Integrated pest management of the fall armyworm

By Ursula Human

Farmer education and community action are critical elements in the strategy to sustainably manage fall armyworm (FAW) populations. This is especially true for smallholder farmers in Africa. The United Nations' Food and Agriculture Organization (FAO) has taken the lead in the provision of education to manage FAW.

The FAO is making use of Farmer Field Schools (FFS) to implement an integrated ecological and sustainable FAW management strategy for smallholders in Africa. FFS is an intensive farmer education approach promoted by the FAO and many organisations worldwide, establishing platforms for farmers to learn, experiment and exchange information.

In this context the FAO recently published an educational guide to provide smallholder farmers in Africa with the necessary information to implement an integrated pest management system, especially for maize production.

South African context

FAW is a polyphagous pest with a preference for grain crops. Although concerns over FAW damage are mostly centred around maize crops, it also affects other important crops. According to the Department of Agriculture, Forestry and Fisheries (DAFF), South African crops also at risk include sunflower and soya, among others.

In March 2017, FAW was reported on soya beans after its appearance on maize in December 2016. DAFF reported minimal damage to soya bean crops. In February 2018, DAFF announced that FAW was detected on young sunflowers in Komatipoort, Mpumalanga. Producers were urged to scout their fields and report any occurrence or suspected

Fall armyworm in a maize whorl. (Photo by FAO)

The larvae are generally characterised by three yellow stripes on the back, followed by a black, then a yellow stripe on the side. (Photo by FAO)

occurrence of the pest to DAFF.

To control and monitor FAW effectively, a steering committee was established that meets once a month. Regulations have also been put in place to limit the spread of the pest. These regulations were published on 26 May 2017 in the *Government Gazette*. National surveillance programme traps have been placed in several provinces.

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According to feedback from the steering committee in February 2018, FAW had been reported in Gauteng (confirmed in Bronkhorstspruit, Cullinan, Vereeniging and Melapong), Mpumalanga (Witbank area and parts of the Nkangala district), Limpopo (Mopani, Vhembe and Waterberg districts), North West (unconfirmed cases around Groot Barn and Koster), KwaZulu-Natal (high infestations in Greytown and other parts), Eastern Cape (confirmed FAW presence), Free State, Northern and Western Cape (no new reports).

High infestation rates

Later in February, DAFF released an update that named Gauteng, Mpumalanga, North West, Free State and Eastern Cape as the provinces least affected. High infestation rates were reported in Limpopo (4 316ha affected in Capricorn, Sekhukhune, Waterberg, Vhembe and Musina District Municipalities) and KwaZulu-Natal (219,1ha affected in Umkhanyakude District Municipality).

This can be compared to only 14ha in the Buffalo City Metro Municipality in the Eastern Cape. It is likely that the areas are less affected due to dry weather, but in other areas the recent La Niña conditions (wet and cool) were more favourable for the pest.

According to DAFF, the overall infestations are less in 2018 compared to 2017, since most farmers are spraying as a preventative measure. There were more chemicals registered during 2017 to control and manage FAW.

In order to successfully control FAW, identification is of the utmost importance. To this end, a protein kit for diagnostic identification has been made available. Pest fact sheets have also been translated into Xitsonga, Sepedi, isiZulu, Siswati, and isiNdebele and distributed by DAFF.

Armyworm identification

The first step in FAW management is the identification of the worm. The pest is new to Africa and farmers need to be able to distinguish it from other pests. It is important to identify it in its various life cycle stages – from egg to larva and pupa to adult.

Half-grown or fully-grown caterpillars are the easiest to identify. The larvae are generally characterised by three yellow stripes on the back, followed by a black, then a yellow stripe on the side. Look out for four dark spots forming a square on the second to last segment. Each spot has a short bristle (hair).

The extensive damage caused by FAW in maize can be seen in this photo. (Photo by FAO)

The head is dark and shows a typical upside-down Y-shaped pale marking on the front.

