



Food and Agriculture
Organization of the
United Nations



Community-Based Fall Armyworm (*Spodoptera frugiperda*) Monitoring, Early Warning and Management

Training of Trainers Manual

First Edition



USAID
FROM THE AMERICAN PEOPLE



Community-Based Fall Armyworm (*Spodoptera frugiperda*) Monitoring, Early Warning and Management

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Cover Photo: Extension workers using FAMEWS for data collection © CABI

Inner cover: Fall Armyworm; © Georg Goergen, IITA

Back inside cover: FAW infested maize

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Foreword

Fall armyworm (FAW) (*Spodoptera frugiperda*) was first reported to be present in Africa in 2016. Since then, it has become a very destructive invasive pest in sub-Saharan Africa. Its main impact is on maize crops, which it attacks: it affects the crop at different stages of growth, from early vegetative to physiological maturity. It can cut down young plants and can also damage leaves, giving them a ragged, torn appearance. The pest feeds inside whorls and can destroy silks and developing tassels. FAW can also feed on developing kernels, which can reduce yields through direct losses, exposure of cobs to secondary infection and loss of grain quality and quantity.

In several countries in Africa affected by FAW attack, farmer responses are predominantly based on the use of chemical pesticides. It is therefore important first to ensure the safe use of such pesticides by farmers, but also, at the same time, to promote and deploy against FAW an integrated pest management (IPM) package made up of proven, sustainable and available technologies. Such a package should include: effective monitoring, scouting and surveillance; timely and need-based application of environmentally safer and low-risk synthetic pesticides and biorationals; conservation of indigenous natural enemies and classical biological control; deployment of cultivars with tolerance or resistance; promotion of low-cost agronomic practices/cultural control; and habitat management strategies, including push-pull technology.

The direct actions that can be taken to manage FAW are largely up to individual farmers in their fields. Farmers therefore need the right advice, tools and resources to sustainably manage FAW. This manual presents a significant step towards providing farmers and frontline community extension service providers with easy-to-use information on how they can manage FAW within their smallholder cropping systems. It provides information about modules for training trainers in FAW pest diagnostics, scouting, management and data collection. It sets out the information that those delivering such training need to know. The objective of this training is to provide the trainers, and farmers, with the knowledge and skills that will enable them to: identify FAW, and differentiate it from other similar pests; understand the life cycle of FAW; and know how to monitor and manage the pest. This manual gives the trained trainers all the information they will need in order to support and sustain an IPM approach for FAW management in their communities, and it provides information that will allow trainers to provide behavioural change communication targeted at farmers. The manual is modular, and allows for updates in the future as more knowledge, and more solutions farmers can use to manage FAW on their farms, become available.

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This manual was the result of the contributions of FAO Subregional Office for Eastern Africa (FAOSFE), CABI, International Centre of Insect Physiology and Ecology (ICIPE) and Desert Locust Control Organization for Eastern Africa (DLCO-EA). The manual was written by M. Mulaa (CABI), M. M. Abang (FAOSFE), K. Cressman (FAO Rome), F. Elias (DLCO-EA), S. W. Gelalcha (FAOSFE), A. T. Haile (FAOSFE), A. Hruska (FAO Rome), D. Karanja (CABI), M. Kimani (CABI), B. Mutune (ICIPE), E. Negussie (CABI), S. Niassy (ICIPE), A.-S. Poisot (FAO Rome), I. Rwomushana (CABI) and S. Subramanian (ICIPE).

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This trainers manual has adapted some of the material from the *Community-Based Armyworm Forecasting Manual for Training of Trainers and Forecasters* (Negussie et al, 2010) of CABI, *the Fall Armyworm in Africa: A Guide for Integrated Pest Management* (Prasanna et al, 2018) of USAID/CIMMYT and the *Integrated management of the Fall Armyworm on maize: A Guide for Farmer Field Schools in Africa* (FAO, 2018) in a simplified format for trainers of trainers. In particular, the training programme for training trainers follows the format of Negussie et al. 2010.

The manual benefited from advice and recommendations from the Americas, where both maize and FAW are native. Sources of information on the various technologies are referenced at the end of the manual for further reading.

Abbreviations/acronyms

AAW	African Armyworm
AESA	Agroecosystem Analysis
Bt	Bacillus thuringiensis
CABI	CAB International
CIMMYT	International Maize and Wheat Improvement Centre
DLCO-EA	Desert Locust Control Organization for Eastern Africa
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária (Brazilian Agricultural Research Corporation)
FAMEWS	Fall Armyworm Monitoring and Early Warning System
FAO	Food and Agriculture Organization of the United Nations
FAW	Fall Armyworm
FFS	Farmer Field School
GPS	Global Positioning System
ICIPE	International Centre of Insect Physiology and Ecology
IITA	International Institute of Tropical Agriculture
IPM	Integrated Pest Management
NPV	Nucleopolyhedrovirus
OFDA	Office of US Foreign Disaster Assistance
USAID	United States Agency for International Development

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Training workshop curriculum and anticipated participants

This training workshop curriculum follows a similar approach to that developed by Centre for Agriculture and Biosciences International (CABI) for the related African armyworm (AAW) (Negussie et al., 2010). There are two parts to the training: one covers the training of trainers and the other covers the training of community facilitators. Reference materials for the curriculum include the following: *Armyworm Forecasting Manual for Training of Trainers and Forecasters* (Negussie et al., 2010); *A Guide for Integrated Management* (Prasanna et al., 2018), produced by the US Agency for International Development (USAID)/International Maize and Wheat Improvement Centre (CIMMYT); and *Integrated Management of the Fall Armyworm on Maize: A Guide for Farmer Field Schools in Africa* (Food and Agriculture Organization of the United Nations (FAO), 2018). The training topics contained in the curriculum include the following: FAW identification, biology and ecology; damage symptoms and signs of FAW in relation to other similar caterpillars; monitoring and scouting techniques for FAW; IPM options for FAW; and farmers' role in community-based monitoring, surveillance and management. The duration of the training of trainers is three days, and this is to be followed by those who have been trained then training community facilitators, for two days.

The participants of the training of trainers are expected to be extension officers from FAW hot spot region/district/location. It is anticipated that they will be relevant subject matter specialists who regularly work with affected communities and can easily access villages. The participants will be identified by their offices and supervisors. The participating farmer facilitators will be elected by the farmers themselves, based on criteria given by the staff at different region/district/location, and agreed on by the farmers and community leaders.

