Research Article

Impacts of Farm Mechanisation on Wheat and Maize Crops' Productivity in Peshawar Valley

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Abstract | This study has been carried out to assess the impact of farm mechanisation on wheat and maize crops productivity in Peshawar valley. For this purpose, three districts, i.e. Peshawar, Charsadda and Nowshera in the said valley, were randomly selected followed by a selection of three villages in each district under simple random selection. In this way, a sample size of 175 farmers was randomly selected from nine villages on a proportional basis. The study reveals that a large number of both types of farmers are neither completely mechanised nor completely non-mechanised. Majority of the farmers in each type of farmers do not have their own farming machines/animals. Per acre productivity of mechanised farmers is a little bit greater than the non-mechanised farmers. The outstanding feature of farm mechanisation is the time-saving factor that enables mechanised farmers to spend their spare time on other aspects of life like education, business, other professions and social activities.

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Introduction

Agriculture sector plays an important role in the economy of Pakistan and is one of the major determinants of the economic growth and well-being. It contributes about 21% to Gross Domestic Product (GDP) and employs 45% of labour force. Majority of the population i.e-62% belongs to rural areas, and their livelihood directly or indirectly depends on agriculture. It facilitates markets for industrial products like fertilisers, pesticides, tractors and other agricultural implements. Although agriculture has critical importance to the economic growth, exports, income and food security, unfortunately, this sector has been suffering, and the agriculture growth is declining since 1960 except the 1980s. The productivity remains low as compared to other agricultural economies. No visible investment in new seeds, farming technology and water infrastructure has been realised. Therefore radical measures are needed to tackle the problems of declining water availability to make the country self-sufficient in food and other agricultural products (Economic survey of Pakistan, 2009-10).

It is argued that tractor utilisation and timely tube-well water supply raise cropping intensities and ultimately leads to greater production and larger employment. There is no other way to increase agricultural productivity and meet the growing demand for agricultural products. As a result, the ultimate option is to adopt mechanisation in agriculture to increase farm products and the use of tractor would assist farmers to cultivate additional land which is not under use and untilled (Shami, 1989). The technological choice in the process of agricultural development and the critical factor that affects the decision of adopting mechanisation are the wage rate, greater cropping intensity, timeliness of operation and the farm size (Thorbecke and Karunasekera, 1980). The adoption of mechanised farming would worsen the existing non-mechanised agricultural situation and would also have negative effects on the cities. The ultimate cost of mechanisation would be borne by the peasants. However, farmers and agricultural planners should not be discouraged to roll back the entire mechanisation program. Agricultural and mechanisation policies should be designed in such manner that the losses and dislocation of labour could be minimised. The promotion of small-scale rural industry might be the real hope and solution to sustain the growth of income and employment (Richards, 1981). The use of machines allows farmers to complete their agricultural activities well in time and as a result, reduce the turnaround time between two consecutive crops. In addition to machines, some other factors like irrigation, provision of financial resources for providing fertilisers and crop protection, access to the credit market and the variation in managerial quality of farmers increased yield and cropping intensity of mechanised farming (Tan, 1984).

The major determinants of productivity and cropping intensity for both seasons appear to be irrigation. There is a negligible difference in fertiliser productivity between mechanised farmers in rain-fed and irrigated areas. It can be concluded that the contribution of mechanisation in yield is not significant (Shields, 1985). The tube well-tractor technology has been highly rewarding in Pakistan in the shapes of continuing investments in the tube well-tractor technology and has added tremendously to productive capacity. It was basically a response to the emerging resource constraints such as scarcity of water and labour, especially during the peak demand periods, mechanised cultivation has been cost-reducing and output augmenting, the technology, far from being labour displacing and mechanical cultivation has had a positive impact on income distribution as small farmers and landless agricultural workers, as well as barani (i.e. the cultivated area where no irrigation facility exists and the crops are totally dependent on rain) and waterlogged areas have been the major beneficiaries of the technology (Ghaffar, 1986). The use of a tractor and the timely availability tube well water allows for an increase in the cropping intensities and as a result, increases production and job opportunities. Self-sufficiency in agriculture production is a gradual and long process, and mechanisation in agriculture can provide the growing needs of the food security. Without mechanisation, the achievement of the above goals are not possible and therefore are needed and essentials for the balanced growth of the economy (Shami, 1989).

