Research Article

Influence of Farmers' Characteristics on Knowledge Gap of Recommended Sugarcane Production Technology in Khyber Pakhtunkhwa, Pakistan

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Abstract | This study was conducted in Mardan and Dera Ismail Khan (D.I. Khan) districts of Khyber Pakhtunkhwa province in Pakistan during 2018. The main objective of the study was to find the influences of farmers' characteristics on knowledge gap of sugarcane recommended production management practices in the research area. Data were collected personally through face to face interview schedule from 285 sample respondents randomly selected from eight villages of the eight selected union councils. The empirical results indicated that farmers of district Mardan had 41 percent knowledge gap with cane yield 58387 kgs/hectare and sample farmers of district Dera Ismail Khan had 33 percent knowledge gap with 82184 kgs/hectare. The results showed that in both districts sugarcane farmers had medium knowledge gap (37%) with cane yield 70912 kgs/hectare. Findings revealed that one-year improvement in the education level of the farmers would bring likely 58 percent decrease in the knowledge gap. Similarly, a year increase in the cane farming experience of the farmers would likely bring 6 percent reduction in the knowledge gap of the farmers. The results further explained that land owners had more knowledge gap than that of tenant farmers while contact with the agriculture extension department reduces the knowledge gap of sugarcane recommended management practices. The results further show that the coefficient value of knowledge gap of district Mardan farmers is high than the farmers of district D.I. Khan research area. The study suggested that government should provide proper education facilities to the farming community for reducing illiteracy. Agricultural extension department should provide training and special information about sugarcane recommended management practices in the research area.

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Introduction

Sugarcane is one of the main and high value cash crops in Pakistan that contributes 2.9 percent in agriculture value addition and 0.5 percent share in Gross Domestic Product (GoP, 2019). Sugar industry is the second largest agro based industry and involved more than 1.5 million people as labor directly or indirectly in this sector. Sugarcane is mostly grown for sugar and gur production in Pakistan. The main by-products of sugarcane are molasses (processed into ethanol) and bagasses that are largely used for

paper, particle boards manufacturing, animal feed and also utilized for in-house power generation (Khan and Deshmukh, 2015). Sugarcane green portion (tops) are used as fodder for livestock when other rabi fodders availability shrink significantly during winter months (Sharif et al., 1994).

Pakistan ranked 8th among the sugar producers and consumers while 5th in cane sugar producer and 7th largest white sugar net exporters in the cane producing countries (PSMA, 2018). Whereas 6th in term of area and production and 52nd in respect of per hectare cane yield among the sugarcane producing countries of the world (FAO, 2017).

In order to sustain the sugar demand for domestic and export purpose, sugarcane was grown on area 1.102 million hectares during 2018-19 as compared to last year 1.343 million hectares with 17.9 percent decreased as compared to previous year (GoP, 2019). Province wise comparison illustrates that Punjab is the most important province in respect of area, production and per hectare yield followed by Sindh and Khyber Pakhtunkhwa. Likewise, the sugarcane yield per hectare of Khyber Pakhtunkhwa province is very low as compared to Punjab and Sindh provinces (GoKP, 2019).

Pakistan is a low yielding country than potential yield in the list of sugarcane producing countries. Ahmad et al. (2012) identified that intercropping, high weed infestation, insect/pest management, low and irregular used of fertilizers were the main reasons for low yield in Pakistan. Zaidi et al. (2013) found that water shortages, soil salinity and low yielding varieties were the main constraints in sugarcane production. Nazir et al. (2013) reported that gap between the actual and potential yield is due to socioeconomic and technical constraints. Gurjar et al. (2017) revealed that sugarcane yield per hectare and sugar recovery cane be increased if the improved technologies are transferred to the farmers' field.

The findings of the above have vital importance in the literature. But, the studies in the area of farmers' socioeconomic impact on farmers' knowledge gap about sugarcane crop were limited in scope. Therefore, this study was carried out with objective to find the influence of farmers' characteristics on knowledge gap of recommended sugarcane management practices in the research area.

Materials and Methods

Selection of research sites and samples

Present study was conducted in Mardan and Dera Ismail (D.I. Khan) districts of Khyber Pakhtunkhwa during 2018. Multistage sampling techniques were used. Districts, tehsils and union councils were selected on the basis of maximum sugarcane area allocation and production, whereas villages were selected randomly in the research area. Overall eight villages were randomly selected from eight union councils in two tehsils of Mardan and Dera Ismail Khan districts as depicted in Table 1.

