



RESEARCH ARTICLE

KNOWLEDGE AND PRACTICES OF FALL ARMYWORM (*Spodoptera frugiperda* J.E. Smith) MANAGEMENT AMONG MAIZE GROWERS IN GULMI, NEPAL

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ARTICLE DETAILS

Article History:

Received 10 February 2025
Revised 28 March 2025
Accepted 15 April 2025
Available online 23 May 2025

ABSTRACT

With the aim to assess farmer's knowledge on fall armyworm and management practices adopted by farmers, the study was carried out in the Satyawati, Chandrakot and Chatrakot rural municipality and Musikot municipality of Gulmi district of Nepal. By using purposive sampling, 100 household were selected for the questionnaire interview. This study highlights 87% of farmers have over 20 years of experience in maize cultivation. Most farmers rely on traditional methods, planting local varieties (53%) and saving seeds from their own production (55%). While these practices help preserve traditional agriculture, they limit the adoption of improved seed varieties that could enhance pest resistance and yields. While 55% can identify the pest, 45% struggle to differentiate it from similar pests such as maize stem borer, which may hinder effective management strategies. Despite acknowledging FAW's impact, 45% of farmers do not implement any pest management practices. Among those who do, only 25% use insecticides, with many relying on low-input methods like collecting eggs and larvae (15%) and using plant-based solutions mainly Neem-based (15%). Irrigation practices reveal a heavy dependence on natural sources, as 58% of farmers rely solely on rainfall for summer maize cultivation. Only 22% have access to concrete canal irrigation, and 20% utilize traditional irrigation, making them vulnerable to climate fluctuations that could worsen pest problems. Fellow farmers were the primary source of information about FAW for 48% of respondents, underscoring the importance of peer knowledge-sharing. Although 52% of farmers perceive that less than 25% of their cultivated area is affected by FAW, this perception may lead to carelessness in pest management. High costs and the untimely availability of insecticides are major concerns while pest identification is seen as a lesser issue. Farmers express a strong preference for hands-on learning methods, particularly field trials and demonstrations, suggesting that practical education would be more effective in enhancing their pest management skills. This study underscores the need for management strategies that align with farmers' needs and priorities, providing a valuable baseline for policymakers to develop sustainable pest management strategies.

KEYWORDS

Fall armyworm, Gulmi, Perception, Traditional agriculture

1. INTRODUCTION

1.1 Background information

Maize (*Zea mays L.*), native to Mexico and belonging to family Gramineae has emerged as a cornerstone of global agriculture, playing an important role in food security, economic development and environmental sustainability. Globally, maize is known as queen of cereals as it has the highest genetic yield potential among the cereals (Bourgeois, 2010). In Nepal, it is the second most important cereal crop after rice in terms of both area i.e. 985,565ha and production i.e. 3,106,397Mt with a productivity of 3.15 Mt/ha (MoALD, 2023). With the rapid increase of poultry and feed industries demand of maize has been increased by multiple folds. There is a huge gap between the demand and production level of Maize in Nepal due to various challenges posed by insect pests, diseases and inadequate technological support (Kandel et al., 2018).

Gulmi is one of the prominent maize producing district which falls on Lumbini province. The elevation of the district is 2000 to 3000 masl. The latitude and longitude of Gulmi are 28.088934°N and 83.320801°E respectively. Total production of maize in Gulmi district is 117,262 ton within the area of 40,780 ha with the productivity of 2.88 mt/ha in the last

year (MoALD, 2023). Maize is a staple and a source of income and employment for thousands of farming families in this region yet, the menace of insect infestations undermines its potential, leading to substantial losses and diminished agricultural productivity. Out of more than 40 species found, 20 species are identified as most destructive pests in maize. Maize is attacked by a wide range of pests in field condition. The major insects in field condition are white grub, cut worm, red ant, fall army worm, maize stem borer, maize aphid, field cricket (Maharjan, 2021). Maize stem borers cause significantly more damage to the crop in comparison to aphids and grasshoppers (Bhusal and Chapagain, 2020).

