Managing stored cereals grains insect pests: Farmers' knowledge, perceptions and practices in Punjab, Pakistan

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Abstract

Grains are the essential nutritional source as it provides food to one-third population of the world. Cereal grains such as wheat, rice and maize are widely grown in different parts of the world and used as staple food. However, these grains are affected by various factors which produce postharvest losses. It has been estimated that under storage condition 50–60% losses of cereal grains have been caused due to technical incompetence among which 10–30% of the grains losses has been caused by insect pests. Keeping in view the importance of stored grains and potential impact of insects and different control measures the survey conducted in different five agro climatic zones of Punjab, Pakistan. Total 225 respondents were interviewed and discussions were made to assess the farmer perceptions, knowledge and awareness about stored grains insect pests, their detection and current management practices used by farmers. Majority of the respondents used to store their product in godowns which were traditionally constructed granaries, only 10.2% of them were using modern grainary, mainly due to inability to afford these. Majority of the respondents were not measuring the storage temperature and humidity which is key factor for growth and development for insect pests and disease. Mostly farmers (45%) were using the plastic gunny bags for storage of grains. Different types of insects have been observed by farmers among which the Khapra beetle, Lesser grain borer, and Confused flour beetle were mostly observed under different storage structures. Farmers' perceptions regarding insect pest and their detection under storage structures were significantly associated with the level of education, farming experience and family size. As the farmers education and farming experience increase, the knowledge and awareness for storage pests, as well as the ability to detect and manage them. The respondents were found to be lacking in attending meetings, seminars or trainings regarding storage pests detection, identification and their management. The farmers also don't contact extension department in case of any pest problem. The study highlighted the significance of the interventions such as training, extension services and importance of collaboration between agriculture extension and farming communities. The study also emphasised on the gap between conventional and modern techniques to improve the sustainability of agricultural practices while promoting food security and economic stability of the area.

Keywords: cereals grains, storage pests, sustainability, economic stability

1 INTRODUCTION

Post-harvest losses are one of the most important concerns of food security and safety in the developing world. In Pakistan farmers use grains for consumption, cultivation and selling. Stored grains become deteriorated due to the traditional storage structures [21]. The grains get deteriorated by different physical, chemicals and biological activities which are involve in supply chain form cultivation to consumption [5]. Majority of farmers used traditional method for storage which are exposed to insect pests and other microbial activities [5]. The deterioration of grains is due to the infestation of stored grains insects, fungi, bacteria and mites which reduce the quality and quantity of grains.

Poor post-harvest managements are the key constraints of stored grains losses [12]. It has been estimated that the more than 20 thousand insects species attack on cereals crop under field and storage conditions those leads to destruction of quality and quantity of the grains [21]. Stored grains insect pests are the major issue of the farmers of the world especially in the developing countries like Pakistan. The most destructive insect pests of stored product belongs to orders Lepidoptera and Coleoptera [2]. Beside these insect pests stored grains get deteriorated by fungus which produced different types of mycotoxins [1]. Such kinds of infestation lead the stored grains unfit for human consumption and cultivation as seed. It has been estimated about 55% of average post-harvest losses of grains occur during storage [1]. Insect pests cause 12% losses which may increase upto 50% [6]. The grains losses varied form countries as 9% has been reported in developed countries while more than 20% have been reported from developing countries. The highest stored grains losses have been reported form developing countries of Asian [19].

The protection of these stored commodities is extremely important. To reduce the stored grains losses, it is crucial to find the suitable solution. The aim of this research to carry out the survey, identify the pre- and post-harvest practices

related to stored grains, storage types, stored grains insects' detection techniques and their management used by farming communities in different grains storage structures of Punjab, Pakistan.

2 MATERIALS AND METHODS

2.1 Data Collection

The data was collected by a survey conducted throughout the Punjab province representing the five agro climatic zone (i) Rice-Wheat Punjab (ii) Mixed Punjab (iii) Cotton-Wheat Punjab (iv) Lower Intensity Punjab, and (v) Arid Zone Punjab. From each zone 45 farmers were selected. In total, 225 farmers were interviewed to collect the data. The farmers were interviewed physically to get the required information. A semi structured questionnaire was designed to gather the information. The data was collected according to the types of cultivated crops, total amount of stored products, amount of losses during storage, damage caused by insects, types of storage containers and condition and different types of insect detection techniques used by farmers during storage were collected. The interview was started by confirming the farmers/interviewee was responsible for the handling of stored grains of targeted crops. The targeted farmers were first confirmed for their time of availability. The interviewees were informed first that their answer will be anonymous. They may withdraw their participation at any stage of information. The questionnaire included information (i) Socio-economic profile of farmers, such as age, education, source of income, family size, occupation, farming experience (ii) Farm and storage characteristics such as farm size cultivated crops, source of seed for cultivation, sowing pattern, seed treatments, fertilizer and pesticides applications (iii) Storage structure such as storage types, size, storage containers and sanitation (iv) Storage constraints such as insect pests, insects detection techniques used and their control.

