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Effects of COVID-19 on Agricultural Productivity of Farmers in District Dir Lower, Khyber Pakhtunkhwa

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Abstract

This study aims to examine the effects of COVID-19 on agricultural productivity of farmers in District Dir Lower. To the best of our knowledge, previous literature has ignored the impact of COVID-19 on agricultural productivity, and no empirical data have been collected in this regard in District Dir Lower. This study used multistage purposive and simple random sampling techniques for sample selection. Primary data were collected through interview schedules. A binary logistic regression model was applied to examine the effects of COVID-19 on the agricultural productivity of farmers. The results found that COVID-19 has significant effects on the agricultural productivity of the farmers in District Dir Lower. The study recommends that farmers should collaborate in groups to share farm inputs during the pandemic. Online marketing platforms should be established to increase farmers' access to farm inputs and connect with customers. Government and private sectors should provide financial aid and essential farm inputs to support farmers in increasing productivity. This study provides a unique perspective on the effects of COVID-19 on agricultural productivity in District Dir Lower, contributing valuable insight that has never or rarely been conducted previously.

Keywords: COVID-1, Agricultural Productivity, Binary Logistic Regression, Farmers Affected by Lockdown, Dir Lower.

INTRODUCTION

The coronavirus disease 2019 (COVID-19) was first discovered in China in December 2019 and has become a worldwide health problem. Due to its past transmission and widespread impact on nearly every aspect of life, the World Health Organization (WHO) announced the outbreak as a pandemic on March 11, 2020 (Agarwal et al., 2020). The coronavirus is transmitted through direct link with surfaces, touching, or respiratory droplets from sneezing and coughing. It poses a higher risk to people with weakened immune systems or those residing in densely populated areas (Eisenberg, 2020; Mandal et al., 2020). To control the spread of the coronavirus, strict measures including lockdowns, mass and travel restrictions, and maintaining social distancing were implemented by governments globally. These measures disrupted economies worldwide, causing uncertainty in various sectors, including agriculture. The agricultural sector is vital for over 1 billion people as a source of income, poverty

reduction, and access to food. The lockdowns have adversely impacted the entire agricultural productivity and supply chain from suppliers to customers. Lockdowns and travel bans have resulted in a shortage of workers and restricted access to essential farm inputs such as seeds and fertilizers, leading to a decline in agricultural production (Sridhar et al., 2023). The COVID-19 crisis has presented significant challenges, especially in developing countries, including Pakistan. Pakistan is an agrarian country where agriculture is crucial for economic development and essential for ensuring national food and nutritional security. It is the primary economic sector that provides employment to around 45 percent of the country's workforce. It contributes nearly 21 percent to the Gross Domestic Product (GDP) and accounts for approximately 60 percent of the country's exports (Syed et al., 2022). In Pakistan, the agricultural sector consists of major crops, minor crops, fishery, forestry, and livestock. The major crops contribute 18.23 percent to the value addition in agriculture and account for 4.18 percent of GDP, while minor crops contribute 14.49 percent to the value addition in agriculture and account for 3.32 percent of GDP. The fishery contributes 1.39 percent to value addition in agriculture and the share is 0.32 percent in GDP. The forestry contributes 2.23 percent in value addition to agriculture and provides 0.51 percent to GDP.

The livestock sector accounts for 62.68 percent of value addition in agriculture and contributes 14.36 percent to GDP (GOP, 2023). The agricultural sector holds equal importance for the people in District Dir Lower. The economy of the district is largely reliant on the agricultural sector and agri-based products. Around 46 percent of the population relies on this sector for their livelihoods (USAID, 2009). In Pakistan, the first positive case of COVID-19 was identified in Karachi on February 26, 2020, with another case reported the same day in Islamabad. In the span of about two weeks, the number of confirmed coronavirus cases increased to 20 out of 4,721 suspected cases. The maximum number of cases was recorded in Sindh with 14, followed by Gilgit-Baltistan with 5 cases, and Balochistan with 1 case. On March 15, 2020, District Dir Lower reported its first case of COVID-19, when a woman returned from Saudi Arabia after performing Umrah tested positive. This announcement caused widespread fear and concern among the local population (Ahmad & Jan, 2023). To curb the spread of the coronavirus, strict restrictions were imposed on public movement and transportation. Businesses, shops, and markets were closed, and farmers faced limited access to essential inputs for agriculture. Consequently, production levels declined, and farmers were unable to sell their produce, disrupting supply chains and severely impacting agricultural production. To investigate the effects of COVID-19 on agricultural productivity of farmers in District Dir Lower.