Fall armyworm (*Spodoptera frugiperda*) commonly known as FAW is polyphagous pest of maize and its host exceeds 80 plant species including rice, millet, sorghum, cotton. It is native to tropical and subtropical region of America (Kandel and Poudel, 2020). After its first incidence in Africa in 2016, it has already spread in more than 100 countries within a short period of time. It was seen in India for the first time in 2018. Due to the open border between Nepal and India, there is high threat of pest incidence in Nepal. Both migratory habit and more localized dispersal habit are performed by the moths. They can migrate over 500 km (300 miles) before oviposition which can leads to greater spread and damage in short period (Bhusal and Bhattarai, 2019). In Nepal, FFAW was first

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DOI:
10.26480/aedc.01.2025.50.54

reported on May 9 2019 from Nawalparasi district (Bhusal and Chapagain, 2020).

Damage is manifested with loss of photosynthetic area, structural damage in the whorl, lodging, impaired reproduction, and direct damage. It was found that yield losses ranging from 15 to 73% when 55 to 100% of the maize plants were infested with the fall armyworm during mid through late whorl stage grain as young caterpillar feed superficially and feeding is more active during night while matured larvae of fall armyworm feed on maize cob or kernels reducing yield and quality (Chimweta et al., 2020). Hybrid varieties of maize like Rampur hybrid-4, Rampur hybrid-6, Arun 3, 4, and 6 are recommended for different parts of Nepal. It was found that late-planted and hybrid varieties are more susceptible to infestation by FAW (Naharki et al., 2020). A group researchers estimated a 21 to 53 % loss in the annual production of maize (Abrahams et al., 2017). In case of minimal damage too, the estimated loss of maize will be more than 460,024 MT productions with 180,057 ha of area field affected in the case of Nepal.

1.2 Status of maize production in Nepal

In Nepal, it is the second most important cereal crop after rice in terms of both area i.e. 985,565ha and production i.e. 3,106,397Mt with a productivity of 3.15 Mt/ha (MoALD, 2023).The maize is mainly grown in hilly region covering 72.28% area while it covers only 18.95% in terrain and 8.76% in mountains. The maize is grown in 891,583 ha of land and production 2,231,517 metric ton with national average yield of 2503 kg/ha. Maize demand has been constantly growing by about 5% annually in the last decades (Maharjan, 2021). More than two third of the maize produced in the mid hills and high hills is used for direct human consumption at the farm level (Sapkota and Pokhrel, 2013). Maize is being consumed as staple food in large scale and latest hiked demand from poultry is cementing its value as it contains about 72% starch,10% protein,4.8% oil,9.5% fiber,3% sugar and 1.7% Ash (Tiwari et al., 2009). Maize constitutes about 60% of poultry feed.

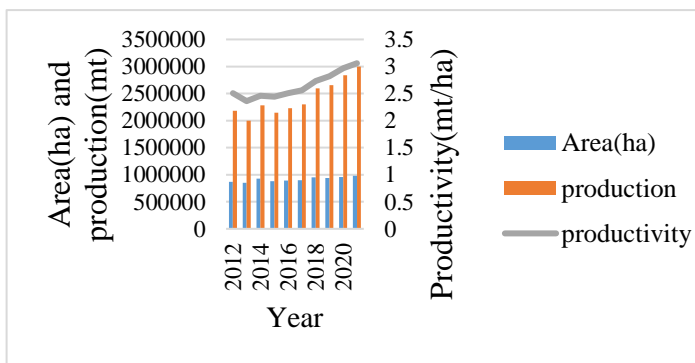


Figure 1: Maize production trend of country (Source: MOAD 2021/22)

1.3 Occurrence and Distribution of FAW in Nepal

Soon after declaration of its invasion in Nepal, governmental and nongovernmental organizations have been monitoring FAW occurrence in different districts of the country. FAW has been reported from sixty-four districts of Nepal from all provinces (PQPMC,) ranging from mid hills to terai districts until February 2021.