Table 1: Training programme for training of trainers

Time	Topic	Activity	Responsible persons
DAY 1			
08.00–08.15	Registration	Gathering contacts and personal profiles of participants	Lead facilitator and national coordinator from Ministry of Agriculture
08.15–08.30	Introductions/ contextualizing the problem	Brainstorm to identify their experiences and knowledge gaps, and participants' training needs and expectations from the workshop	Local national trainer
08.30–08.45	Welcoming remarks/ official opening remarks	Overview of country status on FAW and government initiatives	Government representative
08.45–09.15	An overview of current status of FAW in Africa and training objectives	PowerPoint presentation and discussions	Facilitator

Time	Topic	Activity	Responsible persons
09.15–10.30	Updates from regions/districts	A brief on the region/district/location experience with FAW Update on farmers' experiences in the different region/district/location	Participants to be given an outline of information required and format for presenting the status of FAW from the region/district/location they originate from, and their experiences before the training
10.30–11.00	TEA BREAK		
11.00–13.00	Identification, biology, ecology, damage symptoms and signs of FAW in relation to other common caterpillars	• Description of the life cycle and conducive environment • Signs and symptoms • Feeding behaviour, oviposition • Differentiating FAW, AAW, <i>Helicoverpa armigera</i> and other stemborers	Facilitators to be assigned before the training
13.00–14.00	LUNCH BREAK		
14.00–14.30	Monitoring and scouting techniques for FAW	• Selecting scouting points • Number of plants to be sampled • What to look for and how to record	Facilitators
14.30–15.30	Agroecosystems analysis- (AESA-) based IPM in the context of FAW	• Definition of AESA and the procedures • IPM principles	Facilitators/farmer field school (FFS) expert
15.30–16.00	General discussion	• Planning	
16.00–16.30	Wrap-up of Day 1		Facilitator/Participant

DAY 2			
8.00–12.30	Field Visit	• Practical application of the AESA-based IPM in farmer's field: identification, sampling, collection, decision-making – observing and correctly identifying FAW egg masses, young larvae and damage, observing natural enemies (wasps, coccinellids, earwigs, ants; and parasitized eggs) • Demonstrating scouting techniques in the field and comparing damage caused by FAW to other caterpillars	Facilitators/ FFS expert
12.30–14.00	LUNCH BREAK		

Time	Topic	Activity	Responsible persons
14.00–16.30	Feedback from the field	• Feedback and synthesis of the key learning points from the field • Group presentations of their' field analysis • Observation of samples collected from the field • Differentiation of farmers' friends: parasitoids, predators, and micro-organisms, including viruses (nucleopolyhedrovirus (NPV)) and bacteria (<i>Bacillus thuringiensis</i> (Bt)); modes of action • Conservation and use of farmers' friends: natural enemies (use of less toxic pesticides, landscape management, plant diversity, etc.)	Participants groups to present their analysis from the field visit

DAY 3

08.15–08.30	Recap Day 2		Participants
08.30–10.30	IPM option (biological control/ natural enemies, cultural practices, pesticides)	• Management practices (how to minimize build-up of pest population and conserve natural enemies) • Botanical pesticides • Observation of the development of the samples collected from the field • Varietal diversity, crop diversification and intercropping to reduce oviposition and build population of natural enemies • Stover management • Crushing egg masses as a key practice: <i>"Is it more cumbersome than spraying pesticides?"</i> • Host plants; effects of repellent plants and attractants and mode of action • Seed treatment • Planting dates – avoid staggered planting • Good soil and plant health • Natural enemies	Facilitator
10.30–11.00	TEA BREAK		
11.00–11.30	Awareness and communication	• Mass extension campaigns • Reporting mechanisms for FAW: <i>"Why should farmers report, to whom, how?"</i> • Role of farmers in sharing information with the rest of their communities and with other FFSs	
11.30–12.00	Participatory training and adult education	• Participatory training • Non-formal adult education • Skill and role of facilitators	

Time	Topic	Activity	Responsible persons
12.00–13.00	Action planning	• Presentation of action/contingency plan by each region/district • Developing of season-long learning programme • Identification of possible facilitators	
13.00–13.30	Closing remarks Official closure	• Issuing of certificates • Recommendations from the training course	Government official/facilitator
13.30–14.00	LUNCH BREAK AND DEPARTURE		

Table 2: Training programme for farmer community facilitators

Time	Topic	Activity	Responsible persons
DAY 4			
08.00–08.15	Registration	• Gathering contacts and personal profiles of community facilitators (participants)	Lead facilitator
08.15–08.30	Introductions	• Roundtable sharing of participants' experiences and expectations from the training	National trainer
08.30–08.50	Welcome remarks/ official opening remarks	• Region/district FAW status and local government initiatives	Region/ district or local government representative
08.50–09.15	An overview of current status of FAW in the country and the training objectives	• PowerPoint presentation/life specimens and discussions	Facilitator
09.15–10.30	Updates from communities	• Update on farmers' experiences from the different communities	Group work and plenary
10.30–11.00	TEA BREAK		
11.30–13.00	Identification, biology, ecology, damage symptoms and signs of FAW in relation to other common caterpillars	• Display of different stages of FAW to construct the lifecycle • Damage symptoms • Differentiating FAW, AAW, <i>Helicoverpa armigera</i> and other stemborers using live or preserved specimens	Facilitators to be assigned before the training
13.00–14.00	LUNCH BREAK		

Time	Topic	Activity	Responsible persons
14.00–14.30	FAW surveillance process and benefits	What you need to know before setting up the pheromone trap in the field	Facilitators
14.30–15.30	Pheromone trap	- How the trap works - Demonstration on how to assemble and dismantle the trap - When and how to replace the lure	Facilitators
15.30–16.00	Keeping a record of the moth catch	- How and when to take records - How to use the moth catch and make a forecast	Facilitators
16.00–16.30	Wrap-up to Day 4	General discussions	Facilitator/ participants

DAY 5

8.00–12.30	Field visit	- Demonstrating scouting techniques in the field and comparing damage caused by FAW to other caterpillars - Setting up the pheromone trap in the field - Demonstrating data collection apps - Recording moth catches	Facilitators
12.30–13.50	LUNCH BREAK		
14.00–15.30	Communication	- Reporting mechanisms for FAW: <i>“Why should farmers report, to whom, how?”</i> - Role of farmers in sharing information with the rest of their communities	Facilitator
15.30–16.00	Closing remarks; official closure	- Issuing of certificates - Issuing FAW monitoring pack	Facilitator