Hypothesis

- The COVID-19 lockdown has no significant impact on agricultural productivity of farmers in District Dir Lower.

LITERATURE REVIEW

Research conducted by Yamano et al. (2020) examined the influence of COVID-19 on farm families in Punjab, Pakistan. The study collected data from over 400 farmers in a cross-sectional analysis. Results showed that approximately one-third of the households experienced a decrease in their wages and earnings from nonfarm activities. Additionally, 22% of household members moved back to their rural homes from urban regions due to lockdowns and limited job opportunities. The lockdowns led to disruptions in the supply chain of horticultural products and milk, while the wheat

crop was relatively less affected. Abid and Jie (2021) analyzed the effect of the coronavirus on agricultural food security in Pakistan. The researchers observed an increase from 3-10% in severe food insecurity and from 13-30% in modest food insecurity among households, with 60% of households being food secure during the pandemic. Rural households recorded lower severe food insecurity with 8%, while it was 13% in urban households. The modest insecurity was 33% in urban regions and 30% in rural regions. Sindh recorded the most significant food insecurity while KP reported the lowest food insecurity.

Asegie et al. (2021) indicated the influences of COVID-19 on the rural population in Ethiopia. Data were collected from 275 respondents using a multiple-stage random sampling method through interview schedules. The findings showed that 97.4% of the respondents depend on crop production, 77.4% on livestock rearing, and 30.7% on livestock trading for their livelihoods. The study found that the pandemic had influenced the livelihoods of 88.89% of respondents with crop production being the most affected, followed by livestock rearing and trading.

Gatto et al. (2021) studied the effect of COVID-19 on rural people's livelihoods in Bangladesh. Panel data were analyzed from 2018 (pre-pandemic) and 2020 (post-pandemic) to assess the effects of the pandemic on livelihood outcomes. The results showed that government interventions during COVID-19 significantly affected the livelihoods of rural people. Fear of sickness had affected food security, decreased agricultural productivity, and reduced sales in markets, particularly for rice crops. Lower income decreased spending on food items, particularly on fruits.

Rasul et al. (2021) investigated a research on the socio-economic consequences of COVID-19 in South Asia. The authors noted that approximately 50% of the region's workforce is engaged in the agricultural sector for their livelihoods. To control the transmission of the coronavirus and protect human lives, measures significantly disrupted agricultural activities and hindered workers from working in the field. These disruptions affected the entire agricultural sector and its supply chain, including transportation, essential inputs, agricultural output, distribution, and consumption, resulting in disruptions in agricultural markets.

Streimikiene et al. (2022) exhibited the negative impacts of the COVID-19 pandemic on agriculture. The authors observed that COVID-19 has severely influenced the agriculture sector, leading to significant challenges in food safety and security. Government-imposed measures like mobility restrictions, reduced social interactions, and decreased purchasing power have threatened the stability of the food supply chain. Farmers have experienced losses, especially in fresh produce and dairy products, due to labor shortages.

The shutdown of restaurants and hotels reduced demand for agricultural products. The above discussion concludes that COVID-19 has a significant impact on agricultural production globally. Necessary measures to curb the transmission of the coronavirus have affected farm inputs, market access, transportation, and supply chains, thus impacting agricultural production. The influences of COVID-19 are equally felt in Pakistan including District Dir Lower. However, to our knowledge, no study has been conducted regarding the effects of COVID-19 on the agricultural productivity of farmers. The literature has ignored quantitative and empirical analysis in this regard. The present study assesses the effects of COVID-19 on agricultural productivity and aims to fill the gap from the local population's point of view.

MATERIALS AND METHODS

Study area

The study focuses on District Dir Lower as the study area, located in the Malakand Division of the KP province. The district is known for its fertile land and agricultural significance. According to the Government of Pakistan (2023), the total population of the district is about 1.65 million, with 51% females and 49% males, covering a total area of 1,583 km^2 and a population density of 1042.44 persons/km^2.

