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Perception, Farm – Level Management and Production Constraints of Fall Army Worm (*Spodoptera frugiperda*) Among Maize Farmers in Imo State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

One of the major threats to maize farming in Africa, especially Nigeria, is the menace of fall army worm. It has attacked to the point of reducing both quantity and quality leasing to eventual death of plant. Therefore, fall armyworm (FAW) being a serious menace to maize, a staple grain in Nigeria,

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need be controlled. This paper investigates maize farmer's perception of the fall armyworm (FAW), menace; the farm- level management practices and production constraints. Using questionnaire, 450 maize farmers purposively selected among maize farmers were interviewed. Mean (M) and percentages were used in analyzing data. Results showed that, farmers already knows the serious of fall army-worm infestation. They agreed that army-worms does great damage to the maize plant (M=42), reduces maize quality (M=2.89), great threat to maize production (M=3.50%), among others. To manage it, chemical insecticides /pesticides are used (99.3%), practice of crop rotation (100%), use of other crops as trap (95.5%), manual collection, distract of eggs/larvae (90.4%), early planting of maize (91.7%) and other measures. However, farmers face the following problems of producing maize under fall armyworm attack; high cost of pesticides (100%), high cost of labour charges (93.5%), inability to identity fall army-worm early (95.7%), unable to use the right amount of chemical (89.1%), lack of training on chemical use (96%), among other challenges.

Keywords: Army-worm; farming; management; maize; farmer; production.

1. INTRODUCTION

Agriculture remains the primary source of income and livelihoods for most households in sub-Saharan Africa (SSA), Nigeria inclusive [1]. However, the sector's contribution to food security and poverty reduction is limited by many, often interacting, biotic and abiotic factors. The fall armyworm (FAW), being an invasive and damaging pest native to tropical and sub-tropical America, is spreading very fast across Africa. The pest arrived in SSA during a time when the region is challenged to feed its rapidly growing populations – an on-going battle. Since its arrival, it has spread rapidly through the continent, currently affecting 44 countries [2]. The outbreak of FAW is a major setback in SSA as it causes enormous damage to maize crops, the prime staple food for more than 300 million farmers in Africa [3-5].

For example, the emergence, occurrence and rapid spread of the fall army worm (FAW) *Spodoptera frugiperda* in Nigeria in 2016 has threatened the food and household income security of several millions of small holder maize farmers [3,6]. The FAW major preference for maize, a staple food of over 300 million small holder farmers, posed a threat to their livelihoods, nutrition and food security [7]. This is true as it has been documented that FAW feed on 353 host plants belonging to 76 plant families, mainly *Poaceae, Asteracea* and *Fabucae* [8].

One of the crops that is cultivated most often worldwide is maize. Over the previous few decades, the average global output of maize has exceeded 1,000 million metric tons (MMT) [9]. Nigeria is likely Africa's second-largest maize producer after South Africa, with a total production of 11 MMT [9,10]. Ethiopia was ranked third among the African countries that produce the most corn. In 2019, the combined output of maize in South Africa, Nigeria, and Ethiopia accounted for around 39% of the overall output of the continent. Nearly two-thirds (64%) of the maize produced in Nigeria is produced in the top 10 states (Borno, Niger, Plateau, Katsina, Gombe, Bauchi, Kogi, Kaduna, Oyo, and Taraba) [9,10].

Poultry farmers in Nigeria use over 98% of all animal feeds produced in the country, which is made from around 45.5% of the country's corn crop. Again, 60–65% of the ingredients in chicken feed are made up of maize. While 13% of Nigeria's maize crop is used to make industrial flours, corn flakes, and other confections, the remaining 6.5% is utilized by brewing enterprises. On the other hand, just 10% to 15% of homes consume maize [9,10]. Nigeria is the continent's second-largest producer of maize, but its export potential is pitiful when compared to competitors like South Africa, which exports about two thirds of the grain on the continent. Nigeria's comparatively low export of maize is primarily due to several factors including poor maize yield caused by the invasive fall armyworm. Presently, fall armyworm invasion has forced many maize farmers in Nigeria to switch from maize farming to production of cassava and other crops.

