Research Article

The Impact of Improved Farming Practices on Maize Yield in Federally Administered Tribal Areas, Pakistan

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Abstract | This study intended to estimate and examine the impact of improved farming practices on maize yield in Bajaur Agency of Federally Administered Tribal Areas (FATA) of Pakistan. A sample of 166 respondents was selected through multistage stratified random sampling technique. Data were collected with the help of a pre-tested and validated well-structured interview schedule. Analysis was carried through multiple regression and independent sample t-test. Results indicated that extension visits, involvement in agriculture, adoption of recommended farming practices, irrigation and HYVs had significant effect, while disease, fertilizer and pesticide had non-significant effect on maize yield. Nevertheless, adoption of recommended technologies were low due to some constraints in the study area out of which low income of the families and lack of required technical knowledge were of major concerns. The results of t-test indicated that higher maize yield was obtained for the respondents who irrigated their fields using hybrid seed, as well as with the help from extension specialists' visits and with the adoption of recommended farming practices. It is established that improved farming practices have significant influence on yield. The study recommends transfer of technical and timely information to the farming community and organizing local trainings and learning workshops. It is recommended that farm inputs i.e. fertilizers, seed and pesticides needs to be subsidized to enable farmers apply recommended quantities of these inputs for getting the optimum yield. Extension department needs to introduce improved farming practices among farming community to achieve higher maize yields.

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Introduction

Maize (*Zea mays* L.) family (Poaceae) is the top yielding cereal crop in the world. Maize is the third most grown crop across the world, and the largest producer and exporter of maize is United States of America (USA) which contributes about 35.9% of the total production in the world (Global corn production, 2017-2018). The USA has the highest maize yield (> 9.6 t/ha) as compared to China and rest of the world (5.1–5.5 t/ha) yield. In India, maize is the third most important food crops after rice and wheat with productivity of 5.26 t/ha (Murdia et al., 2016). In the USA and in other developed countries in Europe, South America and Australia, cultivation of maize using improved hybrids and advanced machinery is the norm (Verheye, 2010).

During 2018-19, maize was cultivated for over one million hectare that produced 6.309 million tonnes.

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This shows a major increase of 5.1 percent over the previous year's production of 5.902 million tonnes (GoP, 2018-2019).

To get higher yield of maize crop, different improved farming practices are used by the farmers. Farmers are increasingly interested and seeking guidance about maize production, for instance identifying right planting window, soil type and temperature to support rapid and uniform emergence and crop stand.

Field visits of extension workers are important for farmers to gain practical and timely information. They offer practical solutions toward different farming problems through demonstrations and discussions. Farmers expect a variety of assistance and guidance from extension specialists that yields to a satisfied and engaging farming community (Umeta et al., 2011; Siddiqui and Mirani, 2012; Benjamin, 2013). Therefore, regular contact of extension with farmers have positive influence on farmer's adoption of improved production technologies regarding maize crop (Kidane, 2001; Abrhaley, 2007).

In agriculture; the adoption pattern for a technological change is a multidimensional process. Agricultural technology adoption patterns often vary from one smallholder farmer to another and this variation is due to the discrepancy in institutional and socioeconomic factors. The reasons why farmers do not use improved maize practices are; poor availability and lack of technical knowledge, high cost of improved seed, and poor extension contact (Lyimo et al., 2014). There is a dire need to involve farmers as active participants in the generation and conduction of recommended technological practices. Gecho and Punjabi (2011) mentioned that most of the farmers do not follow the extension recommendations especially seed rate, type of fertilizer and rate of its application.

Infestation of insects and disease is one of the main reasons for low maize production (Gianessi and Williams, 2014). Stem borer and seedling blight diseases are the most common diseases among other diseases that cause yield losses in maize crop produced throughout the world (Oerke, 2006). About 50% yield losses occur due to stem borer attack among the maize growers in Mozambique (Cugala and Omwega, 2001). In Ethiopia, 20-50% loss due to stem borers in maize yield was observed (Getu et al., 2002).

Declining soil fertility is a main reason for the low maize production, the combination of inorganic sources with inorganic fertilizers increases the nutrient availability, improves soil texture as a result enhance crop productivity (Smaling et al., 1997). Nitrogen and phosphorus fertilizers are critical inputs needed to obtain better maize yield. To achieve better maize yield, proper amount of micro and macro nutrients should be applied especially N, P and K.

