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IMPACT OF SOCIO-ECONOMIC FACTORS ON ADOPTION OF ADVANCED AGRICULTURAL TECHNIQUES: EVIDENCE FROM CENTRAL PUNJAB, PAKISTAN

Khizra Sarfraz [1], Maryam Nawaz [2], Shoaib Akhtar [3,*], Muhammad Haseeb Raza [4], Abdul Subhan [5] and Muhammad Asad ur Rehman Naseer [3]

[1] *Department of Economics, University of Lahore, Sargodha Campus, Sargodha, Pakistan*
[2] *School of Economics, BZU, Multan, Pakistan*
[3] *Department of Agriculture Business and Marketing, BZU, Multan, Pakistan*
[4] *Department of Agribusiness and Applied Economics, MNS University of Agriculture, Multan, Pakistan*
[5] *Pakistan Institute of Development Economics (PIDE), Islamabad, Pakistan*

ABSTRACT

The biggest way in which technology proved to be beneficial for improving the farmer's lives, is by providing information about access in the market, and in that way, it reduced the exploitation of farmers. Farming approaches and techniques go through different advancements and a lot of changes within the past century. The objective of the study was to find the impact of socio-economic factors affecting the adoption of advanced agricultural techniques. For estimation purposes, Sargodha District was chosen and for collecting data a survey was conducted, the well-organized questionnaire was distributed among 6 Tehsils from the district Sargodha to 200 farmers. The study used an econometric model of OLS. The results obtained from this study show the positive association of the socio-economic characteristics of farmers with the adoption of advanced technology. The variables of land holding, family members engaged in farming, family system, education, and experience have positive impact. A dominant role should be played by the government and organization running for agricultural welfare in motivating and funding the research for agricultural technological advancement. The technology adoption process can be increased through education. A necessary sensitization process must be turned to facilitate change in traditional techniques.

Keywords: Adoption; Advanced agricultural technologies; Farmer's socio-economic characteristics.
** Email: shoaibakhtar@bzu.edu.pk*

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INTRODUCTION

The foremost objective of the agriculture sector in Pakistan focuses on providing suitable and necessary food and nutrition for the people of Pakistan as well as making way for people's earnings and becoming the source of value-added production. The sector grew by 0.85 percent on aggregate, much below the set goal (3.8%) earlier at the start of the year. Various reasons become the hurdle plunge in cultivated areas way of this low performance such as inadequate accessibility of water and slump in taking off fertilizer which leads toward plunge in cultivated portion (GOP, 2019). The kharif crop exhibited ups and downs in the production of various crops such as rice and maize production rose while cotton and sugarcane production declined. The rice output rises by 2.9 percent to 7.4 million tons and maize production by 6.0% to 7.2 million tons. The negative growth in cotton production is -6.9% to 9.2 million bales and -0.4% decline in sugarcane production to 66.8 million tons. The Rabi crop wheat showed positive growth by 2.5 percent to attain an increase of 24.9 million tons, this is also an important crop of Rabi. The performance of agriculture throughout 2019-20 remained incredible. Overall agriculture sector set down a remarkable growth of 2.7

percent significantly higher than the growth of last year (0.58 percent) achieved (GOP, 2020). The agricultural sector of Pakistan is considered to be the second largest sector of Pakistan, as well as generating approximately 19.5% of the Gross Domestic Product. According to the census, about 62% of the population live in rural areas and work in the agriculture sector to maintain their livelihood. Major crops like cotton, wheat, rice, maize, etc. contribute 23.8% in value-added in whole agriculture as well as 4.66% in GDP. The remaining minor and other crops participate/contribute 11.03% of whole agricultural value-added along with 2.15% of the gross domestic product (GOP, 2017).

According to Lapple et al. (2016), innovation in agriculture is categorized into two ways, one is Technological and the other is non-technological innovations. The first one (Technological innovation) is considered a completely new product used in the way of production like newly invented seeds, breeds, and manure. The second type of innovation called non-technological does not consist of product but it can be a fluctuation in human nature/behavior etc. (Schut et al., 2016).

