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Impact of Certified Wheat Seeds on Food Security: A Case Study of Karak, KP, Pakistan

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Abstract: *Wheat is a major food crop in the study area. However, wheat yields continue to remain very low in this region mainly due to the use of poor-quality seed. The purpose of this study is to explore the impact of certified wheat seeds on food security, a case study of district Karak (Khyber Pakhtunkhwa) Pakistan. The multistage sampling technique was applied to collect data from 100 formers through a face-to-face interview, and a well-structured questionnaire was used to collect information from the respondents. Analysis of Covariance (ANCOVA) was used to determine the factors that influence household food security. The results of our study revealed that certified seed, age, access to credit, irrigation, education, off-frame employment, livestock size, and operated area have a positive and significant impact on household food security, but household size has a negative and significant effect on household food security. The policies should be set to promote the use of the certified seed, enhance the level of education, increase the irrigated area, and foster employment opportunities as they have a significant impact on food security. This study also recommended that government and non-government agencies should intensify efforts on the importance of family planning and advocate small family size in rural areas.*

Key Words: Certified Wheat Seeds, Food Security, Karak, Pakistan, Analysis of Covariance

Introduction

The words "food security" and "food insecurity" are used to describe whether households have access to an adequate amount and quality of food or not. Food security issues first came to the forefront of the public consciousness in the 1970s. At the global, national, family, and individual levels, people have different perspectives on what constitutes food security. Food safety at the international level is not necessarily synonymous with food safety at the National Level. In addition, the presence of food security at the national Level does not necessarily imply the presence of food security at the household or even the individual Level. Up until very recently, the agricultural sector of Ghana's economy was by far the most important contributor to the country's GDP. Despite the fact that it is the second greatest contributor to the nation's GDP after the service sector, the agriculture industry is characterized by poor productivity and weak competitiveness. This is because most production units in the sector are focused on subsistence and smallholder agriculture, and most of them use basic and low-level technologies (Duffour, 2010).

The concept of "food security" refers to a situation in which "all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life." This is the commonly accepted definition of the term (FAO, 1996). In light of this, the nutritional aspect is an indispensable part of the food security component (FAO, 2009). Access to food is another aspect of food security that is both safe and nutritious, which is essential for leading an active and healthy life. In order to lead an active and healthy life, the human body must be able to make efficient use of the nutrients that are provided by the food that it consumes (Staaz et al., 2009).

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The most important problem that the world must help address right now is ensuring that millions of households that are currently living in poverty have access to sufficient food in order to lead healthy lives. The pursuit by world leaders, over the course of many years, of a solution to the issue of food insecurity has been an ongoing one, and it has appeared to be the topmost priority in their discussions at every opportune summit (Omotesho, Adewumi, and Fadimula, 2010). It is reported that the global number of food insecure or undernourished people has increased over the years from 848 million in 2003 to 2005 to 925 million in 2010 (FAO, 2010). Presently, emerging nations are confronted with two significant obstacles, namely guaranteeing food security and reducing poverty. The development of agricultural output is seen as essential for enhancing the well-being of small-scale farmers in these nations. Because of their rapidly expanding populations and scarcity of farmable land, developing nations may have little choice but to resort to technological solutions if they hope to feed their people and create new agricultural jobs. The rapid uptake of high-yield crop types by both large and smallholder farmers is predicted to provide a boost to agricultural output, which in turn can help alleviate poverty and improve food security for those living in rural areas (Moyo et al. 2010)

Due to the country's rapidly increasing population, guaranteeing food security has been one of the government's top objectives. As a result, policymakers in Pakistan have been working hard to create sound food policies that would help them reach their objective (Tariq et al. 2014). However, poverty and the risk of food insecurity have both risen in many parts of Pakistan during the past few years. A little over 12% of the population in the Potohar district, for instance, is chronically food insecure, while a further 38% is on the verge of food insecurity (Abbasi et al. 2014). To achieve the United Nations' second sustainable development goal to end world hunger, improve nutrition and food security, and promote environmentally friendly agriculture, crop yields need to increase in a number of places, including Pakistan (Akram et al., 2018).

Agriculture is Pakistan's primary source of both food security and the ability to meet its growing population's nutritional needs, despite the fact that Pakistan is a developing nation with a low per capita income. While the growth rate of cultivated land is comparatively very low and the urban population is increasing, which results in pressure on cultivated land, the current rate of population growth will cause the population to double in the year 2050 if the trend continues as it is. Wheat is the most important staple food, and a significant amount of it is still imported. Given all the facts, the country needs to slow down the rate of population growth and improve technology so that it can grow more food at home. This will reduce the gap between the amount of food that is needed and the amount that is available (Ahmad & Farooq, 2010).

