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The effect of COVID-19 pandemic on market integration: Evidence from vegetable farmers in Pakistan

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ABSTRACT

The COVID-19 pandemic exposed the agriculture sector and farming communities to unprecedented risks. This study investigates the impact of the pandemic, identifying the suggestions of community elders for effective resilience via in-depth interviews (IDIs) and Focus Group Discussions (FGDs). We also examine determinants of vegetable farmers’ inputs and outputs market participation using a binary logit model. The findings reveal poor business owners’ support, difficulties accessing inputs and outputs markets, non-availability/shortage of inputs recommended by extension services, and poor access to mechanizations. Labor shortages, lack of access to agricultural credit, and lack of information on innovations and markets are also barriers to market integration of farming communities in Pakistan. Results of the logit model show that farming experience and support from market owners drive the participation of both the inputs and outputs market. Similarly, ownership of personal vehicles and the availability of farm machinery drive the participation of farmers in outputs markets. Various strategies are suggested to mitigate the risks of the Covid-19 pandemic, including the establishment of inputs and outputs markets, strategies for transportation, access to information, and farm machinery at the local level.

1. Introduction

The unprecedented shock of the COVID-19 pandemic is affecting the entire world, becoming a significant threat to the livelihood of billions of people [1]. In particular, the pandemic created a series of disruptions affecting small farmers, who are integrated with input and output markets [2]. The pandemic also affected farmers in both the short- (through lockdowns) and long-run (such as quarantines, travel bans, and restrictions) [3]. The lockdowns, mobility restrictions, quarantines, and transport restrictions are common responses to the pandemic that proved highly challenging for farming communities [3,4]. Such measures disrupted agricultural productivity, participation in input and output markets (markets integration), and supply chains, delivering an enormous shock to the global economy in 2020, as indicated by early estimates of 495 million jobs lost and a 5.2% contraction in global output [5]. Consequently, farmers involved in market-oriented farming suffered significantly during the COVID-19 pandemic [6].

Literature on agricultural growth and rural development suggests that the poverty alleviation strategies will be of little importance

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without integrating farmers into markets [7]. Inputs and outputs markets integration enhance rural livelihoods by promoting improved agricultural technologies while boosting crop productivity and farming profits [8]. Thus, market integration is vital for the social and economic wellbeing of the rural poor [9]. Inputs and outputs market integration is a decisive factor in purchasing modern farm technology, productivity enhancement, economic growth, and food security of vegetable farmers [10]. Market integration shifts the farm from low agricultural productivity to high commercialized agriculture [11]. Farmers’ market integration promotes agricultural transformation, thus reducing poverty and increasing sustainability [12]. Market disintegration results in crop failures and food shortages [13], which leads to income losses, threatens the viability of farming households, and potentially pushes farmers into poverty [14].

The farming community suffered during COVID-19: the timely purchase of modern agricultural inputs was prevented [15] and profitability was inhibited [16]. Along with COVID-19 restrictions that affected farmers’ markets integration, the farmers not only received inadequate extension services and faced imperfect inputs and outputs markets, but the poor infrastructure in rural areas prevented speedy adaptation to the circumstances [3,8,17]. Farmers, especially vegetable farmers, were affected by the disruptions to supplies of improved seeds and chemical fertilizers [22]. On the other hand, agricultural profit depends on the distribution of agrarian inputs among farmers, improved post-harvest handling, and outputs market participation [18]. Market disintegration results in increased food insecurity and hunger among people and isolated communities [19].

Farmers faced numerous market challenges concerning post-harvest technologies and output markets integration [20,21]. Beyond inputs market participation, the pandemic maximized the post-harvest losses by affecting vegetable and vegetable distribution handling and storage [21]. Farmers mobilized financial resources to address the post-harvest inefficiencies in the supply chain of produced vegetables [22]. However, the vegetable farmers’ participation in output markets was challenged throughout the pandemic [23]. Farmers’ participation in agricultural output markets is essential in rural development as it plays a major role in economic growth and poverty alleviation [24]. Effective market participation improves the capacity of a farmer to purchase modern agricultural inputs, thus increasing productivity and preventing food/vegetable and economic losses [25].

Numerous studies focus on the factors that hinder the vegetable farmers’ participation in inputs and outputs markets (market integration). These studies include the farmers’ socio-economic factors [8], policy variables [26], social capital [27], external agents facilitating inputs and outputs markets services [8,28], as well as the provision of timely information on inputs and outputs markets and credit [8,29]. Therefore, the success of farmers’ market integration and the agriculture sector requires cooperation among farmers, market owners, policymakers, extension agents, scientists, and other stakeholders. Farmers should participate in the inputs and outputs markets for better outcomes [30]. Thus, there is a need to identify the effects of different disasters, like the COVID-19 pandemic, on vegetable farmers’ inputs and outputs market integration by incorporating qualitative and quantitative data when determining agricultural productivity and income/livelihood outcomes. Since poverty is high among smallholders in the HKH region, they operate small acreage and few off-farm employment opportunities, and communities tend to rely on farming for their livelihoods [3,31].