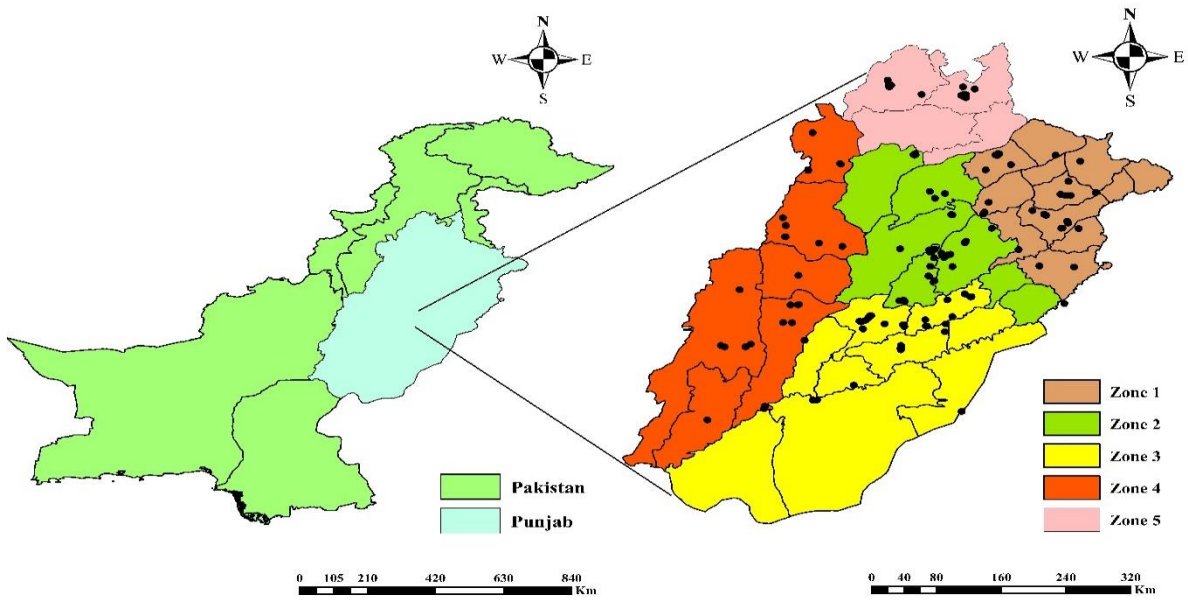

Figure 1: Geographical map of surveyed areas of different agro climatic zones of Punjab.

2.2 Data analysis

The survey data was analysed using the descriptive statistical analysis (frequencies and percentage) using SPSS version 20. The Ordered Probit Model (OPM) was used to assess the significance of the knowledge on insect detection over farmers age, education, family size, seed treatment, pest scouting and contact to extension worker in case of any problem for insect pests detection, identification and management strategies. OPM for dependent variables of the study may be formulated as:

$$Y^* = \beta^{l}X + \varepsilon \qquad (1)$$

Where,

Y^*= unobserved value
ε = distributed with zero mean
β^{l} = vector of unknown parameters to be estimated.
X = vector of a respondent characteristics.

$$Y^* = \beta_0 + \beta_1 AGE + \beta_2 EDU + \beta_3 FSIZE + \beta_4 STRT + \beta_1 PSCO + \beta_1 CON + \varepsilon \qquad (2)$$

Where

Variable Name	Description of Variable	Type of Variable
AGE	Farmers' Age	Continuous
EDU	Farmers Educational level	Discrete
FSIZE	Family Size	Discrete
STRT	Seed treatment	Continuous
PSCO	Pest scouting	Continuous
CON	Contact to extension workers	Continuous

3. RESULTS

The survey was conducted across the diverse agro climatic zones of Punjab, Pakistan. The study provides the valuable understanding of farmers' perceptions, practices, and attitudes towards various aspects of stored grains and seed management, insect detection technologies, and their impact on agricultural production. This section presents a comprehensive analysis of the survey data, highlighting key findings and trends observed within each parameter.