Sampling Techniques and Sample Size

The present study utilized multistage sampling techniques to purposively select District Dir Lower from 36 districts in KP due to its agrarian nature. Additionally, the researcher is from this district, which helps reduce financial and time constraints and is also familiar with the agricultural practices and conditions of the people. In the next step, three tehsils, namely Timergara, Balambat, and Adenzai, were purposively selected from seven tehsils for the study. The selection of these tehsils was based on their high population density, vast cultivated areas, and easy accessibility. Following this, two village councils were chosen from each of the three selected tehsils. In Tehsil Adenzai, village councils Badwan Bala and Tendodog were selected. In Tehsil Balambat, village councils Hajiabad and Odigram, and in Tehsil Timergara, village councils Amlook Dara and Nasafa were selected. The selection of village councils is also based on purposive sampling due to the fact that the majority of the people in these village councils are engaged in the agricultural sector. Snowball sampling was applied to determine the sample size. Initially, 4-5 farmers were selected based on referrals from relatives, friends, community leaders, and the Village Council (VC) chairman. The initially identified farmers recommended more farmers until the saturation point was reached. At the saturation point, a total of 938 farmers were identified, representing the total population in the research area. Finally, the proportional allocation technique was employed to randomly select 265 farmers from the total population. The sample size was calculated using Yamane's formula, as shown in Equation 1 as follows.

$$n = \frac{N}{1+N\,(e)^2} \quad \text{..... (1)}$$

Where:

n = Total sample size

N = Total farmers

e = Margin of error (5%)

Substituting the values in Equation 1, the total sample size is calculated as follows:

$$n = \frac{788}{1 + 788\,(0.05)^2} = 265$$

The formula for Proportional Allocation Technique is represented by Equation 2.

$$n_i = \frac{N_i}{N} \times n \text{..... (2)}$$

Where:

n_i = Sample size in each village council

N_i = Total farmers in each village council

N= Total farmers

n= Total sample size

The sample size from each village council is detailed in Table 1.

Table 1.
Sample Size by Village Councils

Village Councils	Total Farmers	Sample Size
Badwan Bala	156	156/788 × 265 = 52
Tendodog	128	128/788 × 265 = 43
Hajiabad	140	140/788 × 265 = 47
Odigram	124	124/788 × 265 = 42
Amlook Dara	110	110/788 × 265 = 37
Nasafa	130	130/788 × 265 = 44
Total	788	265

Source: Authors' Estimation

Data Collection Tool

The current study is based on primary data collected through interview schedules. The data were collected from selected farmers who served as the data source. The data collection period spanned one year from May 2020 to May 2021. The data were collected regarding the socio-economic features of farmers and the influence of COVID-19 on their agricultural productivity.

Data Analysis

The data collected from the sampled farmers were analyzed using SPSS. The study utilized descriptive as well as inferential statistics. In descriptive statistics, percentages and frequencies were calculated, while in inferential statistics, a binary logistic regression model was employed to assess the effects of COVID-19 on the agricultural productivity of the farmers as outlined below.

$$logit\left(P(Y=1)\right) = \ln\left(\frac{P(Y=1)}{1-P(Y=1}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + D_1 X_1 + D_2 X_2$$

Where:

P(Y = 1) = Probability of agricultural productivity affected by COVID-19

ln (p(Y=1)/1-p(Y=1) = Logit or log odds of agricultural productivity affected by COVID-19

X_1 = Family size of respondents (No. of family members)

X_2 = Farm size of respondents (Kanals)

X_3 = Livestock holdings of respondents (No. of animals)

D_1 = Dummy for farmers (1 = mildly affected by lockdown, 0 = not affected)

D_2 = Dummy for farmers (1 = highly affected by lockdown, 0 = not affected)

β_0 = Intercept of the model

β_1, β_2, β_3, and β_4 = Coefficients of the model

RESULTS AND DISCUSSION

Family size of Respondents

Family size has a substantial impact on agricultural productivity. A larger family size means more members can participate in farming activities, resulting in improved productivity. The relationship between family size and agricultural productivity is expected to be positive, while it may be negative when agricultural productivity is affected by pandemic. In the research area, respondents had various family sizes, and their distribution is presented in Table 2.

Table 2;
Distribution of Respondents by Family Size

Tehsils	Up to 5	%	6-10	%	11& above	%	Total
Adenzai	19	20	56	59	20	21	95
Balambat	28	31	47	53	14	16	89
Timergara	19	23	44	54	18	22	81
Total	66	25	147	55	52	20	265

Source: Authors' Estimation

Table 2 indicates that 55% of the respondents had a family size from 6-10 persons, 25% had up to 5 persons, and 20% had 11 persons and above. In the family size ranging from 6-10 persons, Tehsil Adenzai reported 59% of respondents, Tehsil Timergara 54%, and Tehsil Balambat 53%. For a family size of up to 5 persons, Tehsil Balambat recorded 31% of respondents, Tehsil Timergara 23%, and Tehsil Adenzai 20%. In the family size of 11 persons and above, Tehsil Timergara represented 22% of respondents, Tehsil Adenzai 21%, and Tehsil Balambat 16%.

