Journal of Pure and Applied Agriculture (2020) 5(1): 99-106
ISSN (Print) 2617-8672, ISSN (Online) 2617-8680
http://jpaa.aiou.edu.pk/

RESEARCH PAPER

An assessment of knowledge level and training gap of the farmers regarding post-harvest losses of wheat in Punjab, Pakistan

Adeela Manzoor[1]*, Farooq Tanwir[1], Saira Akhtar[1] and Babar Shahbaz[2]

[1]Department of Rural Sociology, University of Agriculture, Faisalabad, Pakistan
[2]Institute of Agricultural Extension and Rural Development, University of Agriculture, Faisalabad, Pakistan

*Corresponding author: Adeela Manzoor (adeela.bhatti@uaf.edu.pk)

Received: 18 February 2020; Accepted: 17 May 2020; Published online: 20 May 2020

Key Message: This research concludes that most of the farmer's need trainings in different post-harvest activities. Reducing post-harvest losses offers an important way of increasing food availability without requiring additional production resources.

Abstract: The major objective of this study was to assess the training needs of farmers to reduce the post-harvest losses of wheat. For this purpose, face to face interviews were conducted to assess the training needs of farmers from four hundred (400) farmers selected on the basis of multi-stage sampling technique. Results of the study show that one-third (28.5%) of the respondents have 20 years and above farming experience. A majority of the farmers (59.5%) in the study area were cultivating a wheat crop for domestic purpose, while other farmers (40.5%) were cultivating wheat for commercial and seed purposes. A large number of farmers (52.4%) needed trainings in various aspects from harvesting of wheat to its consumption. The results of the study show that greater farming experience, use of wheat harvester and improved transportation of wheat reduce the post-harvest losses. Knowledge of combine harvester is positively associated with the farming experience. Results concluded that (85.6%) of farmers do not have access (or have less access) to extension workers and their services. So, there is a dire need to start training sessions especially at household level, including men as well as women, and training sessions should be started after need assessment.

Keywords: Extension services, Farming practices, Post-harvest losses, Training needs, Wheat cultivation

To cite this article: Manzoor, A., Tanwir, F., Akhtar, S., & Shahbaz, B. (2020). An assessment of knowledge level and training gap of the farmers regarding post-harvest losses of wheat in Punjab, Pakistan. *Journal of Pure and Applied Agriculture, 5*(1), 98-105.

Introduction

Wheat is considered as a key crop for human survival as well as a major shareholder in the economy of any country (Yu et al., 2017). Wheat is a major source of food in Pakistan. It also fulfills the food requirements of those who cannot afford high protein foods like meat and pulses. Among other crops, it is a widely grown cereal crop in all provinces of the country (Khan & Kulachi, 2002) covering the area of nine million hectares (Government of Pakistan [GOP], 2019). Wheat flour is the most important food for Pakistani people and it is enriched with nutritional value and energy. It supplies 72 percent of daily caloric energy. In Pakistan, the estimated consumption of wheat flour is 124/kg/capita which is the highest amount all over the World. It is exceeded from China and India although they have a higher level of income and population than that of Pakistan (Rashid & Ayaz, 2015).

Postharvest losses are measured through quantitative ways such as reduction of weight or volume of food grains as well as qualitative ways: loss of nutritional or processing quality including contamination with aflatoxins) and economic (e.g. reduced value or access to some markets). The major losses of wheat occur at the storage level due to the traditional storage practices at the household level which may gauge biotic factors (e.g. insects, rats, birds, and moulds) (Campanhola, 2018). In Pakistan, about 10% of cereal food losses occur due to poor post-harvest methods. These post-harvest losses mainly occur at the time of harvesting of the crop, threshing, transportation and improper storing techniques. According to the estimates, the required storage facilities are three times higher than the current storing facilities. Some other factors that cause losses of food include improper use of agricultural inputs, poor irrigation methods, insect pest attack, poor harvesting techniques, poor transportation, and improper storage facilities (GOP, 2017).