Table 1: Characteristics of the respondents in five agro-climatic zones of Punjab, Pakistan

Parameters	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Overall sample
	N=45	N=45	N=45	N=45	N=45	N=225
Age						
-20-30years	13.3	33.3	31.1	20.0	20.0	23.6
-30-40years	40.0	44.4	53.3	62.2	55.6	51.1
-40-50years	42.2	17.8	15.6	17.8	17.8	22.2
-above	4.4	4.4	0.0	0.0	6.7	3.1
Level of education						
-Illiterate	8.9	8.9	4.4	0.0	8.9	6.2
-Primary	35.6	8.9	15.6	22.2	20.0	20.4
-Matric	20.2	24.4	33.3	8.9	15.6	20.4
-Intermediate	13.3	37.8	35.6	46.7	37.8	34.2
-Graduation	15.6	20.0	11.1	22.2	15.6	16.9
-Post-Graduation	6.7	0.0	0.0	0.0	2.2	1.8
Source of Income						
-Agriculture	60	55.6	73.3	86.7	62.2	67.6
-Livestock	11.1	0.0	4.4	0.0	2.2	3.6
-Business	6.7	0.0	6.7	0.0	0.0	2.7
-Other	22.2	44.4	11.1	13.3	35.6	25.3
Farming experience (years)						
-1-5	6.7	22.2	22.2	0.0	13.3	12.9
-6-10	28.9	57.8	31.1	48.9	53.3	44.0
-11-15	20.0	16.6	28.9	33.3	20.0	23.6
-above	44.4	4.4	17.8	17.8	13.3	19.6
Farm/field size (acre)						
-1-5	20.0	24.4	31.1	8.9	15.6	20.0
-6-10	55.6	37.8	37.8	62.2	51.1	48.9
-11-15	15.6	20.0	15.6	20.0	11.1	16.4
-above	8.9	17.8	15.6	8.9	22.2	14.7
Cultivated crops						
-Wheat	33.3	8.9	33.3	37.8	22.2	27.1
-Rice	4.4	11.1	2.2	0.0	8.9	5.3
-Maize	6.7	2.2	2.2	0.0	0.0	2.2
-Cotton	0.0	0.0	2.2	0.0	0.0	0.5
-Mix	55.6	77.8	60.0	62.2	68.9	64.9
Source of seed						
-Own production	55.6	62.2	62.2	62.2	60.0	60.4
-Market	44.4	35.6	37.8	37.8	40.0	39.1
-NGOs	0.0	2.2	0.0	0.0	0.0	0.4
Soil fertilization						

-Fertilization	51.1	77.8	71.1	91.1	73.3	72.9
-Crop rotation	6.7	4.4	11.1	0.0	2.2	4.9
-Intercropping	0.0	2.2	0.0	0.0	0.0	0.4
-Tillage	0.0	2.2	2.2	0.0	0.0	0.9
-Mix	42.2	13.3	15.6	8.9	24.4	20.9
Pests and disease control						
-Biological & organic control	0.0	11.1	2.2	2.2	4.4	4.0
-Pesticides	88.9	84.4	93.3	97.8	93.3	91.6
-Don't use	0.0	0.0	4.4	0.0	0.0	0.9
-Combine	11.1	4.4	0.0	0.0	2.2	3.6

The sample form the study area cover equal proportion of the respondents (N=45/Zone) (Table 1). Majority of the respondents form all five zones were between the age of 30-40 years (51.1%,). The table also represented education of the respondents. The greatest proportion of the respondents (34.2%) had the intermediate level of education, while having high level of education i-e post-graduation) was recorded for 1.8% of the respondents. More than half of the respondents belongs to agriculture as the source of their income (67.6%) followed by the others or mix income sources (25.3%) least number of the respondent of the study areas belongs of business (2.7%). Nearly half of the respondents (44.0%) had 6-10 years of farming experience, while 23.6% of the respondents had 11-15 years of farming experience. The average farm/field size was between 6-10 acres followed by 20%, 16.4% and 14.7% with size of 1-5, 11-15 and above, respectively. indicating that these were largely smallholder farmers.

Overall, high percentage of the respondents were cultivating mix cropping pattern (64.9%) while 27.1% of the farmers were cultivating wheat crop followed by 5.3, 2.2 and 0.5% Rice, Maize and cotton, respectively. 60.4% of the farmers were utilizing their own production as the source of seed while 39.1% of the farmers purchased seed from different market only 0.4% of the farmer received seed form the NGOs working in the study area. Majority of the farmers used synthetic fertilizers (72.9%) to save soil fertilization 20.9% of the farmers utilized combine methods for preservation of soil fertility. the data also indicates that the majority of respondents across all zones prefer using pesticides for pest and disease control. However, there are some respondents in each zone who prefer alternative methods such as biological and organic control or a combination of methods. Zone 4 stands out with the highest preference for pesticides, while Zone 1 has the highest preference for a combined approach. Zone 3 has a small percentage of respondents who prefer not to use any specific method.

