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Farmers' knowledge, perception and management practices of fall armyworm (*Spodoptera frugiperda* Smith) in Manica province, Mozambique

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Abstract

This study aimed to gather information about farmers' knowledge, perception and management practices of the newly introduced insect pest, the fall armyworm *Spodoptera frugiperda* Smith (Lepidoptera: Noctuidae) in Manica province, Mozambique. A total of 200 smallholder farmers with experience in maize cultivation were surveyed using a semi-structured questionnaire. The survey was conducted between May and August 2019 in four districts: Macate, Manica, Sussundenga and Vanduzi. Most farmers were unable to morphologically identify fall armyworm (FAW) (from 93.9% in Vanduzi to 98.0% in Manica). Most farmers have experienced FAW damage in their farms (from 92% in Macate to 98.0% in Manica). Maize is mostly planted in October and November (from 44.0% in Sussundenga to 60.0% of farmers in Manica), but the highest infestation period is believed to be between November and February. With the exception of Vanduzi where 65.3% of farmers apply insecticides, most farmers in other districts do not use any method to control FAW (from 60.8% in Macate to 88.0% in Manica and Sussundenga respectively). Among those applying insecticides, from 65.0% in Manica to 75.0% in Vanduzi have confidence in the efficiency of the insecticides being used against FAW. Most farmers reported an increase in the spread of FAW. The lack of financial resources is reported as the main constraint in the fight against FAW. This study is the first of its nature in the province of Manica and provides valuable information that may support extension services and researchers when designing FAW management options for local smallholder farmers.

Keywords
Attack symptoms, constraints, morphological identification, pest management, smallholder farmers

Introduction

The fall armyworm *Spodoptera frugiperda* Smith (Lepidoptera: Noctuidae) is a polyphagous insect pest originating from the Americas, where it has more than 350 different host plants including both crop and non-crop species (Montezano et al. 2018). Despite its ability to survive in different host plants, fall armyworm (FAW) is known to have a high preference for maize (Molina-Ochoa et al. 2001; Nagoshi et al. 2018). In Africa, FAW was first reported in West and Central Africa in 2016 (Goergen et al. 2016) and rapidly spread to the rest of the continent with devastating consequences on maize production (Feldmann et al. 2019).

The larval stage of FAW consists of six instars. Young larvae usually feed on leaves creating windows and moistened sawdust-like frass near the funnel and upper leaves. During daylight, young larvae hide in the funnel, becoming active during the night. Older larvae stay in the funnel where they are protected from insecticide application and natural enemies, making it difficult to control them (Prasanna et al. 2018). Development rate is affected by diet (Abrahams et al. 2017) and temperature (Early et al. 2018). FAW populations can expand rapidly in tropical areas, where warmer temperatures allow more generations per year (Assefa and Ayalew 2019). At an average temperature of 28 °C, the life cycle of FAW is completed in around 30 days but can be extended in cooler temperatures (Prasanna et al. 2018).

In Mozambique, FAW was confirmed in early 2017 (Cugala et al. 2017). In 2018, FAW was also reported in Asia (Sharanabasappa et al. 2018). The rapid spread of FAW is largely attributed to its migratory potential (Meagher et al. 2004) and high dispersal capacity (Kumela et al. 2018). The problem of FAW in sub-Saharan Africa is exacerbated because its preferred host plant, maize, is a staple food in the region (Midega et al. 2018; Prasanna et al. 2018; Harrison et al. 2019). In Mozambique, for example, 21 to 90% of households depend on maize for daily consumption (MASA 2016). In 2017, it was estimated that by 2018, FAW would have caused an economic loss of around US$ 3 billion in Africa (Abrahams et al. 2017). In the absence of proper control methods, FAW has the potential to cause huge yield losses (Prasanna et al. 2018) as was reported in Mozambique where a year after its detection, around 49 thousand tons of maize were reported to be lost as a direct consequence of FAW attack (FAO 2018).

Farmers have various forms of indigenous knowledge to tackle pest problems, but such knowledge is often neglected (Mendesil et al. 2007). Surveys designed to ascertain farmers' knowledge and practices regarding pest management are important because they can highlight the need for the training of farmers in the identification of pests and the debunking of pest management misconceptions (Arshad et al. 2009). Crop

losses due to insect pests may be prevented, or reduced, by deploying effective crop protection measures, which to a large extent depend on farmers' knowledge and behaviour towards pest management (Midega et al. 2016; Kansiime et al. 2019).

