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Assessment of Maize Farmers' Knowledge, Perception, and Management Practices Against Fall Armyworm (Spodoptera frugiperda) in Punjab, Pakistan

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ABSTRACT

Spodoptera frugiperda (FAW) ia a destructive polyphagous pest that can reduce the yield of maize by approximately 50%-70% percent in Punjab, Pakistan. Current study was aimed at assessing farmers' knowledge, perception, and management practices against fall armyworm on maize crop. This research has applied the quantitative, cross-sectional design and used a structured questionnaires to collect data from 300 farmers, selected randomly. SPSS was used to analyze data using descriptive statistics, correlation, regression and chi-square analyses. The findings indicated that farmers possessed sufficient information on the FAW larval recognition (Mean = 4.12 ± 0.68) and the damage symptoms in the leaves (Mean = 4.05 ± 0.70), but their information about other life stages and feeding characteristics was limited. FAW was considered an extremely threatening to crop productivity and by farmers' income (Mean = 4.35 ± 0.62). The most commonly used, and perceived effective control method was the use of insecticides (frequency = 4.20 ± 0.65; effectiveness = 4.10 ± 0.70), while the least common and seemingly ineffective control method was the use of the cultural and biological method. There were positive significant relationships between knowledge and perception and management practices (r = 0.48-0.62, p =.01). Regression showed that the severity of pests (β = 0.40, 0.001) and the expected economic loss (β = 0.33, 0.001) as decisive factors in taking a decision on specific pest management practice. Two of the most significant determinants of control measures were education level and the size of farm. These outcomes are positive indicators that special extension activities, integrated pest management promotion, should be undertaken to achieve the sustainability of managing FAW, maize protection, and livelihoods protection among farmers.

***Keywords*:** Fall Armyworm, maize, knowledge, perception, management practices, Punjab, Pakistan, integrated pest management.

INTRODUCTION

The value of maize (Zea mays L.) as a staple food and animal feed, makes it one of the most prized cereal crops worldwide. Maize is also a crucial crop in Pakistan as it not only contributed in national economy but also vital for national food security. Approximately 70 percent of all maize in the country is produced in Punjab province (Government of Pakistan, 2025). Maize, however, is affected by numerous biotic and abiotic constraints as a crop in Punjab, with the worst being the insect pests.

Over the last few years, much of the maize production has fallen victim to the deadly polyphagous and Amerindian origin fall armyworm (Spodoptera frugiperda J.E. Smith). It was initially found in Sindh (Pakistan) in 2019 (FAO, 2020). It is highly reproductive difficult to control, considering its long migration tracks, has a large number of hosts and resistance to chemical insecticides.

In maize cultivation, which constitutes a large part of both subsistence and commercial agriculture, the fall armyworm has ravaged Punjab. farmers lacking knowledge and choice for its control, utilize available pesticides and traditional practices. However, the effectiveness of these measures varies considerably due to differences in knowledge, awareness, perception, and access to technical support. Studies have highlighted that the success of integrated pest management (IPM) in managing FAW widely depends on the extent of farmers knowledge, skills and support from extension and technical support regarding (Dossa et al., 2023; Badu et al., 2023). Similar to the above findings, a study in Pakistan has revealed that, knowledgeable agricultural farmers are able to identify FAW, but are ignorant of its sustainable management i.e. biological control. The most widespread control tool is the use of chemical

pesticides, which, once again, is arbitrary, unnecessary, and adds to the cost of production or poses a danger to the environment or human health (Ojumoola et al., 2022).

Understanding farmers' knowledge, perception and adopted practices with reference to fall armyworm is highly relevant for policy intervention and design of extension program. Managerial efforts to minimize loss in crops through cultural (e.g. crop rotation and sanitation of fields), chemical and biological means make up our preventive and reactive control measures. Research also reveals that these three knowledge dimensions have a relationship with each other, and the lack of knowledge could easily lead to poor management decision-making (Kalyebi et al., 2019).

There is scarcity of studies that focused on correlation between knowledge, perception, and management practices among maize growers. Awareness of the socio-economic as well as educational background of farmers is required too, since it would be the factor dictating access to information and the choices and resultant decision parameters to devise in allocating resources to handle pests. This research study therefore tried to fill this research gap by applying the objectives: to determine the perceptions of maize farmers regarding identification, lifecycle of FAW and the catastrophe it causes on production, to explore the management strategy adopted by the farmers to minimize the recurrence of FAW-infestation and to identify the socio-economic factors associated with farmers' behaviour toward pest management.