Table 2: Methods used for storage, storage temperature, humidity and type of containers

Parameters	Zone 1 N=45	Zone 2 N=45	Zone 3 N=45	Zone 4 N=45	Zone 5 N=45	Overall sample N=225
Storage of product						
- Yes	84.4	86.7	91.1	75.6	82.2	84.0
- No	15.6	13.3	8.9	24.4	17.8	16.0
Where do you store?						
-Godowns	62.2	53.3	22.2	73.3	51.1	52.4
-Grainary	11.1	4.4	28.9	2.2	4.4	10.2
-Silos	13.3	28.9	31.1	4.4	24.4	20.4
-Other	13.3	13.3	17.8	20.0	20.0	16.9
Measurement of Storage Temp. & Humidity						
-Yes	62.2	24.4	31.1	26.7	20.0	32.9
-No	37.8	75.6	68.9	73.3	80.0	67.1
Storage Temp						
- 0-10 ^{0}C	2.2	2.2	6.7	0.0	2.2	2.7
- 11-20 ^{0}C	48.9	13.3	15.6	26.7	13.3	23.6
- 21-30 ^{0}C	11.1	4.4	8.9	0.0	4.4	5.8
- 31-40 ^{0}C	0.0	4.4	0.0	0.0	0.0	0.9
- Other (No)	37.8	75.6	68.9	73.3	80.0	67.1
Storage Humidity						
- 50-60%	62.2	20.0	20.0	24.4	17.8	28.9
- 61-70%	0.0	0.0	2.2	0.0	0.0	0.4
- 71-80%	0.0	0.0	6.7	4.4	0.0	2.2

- Other (No)	37.8	80.0	71.1	71.1	82.2	68.4
Type of bag of containers used for storage						
- Jute bag	37.8	33.3	20.0	20.0	26.7	27.6
- Polythene bag	17.8	6.7	8.9	0.0	4.4	7.6
- Plastic gunny bag	17.8	31.1	57.8	75.6	44.4	45.3
- Other (Mix)	26.7	28.9	13.3	4.4	24.4	19.6
Where are bags placed?						
- On mud floor	15.6	28.9	33.3	44.4	35.6	31.6
- Cemented floor	57.8	33.3	44.4	51.1	37.8	44.9
- Wooden shelves	4.4	2.2	13.3	0.0	0.0	4.0
- Concrete shelves	0.0	4.4	0.0	0.0	0.0	0.9
- Others	22.2	31.1	8.9	4.4	26.7	18.7

Table 2 represents that approximately 84.0% of the respondent across all zones store their product, while 16.0% don't store their product and sell directly into the market. The farmers were also asked about the storage conditions. The most common location is "Godowns" with 52.4% of the respondents. 20.4% of the farmer preferred to store their products in Silos or metal bins while 16.9% of the respondents choose mix storge places for storing of their products. Measurements of storage temperature and humidity limited proportion 32.9% of the respondents' measure storage temperature and humidity, while 67.1% of the respondents don't. Out of 32.9% who measure the storage temperature and humidity 23.6% of the respondent store their product within the temperature of 11-20 ^{0}C and 28.9% of the respondent storage at 50-60% of RH. Plastic gunny bags are the most common type of the bag used by the respondents with the value of 45.3% while 27.6% of the respondents used Jute bags and only 7.6% of the respondents store their product in polythene bags. These bags were placed on different places in which 44.9% of the respondent place these bags on the cemented floor, the second most common choice is mud floor with the value of 31.6% while 18.7% of the respondents placed storage bags on multiple locations.

Table 3: Insects pests of stored grains insects and their detection

Parameters	Zone 1 N=45	Zone 2 N=45	Zone 3 N=45	Zone 4 N=45	Zone 5 N=45	Overall sample N=225
Have you ever observed any insect under storage condition?						
- Yes	86.7	77.8	95.6	80.0	82.2	84.9
- No	13.3	22.2	4.4	20.0	17.8	15.1
Type of insects						
- Confused flour beetle	4.4	2.2	6.7	2.2	2.2	3.6
- Rice weevils	0.0	2.2	0.0	0.0	0.0	0.4
- Khapra beetle	20.0	15.6	48.9	13.3	11.1	21.8
- Lesser grain borer	4.4	11.1	2.2	11.1	11.1	8.0
- Red rust flour beetle	0.0	2.2	6.7	0.0	2.2	2.2
- Other (Mix)	71.1	66.7	35.6	73.3	73.3	64.0
Do you check grains before using?						
- Yes	95.6	88.9	100	97.8	91.1	94.7
- No	4.4	11.1	0.0	2.2	8.9	5.3
Do you carry cleanliness of stock?						
- Clean (no impurities, no damage)	40.0	37.8	35.6	37.8	44.4	39.1
- Fairly clean (some impurities, but no damage)	57.8	53.3	53.3	62.2	53.3	56.0
- Not clean (with some impurities and some damage	0.0	6.7	2.2	0.0	2.2	2.2
- can't tell	2.2	2.2	8.9	0.0	0.0	2.7
Have you ever heard about 'Insect detection'?						
- Yes	40.0	44.4	22.2	28.9	33.3	33.8

- No	60.0	55.6	77.8	71.1	66.7	66.2

The above table 3 represent the infestation of stored grains, practices adopted by the respondents for checking and maintaining the quality of the stored grains and awareness of stored grains insects' detection. Approximately 84.9% of the respondents across all zones have observed the insects under storage conditions, while 15.1% have not. Among those who observed the insects in storage the post commonly observed insect was Khapra beetle (21.8%) while maximum proportion of respondents observed all types of insects (other/mix) under storage conditions with the value of 64.0%. The majority of respondents (94.7%) check grains before using the them. The respondents varying the levels of cleanliness for their stored stock. Majority of respondents (56.0%) use fairly clean stock followed by clean stock (39.1%) and not clean stock 2.2%. The respondents were also asked about the insect detection, majority of the respondents across all zone haven't heard insect detection (66.2%) while 33.8% of the respondents have heard the insect detection.