Farm Size of Respondents

Farm size is significantly linked to agricultural productivity, with larger farm sizes generally producing more. The association between farm size and agricultural productivity is expected to be positive, although it may be negative when affected by COVID-19. The respondents have various farm sizes, and their distribution is displayed in Table 3.

Table 3.
Distribution of Respondents by Farm Size (Kanal*)

Tehsils	Up to 5	%	6-10	%	11& Above	%	Total
Adenzai	52	55	32	34	11	12	95
Balambat	37	42	36	40	16	18	89
Timergara	35	43	34	42	12	15	81
Total	124	47	102	38	39	15	265

Source: Authors' Estimation *1 Kanal = 0.125 Acre (Ahmad & Ahmad, 2024)

Table 3 illustrates that 47% of the respondents had a farm size of up to 5 kanals, 38% had 6-10 kanals, and 15% had 11 kanals and above. In the group of up to 5 kanals, Tehsil Aenzai represented 55% of respondents, Tehsil Timergara 43%, and Tehsil Balambat 42%. For 6-10 kanals, Tehsil Timergara accounted for 42% of the respondents, Tehsil Adenzai for 40%, and Tehsil Balambat for 34%. In the category of 11 kanals and above, Tehsil Balambat indicated 18% of the respondents, Tehsil Adenzai 15%, and Tehsil Timergara 12%.

Livestock Holdings of Respondents

Livestock plays an essential role in agricultural output, with a larger number of livestock mostly leading in higher productivity. The relationship between livestock and agricultural productivity is usually expected to be positive, although it may be negative when affected by COVID-19. The negative relationship indicates a positive outcome, leading to an increase in agricultural productivity for the farmers. In the research area, the distribution of the respondents based on livestock holdings is outlined in Table 4.

Table 4.
Distribution of Respondents Based on Livestock Holdings

Tehsils	Up to 5	%	6-10	%	11& Above	%	Total
Adenzai	53	56	34	36	8	8	95
Balambat	47	53	29	33	13	15	89
Timergara	44	54	32	40	5	6	81
Total	144	54	95	36	26	10	265

Source: Authors' Estimation

Table 4 shows that 54% of the respondents had livestock holdings of up to 5 animals, 36% had 6-10 animals, and 10% had 11 animals and above. In the group with up to 5 animals, Tehsil Adenzai reported 56% of respondents, Tehsil Timergara 54%, and Tehsil Balambat 53%. For 6-10 animals, Tehsil Timergara recorded 40% of the respondents, Tehsil Adenzai 36%, and Tehsil Balambat 33%. In the category of 11 animals and above, Tehsil Balambat indicated 15% of the respondents, Tehsil Adenzai 8%, and Tehsil Timergara 6%.

Farmers Affected by Lockdown

The farmers in the study area were interviewed to determine if they had been affected by the lockdown. If they answered "No," no further investigation was conducted. However, if they answered "Yes," they were further assessed to determine whether they were mildly affected or highly affected. The breakdown of farmers based on their level of effects from COVID-19 is highlighted in Table 5.

Table 5.
Distribution of Farmers Affected By Lockdown

Tehsils	Mildly Affected	%	Highly Affected	%	Total
Adenzai	34	36	61	64	95
Balambat	27	30	62	70	89
Timergara	26	32	55	68	81
Total	87	33	178	67	265

Source: Authors' Estimation

Table 5 shows that 67% of the farmers were highly affected, while 33% were mildly affected by COVID-19. In the group of highly affected farmers, Tehsil Balambat represented 70% of the farmers, Tehsil Timergara 68%, and Tehsil Adenzai 64%. In the group of mildly affected farmers, Tehsil Adenzai reported 36% of the respondents, Tehsil Timergara 32%, and Tehsil Balambat 30%.

Effects of COVID-19 on Agricultural Productivity

Agricultural productivity is considered to be affected by COVID-19 when its entire supply chain, including production, domestic consumption, commercial utilization, and market distribution, is disrupted or affected by the effects of the coronavirus. In the research area, farmers engage in the cultivation of crops, vegetables, and fruits, as well as the rearing of livestock for agricultural production. A survey was conducted among the respondents in the study area to examine the effects of COVID-19 on agricultural production, as shown below.