MATERIALS AND METHODS

A quantitative, cross-sectional research design was used to assess the knowledge, perceptions and adopted management practices associated with Fall Armyworm (FAW) in Punjab, Pakistan. The multistage random sampling technique was applied. First, three districts were selected purposively based on Crop Reporting Survey from Agriculture Department Punjab of districts with the highest area under maize crops: Vehari, Pakpattan, and Okara[1]. Next, the stratified random sampling procedure was used through which the selected districts were chosen as strata, to ensure fair representation of farmers from each district. In the next step, 10 villages were selected randomly from each district followed by selection of 10 maize farmers, randomly from each village. Thus, 100 farmers were selected from each district, making a total of 300 respondents from three districts who participated in the study.

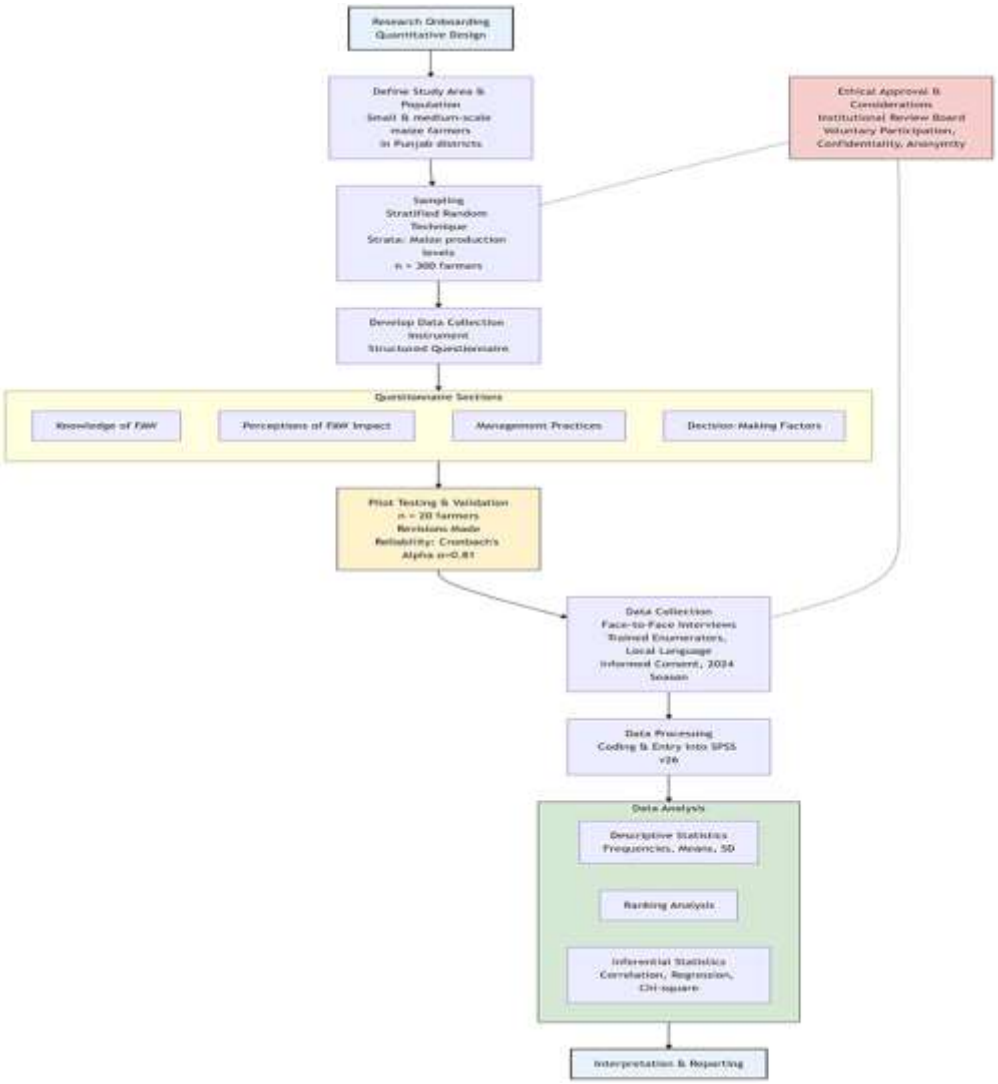

Fig. 1: Schematic Flowchart of Methodology (Self-computed).