For effective deployment of control methods for a given pest, farmers should be able to morphologically identify the target pest and distinguish it from non-target organisms. In cases of economically important and invasive insect pests such as FAW, it is crucial to know how familiar farmers are with the pest, what options they have to control it and what their main constraints are. Understanding these factors is critically important for setting a research agenda, designing extension strategies, and formulating research that meets farmers' demands (Arshad et al. 2009; Mendesil et al. 2016; Kumela et al. 2018). To respond to these concerns, this study was designed to provide baseline information that can be used by extension services and research institutions in determining how the problem of FAW should be addressed at the smallholder farmers' level. This study aimed to assess the knowledge, perception and management practices of FAW among smallholder farmers of the central province of Manica, Mozambique.

Materials and methods

Description of the study area

This study was carried out in the districts of Macate (19°24'50.9"S, 33°30'54.6"E), Manica (18°56'13.2"S, 32°52'33.6"E), Sussundenga (19°24'39.0"S, 33°16'33.0"E) and Vanduzi (18°57'09.4"S, 33°15'51.6"E) in the central province of Manica, Mozambique. According to MASA (2016), the area of the survey belongs to the Agro-Ecological Region (AER) number 4, which is characterized by the large occurrence of ferralsols and litosols with an annual mean temperature around 24 °C and annual mean precipitation ranging between 800 and 1000 mm (Figure 1). In Mozambique, maize is the main food crop and is cultivated in both dry and rainy seasons. The rainy season starts from mid-November to late March. During the dry season, maize is cultivated mainly in areas with irrigation systems or in valleys and river banks. Maize is often grown in small plots (less than 1 ha), in different cropping systems and mainly for family consumption. In general, no fertilizers or pesticides are used for the production of maize by smallholders. It is usually intercropped with roots and tubers (cassava and sweet potato), legumes (cowpea, pigeon pea, groundnut and common beans) and cucurbits (pumpkin, watermelon, melon).

Selection of farmers and questionnaire delivery

The survey was conducted from May to August 2019. Although the main cropping season is between November and March due to the rainy weather, the survey period was intentionally chosen because during the rainy season, some locations would have been inaccessible due to flooding. Furthermore, FAW was officially detected in

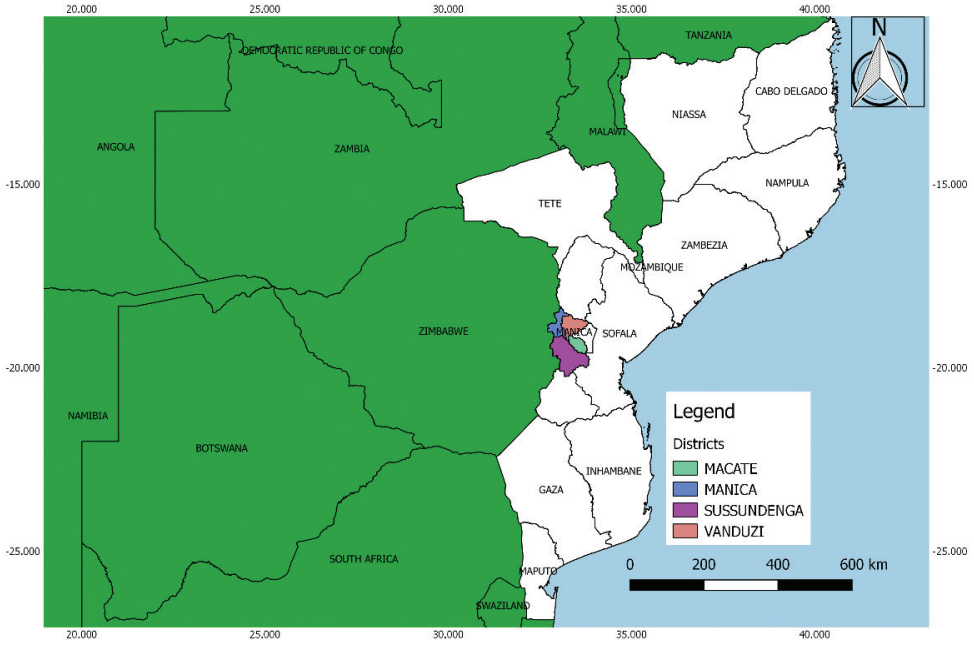

Figure 1. Sampling locations in Mozambique (colored areas within the province of Manica).