Table 1: *Distribution of sample sugarcane farmers by villages.*

Union councils	Villages	Total number of sugarcane farmers	Sampled sugarcane farmers
Tehsil Mardan (District Marda)			
Khazana Dheri	Shiekh Yousaf	140	40
Babeni	Char Banda	130	37
Maho	Bakri Banda	125	35
Kandar	Sharif Abad	80	23
All		475	135
Tehsil Paroa (District Dera Ismail Khan)			
Naivela	Jatta	150	42
Mahra	Mahra	170	48
Malana	Kat Shahani	65	18
Paroa	Paroa	150	42
All		535	150
Overall		1010	285

Source: *Agricultural Extension Department of Mardan and Dera Ismail Khan districts.*

Sample frame

A list of sugarcane farmers was obtained from Agricultural Extension Department of Mardan and Dera Ismail Khan districts of the total 1010 sugarcane farmers in the selected eight villages, 285 sample sugarcane farmers were selected through Sekaran (2003) sampling techniques and 28 percent of sample was drawn from the sugarcane farmers of each village by utilizing proportional allocation procedure as presented in Table 1. The proportional allocation technique also applied by Sajjad et al., 2012 and Ali et al., 2013.

$$ni = \frac{Ni}{N} \times n \quad ....(1.1)$$

Where;
n_i = Number of sampled sugarcane farmers in each village; N_i= Total number of sugarcane farmers in i^{th} village; N= Total population in the sampled villages; n= Total number of sugarcane farmers selected for the present study.

Data collection tools and procedures

This study was based on primary as well as secondary data. The primary data were directly collected from sugarcane farmers through a well pre-structured and pre-tested interview schedule and knowledge test designed in the light of the pre-set objectives. Primary data was collected from sugarcane farmers on their farms and secondary was collected from various sources including review of published research articles, agricultural statistics, economic survey of Pakistan and internet sources.

Statistical analysis

For measuring knowledge gap of sugarcane farmers, sugarcane production practice wise score was assigned such as 0= No Knowledge, 1= Partial Knowledge and 2=Full Knowledge in the knowledge test. Overall score of the thirty-one (31) questions were sixty-two (62) score and each question carried two (2) score. The difference between achievable score and achieved score showed the knowledge gap of the sugarcane farmers. The knowledge index was used to calculate the knowledge gap of the sample sugarcane farmers as used by Kundu et al., 2013; Tomar et al., 2012.

$$KGI = \frac{Kp - ko}{kp} \times 100 \quad \ldots.(1.2)$$

Where as;
KGI= Knowledge Gap Index; Kp= Maximum possible score of farmers; Ko= Obtained knowledge score by a farmer.

Multiple regression model

Multiple regression analysis was used to find the effect of independent variables such as age, education, farm size, farming experience, tenancy status, contact agriculture extension department and districts on the dependent variable (knowledge gap). Roy et al. (2013) also applied similar model:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 D_1 + \beta_6 D_2 + \beta_7 D_3 + \varepsilon \quad \ldots(1.3)$$

Whereas:
β_0, β_1, β_2, β_3, β_4, β_5, β_6, β_7, are parameters; Y (KG) = represents knowledge gap of the respondent; X_1 (Age) = age of the respondent in years; X_2 (Education)= respondent year of education; X_3 (Farm size) = farm size in acres operated by respondent; X_4 (Experience)= respondent sugarcane growing farming experience in years; D_1 (Tenancy Status) = 1 if the respondent is owner of the land, 0 otherwise; D_2 (Contact extension deptt.)= 1 if the respondent contact agriculture extension department, 0 otherwise; D_3 (Districts)= 1 if the district is in the central valley plains, 0 other wise; ε = random error or residual term.

Diagnostic tests

Econometric models are based on some assumptions. To make bold statements on causality from a regression hinges on the validity of the assumptions of the classical linear model. If the model satisfies those assumptions, then the results from the empirical model are valid. The basic assumptions of ordinary least squares (OLS) model include non existence of Multi-co-linearity among the explanatory variables and Homoscedasticity (constant variance). In order to examine whether the model/data employed for the analysis of the results of this research satisfy these assumptions need to apply diagnostic tests for detecting Multi-co-linearity and Hetroscedasticity.