Irrigation water is one of the important components required for maize cultivation. Irrigation water is very necessary to get higher yield otherwise there will be skewed production. Cakir (2004) stated that highest yields were observed in the fully irrigated fields of his research and 40% maize grain yield loss was caused by single irrigation negligence during one of the sensitive growth stages.

Improved maize varieties are those varieties which give more yield as compared to local open pollinated varieties (OPVs). Local maize varieties were preferred by some farmers due to the perception that local maize varieties has longer shelf life and tastes better (Osei et al., 2014). Mugisha and Diiro (2010) indicated that the mean yields obtained from improved maize varieties of 2941.5 kg/ha was higher than local varieties (1694 kg/ha). Agricultural production increases dramatically because of the availability of high yielding varieties (Meissle et al., 2009).

Keeping in view the background and importance of this study, this research was intended to estimate and examine the impact of improved farming practices on maize yield. No such research has been conducted earlier in Bajaur Agency (FATA).

Materials and Methods

Universe of the study

The current study was conducted in Bajaur Agency (FATA) of Pakistan (Figure 1). FATA is the most underdeveloped and impoverished region of Pakistan with only 34 percent of households having a sustainable living standard above the poverty line (Markey and Daniel, 2008). There are few livelihood opportunities available to the people of FATA which may include agriculture, rearing livestock, overseas employment and small scale businesses. Agriculture and livestock rearing have remained the main source of subsistence for over two-thirds of the population (FAO, 2015). The Bajaur Agency was selected as the study area because the agency is very fertile for cultivation of vegetables and crops especially maize. Hence the idea was to study and observe the current situations regarding maize and identify different problems in its farming activities and to investigate the effect of modern farming practices on maize yield in the study area. The area of the Bajaur Agency is 1,290 square kilometers (www.thebajaur.com). Total cropped area reported is 68258 hectares, while total irrigated area of the agency is 13890 hectares. Wheat, barley, rice, maize, rapeseed and mustard are grown in the Bajaur Agency (FATA Development Statistics, 2013).

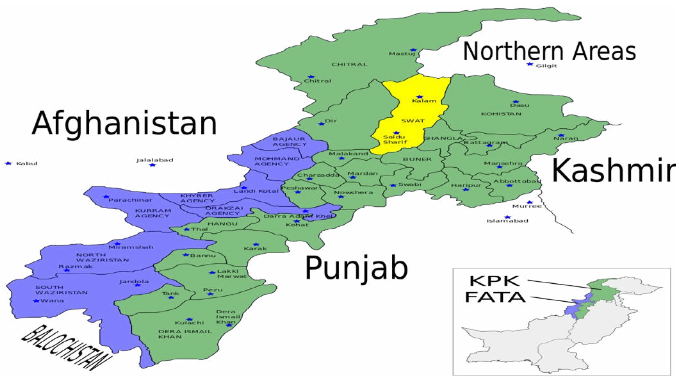

Figure 1: *Sample study area in FATA, Pakistan (Shah et al., 2017).*

Sampling procedure and sample size

Multistage sampling technique was used to select sampled respondents in the study area. In the first stage district Bajaur was purposively selected. In second stage, Tehsil Mamund was randomly selected out of seven tehsils in Bajaur Agency. In third Stage, a list of all villages from Tehsil Mamund was prepared with the help of Agriculture Office (AO) and three villages namely; Zaga derai, Mukha and Gabaray were randomly selected for data collection. In the last stage, 166 farmers from selected villages were randomly sampled through proportional allocation sampling technique as follows (Cochran, 1977) (Table 1):

$$n_i = n * (N_i/N) \quad ... (1)$$

Where;

n_i= Sample size selected from ith village; n= Total sample size; N_i= Population of maize growers in ith village; N= Population of maize growers in all selected villages in the agency.

Data and data collection

A well-planned interview schedule was prepared for the collection of cross sectional data. The interview schedule was pre-tested in field and was modified according to the suggestions of farmers and researcher's own observations. So, that the required and relevant information were obtained (Cho, 2002; Wingenbach et al., 2003; Khan and Akram, 2012). The interview schedule was composed in English language, while the interview was conducted in Pashtoo for the sake of convenience and to acquire accurate data. Most interviews took place either in the Hujra, farm or home of the respondents.