The farmers’ successful integration in markets (both inputs and outputs) is designed and planned based on communities’ social, local, economic, and environmental conditions [32]. In addition [8,33], note that the farmers’ socio-economic and institutional characteristics are the major determinants of their participation in inputs and outputs markets. Moreover, many studies investigate the impact of COVID-19 on the agriculture sector [3,15,34–37]. These studies ignore the effect of COVID-19 on agricultural market integration. Furthermore, there is a lack of studies focusing on rough-terrain regions, like mountainous regions of Pakistan, which are typically isolated from cities and towns. Additionally, no studies examine the factors affecting mountainous region farmers’ participation in the inputs and outputs markets during the COVID-19 pandemic.

Therefore, this study analyzes the effect of COVID-19 on the holistic agricultural system of mountainous communities and livelihood impacts using both quantitative and qualitative data. Specifically, the study analyses the impact of the COVID-19 pandemic on vegetable farmers’ market integration in the Hindu Kush-Himalayan (HKH) region and Dir-Kohistan as a case study area. Though the data has been collected from the HKH region of Pakistan, the approach is specifically helpful in measuring the effect of the COVID-19 pandemic on the vegetable farmers’ market’s integration into the entire HKH community. The HKH community extends 3,500 km over eight countries, including Afghanistan, Pakistan, Myanmar, Bangladesh, Bhutan, China, India, and Nepal. Thus, the results apply to many farmers located in the above countries. The novel aspect of this research is a holistic approach to address farmers’ access to inputs markets, use of extension methods suggested by agricultural input suppliers, agricultural productivity, access to information and credit, outputs markets, farmer’s livelihoods strategy, and support to farming communities in the HKH. Data is focused on the community and household levels, identifying the role of COVID-19 in the failure of agriculture communities’ effective market participation, purchase of inputs, and income. The lead author stayed throughout the pandemic inside the farming communities. In August 2018, the lead author of this paper started working for the extension office in the study area, providing extension services to community members. This made the lead author familiar with the farming communities. The lead author contacted farmers who provided access to the farmers and farming situations despite COVID-19 restrictions. This study addresses three research questions: 1) What were farmers’ inputs and output market participation status during the COVID-19 pandemic? 2) What factors determined farmers’ market integration during the pandemic? and 3) What was the impact of the COVID-19 pandemic on farmers’ technology purchases, productivity, and income?

We queried farmers on community and private sector support, information provision, labor, and credit availability on farmers’ markets integration. The survey also queried the farmers on purchasing technology, farm productivity and income losses. Findings from this study are expected to inform policymakers, helping to improve the planning and implementation of vegetable farmers’ market integration for sustainable crop production during disasters.
2. Conceptual framework

The concept of market integration, namely access to and participation in markets, has gained prominence in recent studies [38]. Farmers’ input and output markets integration during the COVID-19 pandemic depended on the extent the pandemic drove the anticipated changes in farmers’ travel strategies, farming practices, vegetable productivity, institutional access, and land-use practices [39]. The large-scale travel bans, changes in farming practices and farm productivity resulted in market disintegration [40,41]. The market integration process included access to farm inputs in cities and urban markets, adequate purchase of extension suggested innovations, getting back to the farm in their respective villages, cultivating farms and transporting vegetables from the farm to the markets [42]. Also, the impact of the COVID-19 pandemic on vegetable farmers can be divided into two periods. The initial period is access to inputs markets (input market integration) and the second period is access to outputs markets (output market integration). During the pandemic, access to inputs markets affected mountainous farmers’ purchase of modern agricultural technologies (through reduced access to inputs) and farm cultivation. In terms of vegetables to the output markets, most vegetable farmers could not reach output markets and consumers because of movement restrictions imposed by the government. Vegetables produced in the HKH region also depend on socio-economic factors, personnel vehicle availability, and the availability of farmworkers and tenant farmers.

It was challenging for large farmers to find farmworkers. With the COVID-19 lockdown and strict standard operating procedures (SOPs) issued by the Government of Pakistan, many workers could not find work. Due to the lockdown policy, vegetable farmers who were previously well integrated into input and output markets were restricted from entering input markets, timely purchase of agricultural inputs and early return to mountainous regions. Therefore, the farmers faced several problems. They had to adjust their planting period, face labor shortage, and transportation logistics. As a result, due to the COVID-19 pandemic, vegetable productivity and the demand for vegetables were affected. Finally, many farmers’ vegetable production was spoiled due to labor shortages. Thus, the pandemic impacted market integration, inputs purchase, vegetable production, and distribution in mountainous regions. The conceptual framework is explained in Fig. 1.