Nigeria's yield of maize is less than two tonnes per hectare (t/ha), while it is 4.9 t/ha in South Africa and 4.2 t/ha in Ethiopia. This is because of the ravaging nature of the FAW and the nation's maize producers continuous use of open pollinated variety (OPV) seeds rather than enhanced hybrid ones. Because of this, there is an approximately 4 MMT annual gap in the supply of maize, since output is low and barely

able to meet the enormous demand for the grain [11].

However, in the absence of proper management method, the FAW has greater potential to cause maize yield losses of about 8.3 to 20.6 million metric tons per year both in Africa as a whole and Nigeria in particular (Prasanna *et al.,* 2017; Houngbo, *et al.,* [12]. This is where farm-level management comes in. There should be a way of managing crops to minimize the cost and environmental impacts of chemical inputs by introducing non-chemical solutions to managing weeds, pests and diseases. According to Bennett et al. [13], pest management is a system of integrated preventative and corrective strategies meant to lessen or stop pests from seriously harming people or the environment. Achieving desired results at the lowest feasible cost and with the least amount of harm to people and the environment is the aim of pest control. The main goal of pest control is to modify environmental factors that support the growth, survival, and reproduction of invasive species. These things are called habitat; these include things like food, water, and shelter. When pests have the perfect home, they proliferate and have detrimental effects on both the environment and people.

The main management practices used in the Americas against FAW are synthetic pesticides and genetically modified crop varieties [14]. Studies have it that the FAW is resistant to several insecticides such as Pyrethroids, carbaments among others [15,16]. Compared to mechanized crop protection in commercial production systems, smallholder production involves time-consuming and labor-intensive chemical application; effectiveness is hampered by inaccurate dosages and time spent on other field tasks like weeding. Inaccurate dosages can lead to poor control of FAW or induce the development of insecticide resistance, which makes pest management more difficult [17]. Various cultural practices have been found to be beneficial in mitigating fall harvest injury (FAW) in corn. These practices include regular weeding and minimal or no tillage [18], avoiding late planting of the crop [19,20], intercropping with suitable crops but avoiding intercropping pumpkin and maize [18,21]. There have been reports that reducing FAW damage involves handpicking, applying ash to plant whorls, and smashing FAW eggs and caterpillars [19,22]. However, labor-intensive methods like hand-picking and crushing caterpillars and eggs are only feasible in small-cropped areas. Therefore, alternative methods that reduce the application of synthetic chemicals and encourage use of botanicals and natural enemies are germane in Africa [6,23].

This information is critical for conducting regional and national pest risk assessments and devising effective management strategies. Early detection of infestations is crucial, as chemical insecticides are most effective when the larvae are small [24]. Effective pest management practices can help reduce crop losses, but largely depend on farmers' knowledge, attitude, and behavior towards pest management. Therefore, it is important to understand how much farmers know about insect pests, yield damage, and effective management practices through surveys. However, current farmer practices for pest management lack a solid scientific foundation and their reasons for using these methods are unreliable.

Information on farmers perception of FAW, management practice and production constraints are very important for developing appropriate management methods suited to the farmers needs [25-27], The above is especially the case in Imo State where documented evidence of maize farmer's army perception, management strategies are lacking. The maize farmers therefore, developed their own knowledge, perception and management practices and their own ideas on how to solve a particular problem. This paper therefore sought the perception, farm level management and production constraints of maize under fall army worm invasion.

2. METHODOLOGY

The study was conducted in Imo State. It is in the tropical rainforest zone. Imo State has three agricultural zones namely; Owerri, Okigwe and Orlu, subdivided into 27 Local Government Areas (LGAs). Purposive random sampling technique was used in selecting 450 maize farmers from a list of 4500 maize farmers obtained from the Maize Growers Association Zonal Offices, in Imo State. Data were collected using structured questionnaire complimented with oral interview. Mean, standard deviation and percentages were used to analyse data. Objectives 2 and 3 were achieved using percentages presented in frequency tables, while objective 1 was analysed using a 4-point likert type scale of strongly agreed, agreed, disagreed and strongly disagreed to examine maize farmers fall army worm perception. The responses were assigned weight of 4, 3, 2 and 1 respectively and added to

give 10 divided by 4 to give a mean of 2.50. A mean score of 2.50 and above indicated fall army worm positive perception based on the statements, while a mean score lower than 2.50 indicated negative perception

