improved the wheat productivity in study area.

Table 6. Results of GPPF for wheat production.

Variable	Coeffi-cient	Standard Error	Level of Significance
Intercept	3.064	0.725	0.000***
Natural logarithm of Area Under Wheat (ha)	-0.037	0.022	0.105
Natural logarithm of Fertilizer cost (PKR)	0.031	0.007	0.000***
Natural logarithm of Chemical cost (PKR)	0.009	0.108	0.932
No. of Cultivations	0.027	0.009	0.002***
No. of Rota & Disc	0.050	0.021	0.023**
No. of Tube well Irrigations	-0.015	0.013	0.272
Timely Available Implements	0.035	0.014	0.013**
No. of Repairing Workshops	0.027	0.035	0.434
Tractor Ownership (Dummy)	0.047	0.028	0.061*
Loan Services (Dummy)	0.005	0.026	0.836
Harvesting Service (Dummy)	-0.034	0.047	0.470
Sowing Method (Drill/Broadcast)	0.029	0.043	0.502
F-Statistic	22.033		0.000***
Adjusted R^2	0.724		

Dependent variable: Natural log of productivity. Significance Codes: '***'=0.01 '**'=0.05 '*'= 0.1

Conclusions: The study infers that ASPs can improve the wheat productivity significantly by providing the quality and well-timed farm services on economical rates. It is economical especially for the small and medium farmers to hire the agricultural services from ASPs. The cooperation among farmers and ASPs can improve the productivity of wheat as well as the other crops. In addition, the timely

availability of agricultural services, appropriate use of fertilizers and chemicals are also important instruments for wheat production. It is recommended to establish the agricultural services providing units at union council level to ensure the timely availability of farm implements on economical rents. Developmental schemes or projects should be initiated to provide the tractors and necessary farm implements to ASPs and progressive farmers on easy installments. Government has taken steps to provide subsidies to ASPs and farmers during past two years, but still there is lack of easy access to these facilities for the target beneficiaries. As the majority of farmers have small land holdings in Pakistan and they cannot buy their own farm machinery, therefore, the rents of agricultural services should be controlled and regularized by the government.

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