3. Materials and method

3.1. Study area

Dir-Kohistan is located in the high mountainous part of Pakistan’s Hindu-Kush Himalayan (HKH) region (Fig. 2). The region is situated between 350 and 9° and 350–47° N latitude and 710–52’ to 720–22’ E longitude in the north of the Dir Upper District of Khyber Pakhtunkhwa (KP) province. In terms of land area, Dir-Kohistan covers 412,570 acres or 645 square miles (1670.54 square kilometers). Dir-Kohistan is chosen for this study because it typically resembles the geographical, cultural, agricultural, ecological and socio-economic aspects of the entire HKH region. Dir-Kohistan is famous for vegetable production, which farmers export to the rest of the country [3]. Like the rest of the HKH, most Dir-Kohistan regions comprise fertile croplands and are suitable for producing a wide range of tropical and sub-tropical vegetables [3]. The study region is characterized by frequent rainfall between 1000 mm and 1600 mm a year, with temperatures ranging from 0 to 32 °C [43]. This study is conducted in the vegetable-growing areas of the Dir-Kohistan region of the HKH Mountains. The study area is of importance because of the remoteness of the main markets and the lack of local markets in the region.

3.2. In-depth interviews

Between August and October 2020, we interviewed 120 elderly farmers in the study region using semi-structured interviews. Since the communities reside in a traditional setup in the HKH region and are consistent with conventional communities, elders in the study area were selected for interviews. Through these interviews, we obtained valuable information about the impact of the COVID-19 pandemic on vegetable farmers, their socio-economic conditions, and the challenges they faced in accessing markets.
region were key decision-makers [44,45]. Therefore, all farmers who participated in the in-depth interviews (IDIs) were the key decision-makers of their households. At the start of the discussions, farmers were presented with an informed consent form in their local languages with a brief description and purpose of the interview. Before each interview, the farmers were informed that the information would be recorded by a digital recorder and erased after the information was transcribed. The lead author carried out all interviews since farmers knew and trusted him. Further, they were encouraged to speak freely and openly to him. At the beginning of each interview, the participants were asked to recall all problems they faced in adopting extension suggested innovations, farming, and output market participation because of COVID-19. The survey queried smallholders on several issues related to farmers’ input and output market integration status during the COVID-19 pandemic and the availability of community and/or private sector support during the COVID-19 pandemic. The survey collected information on input and output market status and inputs availability during the pandemic. The farmers were queried about their use of farm labor and credit availability to purchase farm inputs. The survey queried the following questions.

1. What difficulties did he experience in purchasing the extension suggested inputs?
   a. Difficulties in market reach?
   b. Markets situation (open/closed)?
   c. Availability of inputs in markets?
2. Difficulties in output markets participation
   a. Yield losses he received during the pandemics?
   b. Income losses he received during the pandemics?
Table 1

| Variables                          | Description and Measurement                                                                 | Mean   | Std. dev |
|-----------------------------------|---------------------------------------------------------------------------------------------|--------|----------|
| Farmer participation in inputs    | If a farmer has participated to an extent in an input market, then D = 1; otherwise, D = 0 | 0.46   | 0.50     |
| markets                           | If a farmer has participated to an extent in an output market, then D = 1; otherwise, D = 0 | 0.50   | 0.50     |
| Age                               | Age of household head (years)                                                              | 33.79  | 9.97     |
| Education                         | Education of household head (years)                                                         | 3.58   | 4.90     |
| Farming experience                | Total vegetable farming experience (years)                                                  | 17.36  | 6.01     |
| Landholding size                  | Total agricultural land in acres owned by a vegetable farmer                               | 4.91   | 3.06     |
| Households size                   | Number of family members in a household                                                     | 12.20  | 5.99     |
| Farm income                       | Annual household income in Pakistani rupees                                                | 121741.66 | 113637.23 |
| Access to credit                  | If a vegetable farmer had access to credit during the pandemic, then D = 1; otherwise, D = 0 | 0.43   | 0.49     |
| Access to information             | If a vegetable farmer had access to information during the pandemic, then D = 1; otherwise, D = 0 | 0.29   | 0.45     |
| Ownership of vehicles             | If a vegetable farmer owns his personnel vehicle for vegetable delivery, then D = 1; otherwise, D = 0 | 0.39   | 0.49     |
| Availability of farm machinery    | If a vegetable farmer had access to farm machinery during the pandemic, then D = 1; otherwise, D = 0 | 0.17   | 0.38     |
| Labor shortage                    | If a vegetable farmer has faced laborers shortage during the pandemic, then D = 1; otherwise, D = 0 | 0.78   | 0.41     |
| Support from market owners        | If a vegetable farmer has received any support from the market owner during the pandemic, then D = 1; otherwise, D = 0 | 0.31   | 0.46     |
| Support from community/family     | If a vegetable farmer has received any support from his family during the pandemic, then D = 1; otherwise, D = 0 | 0.93   | 0.25     |

Note: A variable “Extension contact” is not included in the study because the lead author was/is an extension agent of the study area and all respondents were in frequent contact with him.

3. Difficulties in post-harvest handling and processing?
4. Community and private sector support during the pandemic?
5. Perceived changes in farm labor availability during the pandemic?
6. Access to credit during the pandemic?
7. Access to information during the pandemic?