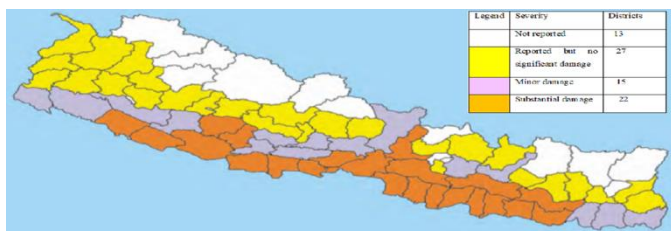


Figure 2: Occurrence and distribution of FAW in Nepal, February 2021

2. RESEARCH METHODOLOGY

2.1 Site selection/Study Area

Gulmi is the district located on the mid hill region in the northwest of Nepal. This district has the enormous potential for the maize. The study was conducted in Satyawati Rural Municipality, (ward 1, 2, 5, 6, 7), Chatrakot Rural Municipality (1, 3, 4, 5), Chandrakot Rural Municipality (4, 7, 8), and Musikot Municipality (3, 5, 6, 7), as these were major maize growing areas. The reason for selection of these sites are:

- This area has been considered as the block of maize production by PMAMP.
- Maize is the major crop produced in this area and is easily accessible too. Also, its production is in the process of commercialization.
- Almost every farming household had been cultivating maize since last 15 years and even more.

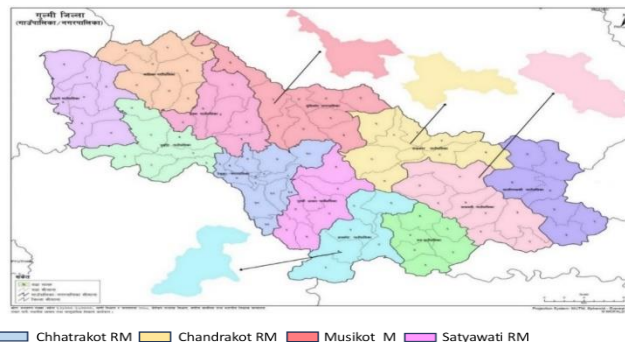


Figure 3: Map of study area

2.2 Sample size and Sampling procedure

A total of 100 maize growers were selected from the study area. Purposive sampling was employed to select respondents proportionally according to the population distribution across municipalities: Musikot accounted for 32 respondents, Satyawati had 25 respondents, Chhatrakot included 26 respondents and Chandrakot comprised 17 respondents.

2.3 Research Design

Data collection was done through personal interviews. Based on the interview schedule and checklist, questions were asked to the respondents in order to gain the aimed information. Key informant interviews (KII) and focus group discussion (FGD) were carried out primarily to triangulate data and information obtained from scheduled interviews and secondarily to obtain additional qualitative information.

2.4 Data Sources and Types

Various sources and techniques were used for the collection of the necessary information. Both primary and secondary data was collected and analyzed. Maize growers were the major sources of primary data. Secondary information was collected from the document of the different institutions/organizations.

2.5 Data Analysis

Data analysis involves making sense of the large volume of information collected from field research. Hence, reducing voluminous text by coding and classifying the related concepts is important for systematic recording and retrieval for later use. Raw data obtained from field was analyzed to obtain a certain conclusion. Information collected from field survey and other methods was coded, tabulated and analyzed by using Statistical Package of Social Science (SPSS) and Microsoft Excel.

3. RESULTS

3.1 Socio-demographic characteristics

The study assessed various socio-economic characteristics of households in the study area. Most respondents (63%) were aged between 30–51 years, with more females (54%) than males (46%), highlighting the active role of women in agriculture. The majority belonged to the Brahmin/Chhetri caste (81%), and while 32% were illiterate, a significant portion had some level of education, indicating potential for technology adoption. The average household size was 5, larger than the national average, with 76.19% of the population economically active. Agriculture was the primary occupation (65%), followed by remittances (21%) and business (14%). Although the average agricultural income was NRs 46,210, the total household income averaged NRs 229,150, showing that agriculture contributed only 20% to total earnings, with significant income derived from other sources.

3.2 Experience of maize cultivation

Farming experience is an important variable in determining the quality and quantity of production as well as the adoption of new production technologies. Maize cultivation in the study area was done since many years. Years of maize cultivation was categorized into 4 categories. Majority of the respondents has done maize cultivation for more 20 years

(87%), followed by 15 years (6%), 10 years (7%). It revealed that maize cultivation in the study area was taken as major farming practices and this cultivation practice is inherited from one generation to another.