Mozambique two years prior to the survey and there was some information about the pest among farmers. Districts were selected based on their potential for maize production combined with the reported occurrence of FAW. Undergraduate finalist students of Agricultural Engineering from Instituto Superior Politécnico de Manica were recruited and trained as enumerators. Enumerators were selected based on their knowledge of the area and the ability to communicate in local languages. A semi-structured questionnaire, written in Portuguese, was used to interview farmers. The questionnaire was pre-tested for its validity and suitability for the survey. Farmers were selected by convenience based on their willingness to be interviewed and on their experience in maize cultivation.

At the beginning of the interviews, farmers were informed of the aim of the study. A leaflet including pictures of FAW and its damage on maize was used to facilitate recognition of the pest by farmers. A total of 200 farmers were interviewed as follows: 50 in Macate, 51 in Manica, 50 in Sussundenga and 49 in Vanduzi. Although the questionnaire was written in Portuguese, interviews were conducted either in Portuguese or in one of the following local languages which are common in the area of study: Chiuté, Chi-Shona and Chi-Ndau. Whenever the interview was conducted in a local language, questions were translated into that language but responses were recorded in Portuguese. In order not to limit the responses from farmers, some of the questions were left "open". Interviews were conducted face-to-face either on the farm or around farmers' homes.

Each interview lasted on average 16 minutes. Information related to farmers' socioeconomic characteristics (age, gender, education level, number of individuals per household, head of the household, monthly income, number of farms and land possession per household), knowledge and perceptions about FAW (morphological identification, recognition of attack symptoms, incidence and spread of the pest), management practices (methods of control, handling of insecticides) and constraints for its control were collected. Whenever farmers were unable to tell their age, they were asked to show their IDs. In cases where no ID was provided, farmers' ages were estimated based on the information provided by other family members.

Data analysis

Data were summarized per district. Descriptive statistics such as means and percentages were calculated through the Statistical Package for Social Sciences (SPSS) version 26. For each question, similar answers were grouped and the percentage of farmers who gave similar responses was determined for each district. Whenever two or more responses were given to the same question, they were again grouped by similarity and the percentage of farmers who gave a similar response was determined for each district. In some cases, the percentage of farmers was determined based on the total number of farmers who gave a particular response.

Results

Socio-economic characteristics

With the exception of the district of Sussundenga, where 64.0% of the interviewed farmers are women, most farmers in the rest of the districts are men (57.0% to 68.0%). The average age for women varied from 37.6 years in Sussundenga to 45.0 years in Macate, while for men, the average age varied from 34.6 years in Sussundenga to 43.4 years in Vanduzi. The average size of households varied from 6.8 individuals in Macate to 7.7 individuals in Manica. Although there is a considerable proportion of illiterate farmers (16.3% to 28.0%), most of them received primary education (54.0% to 69.4%), and have farming as their primary source of income (70.0% to 83.7%). The average monthly income of households ranges from US$ 36.5 in Sussundenga to US$ 82.6 in Macate. Each household has between 2.2 to 3.5 farms with total land possession varying from 3 ha in Macate to 5.2 ha in Sussundenga (Table 1).

Cropping systems, maize varieties and purpose of production

Most farmers have more than 10 years of experience in maize cultivation (from 68.0% in Macate to 90.2% in Manica). While in Manica and Vanduzi most farmers acquire

Table 1. Socio-economic characteristics of farmers per district.

Characteristics of respondents	Number of responses per district (%)			
	Macate (n = 50)	Manica (n = 51)	Sussundenga (n = 50)	Vanduzi (n = 49)
Gender				
Women	40.0	32.0	64.0	42.9
Men	60.0	68.0	36.0	57.1
Age/gender (years)				
Women	45.0	43.2	37.6	44.6
Men	39.6	42.3	34.6	43.4
Head of household				
Women	6.0	12.0	22.0	14.3
Men	94.0.	88.0	78.0	85.7
Number of individuals/household	6.8	7.7	7.0	6.9
Education level				
No education	24.0	22.0	28.0	16.3
Primary education	60.0	54.0	54.0	69.4
Secondary education	14.0	20.0	12.0	10.2
High school	2.0	4.0	4.0	4.1
Tertiary education	0.0	2.0	2.0	0.0
Another occupation				
Yes	20.0	23.5	30.0	16.3
No	80.0	76.5	70.0	83.7
Monthly income/household (US$)*	82.6	69.2	36.5	58.6
Number of farms owned/household	2.2	2.6	3.5	2.4
Land possession/household (ha)	3.0	3.6	5.2	3.0