Many other maize pests resembling FAW are present in Africa. They are most easily differentiated when one can identify the worms in their various life stages and the type of damage they cause. The maize stalk borer closely resembles FAW, for example. The most important stem borer pests on maize are *Busseola fusca, Chilo partellus* and *Sesamia calamistis*.

Scan the QR code for the complete document showing details on life cycles and to see images that can be used to identify FAW and other worms.

FAW in young sunflowers. (Photograph by Grain SA)

The difference in behaviour among stem borers and FAW can help farmers to distinguish between them.
The type of damage inflicted will look different with each type of infestation.
The main differences between stem borer and FAW infestations are:

- FAW causes big holes in maize leaves. Generally, the 'big holes' associated with FAW are not present in stem borer attacks (for both young and old larvae).
- Stem borer damage is characterised by a typical dead heart (a deformed, stunted plant), which is easily seen in young maize plants.
- As stem borer larvae mature, they are found less frequently in the whorl (the leaves around the node of a stem), contrary to FAW. They can, however, be found in the maize stem, where they leave holes with visible frass (excrement of insect larvae).

African armyworm vs fall armyworm

Although the appearance of FAW is new in Africa and South Africa, the African Armyworm is well known. It is important to be able to distinguish between the two, and *Table 1* can be used to identify the main differences between the appearance and behaviour of these pests.

Management options

The most promising options available to African smallholders to manage FAW are presented here. These options build on experiences from the Americas and the latest available research in Africa, reflecting integrated pest management (IPM) strategies. There are several management options for FAW that work well in combination.

Crop management: Good crop management techniques can help prevent FAW infestation. Follow the right planting dates and avoid late plantings, i.e. staggered plantings (the planting of fields at different dates in the same area), as this will continue to provide the FAW with food. It is one of the most important recommendations for smallholders.

Good soil health and adequate moisture are critical – they are essential to grow healthy plants, which can better withstand pest infestation and damage. Unbalanced inorganic fertilisation of maize (especially excessive nitrogen use) can increase oviposition by female FAW.

Maize cultivars: Certain maize cultivars are more resistant to FAW, such as Bt maize, which is grown to control the maize stem borer. Bt maize has been genetically engineered by incorporating genes from the bacterium *Bacillus thuringiensis* (Bt) that produce insecticidal

Table 1: Comparison between the fall armyworm (*S. frugiperda*) and African armyworm (*S. exempta*). (Source: DAFF)

Description	Fall Armyworm (*S. frugiperda*)	African Armyworm (*S. exempta*)
Adult larvae colouring	Brown/green with lateral beige stripes.	Velvet black with lateral beige/yellow stripes.
Larval behaviour	Concealed in plants.	Marches through crops.
Eggs	Batches covered in light brown scale-hairs. Laid under leaves.	Batches covered in black scale-hairs. Laid under leaves.
Male moth	Identified per genitalia.	Identified per genitalia.
Host plants	Predominantly maize and sorghum.	Predominantly veld grasses, teff.
Outbreak dynamics	Migration from countries north of South Africa; local breeding and outbreaks have been confirmed during February 2017 in South Africa.	Sporadic local outbreaks, but mostly migration from countries north of South Africa.

FAW app helps smallholder farmers

The Food and Agricultural Organization recently launched the Fall Armyworm Monitoring and Early Warning System (FAMEWS) mobile app, which enables farmers to identify, report and map the spread of the worm.

The app is useful on two fronts: for farmers and agricultural workers in the direct management of their crops to prevent further infestations and to reduce damage; and for all role-players involved in managing fall armyworm in Africa, by providing vital analysis on risks, spread and management.

Scan this QR code to download the app on an Android smartphone (v5 or higher).

proteins which can kill crop pests. It is important, though, to note that insect populations can adapt to Bt proteins through the evolution of resistance.