3.3 Land holding under maize cultivation in the study area

The total of the land holding of all the respondents was 1670 ropani out of which 749 ropani (44.85%) was used in maize cultivation. The average landholding of the respondents was 16.7 ropani with minimum of 2 ropani and maximum of 75 ropani in total. In an average, 7.49 ropani of land was used by the respondents in maize cultivation. The land under maize production ranges.

3.4 Planting material and fertilizer

3.4.1 Type of Variety

The result showed that, among different types of variety available in the survey area, majority of the farmers (53%) cultivate local variety followed by (32%) farmers cultivating hybrid variety and (15%) farmers cultivating improved.

3.4.2 Various sources of seed

Result showed that majority of the respondents (55%) were found using seeds reserved from their own production, (30 %) of the respondents bought seeds from Agro-vets Whereas, 10% of the farmers were buying seeds from co-operatives. The number of farmers who exchanged seeds with others fellow farmers/ relatives were found only (5%) as source of seed.

3.4.3 Type of fertilizer used by the respondent household in the study area

The result showed that, among different types of fertilizers available in the survey area, all of the respondents (100%) were found using compost but not all using chemical fertilizers for maize field.

3.4.4 Source of fertilizer

The result showed that the majority of the respondents, around (58%) bought chemical fertilizer from agro vets, while (10%) respondents bought the fertilizer from co-operatives. About 32% of farmers were involved in organic farming. They think that using chemical fertilizers is harmful to soil and human health.

3.5 Source of irrigation

Although all people use rainwater as source of irrigation, of the total sampled household, 42% of the respondents had access to irrigation, While 58% of respondent were found fully dependent only upon rain water for maize cultivation. About 22% had access to Water canal as a source of irrigation water, while 20% of the respondent's source of irrigating field was through River irrigation.

3.6 Knowledge and perception of fall armyworm

3.6.1 Identification of fall armyworm in study area.

The result showed that majority of farmers (55%) had knowledge on identifying fall armyworm where 21% of them could identify fall armyworm damage more clearly while 34% Farmers could identify fall armyworm damage little bit. Farmers reported that they could identify by observing morphology and damage symptoms of fall armyworm on maize field. Some of them also reported that they had observed the FAW on infected maize. About 45% of farmers felt difficulty in distinguishing among stem borer and fall armyworm.

3.6.2 Source of knowledge on identification of fall armyworm by household in study area

The result showed that majority of farmers (48%) gained information about fall armyworm through fellow farmers which was followed by extension officers (26%), media (16%) and through agro-vet (10%). This study revealed that fellow farmers were major information source of fall armyworm.

3.6.3 Farmer's perception on severity and intensity of FAW in study area

More than 50% of farmers reported less than 25% of their cultivated areas have been affected with fall armyworm. About 46% of farmers mentioned between 25-50% of their cultivated areas have been affected by FAW. While 2% farmers reported 50-70% area affected by FAW. Hence, there is a decreasing trend of FAW. This perception of farmers have led to carelessness in pest management.

3.7 Management aspects of fall armyworm

3.7.1 Management practices followed by respondent household in study area

Farmers in the study area applied some pest control methods to mitigate the fall armyworm damage although majority of the farmers adopted no management practices by 45%. About 15% of farmers reported of collection and destruction of egg and larvae of fall armyworm while 15% respondents used plant based /botanicals whereas 25% used insecticides. This study revealed that none of the farmers used any innovative methods like use of light trap, pheromone trap, Intercropping and biological methods. Very few farmers mentioned use of effective method of management as they have little or no knowledge about good practices due to poor extension services by concerned authorities. Moreover, farmers perceived that plant based derivatives couldn't give desire result which they required. They also perceived that cultural mechanical and plant based methods of management practices are time consuming and they were not sure of good results.

3.8 Training received by Respondent household for management of fall armyworm

Training for farmers is an important component of any pest management program. An understanding of integrated pest management principles including basic identification of key public health pests and knowledge of pest biology, is important to maximize prevention of pest and target control measures. The result showed that only the 27% of farmers had received training leaving large majority (73%) of farmers deprived of training for management of fall armyworm.