Table 1: *Sampling procedure and sample size.*

Sampled district	Sampled tehsil	Sample villages	Population	Sample
Bajaur agency	Tehsil Mamund	Zaga Derai	87	52.70 ≈53
		Mukha	77	46.64 ≈47
		Gabaray	110	66.64≈66
Total			274	166

Source: *Authors' calculation, 2017.*

Analysis

Theoretical background: Multiple Regression analysis where the dependent variable is concerned with one or more explanatory variables is nearly a logical extension of the two-variable case. Regression analysis is predicting mean value of the dependent variable on the basis of the known values of the independent variables. An individual dependent variable value will revolve around its mean value. Multiple regression follows the method of Ordinary Least Square (OLS). Assumptions of OLS have very striking statistical properties due to which it is one of the most prevalent methods of regression analysis. The causal relationship between dependent and the independent if any, must be based on the relevant theory. Error term encompasses all those variables that cannot be introduced in the model for various reasons. It is assumed that the average effect of all such variables on regress is negligible.

In regression analysis the dependent variable is frequently influenced not only by ratio scale variables (e.g., output, costs, age etc.) but also by qualitative variables or nominal data such as extension visits, adoption of recommended farming practices, sowing of High Yielding Varieties (HYVs) etc. Effect of such variables could also be computed by constructing artificial variables having values of 1 or 0. The digit 1 represents the presence of that quality and 0 shows non presence of that quality. Such variables are referred to dummy variables. In short, a regression model may contain repressors that could be solely dummy or qualitative in nature. These type of models are known as analysis of variance models (Gujarati and Porter, 2009; Ali and Ali, 2018).

Independent sample t-Test: The four null hypotheses are as under.
i. There is no difference between yield of irrigated fields and non-irrigated fields.
ii. There is no difference between extension and without extension visits farmers' yield.
iii. There is no difference between hybrid seed yield and local seed yield.
iv. There is no difference between yield of farmers adopted farming practices and non-adopters.

These hypotheses tests for possible rejection to know whether yield from irrigated and unirrigated field, hybrid and local seed, yield with extension visits paid and without extension visits and maize yield with the adoption of recommended farming practices and non-adoption are same?

The collected data were analysed using t-test of independent sample having identical but unknown variances (Khan et al., 2012). For convenience, t-test is defined as:

$$t = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{s_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \quad ....(2)$$

Which under the null hypothesis (H_o), follows a t-distribution with (n_1+n_2-2) degree of freedom.
Where,

$$s_p^2 = \frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2}$$

Is pooled variation

$$s_1^2 = \frac{1}{n_1 - 1}\sum(X_{1i} - \overline{X_1})^2$$

Is the variance of first sample

$$s_2^2 = \frac{1}{n_1 - 1}\sum(X_{2i} - \overline{X_2})^2$$

Is the variance of second sample.
$\bar{x}_1$ and $\bar{x}_2$ are the means whereas n_1 and n_2 are the sample sizes corresponding to sample first and second, respectively.

Empirical model

Dummy variables regression model was used to estimate and examine the effect of various explanatory variables on maize yield as follows (Gujarati and Porter, 2009):

$$Y_i = \beta_0 + \beta_1 D_1 + \beta_2 D_2 + \beta_3 D_3 + \beta_4 D_4 + \beta_5 D_5 + \beta_6 D_6 + \beta_7 D_7 + \beta_8 D_8 + \varepsilon_i \quad ....(3)$$

Where;
Y_i= Yield of ith farmer (Kg/acre); D_1= Dummy for extension visits; D_1= 1 for extension visits; 0 otherwise; D_2= Dummy for full time involvement in agriculture; D_2= 1 for full time involvement in agriculture; 0 otherwise; D_3= Dummy for recommended farming practices adoption, D_3= 1 for recommended farming practices adoption; 0 otherwise; D_4 = Dummy for disease infestation, D_4= 1 for severe disease infestation, 0 for mild disease infestation; D_5= Dummy for chemical fertilizer use, D_5= 1 for chemical fertilizer use, 0 otherwise; D_6= Dummy for pesticide use, for chemical fertilizer use, D_6= 1, 0 otherwise; D_7= Dummy for irrigation, D_7= 1, 0 otherwise; D_8= Dummy for HYVs, D_8= 1 for sowing HYVs, 0 otherwise; β_0 = Intercept; β_s= Estimated parameters; ε_i= Stochastic error term.