Being a worldwide problem, the situation of post-harvest food loss seems to be more critical in food-deficient countries (Tuffa et al., 2017). According to the estimation of the Food and Agricultural Organization, on average about one-third of the total food produced, which is equal to 1.3 billion tonnes, is wasted on an annual basis (Food and Agriculture Organization [FAO], 2011). Hengsdijk and De-Boer (2017) reported that average post-harvest losses reached up to 24 percent. Three major factors were involved: transportation (use of unwashed or burnt bags openly), marketing (far away from household, lack of knowledge) and storage (openly stored, traditional ways). The post-harvest losses occur at different stages of the post-harvest management chain affecting crop quality and food security efforts. Therefore, understanding the circumstances

around harvest and post-harvest of a given crop may help to reduce the post-harvest losses and improve the income of farm households (Dessalegn et al., 2014). Poole et al. (2019) reported that in Asia, the level of malnutrition being high is threatening the health and living conditions of millions of households. Moreover, insect pest, birds, and rodent attacks are also a major cause of post-harvest losses (Hodges et al., 2011).

Major losses are estimated in food grains during management decisions of harvesting the wheat, traditional storage practices or lack of drying knowledge. Heavy losses of food production occur in different stages due to poor harvesting and transportation, marketing channel, and middleman monopoly of prices ups and downs at the selling and buying time (Khan, 2017). There is a significant difference of food loss between developed and developing countries as in developing countries food losses occur at the time of harvesting and storing of harvested crops, while in case of developed countries, it mainly occur at the time of food consumption (Lipinski et al., 2013). It cannot be denied that the reduction of post-harvest losses is the most important to ensure food security. The reduction of these losses will ultimately increase the opportunities of food production and help in the alleviation of poverty and uplift in rural development in the developing countries (Hodges et al., 2011). So, this study was conducted with the objective to find out the knowledge and practices used in post-harvest activities and explore the training needs of the farmers to reduce the post-harvest losses.

Materials and Methods

Population of the study

This research was conducted in three randomly selected districts (Okara, Faisalabad and Chiniot) of Punjab, Pakistan (Fig. 1). All three districts hold tremendous potential for agriculture.

Sampling procedure and sample size

Four hundred (400) farming households who grow wheat crop and reside in the study districts were selected. The study was conducted by employing multistage sampling technique. At the first stage, three districts were selected i.e. Faisalabad, Okara and Chiniot on the basis of random sampling. At second stage, six rural tehsils (two from each district) were selected through random sampling. Then twelve villages from each tehsil were selected randomly. From the twelve selected villages in third stage, respondent farmers were selected on the basis of proportionate sampling in fourth stage. Sample size of this study consists of 400 respondents. The choice of sample size is based on Krejcie and Morgan (1970) and represents a reasonable sample to draw valid statistical inference. At this stage, meetings were conducted with the agricultural officers of concerned areas for the collection of lists of the wheat farming household. After the collection of household information, it was observed that there are 1636 households who are cultivating wheat crop. Therefore, a sample of 400 farmers (about 25% of the total farmers) was constructed by selecting a proportionate number of farmers from each of twelve villages. This information is provided in Table 1.

Table 1 Multi-stage sample of the study

Sampling Stage	Sampling Type	Sampling Unit	Study sample					
First	Random	District (3)	Okara		Faisalabad		Chiniot	
Second	Random	Tehsil (6)	Okara	Depal Pur	Faisalabad Sadar	Jumra	Bhawana	Lalian
Third	Random	Village (12)						
		Village 1 (V1)	Chak 45/G.D	Arore Wala Jagir	Chak 237 / R.B (Khadi)	Chak 103/J.B (Barnala)	Chak 210/J.B	Kot Kaz
		Village 2 (V2)	Chak 43/G.D	Chichti Qutabdin	Chak 75 / G.B (Mamdot)	Chak 189/R.B (Rasul Pur)	Chak 198/J.B	Chak Bahadur
Fourth	Proportionate	Farmer (400)						
		Total Farmers (V1)	160	118	176	206	90	100
		Proportionate Sample (V1)	39	29	43	50	22	24
		Total Farmers (V2)	170	123	150	189	70	84
		Proportionate Sample (V2)	42	30	37	46	17	21

Tool for data collection

A well-structured close-ended interview schedule was used for data collection. For the survey of four hundred household face to face interviews were conducted.

Data analysis

Data analysis was performed using descriptive as well as inferential statistics by using Statistical Package for Social Sciences (SPSS). In inferential statistics, Pearson Chi-square, and Spearman rank correlation tests were used.