3.9 Problems faced by respondents in management of fall armyworm

Several problems related to fall armyworm management were prevalent in the study area faced by maize growers. Indexing/Scaling technique was employed for analysis of pest management problems faced by sampled farmers. The value 1, 0.80, 0.60, 0.40 and 0.20 are the scale value given by the respondents to each problems and value below the scores are the frequencies of the scale value. Each problem was ranked on the basis of index as per the frequency provided by the respondent to each problem.

This section deals with different problems associated with fall armyworm management in the study area. The details of intensity of fall armyworm management problems and their index value are presented in the table below. The result showed that high cost and untimely availability of insecticide was the most severe problems perceived by the maize grower with the index value of 0.808. The second major problem as indicated by sampled farmer was Poor knowledge on 4R of insecticides (0.758) followed by third as Poor knowledge of management of FAW(0.656), fourth as no attention of concerned authority(0.468) and fifth as lack of pest identification(0.31).

Table 1: Problems faced by respondent household in management of fall armyworm

Problems	Weight	Index	Rank
High cost and untimely availability of insecticides	80.8	0.808	I
Concerned authority doesnot give attention	46.8	0.468	IV
Poor knowledge about management of pest	65.6	0.656	III
Poor knowledge of 4R of insecticide	75.8	0.758	II
Pest identification	31	0.31	V

3.10 Suggestion made by respondent household to overcome the problems in management of fall armyworm

Field trial and demonstration by use of IPM was the most important suggestion offered by maize growers in management of fall armyworm

with index value of 0.942. The second most suggestion made by maize grower was training on pest identification, life cycle and its effective control measures from local bodies as well as from extension officers with index value of 0.902. It was followed by availability of insecticides at right

time low price and local place (0.898) with proper instruction and at fourth, pest forecasting from Ministry of Agriculture and agriculture

university (0.846) and fifth ranking was given for providing knowledge of plant protection measure with index value of 0.81.

Table 1: Suggestion made by farmers for management of fall armyworm in study area

Suggestions	Weight	Index	Rank
Provide knowledge of plant protection	81	0.81	V
Field trial/ Demonstration	94.2	0.942	I
Training on pest identification and effective control measures	90.2	0.902	II
Availability of insecticide	89.8	0.898	III
Pest forecasting	84.6	0.846	IV

4. DISCUSSION

This survey conducted in Satyawati RM, Chandrakot RM, Chatrakot RM and Musikot M of Gulmi district presents a comprehensive analysis of farmer's knowledge and management practices regarding fall armyworm (FAW) which is a significant pest affecting maize cultivation. This survey reveals a gender distribution with 54% female respondents showing important role women play in agricultural activities. This demographic analysis suggests that any training or interventions aimed at pest management should consider the unique perspectives and needs of women farmers. The educational background is a significant concern as 32% of respondents have no formal education and 30% are literate (up to grade 8) followed by 20% basic education (10th grade). This limited education can severely restrict their understanding on pest management concepts, hindering their ability to adopt effective practices. With only 10% with higher education and 8% having a bachelor's degree, there exists a notable gap in knowledge that could limit effective decision-making regarding pest control strategies. The majority of respondents (63%) are between the ages of 30 and 51, predominantly from the Brahmin and Chhetri communities (81%), with an average family size of 5, higher than the national average of 4.32 (CBS, 2021). The economically active population averages 3.84 members per family, reflecting a strong labor force involved in agricultural activities.

Agriculture is the main source of income for most of respondents in Gulmi which have immense importance to their livelihoods. While some households also engage in foreign employment (16.67%) and a few have businesses (10%), the heavy reliance on farming means that threats like fall armyworm (FAW) directly affect their economic stability. With an average agricultural income of Rs. 46,210, effective pest management is crucial for improving yields and sustaining their livelihoods. Additionally, the average landholding is 16.7 ropani, with 7.49 ropani allocated specifically to maize cultivation. This allocation indicates the priority of maize in their livelihoods but also underscores the need for effective pest management to protect their primary source of income. This survey indicates that 87% of farmers have more than 20 years of experience in maize cultivation. While this extensive experience is valuable, it also suggests a reliance on traditional farming methods, which may limit exposure to modern agricultural innovations. The majority of farmers prefer local varieties (53%) and save seeds from their own crops (55%) that shows a commitment to traditional practices. However, this reliance may prevent the adoption of improved seed varieties that could offer better pest resistance and yield. Although hybrid seeds are gaining popularity (32%), the slow shift from traditional to hybrid varieties can hinder farmers' adaptability to pests like FAW. Also 58% get chemical fertilizer from agrovets, 10% from cooperatives and remaining do not use fertilizer and are based on use of compost only. Awareness of FAW is mixed; while 55% of respondents can identify the pest, a significant 45% struggle to differentiate it from similar pests like the stem borer. This lack of clarity is critical, as it can lead to ineffective management strategies. Farmers unable to properly identify FAW may miss early signs of infestation, resulting in delayed responses that could raise crop damage. Therefore, there is a huge need for targeted training focused on accurate pest identification to empower farmers with the knowledge needed to respond promptly and effectively.