Interviews were conducted through phone calls and face-to-face at farmers’ homes and/or on farms with the help of trained interpreters from the agriculture and forest department in the region. Interviews were recorded with a tape recorder and were transcribed in Urdu. Each interview was then translated into English by five independent interpreters. Randomly selected passages were translated back into Urdu for content validation.

3.3. Focus group discussions

Focus group discussions (FGDs) were used to collect community-level data in different villages of the Dir-Kohistan region of HKH. The FGDs were held with members of Village Development Committees (VDCs). The FGDs were held in 8 villages: Kalkot (FGD01), Thall (FGD02), Lamoti (FGD03), Jandrai (FGD04), Badgoi (FGD05), Makrala (FGD06), Junkai (FGD07), and Doon Seri (FGD08). The selected villages have fertile agricultural lands, practice vegetable farming, and are located at high altitudes. These villages supply many vegetables, including cabbage, potatoes, and tomatoes, to city markets throughout Pakistan to meet their households’ economic needs. Each FGD was attended by 25–30 elderly farmers (key decision-makers of their respective communities) with vegetable farming experiences. To prevent disease outbreaks, each group of 25–30 members was divided into 5 to 10 participants [3].

A script, which focused on farming communities’ problems and the strategies to cope with these problems, was prepared for the group discussions. The same script was used for each group discussion. A written consent that clearly explained the purpose of FGDs was prepared in the participants’ local languages and was provided to each FGD. Each FGD lasted for 1–2 h. The lead author and other staff of government extension departments (forestry and agriculture) provided a supportive and friendly environment, with each participant actively participating in the discussion. The same questions drove the FGDs in in-depth interviews, and an additional question of what strategies can be made to protect the farming communities from productivity and income losses during pandemic situations?

3.4. Data analysis

The recorded interviews were translated from Urdu into English and analyzed using qualitative content analysis [46]. We tagged major topics and keywords of our interview transcripts, subjected them to word frequency count using an Excel spreadsheet, and processed them to produce frequencies, tables, and graphs [30,47]. The interviews were then summarized to find general trends of market access, agricultural technology purchased, productivity and market participants to know how mountaneous farmers coped or did not cope with COVID-19 to reveal potential stressors and constraints that farmers faced during the pandemic. Data analysis was double-checked with professionals in Pakistan to check for the meaning and consistency of our findings with the original information.
To ensure the farmers’ anonymity, they were identified as tiny letters just above the line of text. We use logistic regression to identify the factors affecting farmers’ participation in input and output markets [8, 48, 49]. Our variable was constructed across three scales, including no participation, participated to an extent, and full participation. However, no single case among our respondents specified full participation in inputs and outputs markets. Therefore, we divided our respondents into two groups, i.e., not participating in inputs and outputs markets and, to an extent, participating in inputs and outputs markets. Therefore, we used the binary logit model in our study to predict the probability of farmers’ participation and/or non-participation in input and output markets during the COVID-19 pandemic based on socio-economic and institutional attributes. The basic form of the logit model is shown in Equation (1).

\[ \text{Logit}(p_i) = \ln \left( \frac{p_i}{1 - p_i} \right) = \beta_0 + \beta_1 x_{i1} + \ldots + \beta_j x_{ij} \]  

where \((p_i)\) represents the probability of observation \(i\) (farmer) participating in inputs and/or outputs markets and \(x_{ij}\), is the value of the \(j\)th independent variable for the \(i\)th observation.

The Hosmer and Lemeshow test was used for model validation. The test has a p-value of 0.585 for vegetable farmers’ input markets participation and 0.842 for vegetable farmers’ output market participation. Since the significance value is greater than 0.05 for both models, the logit model explains the data.

4. Results and discussion

4.1. Descriptive statistics

Table 1 presents the descriptions of variables used in the logit model, their measurement, and descriptive statistics of the vegetable farmers in the HKH. The predictor variables used in the logit model comprise 13 determinants consisting of demographic, institutional, and production factors; these are coded as presented in Table 1. The integration of vegetable farmers into inputs and outputs markets (response variable) during the COVID-19 pandemic was coded 0 if a farmer has participated in inputs and/or outputs markets during the pandemic and = 1 if the farmer was not able to participate to an extent in inputs and/or outputs market during the pandemic. About 46% of respondents report experiencing input markets and about 50% in output markets.

In existing studies, the variable age is a significant positive predictor of farmers’ participation in input and outputs markets. Older farmers usually have more farming experience and participation in input and output markets [50, 51]. The average age of farmers in the study region was nearly 34 years, much higher than the national mean age of 21.8 [52]. Education improves farmers’ information accessibility and results in a greater ability to make better marketing and farming decisions [53]. The mean years of schooling is 3.58 years, which is consistent with the previous reports from the study area [3]. The literature identifies the farming experience as an important factor that positively affects farmers’ participation in input and output markets [54, 55]. The average farmer in the study region has 17.36 years of vegetable farming experience, mirroring the results of [56], who reports a mean farming experience of 20.57 years in Pakistan. Farm or land holding size is also an important variable that positively affects farmers’ market participation. Large farmers have more knowledge and information about farming and are more likely to take risks than small farmers [57, 58].