The country's staple food is wheat, but until recently, it only fulfilled 80 percent of its consumption demands; the rest was imported at a significant foreign exchange cost. The total amount of cereals and pulses produced increased by 10 million tons between 1999–2010 and 2011–2012, from 30 million tons to 40 million tons (Pak Economic Survey, 2012). Pakistan ranks eighth in the world in wheat production with 23.5 million metric tons, while its wheat yield per hectare is thirty-first in the world at three metric tons per hectare (FAO 2010). There is a substantial difference between the existing wheat yields in Pakistan and the yields that may be obtained with enhanced crop production techniques. This difference can be decreased by providing farmers with more access to certified seeds (Gill 2002).

Given their central role in plant reproduction, seeds are without question the single most important agricultural input for increasing crop yields. Kazakhstan is the world's leading wheat producer, and the country's government has been pushing for increased technical efficiency among farmers by promoting the use of certified seeds. The uniformity and quality of the processed seed are substantially greater than those of traditional (non-certified) seed, so it is hoped that this initiative will assist farmers in producing a healthy and abundant harvest (Baglan et al. 2020). Seed is one of the most important inputs for increasing crop yield and, as a result, ensuring food security. It is possible to significantly increase the yield potential of a crop by increasing the quality of the seeds used in its production. It plays an essential part in guaranteeing the safety of food supplies and contributing to the expansion of the economy as a whole. The provision of seed is one of the agriculture sector's most cost-effective and productive forms of investment (FAO, 2006).

The Karak District is largely rain-fed and is located in the dry zone of the province. The district is divided into two different zones based on rainfall, temperature, and the texture of the soil in each area. One of these is the Thall Zone, sometimes known as the Thall Area, which is characterized by little rainfall and high temperatures. This zone is located in the District's extreme southwestern corner. Sand is the only component of the soil, and the majority of the cultivable land and agricultural yields are dependent on rainfall. However, in some union councils, such as Jahangiri and Chokara, irrigation tube wells and dug wells have been constructed by the public sector. During the months of June and July, the temperature in the Thall region can reach as high as 42–46 degrees Celsius.

The central and north-eastern areas of Tehsil Karak, which are collectively referred to as Chontra, as well as the whole area of Banda Daud Shah Tehsil, make up the second zone. The annual average rainfall ranges from 500 millimeters to 750 millimeters, and the soil consists of medium clay loam. All kinds of agricultural, vegetable, and fruit plants must have access to enough irrigation water at the right times in order to grow well. In the production of grain crops, the Karak District likewise possesses a major competitive advantage similar to the one it possesses in the horticultural industry (wheat, maze, barley, ground nuts, pulses, gram, etc.). Maize, pearl millet (bajra), sorghum, and ground nuts are the primary agricultural products harvested during the Kharif (monsoon) season. While Rabi crops, which are grown in the spring, include wheat, chickpeas, barley, and mustard. The lack of access to potable water presents the most significant challenge for people living in Karak and the surrounding area. Horticulture is therefore lacking over the entire district. Nevertheless, horticulture is something that can be grown in a region if there are water resources available for irrigation. Karak is a dry region in the southwest of KP that is well-known for the Sisyphus trees (Ber) that grow there because of the region's distinctively dry terrain. Honey is produced in large quantities throughout Karak. Sisyphus (Ber) and Phulai are the two native plant species that contribute the most significantly to honey production (Acacia). As a result of the many positive effects that honey has on one's health and its high level of quality, it is widely sold in markets at both provincial and national Levels.

This study will investigate the effects of certified wheat seeds on food security in the Karak district. Although several research works related to food security have been conducted, there has been a debate among researchers and policymakers about the use of certified or uncertified seeds. The literature highlights that countries with a strong agricultural sector employ certified seeds during cultivation (Asiedu et al., 2006; Tanrivermiş & Akdoğan, 2007). This study will focus on the results of certified seeds in district Karak. There is a considerable lack of literature on certified seeds and food security in district Karak. Therefore, the study will fill this gap and will be a pioneering addition to the existing literature. In addition, the study includes some other important determinants (discussed in the description of the variables section) that make a significant contribution to food security but were ignored in previous studies.