Plant diversity: Plant diversity on farms reduces FAW infestation and supports natural enemies of this pest. Although female FAW moths prefer laying their eggs on maize plants, they also lay eggs on other plants, which could help smallholder farmers to divert the pest even if it is present in the area. A farm with monocultures of maize makes it easier for the pest to procreate.

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Intercropping maize with plants the FAW dislikes, or planting it nearby, will most likely force moths to move to other areas more conducive to laying eggs. For example, smallholder farmers in Central America have found that planting maize in their traditional *milpa* systems – combining it with beans and squash – lessens pest attacks.

Biological control: FAW has many naturally-occurring enemies that feed on it. These enemies have the potential to substantially reduce FAW populations, but it is a major challenge to create the right conditions to realise the full potential of these beneficial organisms. Broad spectrum pesticides kill many of the beneficial insects.

Biological control agents (BCAs) include predatory insects that eat their prey, parasitoids (insects that are parasitic on other insects) and entomopathogens (microbial pathogens), such as nematodes, fungi, bacteria, viruses and protozoa, all lethal to FAW.

- **Predators** of the FAW kill several individuals either as eggs, larvae, pupae or adults. The following insects predate on FAW in various life stages: earwigs, ladybird beetles, ground beetles, assassin and flower bugs, and predatory wasps. Spiders, birds and bats have also shown to be predators.
- **Parasitoids** are organisms whose adults lay eggs either inside or attached to a single host organism. To enable development, the resultant larvae feed on the tissues of the host until they are fully grown and pupate. Parasitoid larvae always kill their host as the outcome of their development. The majority of parasitoids known to be associated with FAW are wasps, and less frequently flies.
- **Entomopathogens** are pathogens such as fungi, bacteria, viruses and nematodes that affect insects and can control FAW. Viruses such as the nuclear polyhedrosis virus (NPV) and *Spodoptera frugiperda multicapsid nucleopolyhedrovirus* (SfMNPV) are lethal to FAW. So are the fungi *Metarhizium anisopliae, Metarhizium rileyi* and *Beauveria bassiana*. In the case of bacteria, *Bacillus thuringiensis* (Bt), found in Bt maize, also kills the FAW.

Synthetic pesticides: Several synthetic pesticides have been used in response to the invasion of FAW, including methomyl, acephate, cyfluthrin, benfuracarb, methyl parathion, carbaryl, endosulfan, carbosulfan, lindane, chlorpyrifos, cyfluthrin, diazinon, methomyl, and methyl parathion. Farmers must only use approved insecticides and apply the application dosage rates recommended on the product label.

Scan this QR code to download the DAFF document on FAW control.

An important aspect the FAO report fails to mention is that the application must only be made against young instar (phase between two periods of development) larvae less than 10mm long. This is according to a recent report by DAFF on FAW control in South Africa. According to the DAFF report, application against older larvae is not successful since they feed deep inside whorls of plants and are therefore protected from contact with the insecticide.

FAW checklist

The FAO guide for FAW control provides the following checklist of facts that all smallholder farmers should know:

- Farmers need to be able to identify and differentiate FAW (*Spodoptera frugiperda*) from the African armyworm (*Spodoptera exempta*), cotton bollworm (*Helicoverpa armigera*), stem borers and other worms.
- They must recognise the different stages of FAW and understand its life cycle.
- Farmers need to know where to find the FAW in its different life stages on the plant, how the worm feeds on the plant, and what the damage looks like.
- They must know which plants can serve as an alternative host.
- They must also know which plants repel or attract FAW. The same can be true for natural enemies. Plant diversity is important as food sources for natural enemies.
- Farmers need to know which natural enemies of the FAW are present, how they attack the different stages of the worm and how many pests they can eat, parasitise or infect.
- They must understand how plants can compensate for leaf damage in different stages of crop development.

To read the full report on *The Integrated Management of the Fall Armyworm on Maize* visit *www.fao.org*.
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