Effects on Crops Productivity

In the research area, wheat, maize, and rice are major crops, while barley and oilseeds (canola, rapeseed, and mustard) are minor crops. To determine the effect of

COVID-19, respondents were asked the extent to which COVID-19 had affected their crop productivity, and the answers are given in Table 6.

Table 6.
Respondents' Response to the Effect of COVID-19 on Crop Productivity

Tehsils	No Effect	%	Mild Effect	%	High Effect	%	Total
Adenzai	15	16	24	25	56	59	95
Balambat	12	13	30	34	47	53	89
Timergara	20	25	28	35	33	41	81
Total	47	18	82	31	136	51	265

Source: Authors' Estimation

According to Table 6, 51% of the respondents reported a high effect, 31% mild effect, and 18% no effect of COVID-19 on their crop production. In the high-effect category, 59% of the respondents were recorded in Tehsil Adenzai, 53% in Tehsil Balambat, and 41% in Tehsil Timergara. For the mild-effect group, 35% of respondents were reported in Tehsil Timergara, 34% in Tehsil Balambat, and 25% in Tehsil Adenzai. In the no-effect category, 25% of respondents were noticed in Tehsil Timergara, 16% in Tehsil Adenzai, and 13% in Tehsil Balambat. The results highlight that all farmers have experienced the pandemic's impact on crop productivity, showing reduced crop production in the research area. Our findings are aligned with Meena and Meena (2022), who reported that Rabi and Kharif crop growth rates declined due to lockdowns, resulting in labor and machinery shortages. Additional factors, including fertilizer usage, rainfall, pesticide application, and storage limitations, also significantly affected crop productivity during the COVID-19 lockdown.

Effects on Fruit and Vegetable Productivity

Pakistan is a major fruit producer, with 11.13 million metric tons of fruit produced in 2021. Fruits contribute 4.5% to the agricultural GDP, 0.8% to the national GDP, and earn USD 460 million in exports. Approximately 6 million farmers depend on fruit production for their livelihoods, and the fruit value chain employs around 12 million people (Rauf, 2023). Vegetables are also vital to the economy, covering about 0.27 million hectares of area and yielding an annual production of 3.5 million tons. Potatoes, onions, and tomatoes collectively contribute nearly 65% to the total vegetable production. In 2020, vegetable exports were valued at USD 260 million, with frozen vegetables and potatoes contributing USD 24 million (GOP, 2021).

In the research area, citrus, peach, apple, pear, apricot, plum, grape, fig, and loquat are some of the fruits cultivated for self-consumption and income generation. On the other hand, some of the major vegetable species grown include onion, potato, tomato, okra, zucchini, garlic, radish, cucumber, chili, peas, eggplant, turnip, coriander, and greens. The respondents were interviewed to know if COVID-19 had affected their fruit and vegetable production. The details of their replies are shown in Table 7.

Table 7.
Respondents' Response to the Effect of COVID-19 on Fruit and Vegetable Productivity

Tehsils	No Effect	%	Mild Effect	%	High Effect	%	Total
Adenzai	8	8	25	26	62	65	95
Balambat	10	12	28	33	48	56	89
Timergara	6	7	25	31	50	62	81
Total	24	9	78	30	160	61	265

Source: Authors' Estimation

According to Table 7, the majority of respondents, accounting for 61%, observed a high effect, 30% mild effect, and 9% no effect of COVID-19 on their fruit and vegetable productivity. In the high-effect group, Tehsil Adenzai accounted for 65% of the respondents, Tehsil Timergara for 62%, and Tehsil Balambat for 56%. In the mild-effect category, Tehsil Balambat recorded 33% of respondents, Tehsil Timergara 33%, and Tehsil Adenzai 26%. In the no-effect group, Tehsil Balambat reported 12% of respondents, Tehsil Adenzai 8%, and Tehsil Timergara 7%. The results indicate that more than 90% of the respondents' fruit and vegetable productivity was affected by the pandemic. These results are consistent with Ridley and Devadoss' research (2021), who predicted that workforce disruptions in horticulture production will result in millions of dollars in lost output. Similarly Ahmad et al. (2021) found that agricultural output and distribution in South Asia were affected by limited transports, labor shortages, and trade restrictions. The livestock, vegetable, and fruit sub-sectors were more affected by COVID-19 than crops.