Results and Discussion

Categorization of knowledge gap

Knowledge gap of the farmers is classified in to three scores i.e. low (above 43.57), medium (34.48-43.56) and high (up to 34.48) as presented in Table 2. Most of the farmers (64%) had medium knowledge gap (36%) with cane yield 81695 kgs per hectare, followed by 32% of the farmers were having low knowledge gap (26%) with cane yield 86281 kgs per hectare, while 4% of the farmers had high knowledge gap (49%) with cane yield 57238 kgs per hectare in district D.I. Khan. Majority (76.3%) of the farmers had medium knowledge gap (38%) with cane yield 59717 kgs per hectare, followed by 23% of the farmers were having high knowledge gap (48%) with cane yield 53460 kgs per hectare, while 0.7% of the farmer had low knowledge gap (27%) with cane yield 74100 kgs per hectare in district Mardan. The overall results indicated that the sample respondents of both districts had 37% knowledge gap in recommended sugarcane production technology. District-wise comparison of knowledge gap shows that sugarcane growers in district Mardan had 41% knowledge gap where district D.I. Khan farmers

had 33% knowledge gap in recommended cane production technology. The possible reason for low knowledge gap of the respondents might be due to more awareness regarding recommended sugarcane cultivation practices and more dependency on cane crop income. These results are in line with the findings of Pillegowda et al. (2010) who stated that 76% sugarcane farmers had medium knowledge, Jaiswal and Tiwari (2014) found that sugarcane growers had medium knowledge level. Kundu et al. (2013) reported that about two third (64.3%) respondents had medium to high knowledge gap in pulses production. Abura et al. (2013) observed that farmers had medium knowledge gap in land preparation, cane propagation and plant spacing. Sahu et al. (2010) said that 46.7% sample farmers had high level of knowledge about organic farming practices. Hun et al. (2017) stated that implementation of high technology level can increase the yields of sugarcane compared to low or medium technology. Sharif et al. (2014) found that adequate supply of water, optimal use of fertilizer and sensible use of pesticides can improve yield and reduce knowledge gap.

Table 2: *Categorization of knowledge gap of sugarcane growers.*

Knowledge Gap	Districts	Freq	KG (%)	Yield Kgs/ha
Low (Above 43.57 Score)	D.I. Khan	48(32)	26	86281
	Mardan	1(0.7)	27	74100
Medium (34.48-43.56 Score)	D.I. Khan	96(64)	36	81695
	Mardan	103(76.3)	38	59717
High (Up to 34.48 Score)	D.I. Khan	6(4)	49	57238
	Mardan	31(23)	48	53460
All	D.I. Khan	150	33	82184
	Mardan	135	41	58387
Overall		285	37	70912

Source: *Field Data, 2018 Obtainable Score:62 Mean: 39.19 S.D: 4.379 Figures in Parenthesis are percentages.*

Analytical tests

Econometric models contain various forms of tests based on some declarations. These models can be used to estimate the difference between the two or more groups. To make valiant statements on contributory from a regression turning point on the strength of the statements of the standard linear model, if the model satisfies these statements then the results from the experimental model are valid. These statements include nonexistence of multi-co-linearity among the descriptive variables, correlation matrix, regression and constant variance. With the aim of checkup, the data employed for the analysis of this research assure these statements need to apply analytical tests for identifying regression, multi-co-linearity, hetroscedasticity and correlation among the variables. The explanation can be seen in Tables 3, 4, 5, 6 and 7.

Table 3: *ANOVA test.*

Source	SS	Df	MS	Number of obs	=	285
		F (7, 277)	=	36.23		
Model	6771.695	7	967.385	Prob > F	=	0.000
Residual	7396.843	277	26.7034	R-squared	=	0.4779
		Adj R-squared	=	0.4647		
Total	14168.54	284	49.88922	Root MSE	=	5.1675

ANOVA test

Before obtaining final results, the data was checked for the existence of multi-co-linearity and Heteroscedasdicity. Results of the model show that model as a whole is statistically significant on the basis of F. test value which is clearly confirmed from the p-values (0.000) of the model. The value of R-squared are high for cross sectional data and show about 48 percent variations in the dependent variable (Knowledge Gap) has been explained by the independent variables i.e. Age, Education, Farm size, Experience, Tenancy status, Contact agriculture extension department and Districts D.I. Khan and Mardan (Table 3).