Table 4: Proportion of meeting, seminar attended insect pests problem, sorting and separation of varieties

Parameters	Zone 1 N=45	Zone 2 N=45	Zone 3 N=45	Zone 4 N=45	Zone 5 N=45	Overall sample N=225
Have you ever attended any meeting, seminar on insect detection technologies?						
- Not At All	68.9	68.9	80.0	97.8	77.8	78.7
- Some Extent	26.7	2.4	8.9	2.2	17.8	16.0
- Great Extent	4.4	6.7	11.1	0.0	4.4	5.3
Do insect reduce crop yield?						
- Not At All	4.4	4.4	6.7	0.0	4.4	4.0
- Some Extent	57.8	75.6	75.6	77.8	75.6	72.4
- Great Extent	37.8	20.0	17.8	22.2	20.0	23.6
Do you have insect pest problem in your field or storage?						
- Not At All	6.7	8.9	0.0	8.9	8.9	6.7
- Some Extent	82.2	75.6	71.1	75.6	77.8	76.4
- Great Extent	11.1	15.6	28.9	15.6	13.3	16.9
Do you clean grains/seeds?						
- Not At All	6.7	0.0	0.0	0.0	4.4	2.2
- Some Extent	84.4	91.1	46.7	62.2	80.0	72.9
- Great Extent	8.9	8.9	53.3	37.8	15.6	24.9
Do you perform sorting of grains/seeds						
- Not At All	8.9	11.1	4.4	0.0	11.1	7.1
- Some Extent	66.7	62.2	64.4	80.0	66.7	68.0
- Great Extent	24.4	26.7	31.1	20.0	22.2	24.9
Do you maintain separation of verities?						
- Not At All	7.8	15.6	8.9	0.0	11.1	10.7
- Some Extent	22.2	33.3	44.4	15.6	31.1	29.3
- Great Extent	60.0	51.1	46.7	84.4	57.8	60.0
Do you spray or fumigate the grains/seeds?						
- Not At All	13.3	13.3	24.4	2.2	8.9	12.4
- Some Extent	82.2	82.2	55.6	86.7	84.4	78.2
- Great Extent	4.4	4.4	20.0	11.1	6.7	9.3
Do you contact extension department in case of any problem?						
- Not At All	17.8	48.9	53.3	71.1	48.9	48.0
- Some Extent	68.9	40.0	42.2	28.9	44.4	44.9
- Great Extent	13.3	11.1	4.4	0.0	6.7	7.1
Do you perform germination tests before sowing?						

- Not At All	62.2	57.8	42.2	88.9	68.9	64.4
- Some Extent	35.6	26.7	37.8	8.9	24.4	26.7
- Great Extent	2.2	15.6	20.0	2.2	6.7	8.9

Table 4 shows that many respondents did not have attended any meeting or seminar for stored grains insect detection technologies (78.7%). The respondent scaled that 72.4% of the respondent think that the insects reduce the crop yield to some extend under storage conditions and 23.6% think that insects reduce the crop yield to the great extent. The majority of the respondents (76.4%) report they are having some extent of insect pest problem in their field and storage conditions. 72.9% of the respondents clean their stock to some extent. Respondents generally perform sorting of the grains to some extent (68.0%) small percentage (24.9%) perform sorting to great extent. Most of the respondents (60.0%) maintain the separation of the varieties to great extent. Very small percentage (10.7%) of the respondents don't maintain the separation of the varieties. Respondents commonly fumigate grains to some extent (78.2%). A smaller percentage (9.3% on average) spray or fumigate to a great extent. A small percentage (12.4% on average) do not spray or fumigate at all. Majority of respondents (48.0%) do not contact the extension department in case of any problem. Some respondents (44.9%) contact the extension department to some extent. A small percentage (7.1%) contact the extension department to a great extent. A significant percentage of respondents (64.4%) do not perform germination tests before sowing. Some respondents (26.7%) perform germination tests to some extent. A small percentage (8.9%) perform germination tests to a great extent.