Effects on Livestock Productivity

In the research area, livestock species such as cattle, buffaloes, sheep, and goats are commonly reared for domestic and commercial purposes. To know the effect of COVID-19, the respondents were interviewed about the extent to which their livestock productivity had been affected and their responses are shown in Table 8.

Table 8.
Respondents' Response to the Effect of COVID-19 on Livestock Productivity

Tehsils	No Effect	%	Mild Effect	%	High Effect	%	Total
Adenzai	18	19	32	34	45	47	95
Balambat	19	21	33	37	37	42	89
Timergara	22	27	23	28	36	44	81
Total	59	22	88	33	118	45	265

Source: Authors' Estimation

Table 8 indicates that 45% of the respondents noted a high effect, 33% mild effect, and 22% no effect of the pandemic on livestock productivity. In the high-effect category, Tehsil Adenzai accounted for 47% of the respondents, Tehsil Timergara for 44%, and Tehsil Balambat for 42%. In the mild-effect group, Tehsil Balambat indicated 37% of respondents, Tehsil Adenzai 34%, and Tehsil Timergara 28%. In the no-effect category, Tehsil Timergara presented 27% of respondents, Tehsil Balambat 21%, and Tehsil Adenzai 19%. The results present that the majority of the farmers reported an impact of COVID-19 on livestock productivity across all tehsils. The results are aligned with a study by Hussain et al. (2020), which highlighted that both the health and products of animals were greatly impacted by COVID-19 through feed shortages and drug unavailability. In future pandemics, farmers should collectively access and share farm inputs with one another. Online and e-commerce platforms should be established to access farm inputs and directly connect the farmers with their customers. Additionally, the government and private sectors should provide financial aid and necessary farm inputs to the farmers.

Measuring Effects of COVID-19 on Agricultural Productivity

In this section, a binary logistic regression model was employed to measure the effect of COVID-19 on the agricultural productivity of farmers. In the model, agricultural productivity (1= affected by COVID-19, 0= not affected) is the dependent variable,

while family size, farm size, and livestock holding are independent or explanatory variables. The estimated results of the proposed model are presented in Table 9.

Table 9.
Estimated results of Binary Logistic Regression Model on the Effects of COVID-19 on Agricultural Productivity

Variables	Beta	Std. Error	t- value	p- value	Odds ratio
Family size	-0.100	.038	6.931	.008	.905
Farm size	-0.244	.036	46.747	.000	.784
Livestock holdings	-0.213	.072	8.645	.003	.808
Farmer (1= mildly affected by lockdown, 0 = unaffected)	0.419	.084	25.159	.000	1.521
Farmer (1= highly affected by lockdown, 0 = unaffected)	0.548	.142	14.832	.000	1.730
Constant	1.358	.501	7.360	.007	3.889
Chi-square = 209.23					
p-value = 0.000					
Nagelkerke R^2 = 0.605					

Source: Authors' Estimation

Table 9 shows that the odds ratio of family size was -0.100 with a p-value of 0.008, signifying a negative and statistically significant association with agricultural productivity affected by COVID-19 ($p<0.01$). This means that for one member increase in the family size, the odds of agricultural productivity affected by COVID-19 decrease by 0.905 times. This result is consistent with Urgessa's (2015) research, which observed a positive and significant association between household size and agricultural productivity. A larger household size typically leads to more labor, which in turn increases agricultural productivity. During the COVID-19 pandemic, labor shortages are prevalent, and larger families are advantageous as they provide more labor for farming activities. The increased labor availability contributes to higher productivity and potentially mitigates the pandemic's impact on agricultural productivity.

The odds ratio of farm size was -0.784 with a p-value of 0.000, representing a negative and statistically significant relationship with agricultural productivity affected by COVID-19 ($p<0.01$). This demonstrates that for each one kanal increase in farm size, the odds of agricultural productivity impacted by COVID-19 decrease by 0.784 times. Our findings are aligned with the research of Samo et al. (2020), which estimated that farm size has a positive and significant impact on agricultural productivity in District Hyderabad, Pakistan. This implies that larger farm sizes often produce more output, thereby reducing the pandemic's effect on agricultural productivity.