The existing system of hiring tractor for ploughing has no impact on the total cultivated area, crop yields and total crop output. It has rather adversely affected crop production income. Even if the government provide tractor free of cost for ploughing the average increase in financial benefit to the farmers over the use of draught animal technology would not be significant because it has been cleared that the adoption of the tractor has no significant effect on total crop output (Panin, 1995). In general, the productivity of major crops like potato, wheat, maize and paddy are higher in power tiller/tractor farms as compared to bullock farms. This increase in productivity is attributable to better seeds bed and land preparation, timeliness of farm operation, less incidence of weeds and better use of farm inputs like fertiliser and manure (Pariyar et al., 2001). The yield per acre can be increased by an increase in the use of irrigation, fertiliser and ploughing. Since the country encounters a severe shortage of canal water, therefore the cost analysis shows that production cost and also the income of wheat crop per acre expands with the expansion of area under cultivation. The main reasons for this increase can be attributed to the use of tractor, timely crop operation, use of more fertilisers, irrigation and wedicides i.e. chemical used for deteriorating unwanted plants. The increase in average output is greater than the expansion in cost. In order to increase productivity, availability of these inputs both in terms of quantity and quality of time should be provided to the farmers. Moreover, availability of credit facility at the lower interest rate and on required time is also needed to increase productivity (Hassan et al., 2005).

Labour and machines can be substituted for one another, but farm technology is comparatively precise, has more power to finish farm activity on time and is therefore preferred to replace for labour. Mechanisation greatly affects productivity, and its share is about 11.7% in total productivity growth (Liu and Wang, 2005). The water use efficiency and irrigation management need to be improved for future agriculture development and also further advances in farm mechanisation, and technology use is the key elements for enhancing farm production with limited water resources in the semi-arid regions (Deng et al., 2005).

The shifting of conventional farming to mechanised farming is not an easy task because farmers have lower purchasing power. In order to overcome the food problems of the people, the government should provide credit facilities to change the existing agricultural system. The inputs used in farming should be made of local materials in order to make them convenient and assessable in all respect, i.e. readily available, adaptable, reliable, affordable, manageable and environmentally friendly (Asoegwu and Asoegwu, 2007).

The adaptation of agricultural technology brings positive impacts in productivity and can change the economic condition of the farmers. By following agricultural technology, the farmers can enjoy high average crop yield, considerably low food prices, higher real wages for unskilled farmers, greater profitability and better welfare indicators. Adoption of agricultural technology should be accompanied by improved transportation facilities, advanced irrigation system, keeping livestock herds, expanding literacy rate, security, secured land tenure and easy approach to extension services. By providing the above facilities, agricultural productivities can be raised and will ultimately alleviate poverty. All this is possible in the long run with the commitment towards agriculture and rural development (Minton and Barrett, 2008). Majority productivity increases depend on intensification, adoption of new technologies, good land market and access to land environmental challenges (Dethier and Effenberger, 2012). With the preamble of mechanisation, two different views, regarding its nature and role in agriculture, emerged. These views can broadly be classified as substitution view and net contribution view. Substitution view elucidates that tractors and animals are two alternative sources of energy, being utilised in agriculture activities and are close substitutes for each other. However, their replacement for one another depends on their relative prices, i.e. the cheaper one is to be replaced for the expensive one. At the same time, it is viewed that the induction of tractor in agriculture will bring unemployment in the economy, i.e. tractorisation at the cost of employment. Under contribution view of mechanisation in agriculture, the question of unemployment is rejected and is argued that tractorisation will enhance productivity through timely operation, deeper tillage, reclamation of land and cropping intensity as these activities will need a greater workforce and the displaced labours can be absorbed in each of the above activities. However, the validity of this view has not been generalised due to insufficient empirical evidence and may be true in some particular cases (Binswanger, 1986).

Farm mechanisation (FM) refers to the process of developing agricultural machines and substituting these machines power for human and animal power for increasing productivity and time-saving. In this research study, mechanised farming (MF) denoted by "1", mean that more than half of the farming activities, i.e. ploughing, sowing, planking, spraying, harvesting and threshing are performed by machines and non-mechanised farming (NMF) or conventional farming (CF) denoted by "0", mean that half or less than half of the above activities are performed by non-mechanical source.