Usually, the landholding size is smaller in the study region. However, our respondents are farmers who are well integrated into the market, with an average landholding of about 5 acres; the national average farm size is 5.6 acres [59]. Finally, household size and annual income from vegetable farming are also reported as potential variables that improve or limit farmers’ ability to participate in inputs and outputs markets [8]. The results of our study show that the mean household size of vegetable farmers is 12 members, and their mean income from vegetable farming is 121,742 Pakistani rupees. The study region’s average household size and income are slightly higher than the national average of 6.5 members per household [3].

Previous studies show that credit availability, access to information, and ownership of personal vehicles for vegetable delivery to markets can also positively affect a farmer’s participation in inputs and outputs markets [8, 28]. About 43% of the respondents reported access to credit (mostly from family members), and 29% reported accessing market information during the pandemic. Similarly, about 39% of the respondents report owning vehicles for vegetable delivery to markets.

Previous studies by Refs. [8, 28] have reported that the availability of farm machinery plays a role in scaling up farmers’ participation in output markets—about 17% of the sample report having access to farm machinery during the pandemic. Moreover, the availability of farm laborers also positively affects farmers’ output markets participation [61]. In our study, about 78% of the respondents report a shortage of laborers during the pandemic. Similarly [8, 28], report that market owner support for farming communities positively influences their market integration. Our descriptive statistics suggest that about 31% of the respondents report receiving support from the input providers and outputs purchasers. During the pandemic, community/family support provided social support and help during stressful events [3]. The availability of community and family support and services is expected to influence vegetable farmers’ market integration positively.

About 93% of the respondents report community and family support during the pandemic. For our in-depth interview respondents, the most significant support for mountainous farmers came from their community or families. Respondents also report that community and families provided money to travel from farm/village to inputs or outputs markets. Still, they also offered farm machinery, free labor, and, in some cases, input like seeds. They report that family or community members were also unable to come to the village while we were trapped in the cities for us while we were trapped in the cities.
4.2. Farmers’ participation in input markets during the COVID-19 crisis

Our IDIs reveal that no farmers reported full participation in inputs markets. Farmers who participated in inputs markets reported poor participation (participation to an extent) because of difficulty reaching input markets and purchasing necessary inputs – summarized best as limited availability of inputs.

4.2.1. Difficulties in reach to inputs markets during the COVID-19 crises

During the 120 interviews of elderly farmers during the pandemic, more than half reported that the pandemic prevented them from reaching inputs markets and purchasing improved technologies (Fig. 3). Deciding to market and buy inputs during the pandemic was not easy for many farmers (Fig. 3). On the one hand, not going to city markets meant reduced productivity and farm income. On the other hand, it was difficult for farmers (even potential adopters) to reach city markets quickly. Our results suggest that many wealthy farmers could reach out to the input markets. However, they were stuck in the city due to the COVID lockdown; most could not reach their community in time to cultivate their land. Many farmers agreed with the comments of this elderly farmer, revealing that these losses, combined with other pre-existing crises of agricultural productivity, were among the most significant adverse impacts of the pandemic on the farming communities in the mountainous regions. One farmer said, “Due to poor inputs markets access, neither we purchased innovations, nor were we able to proceed with older technologies." These results are similar to Arouna et al. [62], who report disruptions in farmers’ access to input markets during the pandemic. They suggest that the organization of inputs at the local level to farm owners with subsidies on essential items such as fertilizers would have ensured maximum farm productivity/output during the pandemic.

4.2.2. Non-availability of extension suggested inputs in markets

The other reason for farmers’ poor market participation, as reported by farmers, was that most farmers who successfully reached out to input markets could not purchase inputs (Fig. 3). Their time and energy were wasted; subsequently, they could not work on the farm upon returning to the village. Many farmers reported, “I didn’t purchase any of the extension suggested innovations. All markets were closed.” Many farmers were in the city to sell their produce and used the sales money to buy farm inputs. Similarly, many farmers’ children and other villagers worked as laborers in the city, hopeful that they could borrow money from their household members to buy inputs. However, they were unable to purchase inputs. A farmer reports, “I visited the city to make money from my households or villagers and buy inputs. However, I realized that everyone had lost their jobs. People didn’t have money because they didn’t have jobs.” It is also reported that farmers had good relations with input providers (see Table 1, Support from market owners) and were successful in purchasing inputs; however, all farmers received less than the quantity required for effective farming.

One farmer reports, “I had very good relations with many input providers. I contacted 3 of them, and they indeed helped me provide input. However, all three input providers together could not provide me with sufficient inputs for my farming." Thus, more than half of the interviewees revealed that they had not purchased inputs or had purchased insufficient farm inputs because of the pandemic (Fig. 3). These were factors affecting farmers’ full participation in input markets. Our results are similar to other studies [28,63], which report severe difficulties in purchasing extension suggested inputs by farmers during the pandemic.