The livestock holdings had an odds ratio of -0.808 with a p-value of 0.000, demonstrating a negative and statistically significant relationship with agricultural productivity affected by COVID-19 ($p<0.01$). This implies that for each additional animal increase in livestock holdings, the odds of agricultural productivity affected by COVID-19 decreases by 0.808 times. Animal power impacts land cultivation, crop selection, yield, and labor in crop production. The income from livestock can directly increase production by purchasing farm inputs and indirectly by improving household food and labor productivity (Powell et al., 1998). During lockdowns, farmers with more livestock experience less impact on productivity as livestock provide essential farm inputs like fertilizer, plowing, and transportation. Livestock products like meat and milk also enhance agricultural output and food security within households. The farmer mildly affected by lockdown had an odds ratio of 1.52 with a p-value of 0.000,

presenting a positive and statistically significant impact on agricultural productivity affected by COVID-19 ($p<0.01$). This means that the farmer mildly affected by lockdown has 1.52 times higher odds of agricultural productivity affected by COVID-19 compared to not affected farmers. The farmer highly affected by lockdown had an odds ratio of 1.73 with a p- value of 0.000, implying a positive and statistically significant effect on agricultural productivity affected by COVID-19 ($p<0.1$).This denotes that compared to unaffected farmers, the farmers highly affected by lockdown have 1.73 times higher odds of agricultural productivity affected by COVID-19. Mahmood et al. (2024) found that COVID-19 has had a negative impact on agricultural production as a result of lockdowns and other necessary measures. Labor shortages, travel restrictions, and fluctuating demand during lockdowns have all contributed to a decrease in agricultural output.

The results showed that Nagelkerke R^2 had a value of 0.605, meaning that 60.5% of the total variation in agricultural productivity affected by COVID-19 was explained by the predictors included in the model. The Chi-square test had a value of 209.23 with a p-value of 0.000, indicating that the overall model is statistically significant ($p<0.01$).

CONCLUSIONS AND RECOMMENDATIONS

The study concludes that COVID-19 is a global health pandemic, with consequences recognized globally. Apart from human lives, it has affected almost all sectors, including agriculture. In Pakistan, the agricultural sector has been substantially affected, with its widespread consequences felt in Dir Lower. This study was undertaken in Dir Lower with the objective of examining the impact of COVID-19 and its relationship with agricultural productivity of farmers. The results found a positive and statistically significant effect of COVID-19 on agricultural productivity in the region. To minimize the effects of COVID-19 on agricultural productivity, the following are some recommendations based on the study's findings:

- In future pandemics, farmers should collaborate in groups to share farm inputs, increasing agricultural production.
- Online marketing platforms should be established to increase farmers' access to farm inputs and connect with customers, thereby increasing agricultural production and sales.
- Government and private sectors should provide financial aid and essential farm inputs to support farmers and increase productivity.

DECLARATIONS

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REFERENCES

Abid, A., & Jie, S. (2021). Impact of COVID-19 on agricultural food: A Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis. Food Frontiers, 2(4), 396-406. https://doi.org/10.1002/fft2.93

Agarwal, K. M., Mohapatra, S., Sharma, P., Sharma, S., Bhatia, D., & Mishra, A. (2020). Study and overview of the Novel Coronavirus Disease (COVID-19). Sensors International, 1. https://doi.org/10.1016/j.sintl.2020.100037

Ahmad, I., & Ahmad, S. (2024). Impact of Credit Advanced by Zarai Taraqiati Bank Limited on the Income of Farmers in the Livestock Sector in District Dir Lower, Khyber Pakhtunkhwa. Journal of Development and Social Sciences, 5(2), 315-326. https://doi.org/10.47205/jdss.2024(5-II-S)31

Ahmad, I., & Jan, I. (2023). Effect of Covid-19 on Income of the People in District Dir Lower, Khyber-Pakhtunkhwa. International Journal of Human and Society, 3(4), 435-446.

.

Asegie, A. M., Adisalem, S. T., & Eshetu, A. A. (2021). The effects of COVID-19 on livelihoods of rural households: South Wollo and Oromia Zones, Ethiopia. Heliyon, 7(12). https://doi.org/10.1016/j.heliyon.2021.e08550

Eisenberg, J. (2020) How scientists quantify the intensity of an outbreak like COVID-19. In: Michigan Heal. University of Michigan. https://labblog.uofmhealth.org/rounds/how-scientists-quantify-intensity-of-an-outbreak-like-covid-19

Gatto, M., & Islam, A. H. M. S. (2021). Impacts of COVID-19 on rural livelihoods in Bangladesh: Evidence using panel data. PloS one, 16 (11). https://doi.org/10.1371/journal.pone.0259264.