Food security has been a central and far-reaching theme for many policy initiatives around the world. The countries of the world are highly dynamic and frantic in renewing their food security. Seed quality is a vital factor in crop yield potential and, therefore, essential for the advancement of agriculture. According to Shiferaw et al. (2011), developed countries produce several times more than underdeveloped countries, and one of the main factors is certified seeds. Certified seed is one of the most cost-effective and efficient inputs for agricultural development to improve food security, especially for an agrarian-based economy like Pakistan. In agricultural countries like Pakistan, food security needs to be ensured to stabilize the state's economy. Therefore, this study will focus on the impact of using certified wheat seeds on food security in Karak district, Pakistan. Karak covers a total area of 3372 square kilometers and has a population of 706,299 people. Roughly 49% of the population is male, while the female population makes up 51% of the total. Over the course of the previous 19 years, the region's population has increased by nearly 39%. Wheat is grown on 15308 of a total of 75,642 cultivated hectares, yielding 4,404 tons of wheat. The total cultivated area is 75,642 hectares (Govt. of Khyber Pakhtunkhwa, 2019). As Karak has a limited agricultural area due to the accelerated population increase, the use of certified wheat seeds has become a necessity over time to deal with this problem. Based on the empirical results, this study will ensure the implementation of meaningful policies for the region to improve food security and livelihoods of agricultural households. In light of the necessity of knowing the variables of production, the study will have the following significance: first, the results will offer the government and policymakers vital

information regarding the most influential elements of wheat output. Consequently, it will contribute to the development of appropriate policies and strategies for increasing wheat output. This data will also assist farmers in making decisions that will boost their yield. The document will also serve as a reference for researchers to embark on similar or related work in other parts of the country.

Literature Review

Abbas et al. (2007) investigated Pakistan's efforts to ensure its food supply by increasing wheat production. Their research incorporates both secondary data and primary data obtained from surveys conducted at the farm level and by government organizations in the state of Punjab. Their investigation aimed to identify the several factors that affect wheat output across the nation. The majority of farmers grow wheat later in the season, resulting in a lesser yield, according to the research. According to the authors, food security may be ensured by boosting agricultural production, with a particular focus on raising the output of small farmers, and by placing an increased emphasis on important wheat-growing regions.

Ali et al. (2015) examined the correlation between the availability of certified wheat seed to farmers and the poverty reduction rate in Pakistan. The major objective of this study was to identify and explore the characteristics that influence farmers' access to certified seed, as well as to assess the effects of this access on family income, poverty levels, and household food security in Pakistan. In 2012, a field survey was done in Pakistan's important wheat-producing districts in order to collect all of the necessary data for the study. Their findings have significant implications for public policy, including the need to increase farmers' access to certified wheat seed in order to increase wheat production and household incomes and reduce the prevalence of poverty. It is crucial to increase wheat output in order to feed Pakistan's population, which is growing at a rate of 1.8% annually.

Shah et al. (2020) conducted research on the adoption and economic effect of enhanced wheat varieties in rain-fed Pothwar in the Punjab province of Pakistan. Because wheat is the most important crop farmed in the rain-fed Pothwar region of the Punjab Province, the adoption of new technology has a substantial impact on the farmers' ability to maintain their standard of living. When compared to the costs of generating seeds of traditionally used varieties, the costs of producing seeds of improved kinds per kilogram are much cheaper, and the returns on investment are nearly twice what they are. According to their findings, the adoption of enhanced varieties is strongly advised, and it has a major beneficial influence on the farmers of the region that was researched.

Rose and Adil (2021) investigated the variables that influence food security and nutrition expenditures in agricultural families in the Punjab province of Pakistan. According to the findings of their research, the Level of education of the head of the household, the number of people living in the household, the variety of crops grown, the amount of time spent on farming activities, and the size of the farm are significant factors in determining whether or not farming households live in poverty. Their findings also demonstrated that smaller farmers spend a lower proportion of their income on nutrient-rich foods than larger farms do. According to the results of their research, having different cropping patterns led to increased levels of food intake among farmers.

Zohu et al. (2019) analyzed research on the variables that influence the food security of rural households in the northern region of Pakistan. In order to assess the elements that contribute to food insecurity in households, the author used a method called binary logistic regression. According to the findings of the research, major characteristics that determine whether or not a family is food insecure include age, gender, education level, remittances, unemployment rate, inflation rate, assets, and sickness.