Fig. 1 Map of Punjab province of Pakistan showing Okara, Faisalabad and Chiniot districts (Government of Pakistan [GOP], 2019)

Results

Farming experience of the respondents

The data in Table 2 shows that respondents having 4 years and less experience were 10.0%, more than one-fourth (15.3%) of respondents had farming experience of 5 to 9 years, about one-third respondents (30.8%) had 10-14 years of farming experiences, 15.5% of respondents had experience of farming between 15 to 19 years, and about one-third (28.5%) respondents had 20 years and above farming experience. These results show that the respondents of this study were experienced persons regarding farming.

Purpose of wheat cultivation by the respondents

Respondents' distribution regarding the purpose of wheat cultivation shows that farmers might have more attention towards wheat cultivation if they cultivate wheat for business purposes and their production level may increase in comparison to other purposes. Fig. 2 demonstrates that a majority (59.5%) of respondents cultivated wheat for household consumption, while only 4.8% respondents cultivated wheat for seed purpose, and more than one third (35.8%) of respondents' major cultivation purpose is "business".

Table 2 Distribution of the respondents according to their farming experience

Experience (Years)	Frequency	Percent
Less than 4	40	10.0
5-9	61	15.3
10-14	123	30.8
15-19	62	15.5
20 and above	114	28.5
Total	400	100.0

Knowledge and practices of the respondents about cutting

Knowledge, behavior, and attitude are important factors to change any perspective. Harvesting techniques and harvest time have a major impact on crop yield. For threshing and harvesting, combine harvester and thresher are generally used. Table 3 shows that less than one-fourth (15.5%) of respondents did not have enough knowledge of cutting time of wheat, on other side (52.5%) of the respondents did not practice of cutting activities, about one-tenth (9%) had knowledge to some extent, but 16.3% of the respondents had practices of cutting at some extent point, and a large majority of respondents' had great knowledge about the perfect time of wheat cutting but 31.3% of the respondents had only practices of cutting to great extent.

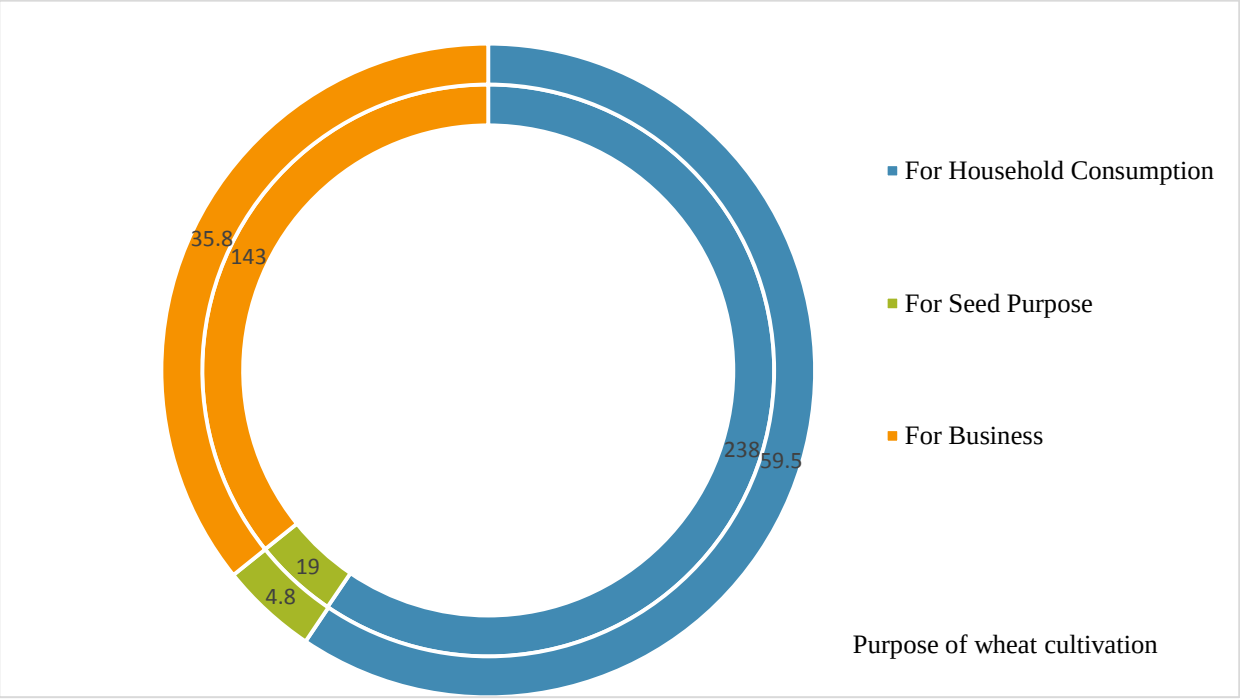

Fig. 1 Distribution of the respondents regarding the purpose of wheat cultivation