Regression model

A relationship can be established between knowledge gap and observed variables regarding Age (X1), Education (X2), Farm size (X3), Cane farming experience (X4), Tenancy status dummy (D1, 1= Owner of the land, 0= Otherwise), Contact agricultural extension department dummy (D2, 1= Contact agriculture extension department, 0= Otherwise) and Districts dummy (D3, 1=district Mardan,0= Otherwise). Results of the model explain that education (X2), farming experience (X4), tenancy status (D1), respondents contact agricultural extension department (D2) and district (D3) (locality of the farmers) significantly affect the knowledge gap of the farmers. On the other hand, age (X1) and operational land (X3) of the farmers has no effect on the knowledge gap of the farmers. Keeping the other variables constant, the

coefficients explain that one-year improvement in the education level of the farmers would bring likely 58 percent decrease in the knowledge gap. Similarly, a year increase in the cane farming experience of the farmers would likely bring 6 percent reduction in the knowledge gap of the farmers. It is astonishing to note that owner's farmers have more knowledge gap than that of tenant farmers while contact with the agriculture extension department reduce the knowledge gap about recommended farming practices of the farmers. The results further shows that the coefficient value of knowledge gap of district Mardan farmers is high than the farmers of district D.I. Khan (Table 4).

The reason behind the highly significance of formal education regarding their low knowledge gap might be that the farmers had more access to various recommended cane production technologies through various information media like printed, electronic media, more exposure visits, innovativeness, more exchange of ideas with farmers and other stakeholders. Similarly, overtime farmers' expertise in cane farming, more contact within the farming community, proper and judicious uses of resources and the ability to overcome the problems faced in farming might be the possible reasons behind the highly significance of farming experience that showed low knowledge gap. The effect of operational land is non-significant and the possible reasons may be the possession of small land holding in the research area and mostly living in joint family system due to large family size. The farmers required more income to meet their livelihood ends so they work off farm jobs because their requirement did not meet for the land they possessed and the farmers had no spare time to receive knowledge from the allied departments of agriculture. The age of the sample farmers is also non-significant because obtaining improved knowledge depend on the interest of farmers not on their age.

Using the dummy variable as 1= contact with Agricultural Extension Department; otherwise 0 showed that contact with agricultural extension department lower their knowledge gap in comparison with those that had no contact. The possible reasons might be that contacts with agricultural extension department help the growers to become aware from the recommended cane production technologies and their practical application on their farms. Similarly, the dummy variable of tenancy as 1=owner; otherwise 0 showed that the owner farmers had high knowledge gap regarding improved cane production technologies. The reason might be that the majority land owners were partly involved in sugarcane farming and mostly the farm operations were carried out by hired labors. Moreover, dummy variable for district (1 = Mardan, 0 = D.I. Khan) exhibited that the knowledge gap of the farmers belonging to district Mardan was high as compared to farmers of district D.I. Khan. The reason of minimum knowledge gap in district D.I. Khan might be due to cane focus farming, more resource allocation, more contact with allied departments of agriculture and sugar mills supported farming. Our findings are similar to Roy et al. (2013) who identified that education, farmers' categories and farmers' localities were significant while age and land holding were non significantly contributed in the reduction of knowledge gap of the farmers in recommended agricultural production technologies. Naik et al. (2009) reported that education, mass media and innovativeness had significant effect on the knowledge level of the farmers at 0.05 level of probability whereas age and land holding were found non-significant relationship. Hakeem and Dipak (2013) found that education, experience, sources of information utilization and exposure to extension methods were significantly contributed to farmers' knowledge about recommended agricultural technology while age was insignificant on this aspect. Pillegowda et al. (2010) stated that education and extension department contact significantly contributing for the knowledge level of cane growers.

Multi-co-linearity test

For indentifying Multi-co-linearity techniques of Variance-Covariance Matrix and Auxiliary regression are commonly applied. We used the technique of Multi-co-linearity and Correlation Matrix. According to this investigation each explanatory variables together with constant is regressed on all other explanatory variables. If the correlation coefficient is equal to or higher than 0.80 than exists Multi-co-linearity and collinearity in the data (Tahir et al., 2012). Our results reveal that the values of the correlation coefficients of all explanatory variables are below the bench mark value i.e.0.80, so we accept the hypothesis that there are no Multi-co-linearity issues exist within the explanatory variables (Tables 5 and 6).