Nkomoki et al. (2019) conducted research in Zambia to investigate the elements that are connected with household food security. Their findings show that policies supporting livestock development initiatives, such as empowering farmer organizations, boosting land tenure security, and training farmers in animal husbandry, have the potential to increase the food and nutrition security of home households.

Asghar and Salman (2018) investigate the effect that agricultural financing has on the country of Pakistan's overall food production and food security. According to the findings of their investigation, the output of the borrowers improved after making use of the loan due to the increased use of high-quality agricultural inputs. In addition, the researchers came to the conclusion, based on their findings, that removing financial barriers leads to an increase in output, which in turn may further alleviate food

insecurity by making sure there is enough food for everyone. Their research is also important for policymakers in formulating and improving food security policy by strengthening credit markets. This is made possible by the findings of their research.

The impacts of agricultural financing on the wheat production of small farms were investigated by Chandio et al. (2018) in the Sindh province of Pakistan. According to the findings of their research, agricultural credit has a favorable and very significant influence on wheat production. Additionally, their research shows that short-term loans have a more substantial impact on wheat output than long-term loans do.

Sani et al. (2014) conducted research to investigate the influence that non-agricultural sources of income have on the Level of food security experienced by rural households in Nigeria. According to the findings of the descriptive statistics, 66.64 percent of the families had farming as their primary employment.

Methodology

Nature of the Study

The research is quantitative in nature, and primary data was used.

Study Area

This study was carried out in the Karak district. It is 123 kilometers from Peshawar, the province's capital. It is situated on the main Indus Highway between Peshawar and Karachi, south of Kohat District and north of the Bannu and Lakki Marnat districts. It experiences hot, dry weather with average highs of 28 C and lows of 15 C with an annual rainfall total of 504 mm. The district covers a total size of 3,372 sq km. The district's total area under irrigation is 14850 hectares, of which the canal waters 5753 hectares, 1982 by tube wells, and 5513 hectares by other irrigation methods (crop statistics, Khyber Pakhtunkhwa, 2019). The district has 706299 residents in total. 655150 people live in rural areas, making up 92.8% of the district's total population, and 51149 people live in urban areas, making up 7.2%. There are 349433 males, 356863 females, and three shemale/transgender people in the entire population. From 1998 through 2017, the average yearly growth rate was 2.63 (Provincial Census, 2017).

Population of the Research

The whole farming community in Karak district is the target population. The district of Karak's three tehsils provided the data. The information was gathered from farmers in the district's three main crop-producing tehsils, Karak, Takhti Nasrati, and Banda Daud Shah, who used both traditional and certified wheat seeds. Consequently, gathering the data needed to analyze under-reference research is possible.

Sampling Technique

Data from all farms were gathered using a multistage sampling procedure. District Karak was purposefully chosen in the first step, and all tehsils were chosen in the second. The district agriculture office provided information on the formers who used certified seeds. The Yamane formula (1967) was used to figure out how many people to include in the study.

$$n = \frac{N}{1 + \mathrm{N(e)2}}$$

N stands for the total population, e stands for sampling error, and n represents sample size. The district agricultural office in Karak provided information on the total number of farmers. The local agricultural office reported that there were 5700 farmers who had registered as farmers overall. Using the aforementioned formula, 100 farmers were randomly selected as a sample from the entire population.

Data Sources

The current study employed primary data to analyze the impact of certified wheat seeds on food security, a case study of district Karak. Field observations, interviews, and a standardized farmer questionnaire were used to gather the information. The researcher visited their field and inquired verbally and through a

questionnaire about their agricultural production, usage of basic agricultural inputs, and certified seeds. The secondary data was collected from the local agricultural office Karak and the Bureau of statistic Department in Khyber Pakhtunkhwa.

Data Analysis Technique

Multiple regression technique was used to estimate the impact of certified wheat seeds on food security. In Equation 1, food security was taken as the dependent variable, and certified seeds, operated area, Access to credit, Irrigated area, Livestock size, Off-farm employment, Age, Education, and Household size were used as independent variables.