The process of adopting mechanisation in the province of Khyber Pakhtunkhwa has not flourished, and therefore the contribution of mechanisation in agricultural productivity is not much clear (Aurangzeb, 2004). As a result, any future policy, regarding mechanisation of agriculture in any region needs a deeper understanding of the situations that under what conditions, formulated agriculture mechanisation policy is adoptable and up to what extent? Therefore, it is needed to assess the impact of farm mechanisation major crops' productivity in Peshawar valley, is the most fertile valley in the region.

The objectives of the study are:

- To determine the comparative analysis of productivities of two major crops under mechanised and non-mechanised farming.
- To identify problems faced by farmers in mechanised and non-mechanised farming and suggest recommendations for the improvement of farm productivity.

Materials and Methods

Site selection

Peshawar valley is comprised of five districts, i.e. Peshawar, Charsadda, Mardan, Nowshera, Swabi and the total numbers of farmers in the stated districts constitute our universe. Out of these five districts, three districts randomly selected by simple random sampling and thus constituted sample frame. Similarly, a list of all villages in each district was prepared, and then three villages in each district were randomly selected by simple random sampling. The small sample size is enough as all the farmers belong to the same locality and also have similar climatic conditions. A list of all farmers in each village was prepared, and 20% sample size in each village was taken on a proportional basis. For this purpose, the following expression of sampling was used.

$$n_i = (Ni / N) * n$$

Where;
n_i: Sample size of the i th village(stratum); N_i: Total numbers of farmers in the i^{th} village; n: Total sample size; N: Total numbers of respondents (farmers) in all nine villages.

Treatment description

The number of farmers in 09 villages are 125, 65, 100, 100, 110, 70, 130, 110, and 65 and the proportional sample size from each village are 25, 13, 20, 20, 22, 14, 26, 22 and 13 respectively. In this way, a total sample size of 175 farmers out of 875 was chosen. Out of these 175 farmers, 117 farmers cultivate their farms by mechanical methods (mechanised farmers), and the remaining 58 farmers cultivate their farms by non-mechanical methods (non-mechanised farmers), and the data is collected through questionnaire. All the 175 farmers returned questionnaires, duly filled, except 06 farmers that did not furnish crops information.

Analytical techniques

The following econometric techniques have been used to analyse the data. For the application of econometric techniques and analysis of data, Statistical Package for the Social Sciences (SPSS) has been utilised.

Multiple regression analysis

This study incorporates five variables - farm size, man-days of labour, amount of fertilisers, amount of insecticides, mechanised/non-mechanised farming in the regression model. Among these first five determinants, the last one is the dummy variable that has taken the value of either "1" or "0". Whereas "1" shows that the farmer is mechanised and "0" reflects that the farmer is non-mechanised. The degree of relationship among dependent and independent variables is measured with the help of multiple regression analysis. Thus, the standard format of the linear regression model is as under;

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 D_5 + u_i$$

Where;
Y: Amount of production of given crop (in mounds) X_1: Farm size (in acre); X_2: Man days of labour (per crop); X_3: Amount of fertiliser (in bags); X_4: Amount of insecticide (in litres); D_5: Dummy variable (Mechanised/ non-mechanised farming); β_0: Intercept of the function and β_1, β_2, β_3, β_4 and β_5 are the elasticities of the respective inputs and u_i is the residual term.

Diagnostic tests used

In order to observe the validity of the overall model, coefficient of adjusted R^2 and for multicollinearity, the values of variance inflationary factor (VIF) have been observed. Furthermore, the presence of heteroscedasticity and normality in the data has also been examined, followed by corrective measures.

Hypothesis to be tested

Existing yield per acre of the major two crops is lower under conventional farming than the yield per acre under mechanised farming.

Description of machinery/ tools used

MB plough. A large piece of farming equipment with one or several curved blades, pulled by a tractor or by animals. It is used for digging and turning over soil, especially before seeds are planted.

Disk plough. It is a plough with its large steel disks dragged by tractor and is very much useful for deep ploughing. It is also useful in stony and hard lands. It sustains moisture in rainy areas and also helpful in controlling land erosion.

Rotavator. It is a machine with blades that turn and break up soil. In more detail, it is a rotary tillage instrument pulled by a tractor which cuts, mixes and levels the soil in a single pass. It can be used for any type of crop especially for uprooting the stubbles of sugarcane, cotton, maize etc. It assists the farmers to catch the season because the harvested plot can be immediately rotavated.

Results and Discussion

This section discusses the ownership of tractor/ animals and a source of land preparation. Before and after cultivating crops, the farmers need to treat their fields through different agricultural activities like ploughing, sowing, planking, spraying, harvesting, threshing, transportation, etc. These activities may either be performed by machines (tractor) or by animals/ labours depending upon resources and decisions of the farmers.