Introduction

FAW's origin and economic importance

FAW is actually a caterpillar, not a “worm”. As befits its name, which evokes an impression of marching masses of larvae akin to an army, wreaking havoc in its path, FAW is a highly destructive pest on cereals and other important cultivated plants. It threatens the food and nutritional security of millions of farming households in Africa. Native to the tropical regions of North and South America, this invasive pest was first detected in Africa in early 2016 in the rainforest zones of Central and Western Africa. Since then, FAW has been reported in almost all sub-Saharan African countries. Regular updates of countries affected by FAW in Africa, and the global distribution, is available on CABI's FAW portal (www.cabi.org/ISC/fallarmyworm) and FAO's FAMEWS global platform (<http://www.fao.org/fall-armyworm/monitoring-tools/famews-global-platform/en/>). The adult moths of FAW are highly migratory in the Americas, capable of travelling up to 1,500–2,000 km per year in search of warmer climate, and can travel 500 km in a single season to find oviposition sites. The ideal climatic conditions present in many parts of tropical Africa, and the abundance of suitable host plants, means the pest can produce several generations in a single. FAW has become a resident pest in African farming systems, unlike other armyworms that are migratory. By February 2018, FAW had been reported in more than 40 African countries. The remaining African countries unaffected, largely in North Africa, remain at high risk and could potentially become a route through which the pest might migrate to the Mediterranean region of Europe.



Figure 1: Head of FAW
© Matt Bertone, NCSU

Left unmanaged, or in the absence of natural biological control, FAW can cause significant yield loss in maize and other crops. There are many variables to consider in determining the potential yield loss due to FAW infestation. In general, how the crop responds to FAW infestation is highly dependent on the population level of the pest and the timing of infestation, natural enemies and pathogen levels that can help to naturally regulate the populations, and the health and vigour of the maize plant (nutritional and moisture status). CABI has estimated that FAW has the potential to cause maize yield losses of 8.3 to 20.6 million tonnes annually, valued at between US\$2.5 to US\$6.2 billion, in the absence of proper control methods, in 12 Africa's maize-producing countries. Extensive host range, including on lucrative export crops, suggests that FAW is likely to spread to Europe and Asia, and as a major quarantine pest, could potentially hamper trade and export, significantly impacting the economies of many countries. Indeed, there have already been reports of FAW being intercepted from cut flowers originating from East Africa (https://ec.europa.eu/food/plant/plant_health_biosecurity/europhyt/interceptions_en).

In several countries in Africa affected by FAW, emergency responses have largely been based on the use of synthetic/chemical pesticides. The purchase and distribution of pesticides (several of which are highly toxic/hazardous) worth millions of dollars, as part of the emergency response to FAW, is not only unsustainable in the long run, but is bound to be highly damaging to human health, biodiversity and the environment, and will result in an unsustainable “pesticide treadmill”. Therefore, it is extremely important to discourage the use of highly hazardous pesticides against FAW, and instead to urgently promote and deploy proven, sustainable and available technologies, as part of an IPM package.

Module 1: Introductory session – Setting the scene

Module1:	Introductory session – Setting the scene
Learning objectives	• To get to know each other • To understand the experiences and expectations of participants • To introduce the objectives and contents of the training
Topics	• Interactive introduction of participants • Official opening remarks/welcome • Participants' expectations and experiences • Setting out the learning norms • Course objectives and overview of the training • An overview of current status of FAW in Africa • Discussions on participants' experiences with FAW
Methods	• Self-introduction, with icebreaking exercises • Speeches by officials • In pairs or in groups, participants will jot down their experiences and expectations on cards, which will then be collected and similar expectations clustered to determine they key objectives to emphasize in the training • Discussion of the learning norms • Facilitators present objectives and introduce the programme in a plenary session • Sharing experiences on level of spread at country and district level
Activities	• Registration • Gathering contacts and personal profiles of participants • Taking passport photos of participants for profiles and taking a group photo • Brainstorm to identify the knowledge gaps
Materials and equipment	• Flip charts, cards, marker pens, pins, masking tape, LCD projector, notebooks and pens

Rationale

In order for participants to focus, follow and participate in the training session it is important to introduce that session by setting the context. The facilitator should explain the training session's purpose, process and expected outcomes, as well as who is participating in it.

At the beginning of the session the facilitators should have the following questions in mind for each module:

- Why is the training session being organized? Why is it important?
- What are the specific learning objectives and desired outcomes for the session?
- What are facilitators' expectations in regard to participants' participation? What are participants' expectations?
- What could affect their participation? What are the participants' needs and preferences? (e.g. prior knowledge and expertise, culture, literacy)
- What will the facilitators' roles be? (e.g. leading sessions, co-facilitating, time-keeping, taking notes, supporting group exercises)

Procedures

Steps for setting the context:

- **Welcome:** session will begin with a welcome and introductions. The lead facilitator or host will introduce him/herself and other facilitators, and explain the role of the facilitators.
- **Purpose:** everyone should be aware of why they are there, why the activity is important, what the key objectives are and what the anticipated outcomes are. Facilitators will provide background information, such as a brief description of the key events leading up to the activity. Facilitators can take this moment to find out from participants what their expectations for the activity are.
- **Process:** facilitators will give a short overview of the process that the participants will go through, e.g. there will be group work, activities in the classroom or the field, demonstrations, etc. Facilitators will briefly present the agenda and let participants know when breaks will be provided.
- **Participation:** facilitators will explain what the roles and expectations are for each participant (e.g. active participation). They will ask the participants what the ground rules will be. The facilitators can add anything that might be important but missing from the ground rules.
- **Expected outcomes:** facilitators will identify the tangible outputs that will come out of the activity. What are the anticipated results?
- **Confirm the group's expectations**

If a training session will involve several group activities, facilitators should consider using a variety of methods for forming groups.

Module 2: FAW identification, biology, ecology and damage symptoms

Module 2	FAW: Identification, biology, ecology, damage
Learning Objectives	• To introduce various aspects of FAW, including its lifecycle and migratory behaviour • To create awareness and understanding of the feeding habits of FAW and the damage it causes
Topics	• Description of lifecycle and conducive environment • The life cycle of FAW • How to identify FAW eggs, larvae, pupae and adults • How is FAW different from similar caterpillars? • Symptoms and signs of FAW in relation to other common caterpillars
Methods	• Interactive lecture presented by the facilitator • Images, posters, leaflets, specimens, video • Question and answer session
Activity	• PowerPoint presentations • Collecting and examining specimens • Group exercises
Additional information	• CABI (2017b) “How to identify fall armyworm” (poster). Plantwise; Prasanna et al. (2018). <i>Fall Armyworm in Africa: A Guide for Integrated Pest Management</i>, FAO (2018) <i>Integrated Management of the Fall Armyworm on Maize: A Guide for Farmer Field Schools in Africa</i>, Fall armyworm portal, www.cabi.org/ISC/fallarmyworm
Materials and equipment	• LCD projector, armyworm specimens, hand lens, petri-dishes, dissecting kit, flip charts, video, TV sets, marker pens, FAW poster, photo sheets

Rationale

As FAW is a new pest in Africa, most extension staff and farmers are not able to diagnose it because it can easily be confused with other similar caterpillars and moths, especially those that belong to the same family. In order to manage FAW effectively it is important that extension staff and farmers are trained in the key features that distinguish FAW from other similar insects, as well as being trained in its biology, ecology and damage symptoms.