Table 3 Distribution of the respondents according to their knowledge and practices of different post-harvesting activities (n = 400)

Post-harvesting activities	Knowledge						Practice					
	1		2		3		1		2		3	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Cutting time	62	15.5	36	9.0	302	75.5	210	52.5	65	16.3	125	31.3
Harvester	18	4.5	61	15.3	321	80.3	205	51.3	65	16.3	130	32.5
Manual cutting (Sickle)	9	2.3	10	2.5	381	95.3	113	28.3	17	4.3	270	67.5
Combine harvester	87	21.8	38	9.5	275	68.8	321	80.3	24	6.0	55	13.8

Scale: 1 = Not at all, 2 = To some extent, 3 = To great extent, Freq. = Frequency, and % = Percent

Knowledge and practices of the respondents about harvester

The present study shows that only 4.5% of respondents did not have knowledge of harvester. On the other side, a majority of the respondents (51.3%) had no practice of harvester, less than one-fourth (15.3%) of the respondents had knowledge of harvester to some extent, rather (16.3%) respondents had a practice of harvester to some extent, and an overwhelming majority (80.3%) of the respondents had knowledge of harvester to great extent, while only 32.5% of the respondents had practice of harvester (Table 3).

Table 4 Distribution of the respondents according to their training needs of wheat post-harvest chain

Require Training N=375		
Post-harvest activities	Frequency	Percent
Cutting	14	3.7
Threshing	15	4.0
Packaging	14	3.7
Transportation	12	3.2
Marketing	14	3.7
Seed storage	78	20.8
Drying	11	2.9
Consumption	21	5.6
All of these	196	52.4
Total	375	100

Knowledge and practices of the respondents about manual cutting

A few (2.3%) respondents said that they have less knowledge of manual cutting with sickle rather less than third (28.3%) of the respondents did not use the practice of cutting, only (2.5%) respondents had a little knowledge of manual cutting. On the other hands, a few (4.3%) of the respondents had a practice of manual sickle at some extent, a large number of farmers (95.3%) had a great practice of manual cutting with sickle. A majority of the respondents (67.5%) had a practice on a large scale of manual cuttings with sickle (Table 3).

H_1: There is an association between farming experience and knowledge of farmer about combine harvester

Table 5 Cross-tabulation of farming experience (in years) and knowledge of combine harvester

Farming Experience (In years)	Knowledge of combine harvester			Total
	Not at all	To some extent	To greater extent	
Up to 4	14	1	25	40
05-09	8	5	48	61
10-14	17	19	87	123
15-19	19	2	41	62
20 and above	29	11	74	114
Total	87	38	275	400

Pearson chi-square value = 22.647; d.f. = 8; Asymp. Sig. (2-sided) = .004

Knowledge and practices of the respondents about combine harvester

About one-fourth (21.8%) of the respondents did not have the knowledge of combine harvester, on other side, a large majority (80.3%) of the respondents did not use combine harvester, only 9.5% of respondents reported that they have a knowledge of combine harvester up to some extent, rather only 6.0% of respondents used combine harvester up to some extent. A large number of farmers (68.8%) had knowledge about combine harvester up to great extent and only a few respondents (13.8%) used combine harvester up to great extent. Table 4 shows that only a few (3.7%) farmers wanted training in cutting aspect, 4.0% of farmers wanted training in threshing aspect, only 3.7% of respondents needed training in packaging. Whereas, 3.2% and 3.7% of farmers needed training in transportation and marketing, respectively. 20.8% of farmers reported that they need training in storage/seed storage aspects, whereas only 2.9% and 5.6% needed training in drying and consumption aspect, respectively. A majority of the farmers (52.4%) needed training in all aspects of wheat chain starting from harvesting of wheat to its consumption.