The ownership of tractors/ animals asked the respondents and their responses recorded in the following Table 1.

Table 1: *Ownership of tractor/ animals.*

Ownership of tractor/ animal				
Mechanised farmers		Non-mechanised farmers		
Owned tractor	Rented tractor	Owned animal	Rented animal	Not responded
05 (4.3%)	112 (95.7%)	17 (29.3%)	21 (36.2%)	20 (34.5%)

Source: *Field survey.*

The above Table 1 explains the extent of ownership situations of the sampled cultivators. Among 117 mechanised farmers, only 05 or (4.3%) farmers have their own tractors, and the remaining 112 or (95.7%) mechanised farmers do not have their own tractors to perform their agricultural activities, and therefore they resort rented tractors to carry out their agricultural activities. This lower number of possessing own tractor may be due to high prices of tractors and its expensive operating and maintenance costs.

The ownership of animals' situations under non-mechanised farming is somewhat better. Out of 58 non-mechanised farmers, 17 or (29.3%) farmers have their own animals to execute their farming activities, 21 or (36.2%) farmers purchase services of animals on rent for carrying their agricultural activities while 20 or (34.5%) farmers have not furnished their information regarding the question under discussion.

Source of land preparation

Ploughing: Among other determinants of crop productivity, one of them is how much the land is ploughed, levelled and prepared before cultivation. Different types of equipment, attached either with tractor or bullock (excluding disk plough and rotavator from bullock), used for this purpose. Commonly used equipment for the said purpose includes mould board (MB) plough, disk plough, rotavator and others. After investigating cultivators, regarding the use of the above equipment, their expressions recorded in the following Tables 2a and Tables 2b.

In above Table 2(a), out of total mechanised farmers (117), 37 numbers of farmers (31.6%) use MB plough for one time, 20 numbers of farmers (17.1%) use MB plough for 2 times, 54 numbers of farmers (46.2%) use MB plough for 3 times, 04 numbers of farmers (3.4%) use MB plough for more than 3 times and 2 numbers of farmers (1.7%) did not respond.

Table 2a: *Percentage number of respondents uses MB plough and disk plough.*

Type of farming	Number of time(s) uses MB plough	Number of farmers	Number of time(s) uses Disk plough	Number of farmers
Mechanised farmers	1	37 (31.6%)	1	28 (23.9%)
	2	20 (17.1%)	2	06 (5.1%)
	3	54 (46.2%)	3	34 (29.1%)
	More than 3	04 (3.4%)	More than 3	NA
Mean	2.18		1.21	
Non mechanised farming	1	46 (79.3%)	1	32 (55.2%)
	2	04 (6.9%)	2	02(3.4%)
	3	06 (10.3%)	NA	NA
	More than 3	02 (3.4%)		
Mean	1.38		0.62	

Source: *Field survey.*

Table 2b: *Percentage number of respondents uses rotavator and others.*

Type of farming	Number of time(s) uses a rotavator	Number of farmers	Number of time(s) others	Number of farmers
Mechanised farmers	1	28 (23.9%)	1	28 (23.9%)
	2	12 (10.3%)	2	NA
	3	30 (25.6%)	3	
	More than 3	NA	More than 3	
Mean	1.21		0.24	
Non mechanised farming	1	38 (65.5%)	1	36 (62.1%)
	2	02 (3.4%)	2	NA
	3	NA	NA	
	More than 3			
Mean	0.72		0.62	

Source: *Field survey.*

The use of MB plough under non-mechanised farming is quite different. 46 numbers of farmers (79.3%) use MB plough for 01 time (quite greater than mechanised farming), 04 farmers (6.9%) use MB plough for two times, 06 numbers of farmers (10.3%) use MB plough for 03 times, 02 farmers (3.4%) use MB plough more than 03 times. In this way, mechanised farmers, on the average use MB plough for 2.18 times and non-mechanised farmers use the said plough for 1.38 times.

Table 2(a) further shows that among sampled farmers under mechanised farming, 28 farmers (23.9%) employ disk plough for 01 times, 06 farmers (5.1%) employ disk plough for 02 times, 34 farmers (29.1%) employ disk plough for 03 times and the remaining 49 farmers (41.9%) did not provide answers.