Time: 1.5 hours

Procedure

- Before the training the facilitator will collect some live specimens of both FAW and other similar pests, at different stages (eggs, different larval instars, pupae and moths), and will also collect the damaged plants of maize and alternative hosts that show clear symptoms. Other pests to be targeted should include: AAW, Stemborers (*Chilo partellus*, *Busseola fusca* and *Sesamia calamistis*), African bollworm and others.
- The specimens should not be shown to the participants until after the brainstorming and presentations. The facilitator will ask a few questions, such as: what features the participants usually use to identify FAW, what the different stages of FAW are, where the eggs are laid, where the pupae are found, and the colour of the moth and larvae at different stages.
- The facilitator will then present a PowerPoint presentation on how to distinguish FAW from other pests, which will be followed by another presentation on the biology, lifecycle and ecology of FAW. The facilitator will use the notes, figures and tables in Sections 2.1–2.9 to prepare the presentation, as well as explain the key messages. Posters and leaflets can also be displayed.
- After the presentations the facilitator will divide participants into four to five groups; the groups will then undertake two exercises: one involving looking critically at the key features used to separate FAW from other species, and another involving constructing the lifecycle of FAW using the collected specimens.

2.1 How to identify FAW

Like most insects, FAW can be identified by using morphological characters or through characteristic injury symptoms on susceptible crops or molecular characterizations (e.g. to separate different strains (rice and maize)). Without access to sophisticated tools, farmers cannot tell apart the two strains. However, it should be understood that this is the same species, and the major difference is the host the different strains prefer to feed on.

The outer wings of male FAW moths have whitish patches at the lower outer edges, while inner wings are white with dark trimmings.

The egg masses are cream, grey or whitish, with a hair-like covering, and are usually laid on the underside of leaves but sometimes on upper side of the leaves when not fully out of the whorl.

Larger FAW caterpillars have characteristic marks and spots. The FAW caterpillar has a dark head, with an upside-down pale Y-shaped marking on the front. Each of the body segments of the caterpillar has a pattern of four raised spots when seen from above. It has four dark spots forming a square on the second-to-last body segment. The caterpillar's skin looks rough but is smooth to the touch. A full-sized FAW caterpillar is slightly shorter than a matchstick (4–5 cm in length).

Pupae are usually 15 mm long and are found in the soil in cocoons (20–30 mm across), made of sandy particles.



Figure 2a: FAW adult moth, wing wide open © Georg Goergen, IITA



Figure 2b: FAW adult moth, resting position © Matt Bertone, NCSU



Figure 3: Egg mass on maize leaves © CABI



Figure 4a: Large FAW caterpillar © Matt Bertone, NCSU



Figure 4b: Large FAW caterpillar
© Subramanian Sevgan, ICIPE



Figure 5: Young FAW caterpillar © CABI



Figure 6a: FAW pupa
© Matt Bertone, NCSU



Figure 6b: FAW pupa in maize cob
© Diedrich Visser, ARC



1
Adult females lay 100-200 eggs on the lower leaves. They change from green to light brown before hatching.
©Diedrich Visser, (ARC-VOP)



2
Eggs are covered in protective scales rubbed off from the moth's abdomen.
©Kansas State Uni



3
After hatching, the young caterpillars begin feeding on the leaves.
©Desiree van Heerden



4
As they grow, caterpillars change from light green to brown.
©Russ Ottens, Bugwood.org



5
Fall armyworms have four dark spots forming a square on the second-to-last body segment.
©Russell IPM



6
Fall armyworms have a dark head with a pale, upside-down Y-shape on the front.
©Russ Ottens, Bugwood.org



7
They are at their most damaging when they are 3-4 cm long.
©Russ Ottens, Bugwood.org



8
The pupa is shiny brown and usually found 2-8 cm into the soil.
©Russell IPM



9
Adult moths (top: female, bottom: male). The females are slightly bigger than the males.
©Matt Bertone, North Carolina State University

Figure 7: FAW photo identification guide for FAW life stages for trainers and farmers 1-9 (CABI, 2018)

2.2 Description of the FAW lifecycle

FAW has four stages in its lifecycle: eggs, caterpillar (larvae), pupae, and adults (moths)

Fall armyworm: Life cycle and damage to maize

The fall armyworm life cycle includes egg, six growth stages of caterpillar development, pupa and moth.

After approximately 14 days the fully-grown caterpillar will drop to the ground.