3. RESULTS AND DISCUSSION

3.1 Maize Farmers Perception of Fall Armyworm Menace

Table 1 showed maize farmers sensory view of the damage of fall armyworm on maize. It showed that maize farmers recognize the environment where fall armyworm operates. The maize farmers positive perception of fall armyworm is essential for their survival as farmers. With a discriminating mean index of 2.50, the farmers perceived the damage done to maize to be severe (M=3.41), very big threat to maize (M=2.89), increases maize production cost (M=3.42), damage to maize reduces profit of maize farming (M=3.10), severe damage during early maize growth life(M=2.89), damage worrisome and frustrating (M=3.01), ability to put farmer out of business (M=3.05), cannot be easily managed (M=3.04), requires serious collective efforts to manage (M=3.02), requires quick response to handle (M=3.1) and sufficiently farmers education requires (M=3.40). The above agrees with Kumela et al (2018) who posited that farmers in Ethiopia and Kenya considered the damage by the fall armyworm to cause estimated maize yield to reduce by about 950kg/ha in Ethiopia and 1381kg/ha in Kenya. Most farmers in both countries perceived an increasing trend of spread of fall armyworm in their areas.

In a study by Houngbo et al, (2020), most farmers (91.8%) recognized the damage of *S. frugiperda* on maize crop. The majority (78.9%) of them were able to identify the pest during its larval stage. Farmers (88.6%) observed the activities of *S. frugiperda* in their maize fields. They recorded the first attacks of *S. frugiperda* in 2015 and 2016. They perceived *S. frugiperda* as a new pest.

3.2 Farm – Level Management Decisions for Fall army Worm Control

Farmers in Imo state applied different control/management methods to handle fall armyworm damage to maize (Table 2). All the farmers used crop rotation practice (100%). They rotate maize with other crops to disrupt the life cycle of fall armyworm. Again 99.3% used insecticides as a last resort when populations of the fall armyworm are high and when other methods have proved in effective. However, consulting with local Agricultural Extension services for guidance have proved effective in knowing the safest insecticides to use. Some farmers (95.5%) used other crops as trap, 93.5%, did ploughing before sowing, manual collection/destruction of eggs/larvae (93.5%), use of neem solution (84.4%), early planting of maize (91.7%), used wood ash (88.2%), spraying pepper extracts (63.1%), and soil fertility management (86.47). The above result agrees with Kansiime et al [20], who said in Zambia, majority of farmers (62%) used at least one practice for the management of fall armyworm during 2016/2017 cropping season. Farmers used various methods for control of fall armyworm such as; pesticide, cultural/physical, and biological. Pesticide use was the most common method, used by 60% of the farmers. Physical/cultural practices were dominated by hand picking and crushing egg masses (36%), application of ash, sand or liquid detergent on the

Table 1. Maize farmer's perception of Fall armyworm menace

Perception Statements	Mean	SD
Damage done to maize is revive	3.41	0.86
Fall armyworm is very big threat to maize production	3.50	0.76
Damage reduces quality and quantity of maize	2.89	0.65
Fall armyworm increases maize production cost	3.42	1.01
The damage reduces profit of maize farming	3.10	1.10
Damage is more severe during early maize growth	2.89	0.96
The damage is highly worrisome and frustrating	3.01	0.77
It could put a farmer out of business	3.05	0.45
Fall army worm is not easily managed	3.04	0.54
Requires collective and serious efforts to manage	3.02	0.56
Requires quick response to handle	3.10	0.61
Sufficient farmer education is highly needed	3.40	0.91

Accepted mean = 2.50

larvae (19%), and early planting (7%). Use of biologicals was less common, practiced by only 5% of the farmers. Biologicals included farm-based plant extracts such as neem, tobacco and chili pepper. Use of natural enemies(88.2%), conservation of natural enemies such as parasitoids and predators that attack fall armyworm can help control the spread. Integrated pet management (95.5%) was used by farmers. Here they utilized an integrated approach that combine multiple control methods to manage FAW effectively, while minimizing the impact on the environment.