Association between knowledge of combine harvester and farming experience

Table 5 shows that knowledge of combine harvester is positively associated with the farming experience. The results in cross-tabulation show that as the experience of farming increases, the knowledge about combine harvester increases. This is important for a society where the majority of farmers have small landholdings. In such scenarios, farmers are less likely to use combined harvesters or new technologies due to fewer resources and small landholdings. So, having knowledge about combine harvester can lead a person to get awareness and practice of new technologies. Post-harvest losses occur due to different factors starting from harvesting till its consumption e.g. traditional practices used in harvesting, processing, handling, drying, and others.

Association between farming experience and post-harvest losses of wheat

An experienced person is better on loss management. It was concluded from the results shown in Table 6 that farmers with greater experience of farming reported lesser post-harvest losses (see cross-tabulation) and these differences are statistically significant ($\chi^2(12)=21.213$, p-value< 0.05). It was hypothesized that more practice of wheat harvester leads to lesser losses. This hypothesis was statistically approved by the results of chi-square test (Table 6). So, it is concluded that greater the experience of wheat harvester, lesser the wheat post-harvest losses. The null hypothesis is not supported by data and hence alternate hypothesis is accepted. According to the hypothesis, better transport system can decrease the wheat losses (Table 7). Transport system is an important step while moving wheat from farm to the market place or to storage

place. If the system is not up-to-the mark, losses are supposed to occur. So to avoid wheat losses, vehicles and transportation system must be improved. This is only possible if the farmers use mechanized grain storage methods.

H_3: More the practice of wheat harvester, lesser the post-harvest losses

Table 6 Cross-tabulation of practice of harvester and wheat post-harvest losses approximately

Practice of harvester	Wheat post-harvest losses				Total
	1-5% of total production	6-10% of total production	11-15% of total production	16% and above of total production	
Not at all	36	71	58	40	205
To some extent	15	24	22	4	65
To greater Extent	38	42	31	19	130
Total	89	137	111	63	400

Pearson chi-square value = 12.536; d.f. = 6; Asymp. Sig. = .05

Table 7 Better the type of vehicle used to transport wheat, lesser will be the post-harvest losses of wheat
Symmetric measures

		Value	Asymp. Std. Error[a]	Approx. Sig.
Ordinal by ordinal	Spearman correlation	-.141	.051	.005[b]
Number of valid cases		400		
a. Not assuming the null hypothesis				
b. Based on normal approximation				

Discussion

This research study shows that the respondents of this study are experienced persons regarding farming and a majority of the respondents (59.5%) cultivated wheat for household consumption as compares with the seed and business purposes. A large number of rural farmers have sufficient knowledge of cutting time of wheat, but they do not practically use knowledge of cutting, they prefer to hire labour for cutting their crops. Further, these findings show that an overwhelming majority of respondents have knowledge about harvester but only one-third part of respondents are practicing this technology. However, a large number of people are practicing manual cutting. Further, present study explains that majority of respondents (68.8%) have knowledge of combine harvester but practically only a few (19.8%) are using it. The main reasons behind the use of combine harvester are grain scattering and wasting of husks because most of the respondents have livestock on a large scale and they need husks for their animals.

A similar type of study was conducted by Kiaya (2014) who reported that it is essential for farmers to adopt new techniques and technology for the production of good quality gains. To produce high-quality grains, it is essential that farming households do their postharvest handling in a proper and timely manner. Rosegrant et al. (2015) explored a lot of issues relevant to post-harvest losses, in which a major and quality part of food losses occur during post-harvest management chain. Parfitt et al. (2010) noted that, in the developed world, post-harvest losses are higher on the consumer side, but in the developing world, post-harvest losses seem to be high from early stages like farm level. Aulakh and Regmi (2015) concluded that post-harvest losses mechanization chain is affected from several stages especially at the time of harvesting which is due to the lack of knowledge and inadequate practices. These practices vary from country to country. Similar findings have been reported by Bartholomeu et al. (2017) in Brazil who mentioned that losses occurring along the wheat supply chain, and estimated losses account half of the domestic wheat consumption. Post-harvest losses are approximately about 6% on farms and 5% during storage. Prikhodko and Zrilyi (2013) reported that economic losses are high during many post-harvest activities (which include harvesting, drying, threshing, packaging, transportation, and storage practices) resulting in qualitative and quantitative losses (Grover & Singh, 2013). Kaminski and Christiaensen (2014) explored that loss of cereals at post-harvest level in Africa was 23% during harvesting, transportation, handling at on-farm, and storage level.