Post estimation diagnostic tests

The following post estimation diagnostic tests were employed to check the validity and robustness of the estimated model.

Normality of residuals

Normality of residuals (error terms) was checked utilizing histograms of residuals. Histograms of residuals (graphical representation) give information about how the probability density function of random errors appears (Gujarati and Porter, 2009). Histogram of residuals was constructed to check the normal distribution of error terms. Figure 2 shows the distribution of the residuals. Histogram portrays symmetric distribution suggesting normality of residuals.

Jarque-Bera (JB) test for normality

JB test for normality is actually an asymptotic (large value) test having the following formula:

$$JB = n\,[(S^2/6) + (K-3)^2/24]$$

Here n is the sample size, S for Skewness, while K denotes kurtosis coefficient. When residuals are normally distributed in case of null hypothesis, JB statistic follows the distribution of chi-square (Gujarati and Porter, 2009). As the estimated p-value (0.990) is insignificant, suggesting that we cannot reject the hypothesis that data is normally distributed.

JB test = 0.019 (p-value 0.990).

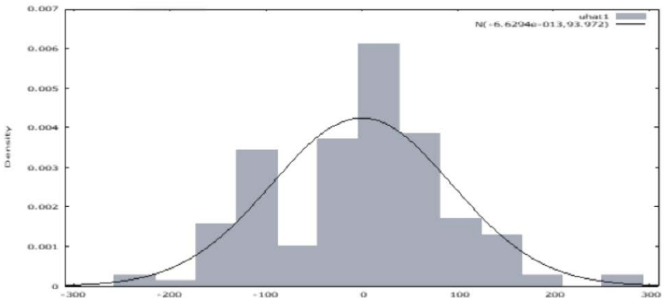

Figure 2: *Histogram of residuals.*
Source: *Estimated from the residuals of estimated model.*

Multicollinearity

Ordinary least square estimation (OLS) technique also assumes that the independent variables should not be correlated with each other. The time when this assumption is violated then the estimated model is plagued with multicollinearity problem. In the presence of multicollinearity, one cannot conclude about the significance of individual explanatory variable/s.

A Variance Inflation Factor (VIF) approach was employed for detection of multicollinearity. A VIF having value greater than 10 is usually considered as the indication of multicollinearity, while VIF value measured less than 10 is an evidence of no multicollinearity problem (Gujarati and Porter, 2009). Table 2 shows results of the Variance Inflation Factor (VIF) of all variables used in model. The VIF results show that the explanatory variables are not linearly correlated with each other. The mean value obtained was 2.59, while the mean tolerance value calculated was 0.38 which means that there is no evidence of multicollinearity in the variables of estimated model.

Heteroscedasticity

In cross sectional analysis the problem of heteroscedasticity (non-constant variance) is more likely. Therefore, Breusch-Pagan/Cook-Weisberg test was applied to check whether the model is plagued with heteroscedasticity. The null hypothesis is set in favor of homoscedasticity (Gujarati and Porter, 2009). The estimated Chi Square value was 24.66 and statistically significant at 0.01 α (p-value= 0.0000) suggesting that the model is beleagured with the problem of heteroscedasticity. To overcome this problem, robust command was used in Stata v. 12 software. Post estimation diagnostic tests were executed in order to check the validity and efficiency of our estimated model which includes normality of residuals, multicollinearity and heteroscedasticity.

Table 2: *VIF (variance inflation factor) results.*

Variables	VIF	1/VIF
Extension visits	5.24	0.19
Involvement in agriculture	3.23	0.30
Adoption of recommended farming practices	5.69	0.17
Diseases	1.05	0.94
Fertilizer	1.02	0.97
Pesticide	1.01	0.98
Irrigation	1.46	0.68
HYVs	2.00	0.50
Mean VIF	2.59	0.38

Source: *Author's estimates from survey data, 2017.*

Results and Discussion

Socio-economic characteristics of respondents

Socio-economic characteristics have always influence on other attributes that's why data collection in these perspectives is very important (Ekanem et al., 2006; Agwu et al., 2008; Saadi et al., 2008; Jensen et al., 2009). Table 3 represent socio-economic characteristics of the sample respondents.