Table 5: Insect detection and government support to get detected grains/seeds

Parameters	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Overall sample
	N=45	N=45	N=45	N=45	N=45	N=225
Grains/Seeds must be checked before import/export and cultivation.						
- Strongly Agree (SA)	2.2	22.2	2.2	0.0	8.9	7.1
- Agree (A)	82.2	46.7	51.1	33.3	51.1	52.9
- No Opinion (NO)	15.6	26.7	35.6	62.2	37.8	36.6
- Disagree (DA)	0.0	4.4	11.1	4.4	2.2	4.4
- Strongly Disagree (SD)	0.0	0.0	0.0	0.0	0.0	0.0
Insect detection can reduce the use of chemical pesticides.						
- Strongly Agree (SA)	24.4	11.1	2.2	0.0	6.7	8.9
- Agree (A)	66.7	71.1	73.3	60.0	71.1	68.4
- No Opinion (NO)	8.9	15.6	20.0	40.0	20.0	20.9
- Disagree (DA)	0.0	2.2	2.2	0.0	2.2	1.3
- Strongly Disagree (SD)	0.0	0.0	2.2	0.0	0.0	0.4
Used of insect detection technologies is too laborious and costly.						
- Strongly Agree (SA)	31.1	17.8	11.1	0.0	15.6	15.1
- Agree (A)	44.4	55.6	46.7	77.8	62.2	57.3
- No Opinion (NO)	15.6	15.6	35.6	22.2	15.6	20.9
- Disagree (DA)	8.9	8.9	6.7	0.0	6.7	6.2
- Strongly Disagree (SD)	0.0	2.2	0.0	0.0	0.0	0.4
Government support to get detected grains/seeds in important.						
- Strongly Agree (SA)	15.6	6.7	8.9	0.0	6.7	7.6
- Agree (A)	11.1	40.0	24.4	15.6	24.4	23.1
- No Opinion (NO)	24.4	4.4	20.0	8.9	8.9	13.3
- Disagree (DA)	40.0	37.8	24.4	15.6	33.3	30.2
- Strongly Disagree (SD)	8.9	11.1	22.2	60.0	26.7	25.8
Properly detected grains/seeds may increase the yield.						
- S trongly Agree (SA)	11.1	22.2	8.9	13.3	15.6	14.2
- Agree (A)	80.0	55.6	57.8	84.4	71.1	69.8
- No Opinion (NO)	8.9	13.3	20.0	2.2	6.7	10.2
- Disagree (DA)	0.0	8.9	11.1	0.0	6.7	5.3
- Strongly Disagree (SD)	0.0	0.0	2.2	0.0	0.0	0.4

Respondents generally agree that grains must be checked before import/export and cultivation, with 52.9% and 36.6% having no opinion (table 5). Zone 1 has the highest agreement rate (82.2%), while Zone 4 has the lowest (33.3%). The respondents were agree that insect detection can reduce the use of pesticides with 68.4% while 20.9% of the respondent have no opinion.57.3% of the respondents agree that insect detection technologies are laborious and costly while 20.9% of respondents have no opinion. There is a range of opinions on government support, with 23.1% of the respondents agreeing that it is important and 30.2% disagreeing while 25.8% strongly disagree. Most respondents agree that properly detected grains may increase yield, with 69.8%. A small percentage (0.4%) have strongly disagree the on this matter.

Table 6: Detection of grains for increasing the cost of production, quality, income and export