*1 US$ = 58 MZN.

their seeds from authorized dealers (56.9% and 63.3% respectively), in Macate and Sussundenga the primary source of maize seeds is farmers' grain from the previous cropping season (68.0% and 88.0% respectively). While in Manica and Vanduzi most farmers use hybrid varieties (70.6% and 69.4% respectively), in Macate and Sussundenga, most farmers rely on local maize varieties (74.0% and 78.0% respectively). In Macate and Sussundenga, 72.0% and 74.0% respectively of farmers plant their maize intercropped with other crops. But in Manica and Vanduzi most farmers plant maize as monocrop (51.0% and 57.1% respectively). The majority of farmers in all districts reported that they produce maize for both home consumption and sale (from 63.3% in Vanduzi to 80.0% in Sussundenga) (Table 2).

Identification and recognition of FAW attack symptoms

When farmers were asked about how they first obtained information about FAW, from 69.4% in Vanduzi to 88.0% in Macate, reported that it was through direct observation in their farms. From 94.0% in Macate to 100% of farmers in Vanduzi, reported having seen FAW larvae. Although farmers have seen FAW, most of them are unable to distinguish FAW larvae from other lepidopteran larvae. From 92.0% in Macate to

Table 2. Farmers' experience in maize cultivation, seed provenience and cultural practices per district.

Characteristics of respondents	Number of responses per district (%)			
	Macate (n = 50)	Manica (n = 51)	Sussundenga (n = 50)	Vanduzi (n = 49)
Experience in maize cultivation				
Less than 1 year	2.0	0.0	0.0	0.0
Between 1 and 5 years	6.0	3.9	6.0	14.3
Between 5 and 10 years	24.0	5.9	6.0	8.2
More than 10 years	68.0	90.2	88.0	77.6
Seed provenience				
Authorized dealer	24.0	56.9	30.0	63.3
Own seed (previous season)	68.0	51.0	88.0	36.7
Neighboring farmer	12.0	9.8	0.0	2.0
Extension services/NGO's	6.0	5.9	4.0	4.1
Type of maize variety				
Hybrid	26.0	70.6	22.0	69.4
Local	74.0	29.4	78.0	30.6
Cropping pattern				
Monocrop	30.0	51.0	26.0	57.1
Intercrop	72.0	49.0	74.0	42.9
Purpose of production				
Home consumption	24.0	19.6	18.0	26.5
Sale	0.0	7.8	2.0	10.2
Both	76.0	72.6	80.0	63.3

Table 3. Identification and recognition of FAW attack symptoms by farmers per district.

Characteristics of respondents	Number of responses per district (%)			
	Macate (n = 50)	Manica (n = 51)	Sussundenga (n = 50)	Vanduzi (n = 49)
First source of information about FAW				
Radio	2.0	9.8	4.0	4.1
Extension Services	0.0	3.9	0.0	10.2
Neighboring farmer	4.0	7.8	18.0	6.1
Own observation	88.0	76.5	76.0	69.4
Other	0.0	0.0	0.0	10.2
Has never heard about	6.0	2.0	2.0	0.0
Observation of FAW larvae				
Yes	94.0	98.0	98.0	100
No	6.0	2.0	2.0	0.0
Ability to identify FAW larvae morphologically				
Can identify	4.0	2.0	2.0	6.1
Unable to identify	96.0	98.0	98.0	93.9
Occurrence of FAW damages on own farm				
Yes	92.0	98.0	96.0	98.0
No	8.0	2.0	4.0	2.0
Training in identification and control of FAW				
Trained	6.0	11.8	6.0	28.6
Non-trained	94.0	88.2	94.0	71.4

98.0% of farmers in Manica, have observed FAW damage in their farms. From 71.4% in Vanduzi to 94.0% of farmers in Macate and Sussundenga did not receive any training for the identification and control of FAW (Table 3).