The results of the presents study shows that a majority of farmers (52.4%) need training in all aspects of wheat chain starting from harvesting of wheat to its consumption. Similarly, Basavaraja et al. (2007) reported that education and training of farmers would ultimately help to minimize food grain losses and improve food quality. Ahmad (2009) also explained that intensive training programs minimize quantitative and qualitative grain losses. Establishment (renovation) of new (existing) grain storage centers and research institutes are one of the important initiatives to avoid post-harvest losses by research and training of farmers and extension workers on safe grain storage. Similar findings were reported by Bala et al. (2010) who discussed the success story

of the training method to address losses. They primarily address the reduction of losses in post-harvest wheat activities and in the technicality of post-harvest chain management.

Kiptot and Franzel, (2019) explained that agricultural extension services provided mostly for male, women and youth have a lack of access to these services. The drivers of successful extension services are different and mainly depend on administration type, whether the extension trainer is paid from any organization. Bartholomeu et al. (2017) highlighted the losses occurring along the wheat supply chain, where half of the production of wheat at a domestic level. Losses during transportation can amount to 0.8%. When they are converted into monetary units, these losses are not negligible and highlight the need for searching for alternatives to minimize them in the chain of post-harvest management activities. Aulakh and Regmi, (2015) explained that agricultural production is affected due to post-harvest losses owing to improper infrastructure, practical uses of traditional ways, insufficient knowledge and skills, monopoly of the marketing system, and insufficient management strategies and skills (Kiaya, 2014). At a time when the world's population is growing and agricultural production is being threatened by climate change, it is estimated that around one-third of the food produced worldwide is lost or wasted (Blakeney, 2019).

Affognon et al. (2015) found that farmers faced issues regarding the proper management of post-harvest activities. Resultantly, when farmers do not have proper information regarding post-harvest management leads to a condition of post-harvest food losses. Grover and Singh (2013) explained that losses at harvest level were high due to late harvesting of crops caused by grain scattering. Campanhola and Pandey (2018) reported that post-harvest losses are high due to low level of farmer's technical and managerial knowledge in various activities like harvesting, processing, packaging, transportation, storage, and marketing. According to our findings, better transport system can decrease the wheat losses. Hodges and Stathers (2012) suggested that farmers should prepare good quality grains and use good and covered transport to bring them to the market. Farmers should take care of their grains for both domestic and seed use. It will directly help to ensure the quality of food and, ultimately, improve food security. This is only possible if the farmers use mechanized grain storage methods. Kumar and Kalita (2017) described the same results and reported that transport is an important grain value chain, as commodities need to be transported from one step to another, such as field, processing and market. The lack of sufficient transport infrastructure results in damage to food products due to bruising and losses due to spillage. Transport losses are relatively low in developed countries due to improved road infrastructure and engineered field installations and processing facilities for loading and unloading vehicles quickly with very little or no loss. Poor road construction, along with these unsuitable and poorly maintained modes of transport results in significant spillage and high contamination. In countries such as India and Pakistan, low-quality jute bags are used during transport and even processing, resulting in high spillage rates due to leakage of bags.

Conclusion

A majority (59.5%) of respondents cultivated wheat with the purpose of household consumption. Resultantly, farmers have awareness about new technologies of wheat post-harvest but few of them use practically. Like that 68.8% of the respondents had a great knowledge of combine harvester but only a few respondents (13.8%) used combine harvester. Results concluded that farmers have less access to extension worker and their services. The post-harvest loss occurs at different stages of post-harvest management chain affecting crop quality and food security. Reducing post-harvest losses leads to an important way of increasing food availability without additional requirements of food. It is a sustainable solution for the reduction of poverty and increase the development of rural people by improving the agri-business of farmers. On the basis of this study, it is recommended that training programs should be started after an appropriate needs assessment. Training programs should be started from household level to curtail post-harvest loss. Due to cultural constraints, separate training programs should be started from men and women.

Author Contribution Statement: Adeela Manzoor conducted this research study and wrote the manuscript. Farooq Tanwir supervised this research study. Saira Akhtar and Babar Shahbaz reviewed this article.

Conflict of Interest: The authors declare they don't have any conflict of interest.

Acknowledgments: The authors are grateful to the Department of Rural Sociology, University of Agriculture, Faisalabad, Pakistan for providing a platform for this research study.

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