A questionnaire was designed to collect data using the available literature on the topic of FAW and pest degradation. A pilot test was also conducted from sample consisting of 20 farmers, other than the actual sample to ascertain the clarity as well as the reliability of this questionnaire. The Cronbach's alpha was found 0.81.

Face-to-face interviews were conducted during 2024 maize growing season. The interviews were conducted in the local language to ensure adequate comprehension and to document the information gathered in response to the inquiries. The collected data were coded and analyzed in SPSS version 26. Frequencies, percentages, means, and standard deviations were used to adequately summarize the various descriptive statistics to generalize the generally known information and perceptions of the farmers and their management practices. An analysis of rankings was conducted to determine which FAW controls are most applicable and which decision-making circumstances have the most significant impact. Moreover, correlation together with regression was applied to investigate relationship among attitude, knowledge and management practices involving farmers. Chi-square tests that would address interactions between demographic variables (e.g. education, farm size) with knowledge or practice in management. Data was collected through trained enumerators. The relevant institutional review board gave ethical approval for the study. Farmers voluntarily participated in the study and provided data contentedly. Before data collection, they were told about the research purpose and objectives, and their informed consent was obtained. They were taken into confidence that their answers/responses would remain confidential and their identities would remain anonymous, not be disclosed to anyone.

RESULTS AND DISCUSSION

1.1. Demographic Characteristics

Table 1 presents the demographic characteristics of 300 maize farmers surveyed in Punjab, Pakistan, regarding their knowledge, perceptions, and management practices related to Fall Armyworm (Spodoptera frugiperda).

Table 1: Demographic Characteristics of Maize Farmers (n=300).

Demographic Variable	Category	Frequency (n)	Percentage (%)
Age (years)	20–30	45	15.0
	31–40	90	30.0
	41–50	90	30.0
	51–60	60	20.0
	>60	15	5.0
Gender	Male	270	90.0
	Female	30	10.0
Education Level	No formal education	60	20.0
	Primary	90	30.0
	Secondary	90	30.0
	Higher education	60	20.0
Farm Size (acres)	<5	75	25.0
	5–10	120	40.0
	11–20	75	25.0
	>20	30	10.0
Farming Experience (years)	<5	30	10.0
	5–10	75	25.0
	11–20	120	40.0
	>20	75	25.0
Household Size	1–4	45	15.0
	5–7	180	60.0
	8–10	60	20.0
	>10	15	5.0

Those reports show that the most of farmers (60%) belongs to the age group of 31-50 years and it is possible to say that the middle-aged group is the primary labor source for farming work in this region. Between 20- and 30-years old agriculturalists constituted 15 percent, indicating the involvement of youth in the farming profession. Whereas, those whose age is above 60 years constituted only 5 percent of the sample. This result aligns with previous findings on Pakistan and other developing nations, where the most widespread group among the agricultural populace is middle-aged adults, as farm labor is physically demanding (Ali et al., 2019). Gender was 9:1; male farmers (90) and female (10). This means that the phenomenon of gendering roles is prevalent in rural Pakistan, as men are typically the decision-makers regarding crop planting (R Core, 2023).

Regarding education, two out of every ten individuals were uneducated, three out of every ten individuals were primary-educated, less than three were secondary-educated and 2 were higher-educated. It also implies that the largest number of farmers are having a primary school level education, potentially affecting their pest control attitudes and behavior (Chimweta et al., 2020). Farm size categories tells that most farmers are small hand owners with 40% owning farm between 5-10 acres land holding category while 25% owns land less than 5 acres. This aligns with landholding information in earlier agricultural surveys (Ojumoola et al., 2022). The farming experience was also high with 40 percent of the farmers with 11- 20 years' experience, 25 percent with more than 20 years. Experience matter

because it helps farmers understand risks in farming and identify pests and the best management practices (Rana et al., 2020). The analysis of household size showed farmers having large families; 60 percent of farmers had 5-7 member families, 20 percent had 8-10 member families, and 15 percent had 10+ member families. Household size may farm labor and tasks regarding pest control mechanisms (Caniço et al., 2021).