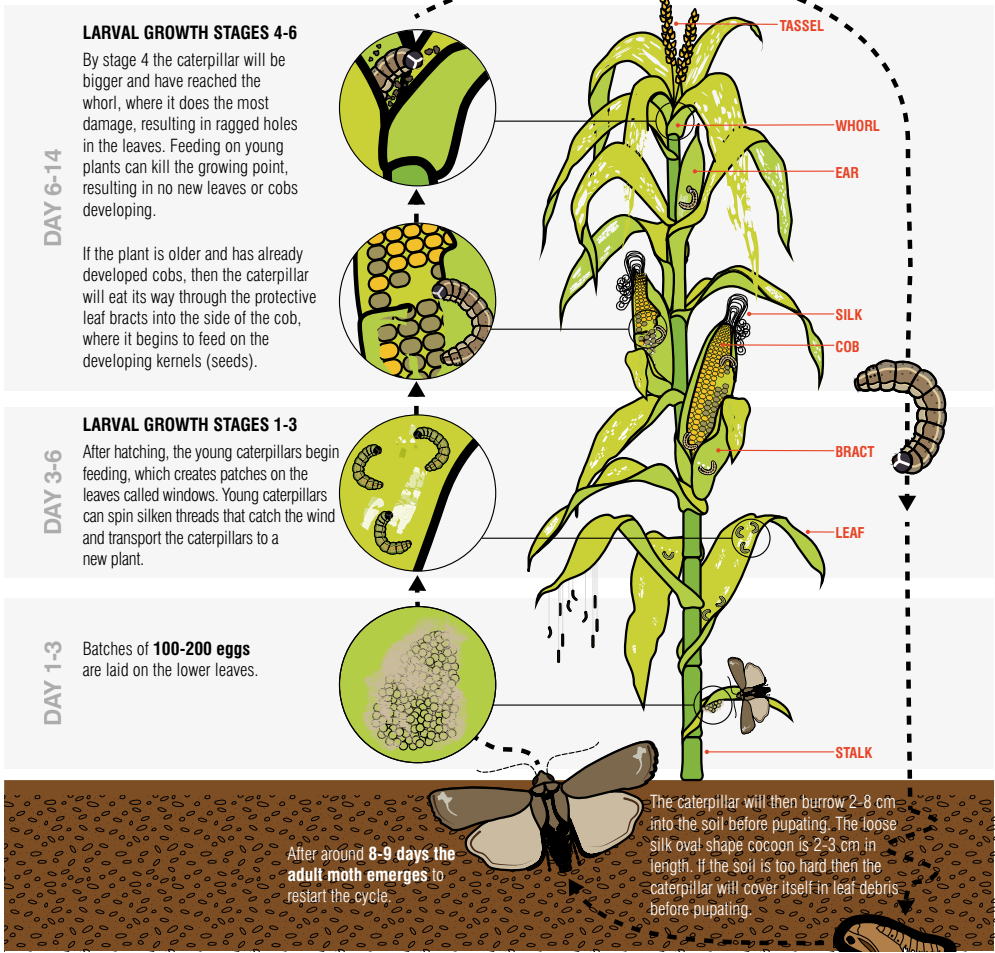


Figure 8: Generalized lifecycle of FAW (CABI, 2018)

Eggs

- Eggs are generally laid on the underside of the leaves, near the base of the plant, close to the junction of the leaf and the stem
- When populations are high, the eggs may be laid higher up the plants, on top of the leaves or on nearby vegetation
- Eggs are white, pinkish or light-green in colour and spherical in shape (Figure 3)
- The number of eggs per mass varies considerably but is often between 100 and 200
- Total egg production per female over her lifetime averages about 1,500, with a maximum of over 2,000
- The female also deposits a layer of scales between the eggs and over the egg mass
- The duration of the egg stage is only two to three days during warm conditions
- Tropical rains are important in breaking the lifecycle of FAW by washing off the eggs from the leaves onto the ground where predators may eat them, or if they hatch they are not nearby a food source

Larvae

- Larvae generally emerge simultaneously three to five days following oviposition, and migrate to the whorl (Figure 9)
- The mortality rate following emergence may be high in some cases due to climatic factors and attack by predators, parasitoids and pathogens
- There are six larval instar stages. In the second and third instar stages, larvae are often cannibalistic, resulting in only one larva in the whorl
- Young larvae are greenish (Figure 5), with a black head, which turns into an orange colour in the second instar. Ballooning often occurs, moving larvae by wind to other plants, which is why 100% infestation sometimes occurs
- Mature larvae are 30 to 40 mm in length and vary in colour from light-tan to green and black (Figure 4a)
- The face of the mature larva is marked with a light-coloured inverted “Y” (Figure 7)
- Larvae mature within 14 to 22 days, after which they drop to the ground to pupate
- Lack of diapause is a key driver to FAW's having at least 12 overlapping generations in a year, making it a major pest both during the rain-fed and winter cropping seasons
- FAW rarely displays the “armyworm” behaviour of larvae massing and “marching” across fields



Figure 9: Eggs hatching to larvae © Bill Hendrix (left), CABI (right)



Figure 10: FAW Larva
© Ted C. MacRae, Monsanto



Figure 11: FAW Larva and eggs © CABI

Pupae

- Pupae are reddish brown and may be hard to find for a typical farmer (Figure 6a)
- Pupation normally takes place in the soil, at a depth of 2 to 8 cm
- The larva constructs a loose cocoon, oval in shape and 20 to 30 mm in length
- If the soil is too hard, larvae may web together leaf debris and other material to form a cocoon on the soil surface. In some instances, the pupae may also be found in the maize cob (Figure 6b)
- The duration of the pupal stage is about eight to nine days during the summer, but reaches 20 to 30 days during the winter

Adult

- Adult moths are 20 to 25 mm long, with a wingspan of 30 to 40 mm (Figure 2a and 2b)
- Adults are nocturnal and are most active during warm, humid evenings
- The male forewing is mottled (light-brown, grey and straw-coloured) and the female has light colouring
- The dark-grey colour of the moths makes them difficult to see, especially when resting near or on the ground, but in some cases when the population is high the farmer may spot some in the field
- After a pre-oviposition period of three to four days, the female normally deposits most of her eggs during the first four to five days of life, but some oviposition continues to occur for up to three weeks
- The duration of adult life is estimated to average about 10 days, with a range of about seven to 21 days

2.3 Host plants of FAW

- FAW is polyphagous: there are almost 100 recorded host plants, in 27 families
- FAW prefers graminaceous plants (grass species) including maize, millet, sorghum, rice, wheat and sugarcane. Feeding damage is also observed on other agricultural crops, such as cowpea, groundnut, potato, soybean and cotton
- Other hosts include barley, bermuda grass, clover, oat, ryegrass, sugar beet, sudan grass, and tobacco. Other crops that are sometimes injured are apple, grape, orange, papaya, peach, strawberry and a number of flowers (as stated earlier, there have been some interceptions in Europe of FAW larvae on cut flowers (https://ec.europa.eu/food/plant/plant_health_biosecurity/europhyt/interceptions_en))
- Weeds, including *Digitaria* spp., *Sorghum halepense*, morning glory (*Ipomoea* spp.), nut sedge (*Cyperus* spp.), pigweed (*Amaranthus* spp.) and sandspur (*Cenchrus* Sp.), are also known to serve as hosts
- Whenever a larva suspected to be FAW is found on any plant other than maize, sorghum, wheat, millet or rice, effort should be made to collect a sample in a container and share this with the extension officer or plant doctor in the area. The sample should be preserved and sent to CABI for molecular confirmation in order to accurately report the host plant record for the country

2.4 The maize growth cycle in relation to crop health and FAW

The growth, development and yield of a maize crop depends on the prevailing natural conditions. A farmer may optimize the environmental conditions by use of improved varieties of maize, soil tillage, timing of planting, fertilizers, irrigation and insect pest control, to enhance the health of the crop and achieve optimum yields. Maize generally goes through several growth stages, divided into vegetative stages (V) and reproductive stages (R). Therefore, ensuring a healthy and vigorous crop by timely planting, use of fast-maturing varieties, use of quality seeds and optimum use of fertilizers and manure will ensure that the maize crop is healthy and can either escape the FAW attack, withstand the FAW attack or recover following attack. A farmer who ensures a healthy crop from the outset is more likely not to suffer from the effects of a FAW attack on his or her field, and to reduce the costs that would have been incurred in applying FAW control methods.