Despite recognizing the impact of FAW, 45% of farmers do not implement any management practices, which raises concerns about their preparedness to combat the pest. Among those who do engage in management, only 25% utilize insecticides, while many are dependent on low-input methods such as collecting eggs and larvae (15%) or using plant-based solutions (15%). This reliance on traditional practices may not adequately address the threat posed by FAW. The limited use of chemical controls coupled with the predominant reliance on low-input strategies, could lead to insufficient management of infestations, threatening crop yields. This survey highlights that 58% of respondents rely solely on rainfall for irrigation, with only 22% having access to canal

irrigation and 20% to river irrigation. This heavy dependence on natural water sources makes farmers particularly vulnerable to climatic fluctuations, which can adversely affect maize health and resilience to pests. Without reliable irrigation options, farmers may experience crop stress during dry periods, creating conditions that can facilitate pest outbreaks, including FAW infestations. My research align with the result of following researchers. Many farmers lack knowledge about nocturnal feeding habits, leading to ineffective morning pesticide applications (Kafle et al., 2023). Many Farmers rely on traditional management techniques like handpicking larvae and using ash or sand in maize whorls but lack scientific validation (Paudel et al., 2022). Farmers are still unaware of the effectiveness of non-chemical control methods like biocontrol agents and crop rotation, largely due to lack of extension programs and demonstrations (Saha et al., 2021). The untimely supply of pesticides has created huge issue, as farmers are unable to access products when needed most, particularly during rainy season when FAW infestations can spread rapidly (Khan and Yadav, 2021). Fellow farmers serve as the primary source of information about FAW for 48% of respondents, showing the importance of knowledge-sharing in agricultural communities. However, this reliance on informal channels may not provide the comprehensive and accurate information needed for effective pest management. When asked about preferred learning methods, farmers expressed a strong preference for field trials and demonstrations (index score of 0.94), indicating that practical, hands-on education would likely be more effective in enhancing their skills and knowledge. This preference suggests that engaging farmers in active learning experiences could improve their capacity to manage pests like FAW more effectively.

The majority of farmers (52%) perceive that less than 25% of their cultivated area is affected by FAW, suggesting a potentially decreasing trend in infestations. However, this perception has led to carelessness regarding pest management. Furthermore, when farmers ranked the challenges they face, high costs and untimely availability of insecticides emerged as the most significant problem (index of 0.80). In contrast, pest identification was the least concerning issue (index of 0.31). This highlights a critical area for intervention.

5. CONCLUSION

This survey reveals important challenges that farmers face when dealing with fall armyworm (FAW). Many farmers have low education levels, which makes it difficult for them to understand how to manage pests effectively. Even though they have a lot of experience growing maize, they mostly stick to traditional farming methods and local seed varieties, limiting their ability to adapt to new problems like FAW. While some farmers are aware of FAW, a significant number do not take any action to manage it. This lack of action could lead to more crop damage and lower yields. Additionally, many farmers depend solely on rainfall for watering their crops, making them vulnerable to weather changes, which can worsen pest issues. To improve the situation, it's crucial to develop training programs that teach farmers how to identify pests and use effective management strategies. These programs should focus on practical, hands-on learning so that farmers can apply what they learn directly to their farms. By helping farmers gain better knowledge and skills, they will be more prepared to protect their crops, leading to higher yields and better incomes. Overall, addressing these gaps in knowledge is essential for making agriculture in the region more resilient and sustainable.

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