1.2. Knowledge About Fall Armyworm

Table 2 presents the results of maize farmers' knowledge regarding Fall Armyworm (FAW) identification, lifecycle, and damage symptoms.

Table 2: Maize Farmers' Knowledge About Fall Armyworm (n=300)

Knowledge Aspect	Mean Score	SD	Rank
Identification of FAW larvae	4.12	0.68	1
Recognizing damage symptoms on maize leaves	4.05	0.70	2
Awareness of FAW infestation signs	3.95	0.74	3
Identification of FAW pupae	3.80	0.79	4
Recognition of FAW eggs	3.75	0.82	5
Understanding FAW lifecycle	3.60	0.85	6
Knowledge of FAW feeding habits	3.50	0.88	7

Note: Mean scores based on a 5-point Likert scale (1=very low knowledge, 5=very high knowledge). SD=Standard Deviation.

These findings indicate that that the first and second-ranked knowledge was the familiarity of farmers to identify the FAW larvae (Mean = 4.12, SD = 0.68) and the symptoms of the damage that FAW caused to maize plants (Mean = 4.05, SD = 0.70). This means that, overall, farmers can monitor the pest and its direct effect on the crop visually, potentially due to recurrence and exposure to maize fields (Kasoma et al., 2021). the data on FAW pupae (Mean = 3.80, SD = 0.79) and eggs (Mean = 3.75, SD = 0.82) demonstrates the moderate knowledge of farmers about these. Mean values for full lifecycle (Mean = 3.60, SD = 0.85) and the feeding habits (Mean = 3.50, SD = 0.85) were relatively lower and ranked in the last. Nevertheless, the above results showed that farmers are capable of detecting infestations successfully, but they also express poor conceptual knowledge of biology and behavior of FAW, which can affect timely management standards (Cokola et al., 2023). In general, the results indicate a need to introduce extension programs with an emphasis on the FAW lifecycle and feeding habits, which will enhance IPM practices. To prevent the occurrence of infection and misidentification and misuse of control methods, enhancing the technical skills of farmers is crucial (Caniço et al., 2021).

1.3. Perceptions of the Severity and Impact of Fall Armyworm

Table 3 presents maize farmers' perceptions regarding the severity and impact of Fall Armyworm (FAW) on maize production in Punjab, Pakistan.

Table 3: Farmers' Perceptions of the Severity and Impact of Fall Armyworm (n=300)

Perception Statement	Mean Score	SD	Rank
FAW infestation reduces maize yield significantly	4.35	0.62	1
FAW causes damage to all growth stages of maize	4.10	0.70	2
FAW is a major threat to maize production in the region	4.05	0.72	3
FAW infestation leads to economic losses for farmers	4.00	0.75	4
FAW infestation is difficult to control using current methods	3.75	0.80	5
FAW damages maize quality, reducing market value	3.70	0.78	6
Timely management can minimize FAW impact	3.65	0.82	7

Note: Mean scores based on a 5-point Likert scale (1=strongly disagree, 5=strongly agree). SD=Standard Deviation.

Results indicated that farmers have very high perceptions regarding hazards of FAW on production of maize crop, with the largest mean score (Mean = 4.35, SD = 0.62). This observation represents the realization of farmers of the direct impact of FAW on crop yields. It is also widely reported in literature that FAW has profound effects on decreasing yields in maize production regions (Kasoma et al., 2020). Another insight that farmers gained is that FAW can be destructive to maize at all stages (Mean = 4.10) and cause loss (Mean = 4.00) of maize, which can be described as an economic and biological risk posed by the pest. Perceptions regarding the difficulty of dealing with FAW through existing management strategies (Mean = 3.75) and FAW's impact on the quality of maize crop (Mean = 3.70) indicated farmers moderate response about these. The relatively low mean of the statement: Timely management can minimize FAW impact (Mean = 3.65) may indicate that although the acuity of the pest is recognized, the farmers may not be sure that the chosen management interventions will be effective. Overall, the evidence suggests that farmers consider FAW an acute pest, and it is required to implement awareness campaigns and provide access to effective control methods to reduce losses and economic damage. There is a need of additional training and extension education to effectively deal with FAW (Ansah et al., 2021; Ojumoola et al., 2022).