The use of the disk plough in non-mechanised farming has some different numbers. Among non-mechanised farmers, 32 farmers (55.2%) employ disk plough for one time, only 02 farmers (3.4%) use disk plough for 02 times, and the leftover 24 farmers remained silent in indicating answers. Mechanised farmers, on the average, utilise disk plough 1.21 times and the non-mechanised farmers 0.62 times (halftime of mechanised farmers).

Responses of mechanised and non-mechanised farmers in the sampled area, regarding how many times rotavator and any other ploughing equipment used by them has shown in Table 2(b). In mechanised farming, 28 farmers (23.9%) reported that they use rotavator 01 times before cultivating crop, 12 farmers (10.3%) reported that they use rotavator for two times before cultivation of crop, 30 farmers (25.6%) told that they use rotavator for 03 times before cultivation of any crop, and the remaining 47 farmers (40.2%) did not answer.

Among non-mechanised farmers, 38 farmers (65.5%) answered that they utilise the said tool for one time before cultivation, 02 farmers (3.4%) told 02 times to use of rotavator, and the remaining 18 non-mechanised farmers (31%) show no reply in the questionnaire. The average time use of rotavator under mechanised and non-mechanised farming are 1.21 and 0.72 respectively.

In the last portion of Table 2(b), responses of sampled farmers have summarised that how many times they use other tools for land preparation. Under mechanised farming, 28 farmers (23.9%) tell that they use other tools before cultivating crop for one time and their replies for more than one times were nil. Similarly, 36 non-mechanised farmers (62.1%) reply that they use other tools before crop cultivation only for one time and their answers for more than one time were also nil. On the average, mechanised farmers use other equipment of ploughing before cultivation for 0.24 times non-mechanised farmers use other tools before cultivation is 0.62 times, almost greater than the double time of mechanised farming.

Table 3: *Summary of regression coefficients and T-tests for the wheat crop.*

Variables	Coefficient	T test	Level of sognigicance
Intercept	0.677	0.123	0.903
Farm size (X_1)	16.783	18.817	0.000
Man days (X_2)	0.227	8.136	0.000
Fertiliser (X_3)	1.326	2.467	0.015
Insecticide (X_4)	0.129	0.133	0.894
Dummy variable (D_5)	10.631	5.847	0.000

R: *0.986,* **Adjusted R square (R^2):** *0.972.*

Table 4: *Summary of regression coefficients and T-tests for the maize crop.*

Variables	Coefficient	T. test	Level of significance
Intercept	0.709	0.132	0.895
Farm size (X_1)	15.844	18.313	0.000
Man days (X_2)	0.245	9.065	0.000
Fertiliser (X_3)	1.703	3.268	0.001
Insecticide (X_4)	0.082	0.087	0.931
Dummy variable (D_5)	11.156	6.325	0.000

R: *0.973,* **Adjusted R square (R^2):** *0.972.*

Diagnostic tests

Before proceeding to the estimation of the production function for the two crops, the following diagnostic tests conducted.

The overall model was checked and was observed from the F-test that it is significant and the same is also confirmed by the value of R^2 i.e. 971 which means that 97% change in dependent variable of both crops (wheat and maize) is explained by the independent variables in the model. For further clarification, three diagnostic tests, i.e. multicollinearity, heteroscedasticity and normality were conducted.

For diagnoses of multicollinearity in both crops, the values of variance inflationary factor (VIF) were observed, and these values reflect that there is no serious case of multicollinearity as the VIF values of all independent variables are less than 10.

The model was also checked for the presence of heteroscedasticity of both crops, using the White's test and was observed from the P values that this is equal to 0.000 and shows that the same exist in the data. It means that null hypothesis of homoscedasticity rejected and the alternative hypothesis of heteroscedasticity accepted. For eliminating heteroscedasticity, White's suggestion was used and the model re-estimated, using the robust standard error. It was found that the presence of heteroscedasticity removed.

In order to check normality of the response variables, i.e. production of wheat/maize, Kolmogorov-Smirnov test was used and showed that the response variables are not normal, i.e. P =0.000. Therefore, logarithms of both crops were taken and again checked for normality using Kolmogorov-Smirnov test, and it was confirmed that logarithms of both crops were normally distributed. i.e. P > 0.05.