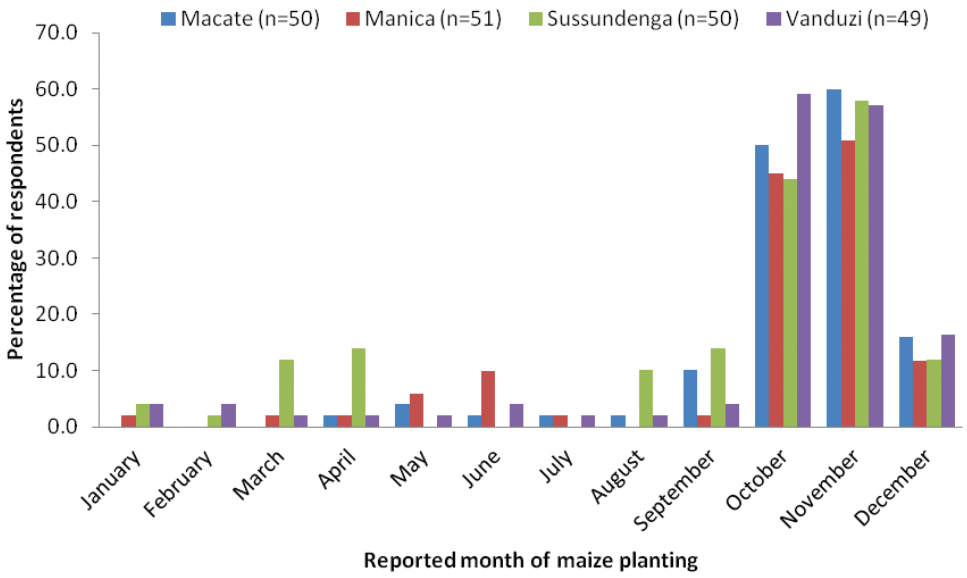

Figure 2. Reported month of maize planting per district.

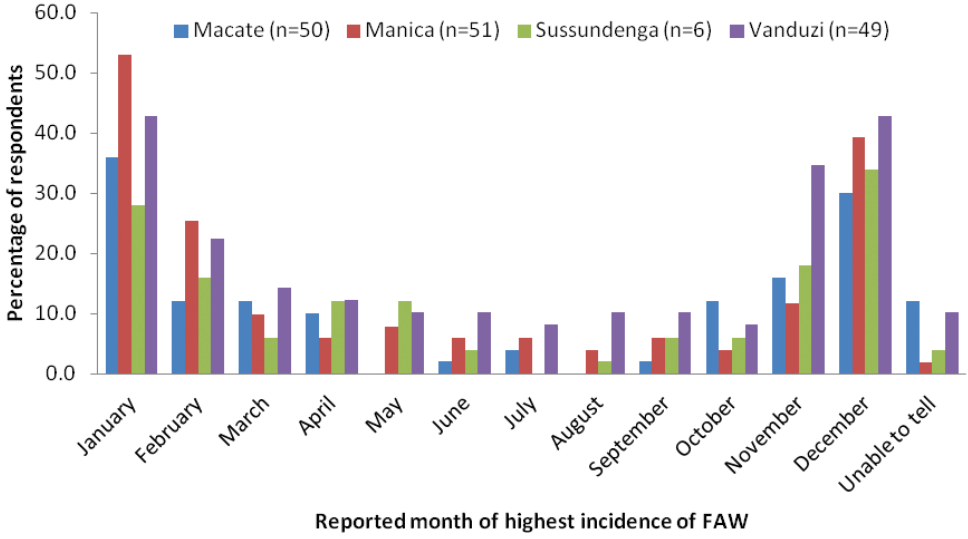

Figure 3. Reported month of the highest incidence of FAW in maize fields per district.

Maize planting and FAW infestation periods

As reported by farmers, maize is mainly planted in October and November, which coincides with the beginning of the rainy season. Nevertheless, the incidence of FAW is reported to be high between November and February as in this period, maize plants are still young (Figures 2 and 3).