1.4. Management Practices

Table 4 presents the management practices employed by maize farmers in Punjab, Pakistan, to control Fall Armyworm (FAW), along with the frequency of use, perceived effectiveness, and rank of effectiveness.

Management strategies using the chemical insecticides is the most commonly used and most effective method among farmers (frequency mean = 4.20, SD = 0.65), (Effectiveness mean = 4.10, SD = 0.70). as the next highly prevalent and frequently utilized category of FAW management and control was the use of botanical insecticides, and handpicking larvae from plants, both ranked at second position in ranking with mean values 3.95, for frequency and 3.85 for effectiveness.

The use of microbial biopesticides (e.g., Bacillus thuringiensis) and adjustments in sowing date to avoid infestation are the moderately used practices and ranked at third (frequency Mean = 3.50, SD = 0.78 and effectiveness 3.40, SD = 0.80), which means they are less frequent and considered not as efficacious as others ranked higher.

The less frequently used approaches were cropping rotation, intercropping and the use of pheromone or light traps. These findings suggest that farmers largely depend on chemicals to supplement FAW management whereby cultural/biological measures are considered less effective and so used less. The trend follows recent research suggesting that farmers use management practices that gave immediate results, even though causing long-term damage to both environmental and farmers' economic status (Ojumoola et al., 2022). The relative underuse of cultural and biological practices suggests that extension services should promote integrated pest management practices that incorporate components of chemical, biological, and cultural approaches to minimize economic damage and promote sustainability.

Table 4: Management Practices Employed by Maize Farmers to Control FAW (n=300)

Practice Type	Practice	Frequency of Use (Mean±SD)	Effectiveness (Mean±SD)	Rank (Effectiveness)
Chemical	Chemical insecticides	4.20±0.65	4.10±0.70	1
	Botanical insecticides (neem-based)	3.95±0.70	3.85±0.75	2
Biological	Use of beneficial insects (e.g., parasitoids, predators)	3.50±0.78	3.40±0.80	4
	Microbial biopesticides (Bacillus thuringiensis)	3.60±0.75	3.50±0.77	3
Cultural	Handpicking larvae from plants	3.85±0.72	3.80±0.74	2
	Timely planting to avoid peak FAW infestation	3.60±0.78	3.50±0.79	3
	Crop rotation with non-host crops	3.50±0.80	3.30±0.82	5
	Intercropping with non-host crops	3.40±0.82	3.25±0.85	6
	Use of pheromone traps / light traps	3.30±0.85	3.20±0.88	7

Note: Frequency of use and effectiveness were rated on a 5-point Likert scale (1=very low, 5=very high). SD=Standard Deviation.

1.4.1. Correlation Analysis

Table 5 presents the Pearson correlation analysis exploring the relationships between maize farmers' knowledge, perceptions, and management behaviors regarding Fall Armyworm (FAW) in Punjab, Pakistan.

Table 5: Correlation Analysis Between Farmers' Knowledge, Perceptions, and Management Behaviors (n=300)

Variables	Knowledge	Perceptions	Management Practices
Knowledge	1.00	0.62**	0.55**
Perceptions	0.62**	1.00	0.48**
Management Practices	0.55**	0.48**	1.00

***Note:** Pearson correlation coefficients; *P<*0.01 indicates significance.*

All the three variables are significantly correlated in the results. Farmer awareness on the subject was closely related with the appreciation of the perceived severity of the pest (r=0.62, p=0.01) and this means that the more knowledge farmers gain with the biology of FAW and its destruction, the higher the chances of them believing that the pest is something to be feared. A moderate positive correlation also existed between knowledge and management practice (r=0.55, p=0.01) indicating that the greater the level of knowledge that the farmers possess, the greater their willingness to use effective pest control practices.

Similarly, the correlation between the perceptions and the management practices had a moderate value (r=0.48, P<0.01), i.e., farmers who perceive FAW as an economically disastrous and wasteful endeavor are more disposed to implement the management practices. These findings have both validated the interdependence between knowledge, perception, and practice, and revealed that perception of risk and awareness are salient predictors of pest control decision-making amongst farmers (Subedi et al.,2020; Abang et al., 2021). Overall, the results reported in the correlation seem to reveal that the growth of the knowledge and awareness of the farmers concerning FAW may directly influence their perception of the severity of the pests and, accordingly, their compliance with effective pests' management practices. This brings to the fore the importance of special purpose extension services, training and awareness on sustainable FAW management.