Estimation of the production function for wheat crop

Production function for the wheat crop estimated as under;

Expression 1:

$$Y_i = 0.677 + 16.783X_1 + 0.227X_2 + 1.326X_3 + 0.129X_4 + 10.631D_5$$

(0.123) (18.818) (8.136) (2.467) (0.133) (5.847)

In above expression 1, the amount of wheat production (Y_i) is determined by above five inputs including area under wheat crop(X_1), man-days (X_2), amount of fertilizers (X_3), amount of insecticide (X_4), & dummy variable (D_5) and their respective elasticities are 16.783, 0.227, 1.326, 0.129, and 10.631. The intercept shows that if the above all inputs except farm size (X_1), i.e. (X_1>0), kept zero, the amount of wheat is 0.677 mound per acre. Stated differently, the elasticity of each input shows the rate of change in total production due to the change in respective inputs. It can be inferred from the elasticities that farm size (X_1), man-days(X_2), fertilizer(X_3) and dummy variable (D_5) are highly significant determinants at 5% level of significance and therefore contribute enough in wheat production and the same is reflected by the respective t-values or (P values) in parenthesis. However, the function of insecticide (X_4) is not much significant as shown by its relevant t-value, i.e. 0.133. The possible reasons for the insignificance of insecticide may be due to insufficient doses used by the farmers, and/or substandard qualities of this input as reported by several farmers. The summary of regression coefficients and t-tests has portrayed in the following Table 3.

Estimation of the production function for the maize crop

Production function for the maize crop has estimated as under;

Expression 2:

$$Y_i = 0.709 + 15.844X_1 + 0.245X_2 + 1.703X_3 + 0.082X_4 + 11.156D_5$$

(.132) (18.313) (9.065) (3.268) (.087) (6.325)

The above production function (Expression 2) of maize crop explains that the production of maize (Y_i) is determined by five independent variables, i.e. area under maize cultivation (X_1), man-days (X_2), amount of fertiliser (X_3), amount of insecticide (X_4) and a dummy variable (D_5). The relevant elasticity of area under crop (X_1) is 15.844, man-days (X_2) have the elasticity of 0.245, amount of fertilisers (X_3) have the elasticity of 1.703, amount of insecticides (X_4) have the elasticity of .082 and the dummy variable has the elasticity of 11.156. In other words, it can be stated that the degree of elasticity of each input reflects the rate of change in production of the maize crop. Furthermore, the coefficient of each input shows the amount of contribution that it will bring in the amount of total maize crop. The coefficients further portray that the most significant variables in the model are; area under maize crop, man-days, fertilisers, and dummy variable and the variable, insecticide, is not much significant and these can be seen from their respective t-tests as given in parenthesis. The possible reason(s) for the insignificance of insecticide has stated above under wheat crop. Here the intercept takes the small value and is equal to 0.709, but it is not required because it conveys a meaningless sense. All the above figures have been summarised in the following Table 4.

Yield per acre of wheat and maize crops

According to the furnished information, yield per acre of wheat and maize crops of mechanised farmers in the sampled area is 26.62, 25.78 mounds and those of non-mechanised farmers are 25.32, 25.23 mounds respectively. The differences in the output of the stated crops among mechanised and non-mechanised farmers are 1.3 (5.13%), 0.55 (2.17%) mounds respectively. These differences show that the average output of the former class is somewhat greater than the later class and the same has been summarised in the Table 5.

Average man-days required for wheat and maize (per crop/per acre)

The data shows that there are many differences in man-days required for completion of all stages of both crops (including all activities from ploughing to threshing and then delivering home/store) in both types of cultivation. The number of man-days required for wheat and maize crops is 7.68 and 9.82 for the mechanised farmer and 26.91 and 22.7 for non-mechanised farmers respectively. The differences between the two types of cultivation for both wheat and maize crops in terms of man-days are 19.23 (250.39%) and 12.88 (131.16%) respectively. In other words, these differences in man-days explain that non-mechanised farmer will need a greater amount of the said days than a mechanised farmer or stated differently, the mechanised farmer will need a lesser amount of the said days than a non-mechanised farmer. These differences in a number of man-days (time) reflect that mechanised farming can save human along with animal power and can be conceived as a soul of mechanisation. This factor enables farmers to complete agricultural activities well in time, and they may sacrifice this time to another aspect of life like business, education, social values etc. The man-days required for each crop and their differences under mechanised and non-mechanised farming are presented in the following Table 6.