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Fig. 3. In-depth interviews results on inputs markets disparities. Note: Total cases on farmers’ inputs markets access are 120. “No” shows those cases that failed to reach markets. “Yes” shows those cases that reached, and “to an extent” shows those cases that thought they reached but were trapped in the market and did not return timely.

Total cases on availability of extension suggested inputs were 60. “No” shows those cases that did not purchase farm inputs. “yes” shows those cases that purchased the inputs, and “to an extent” shows those cases that purchased inputs that were insufficient or incomplete for their farming needs.
4.3. Farmers’ output markets participation during the COVID-19 crises

Our IDIs reveals that half of the respondents reported involvement in output markets. No farmers reported complete participation in output markets like participation in input markets. Those farmers who participated in output markets reported poor participation (to an extent).

4.3.1. Productivity losses

Almost all farmers suffered heavy direct productivity losses during the COVID-19 pandemic (Fig. 4), resulting in limited output market participation. It is reported that more prominent farmers (having more land) experienced greater direct productivity losses. Productivity losses occurred in two ways. The first losses that farmers faced resulted from late cultivation. Since many potential adopters of improved agricultural technologies were trapped in cities, it was too late to cultivate when they returned to the valley. While they tried, the seeds failed to germinate. If there was germination, low productivity resulted. One farmer reports, “When I cultivated my land, it was too late. Immediately after cultivation, rains started. These were rainy days and all my seeds remained inside the soil. Not even a single seedling came out.” The second loss was because farmers had no access to output markets. Another farmer reported, “It was impossible to shift vegetables to markets from our community. Our all vegetables spoiled/wasted.”

Similarly, another prominent farmer reports, “The vegetable was not reaching out to markets. Those small farmers who could use their vegetables at the local level protected them from spoiling. Those farmers who cannot use their vegetables at the local level see them spoiling.” Our findings agree with Zhang et al. [64], who report the direct and indirect effects of the COVID-19 pandemic on agricultural production and project its negative impact on agricultural output market participation.

4.3.2. Fall in prices in vegetable markets

Our in-depth interviews reveal that farmers incurred significant economic losses (Fig. 4) because of the pandemic. They worried about fulfilling their households’ economic needs because of earning less income from vegetable sales. A farmer reports, “I have been farming since 2001 on land I have inherited from my parents for vegetable production. But this was the first time I received extremely less farm income than expected. This year, because of losses, farm income was insufficient, and I accumulated debts to feed my children.”

Similarly, another farmer reports, “we are farming to feed our children. But you know, because of the pandemic, this year, I have sold vegetables worth 12,000 Pakistani rupees (PKR) for only 4,000 PKR. I rented many vehicles to transfer vegetables to markets, and I paid them 10,000 because they were charging more money than normal. In the end, I was deficient in 6,000 Pakistani rupees. This means I did not save anything and paid 6000 Pakistani rupees from my pocket money.” Despite all of these difficulties, about half of the farmers in HKH report participating in output markets (Table 1).

4.4. Factors affecting farmer’s participation in input and output markets

4.4.1. Non-availability of farm machinery

One leading challenge farmers faced during the pandemic was farm machinery services. Farmers believe that farm machinery is a critical component that positively affects a household’s agricultural productivity and outputs market participation. However, they report that the pandemic made it increasingly difficult for many farmers to access machinery services (Table 1). A farmer said, “I have not used farm machinery this year. I used to rent farm machinery such as spray machines and hand tractors from a few particular persons in the area. However, this year I could not access them to rent machinery from them.”

Many farmers, especially those with large farms, report that poor access to farm machinery severely reduced their agricultural productivity, affecting their output market participation. An elderly farmer well-respected in his community reports, “Because of the unavailability of farm machinery, I have received very low production this year, so I could not participate in output markets.”

Those farmers who had used farm machinery had managed to purchase them (previously, they used to rent machinery), and then they first used such machinery in their farming. After they finished their work, they rented it to very close relatives. One prominent farmer reports, “It was impossible to rent machinery this year. I had money, and therefore I purchased them using all possible resources. However, I observed the resource-poor farmers and those who could not buy machinery were hopelessly walking behind one another (rich people
who purchased machinery). Their results are consistent with Amjath-Babu et al. [65], who report reduced production and post-harvest losses due to difficulties faced by farmers in accessing appropriate farm mechanization in Bangladesh.