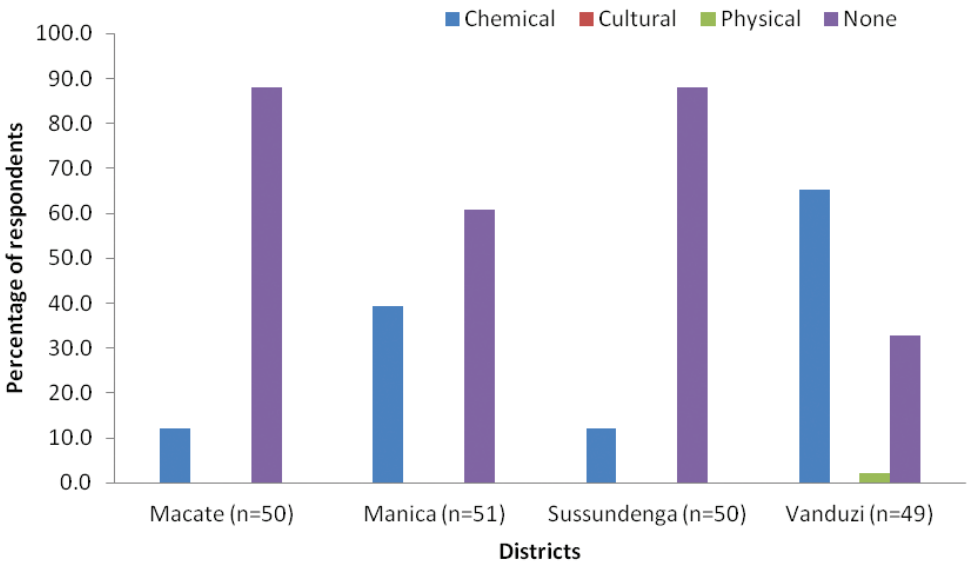

Figure 4. Methods of control of FAW used by farmers per district.

Methods of control of FAW

Except for Vanduzi, where 65.3% of farmers apply chemical insecticides, in other districts, most farmers do not use any method of control of FAW (60.8% in Manica to 88.0% in Macate and Sussundenga) (Figure 4).

Management and application of insecticides

Among those using chemical insecticides to fight FAW, their primary source of insecticides is authorized dealers' shops (from 50.0% in Sussundenga to 90.0% in Manica). But in some cases, insecticides are either acquired through street vendors or donated by extension services. The majority of farmers spray by themselves (66.7% in Sussundenga to 83.3% in Macate). While in Macate and Manica most farmers are partially equipped with protective gear (66.7% and 50.0% respectively), in Sussundenga and Vanduzi at least half of the farmers reported the use of complete sets of protective equipment (suit, rubber boots, gloves, glasses and masks) (50.0% to 59.4% respectively). Between 66.7% and 100% of the farmers reported that they use the recommended dose of insecticides. In Macate 50.0% of farmers using chemical insecticides have the habit of mixing two or more insecticides, but in the remaining districts this practice is not common (16.7% in Sussundenga, 18.8% in Vanduzi and 30.0% in Manica). All farmers reported using backpack sprayers when applying insecticides. The common spraying intervals used by farmers are seven or fourteen days. Between 67.0% and 75.0% of farmers applying insecticides reported that the insecticides used are efficient in the control of FAW. Despite the reported use of insecticides, from 73.5% of farmers

Table 4. Use of insecticides among farmers per district.

Characteristics of respondents	Use of insecticides per district (%)			
	Macate (n = 6)	Manica (n = 20)	Sussundenga (n = 6)	Vanduzi (n = 32)
Source of insecticides				
Authorized dealer	83.3	90.0	50.0	71.9
Street vendor in sealed packaging	0.0	0.0	16.7	3.1
Street vendor in unsealed packaging	0.0	0.0	0.0	3.1
Extension services/NGO's	16.7	10.0	33.3	21.9
Responsible for spraying				
Farmer himself	83.3	75.0	66.7	68.8
Another family member	0.0	20.0	0.0	15.6
Someone hired	16.7	5.0	33.3	15.6
Use of protective equipment				
Fully equipped	33.3	25.0	50.0	59.4
Partially equipped	66.7	50.0	16.7	31.3
Without any equipment	0.0	25.0	33.3	9.4
Dose of application of insecticides				
Recommended	66.7	85.0	100	87.5
Increased	0.0	5.0	0.0	6.3
Reduced	0.0	0.0	0.0	0.0
Unknown	33.3	10.0	0.0	6.3
Mixture of insecticides				
Mix	50.0	30.0	16.7	18.8
No mix	50.0	70.0	83.3	81.3
Application equipment				
Backpack sprayer	100	100	100	100
Spraying interval				
7 days	16.7	50.0	50.0	25.0
14 days	50.0	40.0	50.0	46.9
21 days	0.0	5.0	0.0	9.4
30 days	16.7	5.0	0.0	6.3
Density dependent	16.7	0.0	0.0	12.5
Efficiency of insecticides				
Efficient	66.7	65.0	66.7	75.0
More or less	33.3	30.0	16.7	25.0
Not efficient	0.0	5.0	16.7	0.0
Training in the handling of insecticides				
Trained	6.0	17.7	6.0	26.5
Non-trained	94.0	82.4	94.0	73.5
Application of insecticides based on				
Monitoring	83.3	95.0	83.3	90.6
Calendar	0.0	0.0	0.0	6.3
Recommendation	0.0	5.0	16.7	3.1
Observation of neighboring farmers	16.7	0.0	0.0	0.0