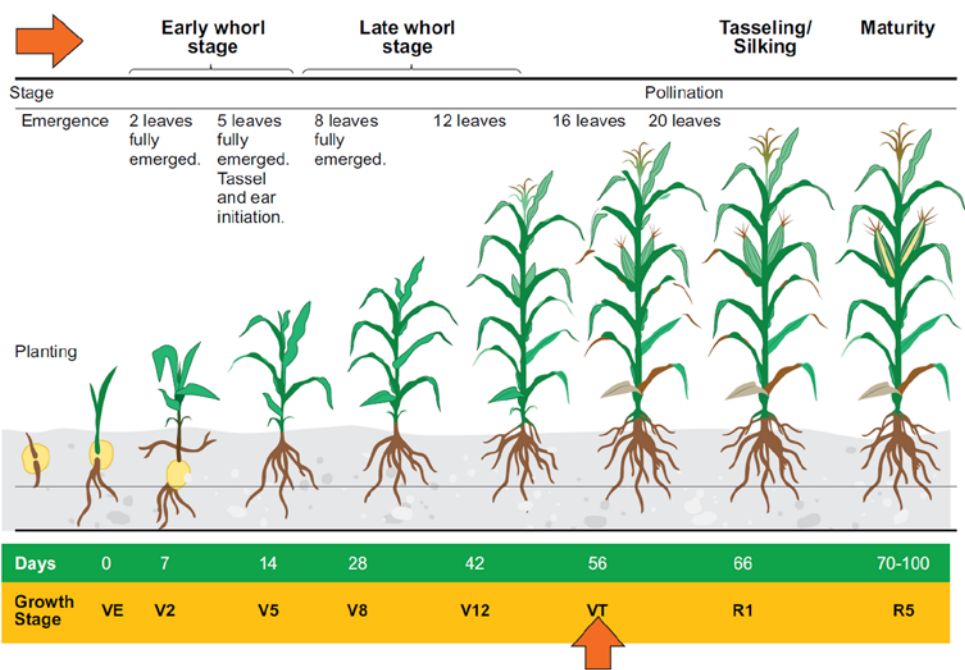
2.5 Critical maize crop stages for FAW attack

FAW will infest maize from as young as V3 to tasseling and ear stage (Figure 12). Late planted fields and later maturing hybrids are more likely to become infested. While FAW can damage maize plants in nearly all stages of development, it will concentrate on later plantings that have not yet silked. FAW can only be effectively controlled while the larvae are small (before third instar). Controlling larger larvae (fourth to sixth instars), typically after they are hidden under the frass, is much more difficult and costly.

Table 3: FAW larval stages

Larval stage (instar)	Head capsule width (mm)	Length of larvae (mm)	Developmental days (at 25°C)
L1	0.35	1.7	3.3
L2	0.45	3.5	1.7
L3	0.75	6.4	1.5
L4	1.30	10.0	1.5
L5	2.00	17.2	2.0
L6	2.60	34.2	3.7

When the tassel emerges from the whorl, it pushes out the larvae within the whorl, where they are at least temporarily exposed to their natural enemies, solar exposure and control using low-risk products. Until ears are available on the plants, larger larvae will look for other places to hide during the day, such as in leaf axils. Larvae pushed from the ear, and any new larvae from eggs deposited on the plants, will quickly move to the developing maize ears. Small larvae usually enter ears through the silk channel, while larger larvae also feed through the husk, or feed up into the bottom of the ear through the protected area around the ear shank, to directly feed on developing kernels. Recognizing these critical stages of FAW vulnerability is crucial in order to control it.



VE to V6 (early whorl growth stage), V7 to VT (late whorl stage), R1 to R3 (tasselling and silking)

Figure 12: Maize growth stages (modified from Clarrie Beckingham, 2007, <https://www.dpi.nsw.gov.au/agriculture/horticulture/vegetables/commodity-growing-guides/sweet-corn>)

2.6 Conditions that favour survival of FAW

The rate at which FAW larvae develop is affected by diet, temperature and humidity. Rising temperatures increase rates of insect development and the number of pest generations. In cooler climates, development slows down to one or a few generations per year. The optimum temperature for larval development is 28°C (development can take place within a range of between 11°C and 30°C), although the egg stage and pupal stage require slightly lower temperatures. Frost kills the insect. Rainfall may wash off some of the immature stages of the insect and wind speed may aid the dispersal of moths.

Higher CO₂ and O₃ (ozone) concentrations may change natural enemy numbers and behaviour that might affect host-finding and predation. The following influence pupal development:

- soil type/conditions
- tillage methods

The following influence the development and survival of the larvae:

- crop variety
- agricultural practices
- crop phenology
- crop stage

2.7 How FAW differs from other similar caterpillars

There are 30 armyworm species, of which four are found in Africa, including AAW, *Spodoptera exempta*. AAW can be easily confused with FAW. Distinguishing features of FAW are the light-coloured inverted “Y” on the head, and four dark spots arranged in a square on top of the eighth abdominal segment. Other features include the lower lateral side lighter than that of AAW, with a brown or black band just above the lighter band; and the FAW head may be black, brown or orange, while that of AAW is brown with dark honeycombed marking. Unlike AAW, the FAW caterpillar does not walk with a looping action. The AAW does not lay eggs in masses, while FAW lays eggs in masses, covered in hairs, that hatch about the same time, in a small black mass (Figure 13).

Although the stripes of FAW may be similar to those of the cotton bollworm (*Helicoverpa armigera*), cotton bollworm larvae can change to various colours as they develop.



Figure 13: Hairs on FAW eggs (left); Egg mass that is about to hatch © CABI

The moth of the lesser armyworm, *Spodoptera exigua*, lays eggs in batches covered by anal hairs and pupates in soil in an earthen cell, like FAW (Figure 14), but the moth has an orange spot on the wings while the larvae has a characteristic pink line or spot at the side unlike FAW whose moth has whitish patches at the lower outer edges.

The Semilooper moth has a characteristic yellow area on each side of the fore wing. Unlike FAW, eggs are not laid in masses and are not covered with hairs. It pupates in the soil in a silken cocoon.

The common cutworm lays eggs singly and not in masses like FAW; its larvae are grey and they cut seedlings, unlike FAW which eats the leaves, but it also pupates in an earthen cell in the soil.