### 4.4.2. Labor shortage, access to credit and information

The other severely affecting variable reported during in-depth interviews was a labor shortage in the farming sector. Agricultural output markets and farming communities faced disruptions throughout the pandemic mainly due to labor shortages created by travel and other restrictions. This sudden labor shortage negatively affected land use sustainability, agricultural productivity, and farmers’ effective market participation. On the one hand, poor tenant farmers could not find work. On the other hand, the wealthy large farmers could not find farmworkers. A tenant farmer reports, “I faced extreme difficulties providing food for my children. Since, after all my efforts, I could not find a wage.” Similarly, a prominent farmer reports, “There was a severe farm labor shortage this year. Despite efforts, I couldn’t find any labor.” Due to lockdown, many mountainous farmers could not farm productivity without farm labor and means of transport (Table 1). Our findings are consistent with Shirzad et al. [66], who found that potential labor shortages during the pandemic negatively contributed to agricultural sustainability in India.

Poor farmers are socially differentiated through economic coercion. Usually, such farmers manage their disparities by taking credits from fellow farmers, banks, or input providers, which is also shown by existing studies from the study province [8, 29]. However, our in-depth interviews reveal that farmers, primarily resource-poor, had less opportunity to access credit (formal, informal, and private) (Table 1). Many farmers who previously had access to credit reveal no or poor access to credit and, thus, the pandemic significantly influenced credit provisions (Table 1). A farmer who showed access to credit in routine days reports, “I used to take credit from input providers in kind. However, during the pandemic, access to markets was limited or even in most cases was impossible.” Similarly, another elderly farmer who was well respected in the valley reports, “In the entire valley, there is no bank from which a farmer may take credit or do savings. The primary source of credit for our community farmers is input providers in markets. And well … this year, there was no market access because of this pandemic.” Many studies report the impact of access to credit on purchasing modern agricultural technology. Like in this study, they find that credit access positively affects farmers’ input and output market integration [29, 67].

Studies by Ullah et al. [8] and Ullah et al. [28] show that timely provision of information is crucial for farmers’ participation in input and output markets. The authors find that a lack of knowledge or asymmetric information provided to farmers plays a vital role in the farmer’s poor purchase of agricultural inputs and participation in outputs markets. Our in-depth interviews reveal that farmers lacked good access to information in inputs markets, especially during the pandemic (Table 1). We also find that the provision of asymmetric information increased severely during the pandemic, significantly affecting farmers’ purchase of extension suggested inputs and output market participation. An elderly farmer who is a key decision-maker in his community reports, “Farmers lack access to information in standard routine days and during the pandemic, they did not have access to information. On the other hand, market owners and input providers are trained and access updated information. They control the market the way they want. They take the inputs and outputs prices from a farmer of his will.” Similarly, another farmer reports, “Farmers usually do not have access to market information. The lack of access to information has increased in pandemics. However, farmers generally face information problems in input and output market participation.” Another farmer reports, “Input providers have updated information and share asymmetric information with farmers. Farmers cannot compete in input and output markets by themselves. All decision powers on rates of inputs and outputs lie in the hands of market owners.”

### 4.5. Factors affecting farmers’ participation in input and output markets

Following the in-depth interviews, we ran a logit model to identify the determinants of farmers’ inputs and outputs market participation during the COVID-19 pandemic (Table 2). The findings show that several factors influence the vegetable farmers’ participation in inputs and outputs markets. Results are consistent with [54, 55]. More experienced farmers have greater and repeated contacts in markets, which helps to build a relationship of mutual trust and allows trading opportunities to be undertaken under...
challenging situations [54]. Ownership of personal vehicles significantly and positively influences the vegetable farmers’ market participation (Table 2). Similar findings by Sigei et al. [68] report that a farmer with a personal vehicle for vegetable delivery usually participates in outputs markets. Further, a vegetable farmer’s availability and/or modern farm machinery likely enhance their participation in outputs markets (Table 2).

Agricultural productivity is highly dependent on the availability of farm machinery, which can achieve the “input-outputs-offset-efficiency” [64]. Similar findings are reported by Sher et al. [67] for Pakistan. Support from market owners is associated significantly with a higher probability of vegetable farmers’ inputs and outputs market participation (Table 2). Interviewed farmers reveal that they have a bond or trust with the market owner under which the market owners are responsible for providing all necessary inputs. Farmers are obligated to sell their vegetables only to input providers. This suggests that, during the COVID-19 pandemic, farmers benefited by purchasing improved farm inputs and selling their vegetables. Not all farmers were happy with these conditions: they noted that market owners controlled them, taking advantage of their poverty and compulsion. However, market owners supported these farmers and comparatively participated in inputs and outputs markets. These results align with Corsi et al. [69] regarding market owners’ support for farmers and their needs.

4.6. Results from focus group discussions

4.6.1. Farmers’ markets participation

Following in-depth interviews, we conducted FGDs with village representatives (VDC members) to examine their perceptions of vegetable farmers’ market integrations and devise strategies to cope with the COVID-19 pandemic. VDC members report that vegetable farmers either did not participate in inputs and outputs markets or only did so to an extent. Many respondents in FGDs agreed with the results of in-depth interviews (Table 3). Regarding inputs, markets reach/access, a member of a FGD reports, “Inputs market access was tough even impossible because of the pandemic. Creating alternative models of farm input deliveries at farm doorsteps would have reduced farmers’ difficulties accessing inputs markets” (FGD06). Similarly, regarding the purchase of farm inputs, most FGD respondents also confirm the statements of in-depth interviews. They report difficulties for farmers in purchasing their inputs, although they successfully reached out to inputs markets (Table 3). An elderly farmer in a FGD reports, “Besides difficulties in reaching out to inputs markets, the farmers also faced difficulties purchasing inputs. Support for farmers in the Farmer Input Support Program could have insured farmers’ purchase of extension suggested agricultural technologies. It would have prevented food shortages for consumers because of limited access and availability of inputs” (FGD02).