in Vanduzi to 94.0% of farmers in Macate and Sussundenga do not have training in pesticides use and management. Although the number of sprays can go up to 20× per crop cycle, farmers in Sussundenga generally spray once per crop cycle. In Vanduzi the average number of sprays per cycle is 3×. But in Macate and Manica, most farmers spray 4× during the crop cycle. Most farmers reported monitoring as the basis for deciding to apply insecticides (Table 4).

Table 5. Reported incidence, spread and constraints in the control of FAW per district.

Characteristics of respondents	Number of responses per district (%)			
	Macate (n = 50)	Manica (n = 51)	Sussundenga (n = 50)	Vanduzi (n = 49)
Perceived incidence of FAW				
Low	12.0	23.5	8.0	28.6
Average	38.0	29.4	34.0	36.7
High	36.0	45.0	54.0	32.7
Unknown	14.0	2.0	4.0	2.0
Perceived spread of FAW				
Increasing	38.0	58.8	80.0	59.2
Decreasing	38.0	31.4	10.0	34.7
No changes	16.0	7.8	6.0	4.1
Unknown	8.0	2.0	4.0	2.0
Constraints in the control of FAW				
None	18.0	15.7	8.0	28.6
Lack of financial resources	52.0	56.9	74.0	59.2
Inefficiency of insecticides	18.0	3.9	6.0	12.2
Unavailability of insecticides	8.0	7.8	6.0	2.0
Lack of technical assistance	4.0	11.8	2.0	0.0
Other	0.0	3.9	4.0	0.0

Incidence, spread and constraints in the control of FAW

Most farmers believe that the incidence of FAW is average or high. There is a common perception among farmers that FAW is spreading in the region and the lack of financial resources for the acquisition of insecticides and spraying equipment is reported as the main constraint in the control of FAW (Table 5).

Discussion

Traditionally, the head of the household in the area of study is a man. But specific circumstances may compel women to take on this role, such as when they are divorced, widowed or single. The educational background of farmers seems to play a major role in their ability to get alternative/additional jobs. Given that most farmers rely solely on agriculture, it is both a means of subsistence and a source of income. Although in this study no relationship was established between the level of education and knowledge of FAW, Abtew et al. (2016), pointed out the importance of education in farmers' level of knowledge of agricultural pests. Given that the majority of farmers in the present study have primary education or are illiterate, that may well explain their lack of knowledge of the FAW. Although farmers may own 3 ha or more of land, one should note that not all the area is under cultivation. Due to their limited income, farmers prefer to use their stored maize seeds from the previous harvest, as certified seeds are seen as expensive.

Invasive alien species represent a serious challenge in the context of pest management because farmers and local agricultural extension workers rarely know about the presence of a newly arrived and spreading species until disastrous damage occurs (Toepfer et al. 2019). In Mozambique, for example, FAW was initially confused with

stem borers by agricultural extension workers (Cugala et al. 2017). A similar scenario was also reported in Nigeria where FAW was also confused with indigenous species of *Spodoptera* (Goergen et al. 2016). Although most farmers in Zambia (91%) (Kansiime et al. 2019) and in Ethiopia (99%) and Kenya (100%) (Kumela et al. 2018) could positively identify FAW larvae through its morphological characteristics, the same could not be observed in the present study, as only a maximum of 6.1% of the farmers could identify FAW larvae. That might be explained by the fact that the majority of farmers (from 71.4% in Vanduzi to 94.0% in Macate and Susundenga) did not receive any training in identification of FAW. It is important to point out that at the time of the study, the extension service workers themselves were under training in identification and control of FAW by the Ministry of Agriculture, FAO and other agriculture related organizations and universities. Because FAW is a new pest, it can be easily confused with other caterpillars, especially those belonging to the same family (FAO and CABI 2019). However, Toepfer et al. (2019) underscored the fact that even if farmers are not trained by extension workers in identification and management of FAW, they will learn, over time, through their own experiences with the new pest.