Adoption of agricultural innovation is directly associated with age (Agwu et al., 2008). Age of the respondents is presented in Table 3. The data revealed that out of 166 respondents, 16% of the respondents were less than 25 years of age, 31% were from the category of 25-35 years, 23% were from the age group 36-45 and the remaining 30% of the respondents were above 45 years of age. Our results are in similarity with that of Farah et al. (2011) who reported that the largest portion of the respondents 211 (35.17%) were from the age category of 18-35 years. It is clear from the results that young respondents were more willing to accept new technologies.

Literacy affect the adoption of new technologies, attitude of an individual towards the adoption of improved farming practices can be changed by educating him (Aziz et al., 2018). Anandajayasekeram (2008) concluded that the literacy status of the rural community affects an acceptance of extension advice. Literacy status of the respondents was also given in Table 3, data reveal that 64% illiterate respondents were involved in the activity. Our results are in contrast with that of Khan et al. (2009) who stated that 83% of the respondents were literate and were more dedicated to accept improved farming practices as compared to illiterate farmers.

Table 3: *Socio-economic characteristics of respondents.*

Variables	Categories	Frequency
Age	< 25 years	26 (16%)
	25-35 years	52 (31 %)
	36-45 years	39 (23%)
	46 years and above	49 (30%)
Education	Illiterate	106(64 %)
	Primary	35(21 %)
	Middle	11(7%)
	Matric and above	13(8 %)
House hold size	Up to 5 members	13(8 %)
	6-9 members	52(31 %)
	10 and above members	101(61 %)
Landholding Size	Up to 5 acres	84(51 %)
	6-10 acres	64(38%)
	11 and above	18(11 %)
Tenural status	Owner cultivator	124(75%)
	Owner-cum-tanent	24(14 %)
	Tanent	18(11 %)
Farming experience	Up to 10 years	44(26 %)
	11-20 years	104(63 %)
	Above 20 years	18(11 %)

Source: *Field survey data 2017.*

Family size is significantly associated with the adoption of innovations (Doss, 1999). Table 3 also represents data regarding household size of the respondents, revealed that out of total 166 respondents, 8% of the respondents were having household size up to 5 members, 31% respondents were in between 6-9 members, while the remaining 61% respondents were laid in family size category of 10 and above members. The results of our study are in similarity with the findings of Muriithi (2003) who reported that most of the households 53% were in between 7-13 members.

The larger the landholding the higher will be adoption of agricultural innovations (Chaudhary, 2006; Belay et al., 2012). Data were categorized into three categories i.e. Up to 5 acres, 6-10 acres, and 11 and above acres presented in Table 3. The data revealed that in the study area 51% of the farmers were having up to 5 acres of land, 38% of the respondents were having 6-10 acres of land, while 11% of the farmers had 11 and above acres of land. From the result it is concluded that majority of the farmers had small land holdings followed by medium sized farmers in the study area. Our results are comparable with the findings of Ali et al. (2016), where they reported that majority of the respondents were small farmers and 72% farmers had less than 5 acres of land. Furthermore, Adil et al. (2004) mentioned that small farmers are main features of agriculture in Pakistan.

Farmers' tenancy status have an impact on exposure to the new agricultural technologies or desire to adopt it (Idrees, 2003). Respondents were categorized into three groups i.e. owners, tenant and owner-cum-tenant. Data of the respondents regarding tenancy status were presented in Table 3. Out of total 166 respondents, majority of the respondents 75% were owner cultivators, followed by owner-cum-tenant 14%, while 11% of the respondents were tenant. Our results are aligned with the findings of Aziz et al. (2018), where they mentioned that majority (71%) of the respondents were owner cultivators.

Farming experience is a typical aspect of a farmer's learning process. According to Agwu et al. (2008) experience has a due importance in the adoption of agriculture innovations. A farmer may turn out to be more rigid with his increase in farming experience (Jensen et al., 2009). Data given in Table 3 also depicted that majority 63% of sample respondents were involved in agriculture from last 11-20 years, followed by 26% respondents from experience group of up to 10 years, while 11% of the respondents had farming experience above 20 years. The mean farming experience observed was 18 years in the study area. Our results are more or less in line with that of Chuks (2014) who also observed that 52% of the respondents had a farming experience of above 10 years.