The statements of farmers during the in-depth interviews regarding their productivity losses because access to output markets was lacking is also confirmed by many FGD members (Table 3). A prominent farmer who was well respected in his community reports, “In our community, we were trying to make a way to reach out our vegetables to markets. But the government parked the vehicles on their way to markets for several days—our community farmers all vegetable spoilage” (FGD05). FGD participants largely agreed with comments made during in-depth interviews regarding income losses: the pandemic caused significant losses. In his community, an elderly farmer who is well-respected reports, “When there were no consumers, then the rates go down. The government’s rates were high. However, we have sold our vegetables, not even at half the government rates. Because in mountainous regions we have cold temperatures; however, in cities (in the rest of Pakistan) where we sell our vegetables, especially the Punjab province, the temperature is very high. We were in the vegetable markets for several days. However, we found no one who might have purchased our vegetables at good rates. We sell our vegetables at meager prices because we thought that … Something is better than nothing” (FGD01).

4.6.2. Factors affecting community members’ participation in inputs and outputs markets (results of FGDs)

Like the in-depth interviewees, FGDs respondents note the poor access to, if not complete, lack of machinery for vegetable farmers during the pandemic (Table 4). An elderly farmer in a FGD reports, “The unavailability of farm machinery during the pandemic resulted in its inefficient use, which negatively affected vegetable production system and alternatively the output markets participation” (FGD06). Similarly, regarding the unavailability of farm labor reported during in-depth interviews, many FGD members agree (Table 4). An elderly

### Table 3
Results of FGDs on farmers’ participation in input and output markets.

| Variables                          | Cases | Percentages |
|-----------------------------------|-------|-------------|
| Farmer inputs markets access      | 89    | 86.41       |
| Purchased of extension suggested inputs in markets | 81    | 71.64       |
| Productivity losses               | 103   | 100         |
| Income losses                      | 103   | 100         |

### Table 4
Results of FGDs on the determinant factors of vegetable farmer’s inputs and outputs markets integration.

| Variables                          | Cases | Percentages |
|-----------------------------------|-------|-------------|
| Farmer access to farm machinery   | 72    | 69.9        |
| Labor shortage                    | 85    | 82.52       |
| Access to credit                  | 94    | 91.26       |
| Access to market information      | 91    | 88.35       |

Total cases 103.
4.7. FGDs on community elder suggestions for mitigation of COVID-19 losses

Keeping in mind the social distancing policies of the government, the community elders presented some viable routes for mitigating agricultural and economic losses while also increasing the efficacy of policy in response to COVID-19 or any other future pandemic. Table 5 shows community elders’ (key decision-makers) suggestions in response to the COVID-19 pandemic.

5. Conclusion and policy recommendations

Farmers’ participation in input and output markets plays an essential role in purchasing suggested inputs, agricultural productivity, and income. The COVID-19 pandemic harmed the economic wellbeing of small and resource-poor farmers in developing and emerging economies. The small vegetable farmers in Pakistan’s rugged mountainous Hindu-Kush Himalayan region are no exception. Farming families’ livelihood, farming systems, and way of life in the poverty-stricken region changed significantly. This study investigates the impact of the COVID-19 pandemic on farmers’ participation in input and output markets and on productivity in the rugged region.
The main barriers were identified during in-depth interviews and focus group discussions in the HKH region. These include poor private sector (market owners) support, difficulties in accessing inputs and outputs markets, non-availability/shortage of extension, poor access to mechanizations, labor shortages, lack of access to agricultural credit, and inadequate information on innovations and markets. Our results further reveal that vegetable farmers in mountainous regions lost productivity and sales due to COVID-19-related barriers that hindered their market integration.

The binary logit model result shows that multiple factors explain the vegetable farmers’ participation in inputs and outputs markets during the COVID-19 pandemic. These include farming experience, ownership of a personal vehicle for vegetable delivery, availability of farm machinery, and support from market owners. However, the influence of these factors varies between input and output markets. Several solutions were developed during FGDs to mitigate the risks of the COVID-19 pandemic and other future pandemics and facilitate a quick return to normality. These include more accessible access to inputs markets, purchasing agricultural technologies, collaboration for sustainable agricultural production, and participation in output markets. Finally, establishing input and output markets at the local level, designing strategies for access to input and output markets, building infrastructures like roads, trucks, and vehicles, and providing access to credit, information, and farmworkers are all recommended.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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