Correspondingly the study explains the word adoption as making full use of an innovation as the finest course of action obtainable. This means that the intention behind the adoption of any innovation is encouraged by extensive research and a lot of effort of research across several types of disciplines, and several recognized technology adoption models and theories (Rogers & Shoemaker, 1971). Likewise, Gershon et al. (1985) enhanced technology is vital for economic growth and assumes even higher value in a farm setting where new technologies can improve yield, decrease risk, and contribute to improved outcomes in a series of other ways. Various hurdles acknowledged in the way of adopting advanced technology in agriculture narrated in literature are considered to be lack of reliable human capital, limited credit, insufficient information and transport obstacles, low tenure protection, lack of economies of scale and lack of balancing inputs. Skinner and Staiger (2005) showed that education and measures of individuals' social networks were the only predictors of adoption significant for all of four key technologies adopted by US farmers over the 20th century. Recent literature found that education improves learning (information processing), and increases the advanced technology adoption and the efficiency of their application (Andrew & Rosenzweig, 2010). But education itself may be endogenous if it is particularly sought in settings where returns to such skills are high. Indeed, Foster and Rosenzweig (1995) showed that returns to education are higher in areas where agricultural technologies are available for adoption and that demand for education increased where, due to the availability of new agricultural technology, returns to education had increased (an effect limited to land-owning households). This is consistent with the finding of many studies that, beyond basic numeracy, education is a statistically insignificant determinant of adoption decisions (Wallace, 2001). One non-traditional factor recently highlighted as important to agricultural adoption decisions is social learning (Conley & Udry, 2010). The crucial factors or variables required for the advanced farming development techniques concerned are improvement in water utilization sources, various new inputs and sophisticated change, and expert proficiency. A variety of studies explore incremental or positive development together to become the reason for profit in the agriculture sector in Pakistan (Kemal et al., 2002).

Agriculture is the main source in Pakistan's economy for revenue generation and absorption of the labor force and raising the chances of employment. This has been proven by experience that agriculture participation in the national economy also assists in sorting out the poor implementation problem of the economy (Ali, 2004). With the strength of development in economic transformation, rural advancement could be achieved. Through scientific knowledge, one can increase the value of agricultural yield because it creates advancement in agricultural activities. These are also useful for resolving problems related to suitable natural environmental needs. The studies recommend that those farmers who use agriculture technology solve their problems easily (Nomi et al., 2002). Correspondingly a study conducted by Arshadullah (2017) inspected the "impact of modern agricultural technology on farm productivity and cropping intensity after adoption of modern agricultural technology" and the outcome shows that advanced technology has a positive impact on the output of wheat over the long span of time. The policy

option presented by him is that the government should support poor farmers financially so that they can afford advanced equipment/ tools. Lack of innovation or advanced techniques is not a major concern and issue but the problem is the management of investment in research and learning related to the usage of machines. The study also added that the resolution in advancements also contains social impacts that are the way to use various controls for significant utilization of it (Russell et al., 2010). Further investigation related to advanced technology and agriculture production "a study of adoption technology" verified the part of advanced technology in Murid district Chakwal. This study explores the replacement of traditional technology with modern technology by using the qualitative way and the sample size used was 200 farmers. The results depict that quicker adopters of technology gained the most benefits as compared with later and find out the proficient utilization of it through evaluation processes (Imtiaz et al., 2015).