Table 4 shows summary statistics of variables used in the model. Mean value of yield computed was 1616.5660 kg per acre with std. dev. of 226.8619 ranged from 1350 to 1900. Mean value of extension visits was 0.6747 with std. dev. of 0.4699 ranged from 0 to 1. Average value obtained for involvement in agriculture was 0.5967 with std. dev. of 0.4921 ranged from 0 to 1. Mean value calculated for adoption of recommended farming practices was 0.6325 with std. dev. of 0.4836 ranged from 0 to 1. Mean value for maize disease was 0.6867 with std. dev. of 0.4652 ranged from 0 to 1. Average quantity of fertilizer used was 0.7229 with std. dev. of 0.4489 ranged from 0 to 1. Average amount of pesticide applied to maize crop was 0.7892 with std. dev. of 0.4092 ranged from 0 to 1. Mean value for irrigation was 0.8494 with std. dev. of 0.3588 ranged from 0 to 1. Average value for high yielding varieties (HYVs) was 0.5120 with std. dev. of 0.5014 ranged from 0 to 1.

Table 4: *Summary statistics of variables used in the model.*

Variables	Units	Mean	Std. Dev.	Min	Max
Yield	Kg/Acre	1616.5660	226.8619	1350	1900
Extension visits	Dummy	0.6747	0.4699	0	1
Involvement in Agriculture	Dummy	0.5967	0.4921	0	1
Adopted recom-mended farming practices	Dummy	0.6325	0.4835	0	1
Disease	Dummy	0.6867	0.4652	0	1
Fertilizer	Dummy	0.7229	0.4489	0	1
Pesticide	Dummy	0.7892	0.4092	0	1
Irrigation	Dummy	0.8494	0.3587	0	1
HYVs	Dummy	0.5120	0.5014	0	1

Source: *Author's estimates from survey data, 2017.*

Table 5: *Estimates of regression analysis (Dependent variable = Yield of maize).*

Variables	Coefficients	Std. Dev.	t-ratio	p-value
Constant	1308.0280	29.3230	44.61	0.000
Extension visits (D_1)	70.6596	40.9731	1.72	0.087*
Involvement in agricul-ture (D_2)	107.6211	39.2281	2.74	0.007***
Adopted recommended farming practices (D_3)	152.4444	45.4385	3.35	0.001***
Disease infestation (D_4)	6.9135	18.5587	0.37	0.71
Fertilizer use (D_5)	-26.3054	17.9120	-1.47	0.144
Pesticides use (D_6)	27.6555	20.8310	1.33	0.186
Irrigation use (D_7)	35.8326	15.7170	2.28	0.024**
HYVs (D_8)	121.5943	23.1457	5.25	0.000***
F (8, 157)	151.29			
R-squared	0.8116			

Source: *Author's estimates field survey data, 2017.*
Note: ****, ** and * indicate significance level at 1%, 5% and 10% probability respectively.*

Estimates of regression analysis

Table 5 reveals estimates of regression analysis of maize growers in the study area. The results showed that extension specialists' visits had positive and significant effect on maize yield. Maize growers who were paid extension visits got 70.65 kg/acre more yield than those who were not offered frequent extension visits. This is due to the reason that because of more extension visits, farmers became aware of the latest agricultural practices resulted in higher maize yield. Our results are also in line with the findings of Kidane (2001) and Abrhaley (2007) where they argued that frequent contacts of extension agents enhanced the exposure of farmers about modern agricultural information required for increased maize yield. Involvement in agriculture was found having significant effect on maize yield at 1% significance level. It means that full time involvement in agriculture gave 107.62 kg/acre more yield than part time farmers. Farmers gain more experience in full time farming due to which they become more flexible towards the acceptance of updated information because farmers have learned from the previous experience that modern farming techniques and practices are proved fruitful as stated by Agwu et al. (2008) that experience has a due importance in the adoption of agricultural innovations. Similarly, adoption of recommended farming practices also had highly significant effect on yield at 1% significance level. Farmers who adopted recommended farming practice obtained 152.44 kg/acre extra yield than those who did not adopt these recommended practices. Most of the farmers do not follow the improved farming techniques and recommendations especially seed rate, type of fertilizer and rate of its application due to the lack of funds and belonged to a weak financial background. Voh (1982) stated that socio-economic status of the farming community has parallel and direct relation to the adoption decision regarding modern farming techniques. Irrigation had significant and positive effect on maize yield at 5% significance level. Those farmers who irrigated their maize crop got 35.83 kg/acre more yield as compared to those who did not kept proper care of recommended irrigation interval. As Cakir (2004) mentioned that higher maize yields were observed in the fully irrigated fields as compared to less irrigated fields. Water quantity and irrigation period are very important for higher maize yield especially more water is required for improved maize varieties. High yielding varieties are varieties which give higher yield as compared to local traditional varieties also called open pollinated (OPVs). High yielding varieties (HYVs) was estimated that had highly significant (p-value = 0.000) effect on maize yield at 1% level of significance. The reason for getting higher maize yield was due to the dissemination of latest agricultural information by extension department to the farmers in the study area. Availability of yielding varieties enhances crop productivity (Meissle et al., 2009). Maize diseases, use of fertilizer and pesticide were observed having non- significant effect on yield of maize growers.