Table 4: *Empirical results of regression model.*

Knowledge gap	Coef.	Std. Err.	T	P>t	[95% Conf.	Interval]
X_1 (Age)	0.031488	0.027788	1.13	0.258	-0.02321	0.08619
X_2 (Education)	-0.58262	0.065715	-8.87	0.000	-0.71199	-0.45326
X_3 (Land)	-0.01379	0.036823	-0.37	0.708	-0.08627	0.058704
X_4 (Experience)	-0.06412	0.031016	-2.07	0.04	-0.12517	-0.00306
D_1 (Tenancy)	2.640878	0.794264	3.32	0.001	1.077318	4.204439
D_2 (Extension)	-2.32609	0.970482	-2.4	0.017	-4.23655	-0.41564
D_3 (District)	7.017664	0.832155	8.43	0.000	5.379512	8.655815
Cons.	35.37063	1.52994	23.12	0.000	32.35885	38.38242

Table 5: *Multi-co-linearity test.*

e(V)	X_1	X_2	X_4	D_1	X_3	D_2	D_3	Constant
X_1	0.000772							
X_2	0.000538	0.004318						
X_4	-0.00047	0.000216	0.000962					
D_1	-0.00091	-0.01111	0.00059	0.630855				
X_3	0.000175	-0.00033	-0.00023	-0.00051	0.001356			
D_2	0.00916	0.00668	-0.00129	0.011499	-0.005	0.741835		
D_3	0.003673	-0.0057	-0.00923	0.230179	0.012272	0.222889	0.692482	
Constant	-0.03158	-0.04011	0.008798	-0.4665	-0.01729	-0.21129	-0.58911	2.340717

Table 6: *Correlation coefficient matrix test.*

Correlation	knowledge gap	X_1	X_2	X_4	D_1	X_3	D_2	D_3
knowledge gap	1.00							
X_1	0.265	1.00						
X_2	0.4977	-0.4542	1.00					
X_4	0.2384	0.5918	-0.3518	1.00				
D_1	-0.1859	-0.1272	0.2728	-0.2269	1.00			
X_3	-0.3231	-0.1899	0.2258	-0.1052	0.2397	1.00		
D_2	-0.3298	-0.1122	0.1691	-0.1366	0.1689	0.1936	1.00	
D_3	0.5065	0.1412	-0.1594	0.3669	-0.5414	-0.4433	-0.3514	1.00

Test for hetroscedasticity

Various tests are available for detecting Hetroscedasticity, we applied Breusch-Pagan/ Cook-Weisberg test for detecting Heteroscedasticity problem in the data. On the basis of probability value decision was made that the result is non-significant, data is free from hetroscedasticity and we accept the existence of Homoscedasty in the data. The model is good and having no problems of Hetroscedasticity (Table 7).

The results of the diagnostic test applied can be concluded that the data used have no problems of Multi-co-linearity, Hetroscedasticity. The main assumptions of OLS model were presented and interpreted the results with confidence in the study.

Table 7: *Hetroscedasticity test.*

Breusch-Pagan / Cook-Weisberg test for heteroscedasticity
Ho: Constant variance
Variables: fitted values of overall gap
chi2(1) = 0.04
Prob > chi2 = 0.8398

Conclusions and Recommendations

The findings of the study revealed that seven independent variables such as age, education, farm

size, sugarcane farming experience, tenancy status, contact agricultural extension department and districts combine together explained 48 percent of the variations with the knowledge gap. The results further showed that five independent variables education, sugarcane farming experience, tenancy status, contact agricultural extension department and districts significantly affect the knowledge gap of the sugarcane growers. The study suggested that government should provide proper education facilities to the farming community for reducing illiteracy in the study area. Agricultural extension department should provide special information and training regarding proper land preparation, improved cane varieties, cane content and recovery, size of cane setts, setts treatment, seed quantity, depth of furrows, latest sowing methods, row to row space, integrated nutrients and pest management techniques, irrigation, cane cutting and stop irrigation before harvesting because farmers had high knowledge gap in these technologies.

Novelty Statement

The article presents useful policy implications by highlighting the extent of knowledge gap in several aspects of sugarcane production among the sugarcane farmers in Khyber Pakhtunkhwa province of Pakistan. Also, the impacts of socioeconomic variables on knowledge gap provide an important insight for researchers and extension workers. Moreover, this research paper also provides overview of knowledge gap of recommended sugarcane management practices in the study area.

Author's Contribution

AF developed questionnaire, collected the data, performed analysis and wrote the research article. MZK supervised the research contributing in designing of the research study and contributed in every stage during development of the article. AH helped in questionnaire development, data collection and data entry and analysis and also helped in interpreted the results. MI Helped in data analysis. AN helped in data collection and data entry and also helped in interpreted the results.

Conflict of interest

There is no conflict of interest exists in the research article.

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