literature (Feder et al.,1985) explores the determinants of technology adoption, together with the intellectual capability to accurately evaluate payoffs from various options/ways, provide accessibility to information/knowledge, and possibly implicit insurance (Conley & Udry, 2010). Recently in Pakistan agriculture growth has been slowed down due to the dissimilarity between real and potential/capable field yield (Elahi et al., 2018). According to Tambo and Wünscher (2018), the Gap between the yields can be removed by participation in sustainable land usage and economic and agricultural growth. Both economic and agricultural growth will provide a source to get rid of it. There are different resources for agricultural production; technology is mentionable in one of them. Ingold (2002) stated that Technology definitions are widely different and it revolves around the idea of whether it covers the whole sector of human works including all societies around the world and during all epochs. Adoption of agricultural innovations has been an important factor affecting the welfare of farmers, the productivity of agriculture, and the economics of the food sector. This paper reviews the literature on technology adoption in agriculture with a focus on the role of uncertainty and learning. It examines the factors affecting adoption benefits for farmers and their linkages with the innovation process. It also discusses the welfare implications of innovation and adoption for farmers and consumers (Chavas & Nauges, 2020).

According to Rogers (1983), Technology is created in such ways that it produces certain desired results in relationships of cause and action. Hardware and software are two main components of technology. Hardware comprises tangible parts that assess technology (Chi et al., 2002). On the other hand, software is intangible parts that contain information and data. Mitcham (1978), "technology as process", includes an essential process which is generally known as making and using. Proficiency in the use of artifact' is a noticeable element while defining the term skill. Ingold (2002) elaborates that technique and technology are different from each other. The household ultimately decides whether the agricultural system uses technology and how to allocate resources to support it (Nkonya et al., 1980). The decision to use technology depends on the farmer's perception of technology. Farmers can obtain technology through technology transfer.

Similarly, Bruegel (2011) analyzed that "rapid/fast adaption of innovation has a positive effect on the increase in agricultural production, has assured the durable use of food and food safety of the agricultural land. Correspondingly, Senyolo et al. (2018) express that inadequate and derisory adoption of output-enhancing innovation well thought-out hurdle, especially in Pakistan. So, there is a great need to identify this problem and remove the obstacles in the way of the adoption of new technology. Likewise, Mirani and Memon (2011) investigate that in Pakistan the farmers are not getting new agriculture information on time which is also a reason for not adopting or negative adoption of innovation due to a lack of proper knowledge rapidly for the reason that of in order to asymmetries (Ndofor et al., 2015). According to Elahi et al. (2018), Farmers in Pakistan mostly rely on informal ways like traders in agriculture, input providers as well as consultative/advisory service because of their easy access and work. So, this will be considered as the main reason for not adopting advanced technologies according to him. Anjum and Rehman (2020) conducted a study on the Impact of microfinance on the socioeconomic status of farmers in District Dera Ismail Khan. Javed et al. (2023) conducted a study on the Impact of agricultural credit on farmer's income. Zhang and Wu (2018) analyzed that the final choice of adopting any innovation lies in the farmer's market association

with innovation and input providers for sustainable farm usage. According to him, both need to integrate for sustainable use of land. Similarly, Thierfelder et al. (2015) explores that the reason behind the less or minimum adoption in rural areas is fewer recourses which raises the need for sufficient recourses and necessitates standardized input. Impact of the social economic factors on the adoption of advanced agricultural technologies.

METHODOLOGY

Sampling and Data Collection

In the research methodology for attaining the research objectives, Sargodha District was selected as the study area due to various reasons such as being feasible for research and as well as suitable according to the nature of research because farming practices are taking place over here and well-known district for oranges production as well as wheat, rice, sugarcane, maize, etc in Pakistan. For the purpose of making this study accurate and robust, a well-structured and organized survey form is designed for data collection, consisting of a combination of questions that are close-ended. Random sampling technique is used for data collection and from 200 farmers data is collected because it is convenient in this current pandemic situation due to COVID-19. In Sargodha District, for the purpose of collecting data, a survey was conducted which was well organized and a questionnaire was distributed among 200 farmers.

Empirical Methodology

There could be a significant impact of the socio-economic characteristics of farmers on the adoption level of agricultural advanced techniques. These socio-economic characteristics of farmers are given below which will be used as independent variables in the analysis. In this model proposed model is a regression model.