Table 5: *Yield per acre of wheat and maize crops.*

Type of farming	The yield of wheat per acre (in mounds)	The yield of maize per acre (in mounds)
Mechanised	26.62	25.78
Non-mechanised	25.32	25.23
Differences	1.3 (5.13%)	0.55(2.17%)

Source: *Field survey.*

Table 6: *Average man-days required for wheat and maize crops (per crop/acre).*

Type of farming	Man-days for the wheat crop	Man-days for the maize crop
Mechanised	7.68	9.82
Non-mechanised	26.91	22.7
Differences	19.23 (250.39%)	12.88 (131.16 %)

Source: *Field survey.*

Summary

It was proposed to observe the impacts of farm mechanisation on crops productivity in Peshawar valley. This valley consists of five districts including Peshawar, Charsadda, Mardan, Nowshera and Swabi. Out of these five districts, three districts, i.e. Peshawar, Charsadda and Nowshera randomly selected, followed by a selection of three villages from each district on the same selection basis. In this way, nine villages were randomly selected by simple random sampling. Proportional sampling technique was used for the selection of 175 farmers from these nine villages @ of 20% sampling. Out of these 175 farmers, 117 farmers turned out mechanised farmers and the remaining 58 farmers turned out non-mechanised.

Although mechanised farmers perform their farming activities through machines (tractor) but only 4.3% have their own tractors and the remaining 95.7% farmers rent tractors. Contrarily, 29.3% non-mechanised farmers have their own animals for cultivation, 36% farmers hire animals on rent, and the remaining 34.5 % farmers did not respond. Mechanised farmers, on the average, plough their farms 2.18 times and non-mechanised farmers 1.38 times before cultivating crops.

The average (per acre) output of mechanised farmer in wheat and maize crops are 26.62 and 25.78 mounds respectively, and those of non-mechanised farmers are 25.32 and 25.23 mounds respectively. The average number of man-days required for wheat and maize crops (per crop/acre) under mechanised farming are 7.68 and 9.82 and those for non-mechanised farming 26.19 and 22.7 respectively. The doses of fertilisers and insecticides, used by mechanised and non-mechanised farmers are about the same and therefore no need to compare.

Conclusions

The following sample results, which may be used to infer the population characteristics, have been noted. A large number of both types of farmers are neither completely mechanised nor completely non-mechanised. Only 4.3% mechanised farmers have their own tractors and the remaining 95.7% rent tractors for performing their agricultural activities. Similarly, 29.3% non-mechanised farmers have their own animals for cultivation activities, and the rest of the same class hire the services of rented animals for farming. By observing the difference of productivity factor between mechanised and non-mechanised farmers in the two crops, it is concluded that the former class is to some extent better than the later one. The brightest aspect of mechanisation is the time-saving factor that enables them to invest the saved time in some other economic, educational and social activities. It can be concluded from this research study that the adoption of mechanisation support contribution view, regarding productivity and another aspect of socio-economic development. The role of insecticides and pesticides is not significant in the two stated crops, and the same insignificance may be due to two or a combination of two possible reasons. First, the farmers do not use the required doses and quantity of pesticides, because of their high prices. And/or second, several farmers complained that the qualities of the said inputs are questionable.

Recommendations

In light of the above-conducted study, the following recommendations are forwarded for increasing agricultural productivity.

The government is required to formulate policy to provide agricultural inputs at subsidised rates. In this connection, steps taken by the present Federal Government of Pakistan in form of "Agriculture Relief Package" (2015) including reduction in prices of fertilizer, electricity, free interest loan facility for the installation of solar tube-well, reduction in taxes on the import of (or purchase of local) agricultural machinery, exemption of withholding taxes on production/ supply of fresh milk, poultry and fishes are highly significant. Furthermore, increase in loan lending amount and making loan lending process easier etc. are also highly appreciable. The government should ensure the provision of quality insecticides and pesticides through their concerned department. There is a need to reform irrigation system in the study area, particularly river Swat and Doaba canal should be renovated to supply water to Charsadda district. For irrigation purpose, loans for installations of solar tube well at zero interest and returning of the loan in instalments should be helpful. There is a need that the government should further concentrate on the extension of Farm Access Market Road (FARM). There is a need that the incentives (in any form) should be delivered to deserving farmers irrespective of their political affiliation to any political party.

Author's Contribution

Rehman-Ud-din: Main investigator of the study who presented the idea, conducted research and wrote the manuscript.

Naeem-Ur-Rehman Khattak: Supervised the project and study, provied full technical support and revised the manuscript.

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