Empirical Model

In order to check the impact of certified wheat seeds on food security, the following model is used

$$FSi = \beta_0 + \beta_1 Dcer,i + \beta_2 logoai + \beta_3 Dac,i + \beta_4 Dir,i + \beta_5 loglsi + \beta_6 logofei + \beta_7 logagei + \beta_8 edui + \beta_9 loghsi + ei \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where FS denotes Food security (Per capita food consumption of household measure in PKR will be used as a proxy). B_0 is constant, B_1, B_2 up to B_9 are coefficients, cer denotes the use of certified seeds, oa represents operated area, ac is the access to credit, ir denotes irrigated cultivated area, ls represents total number of livestock of the household, ofe denotes number family member participates in off farm activity, age represents age of the respondents in years, edu denotes years of schooling of the respondent, and the hs represents total number of family members.

Table 1

Description of variables

Independent variable		
Certified wheat seeds (cer):	Certified seed is defined as seed that has passed an inspection and seed testing process regulated by government agencies and meets those specified variety standards	1 if household uses certified wheat seed, 0 otherwise
Operated area (oa):	The operated area is the area on which it is being used for cultivation.	Acres
Access to credit (ac):	Access to agricultural credit	1 if household have access to credit, 0 Otherwise
Irrigated area (ir):	Irrigated agricultural area refers to an area equipped for irrigation.	1 if cultivated area is irrigated, otherwise 0
Livestock size (ls):	It is the total number of livestock of the household	Number
Off-farm employment (ofe):	Off-farm employment is defined as those activities which helps to receive cash money from any non-agricultural activity.	In PKR
Age (age):	Age is a period of farmer, measured by years from birth.	In years
Education (edu):	Respondent's number of years of education Completed	In years
Household size (hs):	Household size is the number of persons (irrespective of age) living as an economic unit	number

Note: PKR stands for Pakistani rupee, the national currency of Pakistan

Estimation Techniques

In order to find the relationship between food security and certified wheat seeds, statistical analysis was carried out using SPSS version 25. ANOVA and ANCOVA approaches have been used for empirical investigation.

Tests for Diagnostics

The following diagnostic tests were used to check for and eliminate Multi-collinearity, Heteroscedasticity, and Autocorrelation issues.

Test for Normality

Shapiro-Wilk and Kolmogorov-Smirnov tests were employed to determine whether the population was normal.

Test for Multi-collinearity

The explanatory variables in a traditional linear regression model are assumed to be independent of one another (Guajarati, 2006). Multi-collinearity was examined using the variance inflation factor (VIF) and the tolerance test.

Homogeneity of Regression Coefficients

When a regression coefficient is homogeneous, all independent variable values must have the same effect on the dependent variable. In other words, all groups' variances are equal. Levene's test was employed to confirm the homogeneity of the variance.

Test for Heteroscedasticity

The variance of the error term must be constant due to heteroscedasticity. The Breusch-Pagan test was used to determine whether or not the model had heteroscedasticity.

Removal of Heteroscedasticity

White's robust standard error test was employed in demand to eliminate the problem of heteroscedasticity.

Test for Autocorrelation

The conventional linear regression model assumes that error terms are independent of one another. The Durban-Watson test was used to examine the autocorrelation issue.

Results and Discussion

Descriptive Statistics Analysis

The descriptive statistics of the variables chosen are presented in Table 2. The purpose of descriptive statistics is to provide information about the fundamental aspects of the data. It contributes to a better understanding of the basic properties of variables. The required information regarding the variables that were employed in this research can be found in Table 2. This includes the mean, median, maximum value, minimum value, and standard deviation. In statistical terminology, the mean value is also referred to as the average value of the data. The value that divides the lower half of the data from the upper half is referred to as the median. Since it tends to fall somewhere in the middle of the data, the data has to be ordered either ascending or descending in order to accommodate it. According to the findings of this study, there is no indication of an outlier in the data. This is due to the fact that there is no significantly different value between the mean and the median for any of the variables. A value that indicates a significant and unequal deviation of other values in a data set from its mean value is referred to as an outlier. The standard deviation can be thought of as an estimate of how far the data are from their mean value.