The Ordinary Least Squares (OLS) regression equation for predicting the dependent variable, Adoption, based on the specified independent variables can be written in plain text as follows:

Adoption = β_0 + β_1 × Land Holding + β_2 × Family Member Engaged in Farming + β_3 × Marital Status + β_4 × Family System + β_5 × Off Farm Income + β_6 × Age + β_7 × Education + β_8 × Experience + β_9 × Family Member + β_{10} × Farm Labor + β_{11} × Family Expenses + β_{12} × Agriculture Asset + β_{13} × Tenural Status + ε

In this equation:

Adoption is the dependent variable representing the level of adoption.

β_0 is the intercept term.

β_1 to β_{13} are the coefficients associated with each independent variable.

ε is the error term, accounting for unobserved factors not included in the model.

Explanation of variables

Adoption: The dependent variable representing the level of adoption

Land Holding: The amount of land owned or held by the individual.

Family Member Engaged in Farming: The number of family members actively involved in farming activities.

Marital Status: A binary variable indicating whether the individual is married (1) or not married (0).

Family System: Another binary variable indicating the type of family system, Single (0) or joint (1).

Off Farm Income: The amount of income generated from sources other than farming.

Age: The age of the farmer.

Education: The level of education attained by the individual.

Experience: The number of years of experience in farming or a related field.

Family Member: The total number of family members.

Farm Labor: The amount of labor used on the farm.

Family Expenses: The total expenses incurred by the family.

Agriculture Asset: The value of assets related to agriculture.

Tenural Status: A binary variable indicating the tenural status, possibly whether the land is owned (1) or otherwise (0).

RESULTS AND DISCUSSION

For the purpose of making inferences from collected sample data for the adoption of agriculture technology. In this perspective, the socio-economic characteristics of farmers were observed to identify the reason behind the adoption of advanced agriculture technology. Adoption of drip irrigation by farmers is 4% on a high level and 73% of farmers are not adopting it as shown in Table 1.

Table 1. Adoption of advanced techniques among sampled respondents.

Adoption of Drip Irrigation	Adoption Level	Frequency	Percent
	No	146	73.0
	Low	23	11.5
	Medium	23	11.5
	High	8	4.0
Adoption of Tunnel Farming	No	173	86.5
	Low	6	3.0
	Medium	16	8.0
	High	5	2.5
Adoption of Organic Farming Techniques	No	56	28.0
	Low	117	58.5
	Medium	22	11.0
	High	5	2.5
Adoption of ICTs	No	121	60.5
	Low	68	34.0
	Medium	8	4.0
	High	3	1.5
Adoption of Strategies to Climate Change	No	134	67.0
	Low	60	30.0
	Medium	6	3.0
Adoption of Soil Conservation Techniques	No	32	16.0
	Low	139	69.5
	Medium	29	14.5
Adoption of IPM	No	87	43.5
	Low	77	38.5
	Medium	36	18.0
Adoption of Agricultural Credit Facilities	No	132	66.0
	Low	53	26.5
	Medium	5	2.5
	High	10	5.0

Adoption of tunnel farming is 2.5% on high level and 86.5% of farmers are not adopting it. Adoption of organic farming techniques is 2.5% on high level and 28% of farmers are not adopting it. Adoption of ICTS is 1.5% on high level and 60.5% of farmers are not adopting it. No one is adopting the strategies to climate

change on high level and 67% farmers are not adopting it while 3% of farmers are adopting it on medium level. Adoption of soil conservation techniques is 14.5 % on medium level and 16% of farmers are not adopting it. Farmers are not adopting soil conservation techniques at a high level. Adoption of integrated pest management techniques is 18% on medium level and 43.5% of farmers are not adopting it. Adoption of agricultural credit facilities is 5% on high level while 66% are not adopting it.

Table 2. Descriptive statistics of sampled respondents.