Government of Pakistan (2021). Pakistan Export Strategy Fruits and Vegetables 2023-2027. Trade Development Authority of Pakistan (TDAP).

Government of Pakistan (2023). 7th Population and Housing Census - Detailed Results. Pakistan Bureau of Statistic. https://www.pbs.gov.pk/digital-census/detailed-results

Government of Pakistan (2023). Economic Survey of Pakistan. 2022-23. Economic Advisor's Wing, Finance Division, Islamabad, Pakistan.

Hussain S, Hussain A, Ho J, Sparagano OAE, Zia UU, (2020). Economic and Social Impacts of COVID-19 on Animal Welfare and Dairy Husbandry in Central Punjab, Pakistan. Front Vet Sci. 7:589971. https://doi.org/10.3389/fvets.2020.589971.

Mahmood, H., Furqan, M., Meraj, G., & Hassan, M. S. (2024). The effects of COVID-19 on agriculture supply chain, food security, and environment: a review. PeerJ, 12, e17281. https://doi.org/10.7717/peerj.17281.

Mandal, P., Gupta, A. K., & Dubey, B. K. (2020). A review on presence, survival, disinfection/removal methods of coronavirus in wastewater and progress of wastewater-based epidemiology. Journal of Environmental Chemical Engineering, 8(5), 104317. https://doi.org/10.1016/j.jece.2020.104317

Meena, A., & Meena, A. (2022). Impact of Covid-19 Lockdown on Agricultural Production. International Research Journal of Business Studies, 15(2). https://doi.org/10.21632/irjbs.15.2.129-141

Powell, J. M., Pearson, R. A., & Hopkins, J. C. (1998). Impacts of livestock on crop production. BSAP Occasional Publication, 21, 53-66. http://doi.org/10.1017/SO263967X00032067

Rasul, G., Nepal, A. K., Hussain, A., Maharjan, A., Joshi, S., Lama, A., & Sharma, E. (2021). Socio-economic implications of COVID-19 pandemic in South Asia: emerging risks and growing challenges. Frontiers in Sociology, 23.

Rauf, A. (2023, November 15).The Significance of Fruit Economy for Pakistan: A Critical Appraisal. Republic Policy. https://republicpolicy.com/the-significance-of-fruit-economy-for-pakistan-a-critical-appraisal/.

Ridley, W., & Devadoss, S. (2021). The effects of COVID-19 on fruit and vegetable production. Applied Economic Perspectives and Policy, 43(1), 329-340. https://doi.org/ 10.1002/aepp.13107.

Samo, S., Sial, M., Dahri, G. N., & Nangraj, A. N. (2020). Impact of Farm Size on Agriculture Productivity in District Hyderabad, Sindh. Scientific International (Lahore), 32(1), 171-175.

Sridhar, A., Balakrishnan, A., Jacob, M. M., Sillanpää, M., & Dayanandan, N. (2023). Global impact of COVID-19 on agriculture: role of sustainable agriculture and digital farming. Environmental Science and Pollution Research, 30(15), 42509-42525. https://doi.org/10.1007/s11356-022-19358-w

Štreimikienė, D., Baležentis, T., Volkov, A., Ribašauskienė, E., Morkūnas, M., & Žičkienė, A. (2022). Negative effects of covid-19 pandemic on agriculture: systematic literature review in the frameworks of vulnerability, resilience and risks involved. Economic Research-Ekonomska Istraživanja, 35(1), 529-545. https://doi.org/ 10.1080/1331677X.2021.1919542

Syed, A., Raza, T., Bhatti, T. T., & Eash, N. S. (2022). Climate Impacts on the agricultural sector of Pakistan: Risks and solutions. Environmental Challenges, 6, 100433. https://doi.org/10.1016/j.envc.2021.100433

United States Agency for International Development (USAID). (2009). District Profile and Sector Assessments - Lower Dir District. USAID FIRMS PROJECT. USAID. https://pdf.usaid.gov/pdf_docs/PA00K763.

Urgessa, T. (2015). The determinants of agricultural productivity and rural household income in Ethiopia. Ethiopian Journal of Economics, 24(2), 63-91.

Yamano, T., Sato, N., & Arif, B. W. (2020). COVID-19 impact on farm households in Punjab, Pakistan: Analysis of data from a cross-sectional survey (No. 149). Asian Development Bank (ADB) Briefs. http://dx.doi.org/10.22617/BRF200225-2.