1.5. Factors Influencing Farmers' Decisions

Table 6 presents the factors that influence maize farmers' decisions regarding pest management for Fall Armyworm (FAW) in Punjab, Pakistan.

Table 6: Factors Influencing Farmers' Decisions Regarding Pest Management (n=300)

Factor	Mean Score	SD	Rank
Severity of FAW infestation	4.25	0.65	1
Expected yield loss / economic impact	4.15	0.70	2
Advice from extension agents / experts	3.95	0.72	3
Availability of chemical pesticides	3.90	0.75	4
Previous experience with FAW	3.85	0.73	4
Cost of management practices	3.80	0.80	5
Availability of biopesticides / natural enemies	3.75	0.78	6
Peer influence / practices of neighboring farmers	3.60	0.85	7

Results in table 6 indicate that infestation severity of FAW and the expected yield loss or economic loss were the was the most influential factor impacting farmers' decisions with Means value of 4.25 and 15 respectively. The results indicate that farmers make decisions on managing pests based on the perceived threat to their crops and financial well-being. Similarly study by Ojumoola et al. (2022) suggests that economic considerations are the most relevant in the decision-making process among farmers.

Advice by extension agent/expert also played an important role (Mean = 3.95, SD = 0.72), implying that access to technical advice and professional support is considered vital by farmers to make relevant decisions in managing field problems. An expense and availability of chemical or biological pesticides, previous history of employment in FAW, the influence from neighbors (characterized as peer pressure), are the next determinants of making choices by farmers, but are moderately powerful with Mean range from 3.60 to 3.90. At this point, the emphasis lies on the argument that current economic and informational reasons are predominant in making the decision, but social and experiential reasons, although not considered influential by farmers, must also be addressed as discussed in the studies of Abang et al., (2021) and Abebe and Tesfaye, (2023).

1.5.1. Multiple Regression Analysis

Table 7 presents the results of a multiple regression analysis that identifies factors influencing maize farmers' decisions regarding Fall Armyworm (FAW) management in Punjab, Pakistan

Table 7: Multiple Regression Analysis of Factors Influencing Farmers' Decisions Regarding FAW Management (n=300)

Predictor Variable	B (Unstandardized Coefficient)	SE (Standard Error)	β (Standardized Coefficient)	t	p-value
Severity of FAW infestation	0.38	0.07	0.40	5.43	<0.001
Expected yield loss / economic impact	0.35	0.08	0.33	4.38	<0.001
Availability of chemical pesticides	0.28	0.09	0.25	3.11	0.002
Availability of biopesticides / natural enemies	0.20	0.08	0.18	2.50	0.013
Advice from extension agents / experts	0.25	0.08	0.22	3.13	0.002
Cost of management practices	-0.18	0.06	-0.17	-3.00	0.003
Peer influence / practices of neighboring farmers	0.12	0.05	0.11	2.40	0.017
Previous experience with FAW	0.22	0.07	0.20	3.14	0.002
Constant	0.95	0.15	–	6.33	<0.001

Model Summary

$R=0.75$
$R^2=0.56$
Adjusted $R^2=0.55$
$F(8, 291) =45.36$
$P<0.001$

According to table 7, all variables significantly influenced farmers' decisions on FAW management (p-values are less than 0.05) The severity of FAW infestation was found to be the most reliable predictor ($\beta = 0.40$, p 0.001) of the practice that a farmer is likely to use when they are of the view that the pest is very destructive. The anticipated loss of yield or economic impact was also found to be of considerable importance, and it also significantly influenced decision-making ($\beta = 0.33$, $p < 0.001$). The use of chemical pesticides ($\beta = 0.25$, 0.002) and extension agent/expert recommendations ($\beta = 0.22$, 0.002) influenced farmers decisions positively. Similar is the case of access to inputs and expert recommendation. On the other hand, there was a negative impact of cost of management practice on the decision ($\beta = -0.17$, $p = 0.003$), suggesting that high costs may decline adoption of particular interventions among farmers. Generally, the model explains the management decisions of farmers ($R^2 = 0.56$, or 56%) that is, the informational, economic, and experiential variables account for the choice of FAW management strategies. The results above are complemented by previous studies of Jaleta et al., (2023); Ahissou et al., (2022) and; Ojumoola et al., 2022).