(Variables)	(N)	(Minimum)	(Maximum)	(Mean)	(Std. Deviation)
Adoption	200	1.00	6.00	3.5050	1.23597
Land Holding	200	5.00	50.00	11.0450	8.86997
Family Member Engaged in Farming	200	1.00	8.00	2.4350	1.54847
Marital Status	200	.00	1.00	.7600	.42815
Family System	200	.00	1.00	.7550	.43117
Off Farm Income	200	.00	63.00	23.8750	18.37081
Age	200	20.00	80.00	36.9900	11.84913
Education	200	4.00	16.00	10.0250	3.61799
Experience	200	2.00	50.00	15.7800	9.78521
Family Member	200	1.00	25.00	6.8550	3.21491
Farm Labor	200	.00	35.00	2.5600	3.60853
Family Expenses	200	10.00	200.00	41.9700	22.37324
Agriculture Asset	200	.00	2000.00	3.7597	381.57920
Tenural Status	200	.00	1.00	.6400	.48120

Table 2 shows that on average level of adoption of agriculture techniques is 3.5050, with a minimum 1.00 adoption level and a maximum 6.00 level of adoption. The average landholding of farmers is 11.04 acres. While the least landholding of a farmer is 5 acres and the utmost landholding is 50 acres with a standard deviation of 8.869. Family members engaged in farming on average 2.4350, with a minimum 1 and maximum 8 number of person and standard deviation is 1.5484. The variable marital status present that on average mean value is 0.7600 with a standard deviation of 0.42815 farmers is married. The family system shows that on average 0.755 with 0.43117 standard deviation farmers belong to joint family system. Mean value of off-farm income of farmers is 23.8750 rupees per month. While minimum off-farm income is zero (0) and utmost is 63 and standard deviation value is 18.37081. Average or mean age of the farmers is 36.99 years. On other side maximum age is 80 years and bottom value of age is 20 years with a standard deviation of 11.84913. An average year of education of farmer 10.02 years while higher or maximum years of education 16 years and minimum or least years of education of farmers is 4.

An average or mean year of experience of farmers 15.78 years, as well as maximum or utmost years of experience 50 years and bare minimum years of experience of farmers are 2 with standard deviation of 9.78521. Average family member is 6.8550 members or person in a household whereas least/minimum members are 1 and most/maximum 25 members or persons with standard deviation of 3.21491. The Mean of Farm labour is of value 2.56 number of person working in farm, with minimum 0 and maximum 35 number of labor, while standard deviation is 3.6085. The average of family expenses reveals that 41.97 farmers are thousand rupees per month, whereas maximum family expenses are 200 thousand rupees per month and minimum expenses are 10 thousand rupees in a month with standard deviation of 22.37324. Mean/average value of the agriculture assets of farmers is of value 3.7597E2 thousand rupees, with maximum 2000 thousand rupees with standard deviation value is 381.57920. Tenural status shows that

on average/mean value 0.6400 with standard deviation value 0.48120 farmers carry the status of owner. As shown in Table 3, data do not have multicollinearity issues because all values are less than ten.

Table 3. Co-linearity statistics of variables.

(Model)	(Tolerance)	(VIF)
Land Holding	.676	.676
Family Member Engaged	.571	.571
Marital Status	.738	.738
Family System	.704	.704
Off Farm Income	.727	.727
Age	.472	.472
Education	.690	.690
Experience	.510	.510
Family Member	.515	.515
Farm Labor	.851	.851
Family Expenses	.598	.598
Agriculture asset	.846	.846
Tenural Status	.672	.672

Table 4. Impact of the socio-economic variable on adoption level.