Figure 14: Pupation in earthen cell in the soil typical of several armyworm © Diedrich Visser, ARC

The cotton bollworm (*Helicoverpa armigera*) often shows a similar pattern of dots on its back, but its head is usually paler, and although it can also show an inverted Y this is usually a similar colour to the rest of the head. Unlike FAW, the cotton bollworm feels rough to the touch, due to tiny spines

The younger larvae of the three species of maize stem borers (*Busseola fusca*, *Chilo partellus* and *Sesamia calamistis*) feed in the whorls but the older larvae bore into the stems, unlike FAW. The eggs are laid in batches behind the leaf sheath or between the stem and leaves, and they are not covered with hairs. *Chilo* lays eggs on both sides of the leaf and pupates inside tunnels within the ear or stem.

In general, in order to determine if the pest larvae you have found in your maize is FAW or another species, you should look for the following features (Figure 15)/ask the following questions:

- Does it have a dark head with a pale, upside-down Y-shaped marking on the front (see blue circle in middle photo in Figure 15)?
- Does each of the body segments have a pattern of four raised spots when seen from above (see orange and red circles in the third photo to the right in Figure 15)?
- Does it have four dark spots that form a square on the second-to-last body segment (see red circle in third photo to the right in Figure 15)?
- Is its skin smooth to the touch?
- Are the excreta of the larvae in the form of large coarse clumps (Figure 16)?

If the answer to these questions is yes, then the pest larvae you have found is the FAW caterpillar. Images of other armyworms and stemborers are presented in Figure 17.

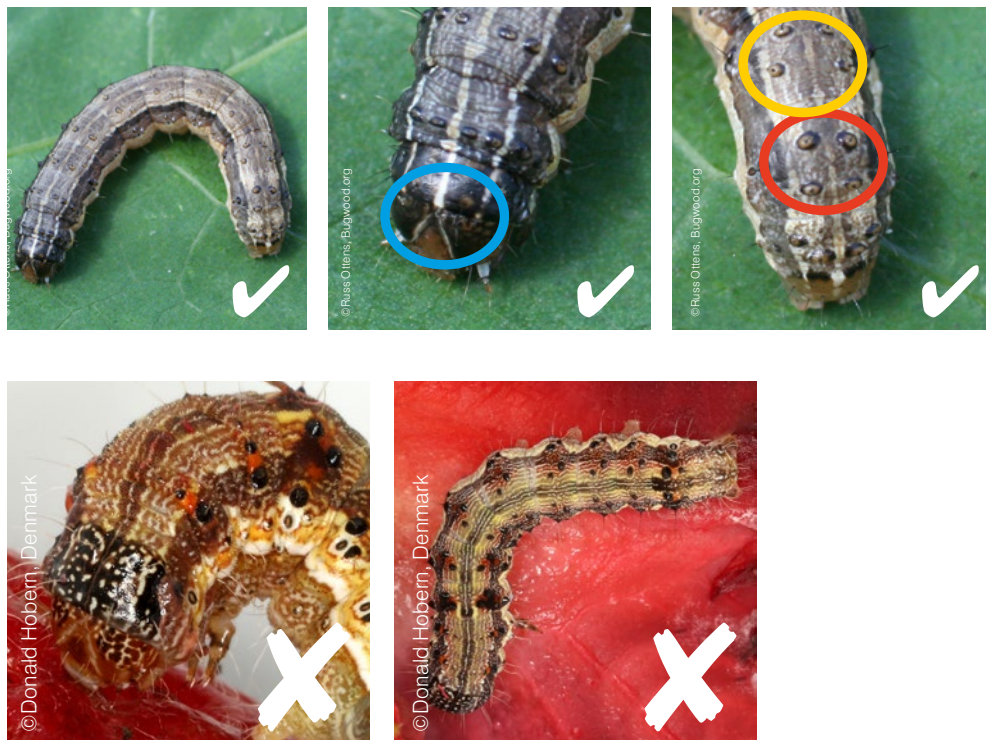


Figure 15: Characteristic diagnostic features of FAW © CABI



Figure 16: Large coarse clumps of FAW excreta © Ted C. MacRae, Monsanto (left), CABI (right)



African armyworm
Spodoptera exempta



Beet armyworm
Spodoptera exigua



African cotton leafworm
Spodoptera littoralis



Spotted stem borer
Chilo partellus



African maize stalk borer
Busseola fusca



Southern armyworm
Spodoptera eridania

Figure 17: Other armyworms and maize stem borers (CABI, 2018)

Table 4: Key similarities between FAW and other common Lepidoptera species

Characteristic	FAW	AAW	TM	LA	SAA	AB	CW	FA	SB
Eggs									
Underside of leaves	✓	✓	x	✓	✓	x	x	x	x
Laid in masses in layers	✓	✓	✓	✓	✓	x	✓	✓	x
Covered with hairs	✓	✓	✓	✓	✓	x	✓	✓	x
Larvae									
Inverted Y mark on the head	✓	✓	x	x	x	x	x	x	x
Four clear raised spots on the eighth segment	✓	x	x	x	x	x	x	x	x
Brownish lateral strips on the side of the larvae	✓	✓	x	x	x	x	x	x	x
Produce excrement in the whorl	✓	x	x	x	x	x	x	✓	x
Ballooning often occurs moving larvae by wind to other plants	✓	x	x	x	x	x	x	x	x
No diapause	✓	✓	✓	✓	x	x	✓	x	x
Cannibalistic	✓	x	✓	✓	x	x	✓	x	x
Pupae									
Formed in earthened cells in the soil	✓	✓	✓	✓	✓	✓	✓	✓	x
Adults									
Nocturnal	✓	✓	✓	✓	✓	x	✓	✓	✓
Outer wings of male moths have whitish patches at the lower outer edges while inner wings are white with dark trimmings	✓	x	x	x	x	x	x	x	x

Note: TM – tomato/tobacco moth; LA – lesser armyworm; SAA – Southern African armyworm; AB – Cotton bollworm; FA – false armyworm; SB – stem borer.