1.6. Chi-Square Tests

Table 8 presents the results of Chi-square tests examining the associations between demographic variables—age, education, and farm size—and farmers' management practices (chemical, biological, and cultural) for controlling Fall Armyworm (FAW) in Punjab, Pakistan.

Results indicate that education level is significantly associated with all three groups of managerial practices, i.e., chemical insecticides ($\chi^2 = 12.45$, $p = 0.006$), biological control ($\chi^2 = 10.32$, $p = 0.016$), and cultural practices of handpicking, intercropping and crop rotation ($\chi^2 = 9.87$, $p = 0.020$). This suggests that the more farmers were well-educated, the greater the possibility that they would adopt pest control methods. Similarly, the size of the farms exhibits a positive correlation with each of the three management practices ($\chi^2 = 9.05$ -14.55; $p > 0.05$). This helps to emphasize how farm resources enable more wholesome and efficient methods of pest control. On the other hand, age and chemical, biological or cultural practices had no significant connections to each other ($p > 0.05$), which leads to the conclusion that the age of farmer as an independent factor cannot be regarded as a significant determinant of adopting FAW management practices. The outlined findings are consistent with the existing body research on how education and farm resources can affect the pest management behaviour of smallholder farmers (Makale et al., 2022; Ahissou et al., 2022).

Table 8: Chi-Square Tests of Association Between Demographic Variables and FAW Management Practices (n=300)

Demographic Variable	Management Practice	Chi-square (χ^2)	df	p-value	Significance
Age	Chemical insecticides	6.12	4	0.187	Not Significant
Age	Biological control (biopesticides/natural enemies)	5.95	4	0.203	Not Significant
Age	Cultural practices (handpicking, intercropping, rotation)	6.87	4	0.144	Not Significant
Education Level	Chemical insecticides	12.45	3	0.006	Significant
Education Level	Biological control	10.32	3	0.016	Significant
Education Level	Cultural practices	9.87	3	0.020	Significant
Farm Size	Chemical insecticides	14.55	3	0.002	Significant
Farm Size	Biological control	11.12	3	0.011	Significant
Farm Size	Cultural practices	9.05	3	0.029	Significant

Note: df=degrees of freedom; P<0.05 considered statistically significant.

Conclusions

The paper presents a detailed assessment of knowledge, perception, and management of maize farmers in Punjab, Pakistan, regarding Fall Armyworm (Spodoptera frugiperda). The findings demonstrate that farmers are moderately to highly educated in identifying FAW larvae and the symptoms of their damage to leaves. However, little is still known about their other life cycle stages and their feeding habits. Farmers regard FAW as a very real threat to the production and economic performance of maize, yet are unconvinced that the current management practices could be relied upon in combating FAW. The most widely used and perceived effective management method to control FAW was the use of chemical insecticides. On the other hand, there was minimal use of the cultural and biological means of controlling pests, because these were considered less effective. The regression analysis showed that farmers respond to pests and chose management method based on the severity of the pest infestation, economic impact and advice from extension agent. In addition, Chi-square analysis indicated that the use of chemical, biological, and cultural practices largely depends on the education level and the size of the farms, with a little effect of age. These results emphasize the need to develop extension programs, build capacity, and support integrated pest management strategies through enhancing the educational level of farmers.

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Conflicts of Interest

Authors have no conflicts of interest.

Data Availability

Data will be available from the corresponding author upon request.

Ethics Statement

The study involving human participants was approved by the University of Agriculture, Faisalabad's Institute of Agricultural Extension, Education, and Rural Development. The studies were conducted in accordance with local laws and institutional norms. The participants provided written informed consent to participate in this study.

Authors' Contribution

Laila Haider**;** Conceptualization, Data Curation, Methodology, Data Original draft, Ali Nawaz; Data Collection, Formal Data Analysis, Rida Bulbul**;** Writing, Review and Editing, Data Analysis

Generative AI Statements

The authors declare that no Gen AI/DeepSeek was used in the writing/creation of this manuscript.

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