Table 2

Descriptive statistics

Variables	Mean	Median	S. deviation	Max	Min
Per capita consumption	3434.4	3385.0	635.58	3510	2180
Certified seed	0.509	1	0.502	1	0
Irrigation	0.583	1	0.495	1	0
Credit access	0.35	0	0.479	1	0
Age	58.83	59.50	7.56	75.00	40

Variables	Mean	Median	S. deviation	Max	Min
Education	5.398	5.00	3.007	13	1
Operated area	7.62	7.00	2.947	14	2
Livestock size	9.064	9.00	3.27	22	4
Off farm employment	5.388	5.00	1.863	11	2
Household size	14.68	14.50	3.57	24	8

Source: Author(s) calculation

When possible, information was gathered from the head of the household or from a family member actively engaged in agriculture. The respondents' average age was 58.83 years, and their average education level was 5.39 years. The joint family arrangement was prevalent among the vast majority of the rural population. The average family contained 14.68 members. average off-farm employment of 5.388. As demonstrated by the average land size of 7.62 acres cultivated by respondents, farms dominate the research area. Pakistan is one of the world's most populous nations, and the present study reveals that respondents had huge families, with an average of 14.68 people. The respondents' land holdings of 7.75 acres show that small farms predominate in the research area. In addition, limited landholdings encourage farmers to diversify their incomes; therefore, the average number of cattle in the study is three.

Tests of Normality

To determine the normality of residual terms, the Kolmogorov-smirnov and Shapiro-Wilk tests are performed.

Table 3

Result of the normality test

Kolmogorov-Smirnova				Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Age	0.481	100	0.25	0.673	100	0.35
Education	0.635	100	0.33	0.404	100	0.21
Operated Area	0.577	100	0.31	0.712	100	0.37
Livestock Size	0.558	100	0.29	0.846	100	0.44
Off-Farm employment	0.673	100	0.35	0.481	100	0.25
Household Size	0.865	100	0.45	0.511	100	0.23
Certified Seed	0.827	100	0.43	0.673	100	0.35
Irrigation	0.538	100	0.28	0.615	100	0.32
credit access	0.500	100	0.26	0.651	100	0.30
per capita consumption	0.519	100	0.27	0.885	100	0.46

Source: Author(s) calculation

Table 3 displays the outcomes of a normality test performed on the chosen model. Null hypothesis: the population is normal, while alternative hypothesis: the population is not normal. If the p-value for the test of normality is less than 0.05, then the null hypothesis is rejected. Both tests for normality fail, with Kolmogorov-Smirnov and Shapiro-Wilk p values all higher than 0.05 thus we accept the null hypothesis. The premise of residual normality is thus adopted.

Multicollinearity Test Result

Multicollinearity is one of the econometric issues that arise when estimating a model. When explanatory variables are interconnected, we refer to them as multi-collinear. In the presence of multicollinearity, parameter estimates do not meet the BLUE property of the conventional linear regression model. A variance inflation factor (VIF) and a tolerance test are employed to determine whether or not multi-collinearity exists in the model.

Table 4
Results of VIF and tolerance tests

Variables	Tolerance	VIF
per capita consumption	0.783	1.276
Age	0. 746	1.339
Education	0. 660	1.514
Operated Area	0.717	1.394
Livestock Size	0.791	1.264
Off-Farm employment	0.762	1.311
Household Size	0. 670	1.491
Certified Seed	0.816	1.225
Irrigation	0.645	1.549
credit access	0.783	1.406

Source: Author(s) calculation

The results of the VIF and tolerance tests are shown in Table 4. The multi-collinearity issue will arise if the VIF value is more than 10. (Gujarati, 2006). If the VIF for a given variable is less than 10, it means that there is no multicollinearity in the model. The problem of multicollinearity arises if the tolerance value gets close to zero (Gujarati, 2006). There is no multicollinearity in the model because all of the tolerance values are greater than zero.

Homogeneity of Variance

In order to determine whether or not there is homogeneity in the variance, the Levene test is performed. If the significance value of the Levene test is greater than 0.05, then we accept the alternative hypothesis, which states that the variance is not homogeneous, and draw the conclusion that the null hypothesis is correct. The outcomes of the Levene tests are presented in Table 5 below. The p-value is greater than 0.05, which provides evidence in favor of our null hypothesis and leads us to the realization that the variance is maintained at the same level across the board.

Table 5
Results of Levene's test

F	Df1	Df2	P value
1.318	7	100	.250

H0: The variance of the dependent variable is the same among each group. Author(s)' calculations

Heteroscedasticity Test

The Breusch-Pagan test is used to assess the model's heteroscedasticity. If the p-value of the Breusch-Pagan test is less than 0.05, the null hypothesis of homoscedasticity is rejected, and the alternative hypothesis of heteroscedasticity is accepted.