During oral discussions on effectiveness of control measures, over 97% of the farmers using pesticides indicated they were effective particularly if used in alternation. Use of biologicals (farm-based plant extracts and biopesticides) and early planting were also considered effective despite the small proportion of farmers using them. Physical methods such as hand picking and use of ash were also considered effective by 38% and 54% of farmers, respectively. The only limitation with physical methods as mentioned by farmers was the high labor demand especially for farmers with large plot sizes, rendering them less feasible. An effective cultural strategy for managing FAW is early planting. Early maize planting during consistent rainfall periods might lessen the harmful effects of FAW. This is due to the fact that the pest population is low during the off-season, when there are fewer green plants available, and before the pest population grows, maize may have developed a physiological response to stressors like insect infection. As a result, by the time the pest population rises over a certain level, the impact on the maize plants has become negligible. Furthermore, when farmers in a given region plant at the same time, FAW damage is reduced. This can significantly lessen the pest strain on a particular field by distributing the insect evenly.

Handpicking (63.1%) was a common method among farmers with smaller farms, especially in Zambia and Ghana during field scouting and monitoring, but it is impractical for farms with a greater surface area. So many farmers around Africa use hand picking (Day et al,2017), which is frequently provided by friends, family members because it is relatively cheap to use. Here farmers handpick and destroy egg masses, larvae and pupae, when feasible especially in small scale as earlier mentioned in backyard farming situations.

3.3 Maize Production Constraints under Fall Armyworm

These act as barriers in control/management of armyworm. The barriers included high cost of pesticides/insecticides (1005%), high cost of labour charges (93.5%), inability of farmers to identify FAW quickly (95.7%), delay in noticing damage caused by FAW (84.4%), unable to use correct amount of chemical (89.1%), unable to use correct combination of chemicals (90.8%),

Table 2. Farm-level management decisions

Farm-level Management	*Frequency	Percentage
Spraying insecticides/pesticides	447	99.3
Crop rotation practice	450	100
Use of other crops as trap	430	95.5
Deep land ploughing before sowing	421	93.5
Collection/destruction of eggs/larvae	407	90.4
Use of neem solution	380	84.4
Early planting of maize	413	91.7
Use of wood ash	397	88.2
Spraying pepper extracts	284	63.1
Soil fertility management	389	86.4
Use of natural enemies	389	86.4
Monitoring	397	88.2
Integrated pest management	430	95.5

**Multiple response*

Table 3. Maize production constraints under fall army worm

Production Constraints	*Frequency	Percentage
High Costs of Pesticides/insecticides	450	100
High cost Of labour charges	421	93.5
Inability to identify FAW early	431	95.7
Delay in noticing damage caused by FAW	380	84.4
Unable to use correct amount of chemicals	401	89.1
Unable to use correct combination of chemicals	409	90.8
Low level of education of farmers	404	89.7
Inadequate capital for farm operation	429	95.3
Death dealing nature of chemicals	441	98.0
Lack of access to improved maize varieties	424	94.2
Lack of training on chemical use	434	96.4

**Multiple response*

low level of education of farmers (89.7%), inadequate capital for farm operation (95.3%), death – dealing nature of chemicals (98%), lack of access to improved maize varieties (94.2%) and lack of training on chemical used (96.4%). The above agrees with Patil et al., [28,29]. who said famers in Dhule district of India indicated that non-readable font of information sheets, unavailability of tricho cards in time, unavailability of pheromone trap, among others were challenges to maize production under armyworm situation [30,31].

4. CONCLUSION

The farmers know much about FAW infestation. They agreed that FAW does great and severe damage to maize plants. It is a great threat to maize production as it increases production cost, reduces quality and quantity of maize. Farmers employed certain management practices such as spraying of insecticides, crop rotation, use of crops, use of wood ash, use of neem solution among other practices. However, high cost of pesticides, high labour charges, lack of access to improved maize variety, lack of training on chemical use, low education level, lack of capital among others hamper maize production.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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