Parameters	Zone 1 N=45	Zone 2 N=45	Zone 3 N=45	Zone 4 N=45	Zone 5 N=45	Overall sample N=225
Use of detected grains/seeds will save on cost of production.						
- Strongly Agree (SA)	8.9	28.9	8.9	0.0	20.0	13.3
- Agree (A)	91.1	57.8	80.0	100	73.3	80.4
- No Opinion (NO)	0.0	13.3	8.9	0.0	6.7	5.8
- Disagree (DA)	0.0	0.0	2.2	0.0	0.0	0.4
- Strongly Disagree (SD)	0.0	0.0	0.0	0.0	0.0	0.0
Use of detected grains/seeds will increase the quality of your products.						
- Strongly Agree (SA)	37.8	22.2	22.2	4.4	15.6	20.4
- Agree (A)	62.2	57.8	57.8	95.6	73.3	69.3
- No Opinion (NO)	0.0	20.0	20.0	0.0	11.1	10.2
- Disagree (DA)	0.0	0.0	0.0	0.0	0.0	0.0
- Strongly Disagree (SD)	0.0	0.0	0.0	0.0	0.0	0.0
Cultivation of quality grains/seeds will increase your income.						
- Strongly Agree (SA)	13.3	24.4	17.8	13.3	17.8	17.3
- Agree (A)	86.7	71.1	60.0	75.6	73.3	73.3
- No Opinion (NO)	0.0	2.2	20.0	11.1	4.4	7.6
- Disagree (DA)	0.0	2.2	2.2	0.0	4.4	1.8
- Strongly Disagree (SD)	0.0	0.0	0.0	0.0	0.0	0.0
Production of quality grains/seeds will get opportunities to reach to increase the export.						
- Strongly Agree (SA)	20.0	24.4	11.1	0.0	13.3	13.8
- Agree (A)	66.7	53.3	37.8	17.8	44.4	44.0
- No Opinion (NO)	13.3	22.2	48.9	82.2	40.0	41.3
- Disagree (DA)	0.0	0.0	2.2	0.0	2.2	0.9
- Strongly Disagree (SD)	0.0	0.0	0.0	0.0	0.0	0.0
Quality grains/seeds will protect the environment.						
- Strongly Agree (SA)	20.0	20.0	2.2	13.3	13.3	13.8
- Agree (A)	75.6	62.2	55.6	66.7	73.3	66.7
- No Opinion (NO)	4.4	17.8	33.3	11.1	11.1	15.6
- Disagree (DA)	0.0	0.0	8.9	8.9	2.2	4.0
- Strongly Disagree (SD)	0.0	0.0	0.0	0.0	0.0	0.0
For you it is difficult to get quality grains/seeds.						
- Strongly Agree (SA)	4.4	13.3	6.7	0.0	4.4	5.8
- Agree (A)	77.8	48.9	46.7	64.4	57.8	58.7
- No Opinion (NO)	6.7	26.7	24.4	15.6	22.2	19.1
- Disagree (DA)	11.1	11.1	22.2	20.0	15.6	16.4
- Strongly Disagree (SD)	0.0	0.0	0.0	0.0	0.0	0.0

Table 6 presents data on the perceptions and attitudes of respondents in five different zones in Punjab province regarding the use of detected grains and their impact on various aspects of agriculture and the environment. A majority

of respondents (80.4%) agree that the use of detected grains/seeds will save on the cost of production. Zone 4 has the highest agreement rate (100%), while Zone 2 has the lowest (57.8%). A significant percentage of respondents (73.3%) agree that cultivating quality grains/seeds will increase their income. Zone 1 has the highest agreement rate (86.7%), while Zone 3 has the lowest (60.0%). Respondents generally agree that producing quality grains/seeds will provide opportunities to increase export, with an average agreement rate of 44.0%. Most of the respondents (66.7%) agree that quality grains/seeds will protect the environment. Respondents have mixed opinions on the difficulty of obtaining quality grains/seeds, with 58.7%.

Table 7: Factors effecting the farmer's perception regarding the stored grains insect pests detection

Insect detection	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Age	.721	.24	3.00	.003	.25	1.192	***
Education	-.049	.189	-0.26	.798	-.42	.322	
Family size	-.669	.23	-2.91	.004	-1.12	-.218	***
Seed Treatment	-.003	.484	-0.01	.995	-.952	.946	
Pests-Scouting	.966	.367	2.63	.008	.247	1.686	***
Contact to extension workers	1.464	.299	4.89	0	.878	2.05	***
Constant	3.47	1.044	.b	.b	1.425	5.516	
Constant	6.202	1.107	.b	.b	4.032	8.372	

Mean dep. variable	1.533	SD dep. variable	0.641
Pseudo R^2	0.145	No. of observations	225
Chi^2	58.530	Prob > chi^2	0.000
Akaike crit. (AIC)	362.488	Bayesian crit. (BIC)	389.816
*** p<.01, ** p<.05, * p<.1			

Table 7 shows the positive coefficient for age (0.721) indicates that as farmers' age increases, the probabilities of encountering insect pests' detection also increase. This relationship is significant statistically (p = 0.003), suggesting that age has a notable impact on insect pest detection under storage conditions. The education coefficient is negative and non-significant statistically (p = 0.798). This recommends that there is no clear association between the level of education and the insect pests detection among farmers in the study. The negative coefficient for family size (-0.669) implies that larger family sizes are associated with lower probabilities of encountering insect pests. This relationship is significant statistically (p = 0.004), indicating that family size have a role in pest occurrence. The coefficient for seed treatment is close to zero and not statistically significant (p = 0.995). This suggests that the use of seed treatment have non-significant effect on the likelihood of insect pest occurrence among the respondents of the study areas. The positive coefficient for pests counting (0.966) indicates that farmers who actively count pests are more likely to face insect pest issues. This relationship is statistically significant (p = 0.008), suggesting that the vigilance in pest monitoring is associated with a higher probability of pest presence. The positive coefficient for contact with extension services (1.464) suggests that farmers who have more contact with extension services are more likely to encounter insect pests. This relationship is statistically significant (p < 0.01), indicating that extension services may play a role in influencing pest outcomes.