Model	Coefficient (B)	Std Error	T	Sig
(Constant)	1.739	.353	4.926	.000
Land Holding	.021	.008	2.427	.016
Family Member Engaged in Farming	.150	.053	2.835	.005
Marital Status	-.607	.168	-3.60	.000
Family System	.297	.171	1.737	.084
Off Farm Income	-.019	.004	-4.84	.000
Age	.007	.008	.947	.345
Education	.122	.021	5.921	.000
Experience	.023	.009	2.602	.010
Family Member	-.023	.027	-.867	.387
Farm Labor	.006	.019	.327	.744
Family Expenses	.001	.004	.311	.756
Agriculture Asset	.025	.000	2.501	.013
Tenural Status	-.082	.157	-.525	.600
R2	.534			
Adjusted r2	.502			
F value	16.411			

Table 4 shows that there exists a positive or incremental effect and significant impact of the size of land-holding on the adoption of advanced technologies. 0.21-unit increases will occur in the adoption of advanced technologies if landholding increases by one acre as proved by Olagunju and Salimonu (2010) suitable land utilization pattern and amplification of technology provide the chance for high enlargement in farm production and income of the farmer. There is a positive and significant impact on family members engaged in farming. One unit increase in family members engaged in agriculture determines the increase in the adoption of advanced technologies by 0.150 units. There is a negative and significant impact of marital status on the adoption of advanced technologies. One unit increase in marital status or (if a person is married), will decrease the adoption of advanced technologies by 0.607 units. There is a significant impact of the family system on adoption of advanced technologies also positively influence. One unit increase in the family system will increase the adoption of advanced technologies by 0.297 units.

The marital status of respondents exhibits a negative relation with the adoption of advanced technology but it significantly influences the dependent variable at 0.05 level of significance. These results are also similar to Ekong (2000) who proved in his study that the majority of farmers are married. There is a negative and significant impact of off-farm income on adoption of advanced technologies One thousand increases in off-farm income will decrease the adoption of advanced technologies by 0.19 units. There is also shown a significant effect of education on adoption of advanced technologies as well as a positive effect on education. One schooling year increase in the level of education will increase by 0.122 units.

There is a positive and insignificant impact of age on the adoption of advanced technologies. One year increase in age will increase the adoption of advanced technologies by 0.007 units. There is a negative and insignificant impact of family members on the adoption of advanced technologies. An increase of one unit increase in family members will reduce the adoption of advanced technologies via 0.023 units. There is a positive but insignificant impact of farm labor on the adoption of advanced technologies. One unit increase in farm labor will increase the adoption of advanced technologies by 0.006 units. One thousand increases in family expenses will increase the adoption of advanced technologies by 0.001 units. A positive and insignificant impact exists of family expenses on the adoption of advanced technologies. There is a negative and insignificant impact of tenure status on the adoption of advanced technologies. One unit raise in tenure status will diminish the adoption of advanced technologies by 0.082 units.

R square (R2) is the most often applied measurement scale for the aim of detecting goodness of fit in regression analysis or model, is also the coefficient of determination that provides us knowledge about how much variation or changes occur in independent variables due to explanatory variables. If all variable explains the dependent variable its value will be 1 and if no correlation is found in variables there will be zero value of R square. According to our depicted value in Table 4 its value is 0.53 which narrates that all the explanatory variables mutually express or explain 53% variation in the dependent variable which is the adoption of advanced agriculture technology. The coefficient of determination also explicates that 47% variation in the dependent variable is due to the variable not included in this model. The Adjusted R square value is a measurement adjusted for degree of freedom and 50% shows that the dependent variable is influenced fifty percent through the independent variable, keeping the remaining factor constant for time. The F ratio explores that is explanatory variable significantly brings change in the dependent variable, 16.41 ($p < 0.05$) explains that it is majorly significant for the appropriateness of the model.

CONCLUSIONS

The outcome obtained from this estimation shows that there exist some factors that encourage and discourage the adoption of advanced technology. The results obtained from this study show the positive association of the socio-economic characteristics of farmers with the adoption of advanced technology. The variables of land holding, family members engaged in farming, family system, education, and experience have positive impacts. Lack of knowledge is considered the core cause of not adoption of advanced technology and not change or increase in agricultural income. To improve the farming strategies farmers should need to get information so that the problem of not adopting agriculture techniques can be sorted.

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