The infestation of FAW in maize fields is reported to be high between November and February. This can be explained by the fact that in this interval, maize planted from October to December is still in the vegetative stage which is the most preferred by FAW. But a field survey conducted from May to August 2019 and between December 2019 and January 2020 in the same area, found that FAW infestation was higher during the dry season (Caniço et al. 2020).

Despite an official recommendation from the government to use a select range of insecticides composed of 23 different active ingredients belonging to the major groups of pyrethroids, organophosphates carbamates and organoclorades, and highly selective pesticides such as Spinosad, *Beauveria bassiana* and *Bacillus thuringiensis* to fight FAW (Cugala et al. 2017), only about 12.0% in Macate and Sussundenga, 40.0% in Manica and 65.3% in Vanduzi appeared to follow the recommendation. Abate et al. (2000), explained that although local extension services in African countries may encourage the use of pesticides for pest management, most smallholder farmers rely on indigenous approaches when dealing with pests such as crop associations, mechanical control, use of herbal products and, sometimes, in supernatural ways. Concerning the specific case of FAW in Africa, several methods of control of the pest were reported in various countries such as Zambia where farmers use chemical, cultural and biological control (Kansiime et al. 2019), Ethiopia and Kenya where among other methods, farmers use physical and traditional methods (Kumela et al. 2018). In Zimbabwe for example, as reported by Chimweta et al. (2020), most of the farmers applied pesticides recommended by the government to control FAW, although some of them used non-conventional materials such as washing powders, indicating lack of knowledge of the pest and its methods of control.

In this study, in contrast to other countries, chemical control was the only method used by a limited number of smallholder farmers. Because of the importance of the

pest and, with the objective of widening available options, African researchers are testing alternative methods of monitoring and control of FAW, such as the push-pull technology tested in Kenya, Tanzania and Uganda with promising results (Midega et al. 2018) and pheromone trap design and lures for monitoring FAW tested in Togo (Meagher Jr et al. 2019). Because insecticides in Africa are mostly used improperly and often traded in dubious markets, it was recommended that the management of FAW should be based on biopesticides such as the fungi *Beauveria bassiana* and *Metarhizium anisopliae* and baculoviruses because they are environmentally safe with a low risk of human intoxication (Feldmann et al. 2019). *Bacillus thuringiensis*, a bacteria-based biopesticide, could also play a role in low-cost methods (Hruska 2019). Furthermore, when biopesticides are combined with good crop management, they can keep pest levels under control (Bateman et al. 2018).

In this study, there was a common belief among farmers from all districts that FAW is rapidly spreading. This behavior of the pest has been predicted in Zimbabwe by Chimweta et al. (2020) and a similar trend was also observed in Ethiopia and Kenya by Kumela et al. (2018). When farmers were asked about their major constraints in the fight against FAW, some reported no constraint while most of them (from 52.0% in Macate to 74.0% in Sussundenga) indicated the lack of financial means to support the acquisition and application of insecticides, combined with the inefficiency of insecticides being used (from 6.0% in Sussundenga to 18.0% in Macate). In Zimbabwe, around 84.1% of the farmers also reported the lack of financial resources as the main constraint, followed by 73.2% who indicated inadequate labor as the main constraint (Chimweta et al. 2020). A similar scenario was reported in Ethiopia, where the major problems affecting FAW management efforts were reported to be lack of adequate knowledge of the pest and its management options, combined with scarcity of financial and material resources (Assefa and Ayalew 2019). Depending on the context, smallholder farmers may have limitations that will define their pest management options (Hruska 2019).

Conclusions

Although farmers are aware of the presence of FAW in maize fields, the majority of them are unable to morphologically distinguish FAW from other caterpillars, which probably affects their ability to control the pest. Despite there being a government list of recommended pesticides to be used in the fight against FAW, a small proportion of farmers apply insecticides while the majority of farmers take no measure against the pest. Nevertheless, most farmers believe that the incidence of FAW in their fields is high and that the pest is spreading to other territories. Given the importance of FAW to food security, educational campaigns addressing the issues of identification and control of the pest should be implemented targeting smallholder farmers. Alternative methods of control of FAW should be investigated as the simple recommendation of insecticides or other methods that are perceived as expensive or hard to implement may not work.

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Supplementary material 1

Questionnaire used to interview farmers

Authors: Albasini Caniço, António Mexia, Luisa Santos

Data type: Pdf. file

Explanation note: Questionnaire used to interview farmers.

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