4 DISCUSSION

The present study enlightened on pre and post-harvest knowledge, perception and practices carried out by the farmers of Punjab for cultivation, storage, stored grain insects and their detection. Over 51.1% of the famers/respondents were between the age of 30-40 years with 44% having farming experience of 6-10 years. Most the respondents were cultivating multiple crops by using their own production of seeds in the study areas. The respondent's knowledge regarding storage temperature, humidity control and seed treatment were related with the age, educational level, family size, farming experience and pest scouting [4]. Previous study found that respondents perceptions of stored grain insect pests were positively linked with their age, level of education and farming experiment, the education level and farming experience improved the understanding of stored grain insects detection, identification and management [12]. Our findings revealed that the farmers required the proper information on grains storage techniques. It was noticed that the only few respondents use the appropriate place and having limited facilities for grain storage which may directly affect the grain quality [3]. This is possibly due to lack of awareness of new technologies, improved insect detection techniques and lack of resources to purchase. Our findings are in lined with the results of previous studies [23], who informed that most of the respondents/farmers lacking knowledge on improved storage technologies thus they are using conventional storage methods for grains/ seeds storage.

In our study, the respondents having higher education level, larger field/farm and family size were well aware of proper grains storage conditions and this awareness may be due to the economic stability and accessibility of the resources. The respondents don't have enough knowledge about measurement of storage temperature and humidity very limited numbers of respondents measure the storage temperature and humidity. The respondents also check the grains/seed insects under storage conditions and before using for processing of cultivation but the respondents don't have enough awareness for proper identification of stored grains insects as farmers don't have received training regarding storage insects' detection and identification. Even though, the farmers don't contact with the extension department in case of any insect pests problem and social participation as [9] informed that the interpersonal sources, like family, friends and neighbours are the main source of any information such as agricultural information. Our study also revealed that the farmers of the study areas are not using the well-developed communication technologies for insect detection, identification and management of stored grains insects. The findings of study are in accordance with the earlier studies [11] [13]. Therefore, the farmers need to improve their knowledge by increasing their learning opportunities in accordance to the changing environment and improvement of technologies.

Most of the farmers are using seeds of their own production (60.4%) as the seeds undergo different processes during the storage in form grains or seeds and therefore these grains/seeds may be attacked by different insect pests and diseases affect the quality, quantity and germination percentage as seeds [7] [14]. Securing the grains is important for effective storage as the successful storage is important with proper insect detection before storing [7] [10]. Deteriorated, cracked or broken grains provide the entry point for the insects and diseases [7] [18]. The quality and quantity of the grains/seed could be affected due to the inappropriate post-harvest handling practices and the unfavourable storage settings, which encourage the infestation of insects as reported by [7].

According to the Food and Agriculture Organization (FAO) proper handling of the grains and seeds should begin form the field (pre-harvest) and continue before the storage (post-harvest) [8] [16]. Proper per and post harvesting management must be followed by the farmers to reduce the infestation of insects and diseases under storage conditions Therefore, it must be confirmed that the grains/seeds must be placed under low temperature and relative humidity. Maintenance of the temperature and relative humidity are very important for the growth and development of insect and diseases under storage conditions. The moisture contents of the stored grains/seeds must be kept under threshold levels. Sometimes the grains are artificially dried and cleaned before storage. This process improves the quality, germination rate and also reduce the fungal and insect pests infestation [8] [16]. Overall assessments showed that the stored grains/seeds in the study areas were infested by the insect pests. The grains/seeds get deteriorated due to the improper pre- and post-harvest managements practices. The study also revealed that the most of the farmers (52.4%) stored their product in poor storage conditions and don't have knowledge about the proper insect detection techniques under storage conditions which increase the threat of insects and disease infestation to the grains/seeds. It has been reported earlier that poor grains/seeds quality caused the huge qualitative and quantitative losses of crops yields and stored products [22]. Farmers don't used innovative technologies, probably because they cannot afford or don't have awareness about them. However, this matter can be resolved by focusing on extensive extension activities [17] such as farmers trainings and seminars. Moreover appropriate interventions must be carried out to adopt new technologies into the local set ups [15].

5 CONCLUSIONS

It was observed that the farmers in the studies area having lack of knowledge and awareness regarding the insects' detection and identification techniques under storage conditions. The main issue was that the farmers also don't have proper storage conditions which increase the threat of higher insects and diseases infestations. The most important factor in storage is temperature and humidity which is directly linked with the grains/seed moisture contents which increase the prevalence of insect pests and diseases under storage conditions. So, it is very important to address this problem. Extension services such as workshops or seminars must be conducted to increase the knowledge, skills and awareness of the farmers to minimize the pre- and post-harvest losses. The government should set up training program to give growers necessary information and skills for proper grains/seeds storage. Legislation must be enforced regarding the use of certified, insects and diseased free seeds, regular inspections of field and storage structures. Further there is need to understand the factors those facilitate the growth and development of storage pests and diseases especially storage structures condition which directly or indirectly effect the quality and quantity of the grains/seeds.

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