Table 6: *Comparison of maize yield through independent sample t-statistics.*

S. No	Variables	Mean yield (kg/acre)	Mean difference (kg/acre)	t-value	P-value
1	Irrigation	1663	313	-7.3204	0.000***
	No-irrigation	1350			
2	Extension visits	1745	395	-18.23	0.000***
	No extension visits	1350			
3	Hybrid seed	1780	335	-14.09	0.000***
	Local seed	1445			
4	Adoption of recommended farming practices	1762	398	-20.54	0.000***
	Otherwise	1364			

Source: *Author's field survey data, 2017.*
Note: **** indicates significance level at 1% probability.*

Difference in mean yield of maize

Significant difference ($p < 0.01$) was found for maize yield between irrigated and non-irrigated fields; using paired t-test statistic. The high mean difference value (313 kg/acre) for maize yield was due to the availability of irrigation water as compared to unirrigated fields. Similarly, statistical results revealed a significant difference ($p < 0.01$) between maize yield obtained when extension visits were paid and when not paid. The mean difference value calculated for maize yield was 395 kg/acre in case of extension visits. Those farmers who had extension contacts are assumed to get updated information that would increase and double agricultural production (Wondimagegn et al., 2011). Respondents who used hybrid maize seed, obtained significantly ($p < 0.01$) higher yield (1780 kg/acre) than the 1445 kg/acre realized form local seed varieties with a mean difference of 335 kg/acre. The significant relationship between maize yield and use of improved seed is in resemblance with the results of Mugisha and Diiro (2010). Table 6 presents the average mean difference of maize yield. The statistical analyses depicted significant difference ($p<0.01$) between adoption of recommended farming practices and otherwise on maize yield. Study findings showed that higher maize yield (398 kg/acre) was obtained when sampled respondents adopted the recommended farming practices than respondents who did not adopt. Our findings are consistent with that of Ogada and Nyangena (2015) where they stated that adoption package i.e. improved maize varieties and inorganic fertilizers significantly improve yields.

Conclusions and Recommendations

This study concluded that extension visits, adoption of recommended farming practices, high yielding varieties (HYVs) Irrigation and involvement in agriculture had positive and significant effect on maize yield. Maize diseases, use of fertilizer and pesticide had non-significant effect on yield of maize growers. As Federally Administrated Tribal Areas (FATA) is among the most remote areas of the country where maize yield is very low as compared to other areas of the province. In this regard, the primary duty of agricultural extension department is to disseminate improved farming practices and modern techniques to the farming community to increase maize yield. Government needs to subsidize costly inputs like pesticides, herbicides, fertilizers and other modern agricultural machinery for the farming community. It is further recommended that public tube wells needs to be installed to overcome deficiency of irrigation water. Extension staff also needs to make frequent visits to ensure the dissemination of latest farming practices to the farming community. Local programs should be telecasted on mass media regarding local agricultural problems to address main issues of the farmers and extension department should arrange field days, training workshops, exhibitions and discussion settings for the farmers in the study area. Chemical control measures against diseases and weeds should be replaced with IPM practices to avoid the environmental and human health hazardous effects of these pesticides.

Novelty Statement

This is the first kind of research work in Tribal District Bajaur in order to encourage rural farmers to adopt improved farming technologies which have significant effect on increasing maize yield.

Author's Contribution

Sanaullah was the principal author who conducted the research, analyzed the data and wrote the manuscript. Urooba Pervaiz was the major supervisor who deleped the theme of the study. Shahid Ali helped in statistical analysis and reviewing write up. Mohammad Fayaz helped in model specification and data analysis. Aftab Khan helped in data feeding and incorporated references.

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