Table 6
Breusch-pagan (BP) r3esult

Chi-Square	df	Sig
6.241	1	.012

H0: There is homoscedasticity. Source: Author(s) calculation

The p-value of the Breusch-Pagan test in Table 6 is less than 0.05, indicating that the model is heteroscedastic. The ANCOVA model with the heteroscedasticity-consistent variance test was designed to address the heteroscedasticity issue.

Autocorrelation Test

The Durban-Watson test is used to examine model 1's autocorrelation. If the value of the Durban-Watson test is 2, there is no autocorrelation in the model, while values of more than 2 indicate negative autocorrelation and values of less than 2 indicate positive autocorrelation.

Table 7

Durban-Watson test result

R	R square	Adjusted R square	Std. Error of the estimate	Durban- Watson
.75	.567	.55	11848.94	1.94

Source: Author(s) calculation

The outcomes of the Durban Watson test are shown in Table 7. The Durban-Watson test statistic of 1.94, which is near to 2, indicates that there is no autocorrelation in the model shown above.

Result of ANOVA

The analysis of variance (ANOVA) model is used to determine the significance of the model as a whole.

Table 8

Result of ANOVA

Model	Sum of squares	Df	Mean square	F- stat	P- value
ESS	3.530	9	.392	162.468	.000
RSS	.237	90	.002		
TSS	3.767	99			

Source: Author(s) calculation

To measure the overall significance of the regression model, an ANOVA test is utilized. The null hypothesis holds that the parameter estimate coefficients are all 0, indicating that our model does not measure the variability of the dependent variable. The F value in table 8 is greater than the F value in the table at the 5% significance level, thus we reject the null hypothesis in favor of the alternative hypothesis that the coefficients of parameters are not equal to zero.

ANCOVA Result

The findings of the ANCOVA model are presented in this section. Table 9 shows parameter estimates with reasonable standard errors.

Table 9

Parameters estimates with robust standard errors

	R	Robust Std. Error	T	Sig.
Intercept	6.005	.238	25.209	<.01
[Certified Seed=1]	.122	.010	11.601	<.01
[Irrigation=1]	.060	.011	5.500	<.01
[credit access=1]	.065	.010	6.368	<.01
Age	.508	.049	10.354	<.01
Education	.119	.009	12.828	<.01
Operated Area	.205	.018	11.552	<.01
Livestock Size	.239	.017	14.164	<.01
Off Farm employment	.013	.045	3.090	<.01
Household Size	-.426	.061	-6.950	<.01

Source: Author(s) calculation

The above results show the effects of explanatory variables on food security. The use of certified wheat seeds favorably and considerably affects food security. The results indicate that, given a certain set of agricultural inputs, adopters achieve wheat yields that are closer to the maximum possible yield than non-adopters. This will aid farmers in producing a healthy and abundant harvest, given that the uniformity of seed size and quality of the processed seed is far greater than that of ordinary, uncertified seed. The above results revealed that certified seed, age, access to credit, irrigation, education, off-frame employment, livestock size, and operated area have positive and significant impact on household food security, but household size have negative and significant effect on household food security.

Conclusion

This current research was conducted in one district (Karak) of KPK, Pakistan. Since wheat plays a vital role not only in the purpose of Pakistan's food insecurity but also in the country's sustainable economic and social development, the study's main purpose was to analyze the impact of certified wheat seed on food security in Karak, Pakistan. For the national analysis, the present study employed cross-sectional data collected from 100 wheat farmers during the production season of 2021. The study uses descriptive and econometric methods to analyze the data. Before the main econometric results, the current study used different tests to check the multi-collinearity, heteroscedasticity, and autocorrelation issues. The current study used the ANCOVA model to find the impact of certified seeds and farmer characteristics on wheat production. According to the findings, people who used certified seeds had less food insecurity than those who did not. However, a minor rise in the usage of factors, particularly financing and irrigation, goes hand in hand with these advantages. The results further revealed that farmer specific characteristics (age, education, operational area, livestock size, off-farm employment) influence positively food security and using certified seed, but household size has a negative impact on food security. This study concludes that certified wheat seed favors farmers' earnings and food security through increased productivity (yield). This study has generally led to the critical conclusion that there is a significant opportunity for using certified wheat seeds to boost wheat output in the Karak district. In order to increase the study area's food security, coordinated development initiatives that will increase wheat output and policy actions aimed at reducing current levels of inefficiency will be of utmost importance. The study further concluded that some factors of the farmer's influence (irrigation, credit access, age, education, operational area, livestock size, and off-farm employment) positively adopted certified seeds and boosted wheat productivity.

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