* ✓ Yes X No

Table 5: A summary of similarities and differences between FAW and other common Lepidoptera species

Insect Species	Similarities with FAW	Differences with FAW
African armyworm (<i>Spodoptera exempta</i>)	• Brownish to greenish larvae when not swarming • Similar brownish lateral strips on the side of the larvae • Inverted Y mark on the head • Eggs are laid in masses and covered with hairs • Pupae are formed in earthened cells • Moths are similar to FAW	• Larvae are usually blackish in colour in the swarming stage • Damaging swarming phase once every five to 10 years • Usually found in grasses in masses and do not hide in the crop in the day time • Lack clear raised spots on the segments of the larvae • Larvae feed mostly on tips and young stems, starting from the edges
Tomato/Tobacco Moth (<i>Spodoptera litoralis</i>)	• Eggs are laid in masses and covered with hairs • Pupae are formed in earthened cells	• Caterpillars are usually brownish, with distinctive black spots; some may have yellow lines or spots on a brown body • Larvae form a characteristic Sphinx stance when disturbed • Moths are brownish, with a characteristic scratch pattern on the forewings
Lesser armyworm (<i>Spodoptera exigua</i>)	• Eggs are laid in masses and covered with hairs • Pupae are formed in earthened cells	• Larvae are usually olive-brown in colour but yellow or darker larvae occur when overcrowded • Characteristic pink lines or spots on the sides of some larvae • Moths have characteristic pink spots on the forewing
Southern African armyworm (<i>Spodoptera eridania</i>)	• Eggs are sub-spherical in shape, laid in large groups on the plant foliage, covered with a layer of grey bristles (scales)	• Young larvae are black with yellow lateral lines, but older instars are grey-brown with a row of paired black triangular spots and mainly feed on broad-leaf vegetables • Larvae are characterized by a prominent yellow line which is broken by a dark (sometimes diffuse) spot on the first abdominal segment • Moths have pearly-white hind-wings, with a strongly marked spot or bar on the forewing

Insect Species	Similarities with FAW	Differences with FAW
African Bollworm (<i>Helicoverper armigera</i>)	- Some individuals may have lighter bands on the sides, similar to FAW - Pupae are formed in earthened cells	- Different larval stages vary in colour - Spots on the small caterpillar are very prominent - Moths are pale-brown, without white markings on the forewings - Moths do not lay eggs in egg masses
Semi-loopers	No similarities except for the moths of some species, which are brown	- Larvae bend their bodies in a semi-loop while walking - Larvae are usually greenish or yellowish in colour - Eggs are not laid in masses - Pupae form silken cocoons on plants
Cutworms (<i>Agrotis</i> sp.)	Pupae are formed in earthened cells	- Do not lay eggs in masses but lay eggs singly on plants - Moths are greyish in colour
False armyworm (<i>Leucania loreyi</i>)	- Produce excrement in the whorl - Larvae are pale pinkish, with longitudinal stripes and bands - Moths are brownish in colour	- Eggs are laid in masses on plants but not covered with hair - Pupae are found in soil or on plants, not in earthened cocoons
Stem borers (<i>Chilo partellus</i> and <i>Busseola fusca</i>)	Young caterpillars feed in the whorl	- Older caterpillars bore into the stems and ears <i>B. fusca</i> lays eggs in batches behind the leaf sheath, between the leaf and stem, while <i>C. partellus</i> lays egg masses on the upper and lower surfaces of the leaf - Pupa are found inside the tunnels in the stem or ears

2.8 How AAW biology and management differ from FAW

The lifecycle of AAW takes a total of 28–57 days, as follows: moth (five to 16 days), egg (two to four days), larvae (14–22 days) and pupa (seven to 15 days). The forewings of the adult are dark-brown, with distinctive grey-black markings; the abdomen is covered with pale grey-brown scales, except for the tip in the female, which has black hair-scales that are characteristic for this species. The hindwings are white with dark veins (Rose et al. 1996). The eggs are pale-yellowish and darken just before hatching, and the black head-capsules of the larvae can be seen through the shells. Eggs are conical, with a slightly rounded apex, and are laid in batches of 10–600 in one layer. One female may lay up to 1,000 eggs in her lifetime (six days). Larvae occur in two principal forms: the gregarious (*gregaria*) form characteristic of high-density populations and the solitary (*solitaria*) form found at low larval densities. The gregarious crowded larvae have a velvet-black upper surface, with pale lateral lines, and a green or yellow ventral surface, while the low-density (solitary) have a variety of shades of green-brown or pink. The larvae undergo five to six larval instars. Newly-hatched larvae climb up the host plant and feed on the young leaves, leading to windowing symptoms. The young larvae can be dispersed on a silken thread like a spider's web. The body does not have hairs. The last instar larvae burrow into the earth to pupate, which is why they seem to disappear suddenly.

AAW usually lays eggs and hatches outside the farm, mainly on grasses and sedges (*Poaceae* and *Cyperaceae* families), while FAW lays its eggs on the crop – mainly cereals like maize and sorghum. Normally, only small numbers of AAW occur, usually on pastures. When conditions are suitable the population increases, causing mass migration of moths and larvae. Conditions favourable for outbreaks of AAW include a preceding drought, suitable storms for concentration of moths, flushes of young grasses and rainless and sunny periods after moth concentration. As for FAW, once it migrates into an area, it attacks all growth stages of the crop, and FAW might not require the conditions listed above for AAW for migration and outbreaks to occur. For control measures to be effective, armyworms must be found in time, when still small. If the caterpillars are discovered when they are fully grown, the use of insecticide control is often not recommended for AAW as most of the damage to crops will have occurred, and the emerging adults will probably move off and not produce a second generation in the same place.

It is possible to forecast an outbreak of AAW based on occurrence of favourable conditions. Outbreaks follow the onset of wet seasons, when dry grasslands produce new growth and cereal crops are planted. Based on moth catches in pheromone traps, studies in Africa have categorized AAW risk areas as follows: low risk (0–25 moths/trap), medium risk (25–50 moths/trap) and high risk (50–100 moths/trap). If more than 25 moths are captured and more than 5 mm of rain is recorded, suitable plants for egg laying are present, a positive forecast is announced, and farmers are then advised to monitor more frequently to look for young AAW larvae. In high risk areas (more than 50 moth catches), farmers are advised to scout for larvae and their damage, and to monitor the field more frequently. By contrast, it is not possible to forecast FAW outbreaks because there is no correlation between moth catches and damage, and the different developmental stages and overlapping populations tend to occur at the same time. The developing caterpillars are mostly found curled up in the whorl of the maize or sorghum plant.

Table 6: Differences between AAW and FAW

Characteristic	African armyworm	FAW
Biology	- Lays eggs outside the farm, mainly on grasses - Lifecycle is 28–57 days - One female may lay up to 1,000 eggs in her lifetime (six days), in batches of 10–600; eggs are covered with black hair scales - Eggs are usually laid in soil and plant residues and are difficult to find - Eggs generally hatch in the early morning - Larvae undergo five to six instars - Two forms of larvae: sluggish solitary and gregarious forms which march in large numbers	- There is a pre-oviposition period of three to four days - Lays its eggs mainly under the leaves on the crop – mainly cereals like maize and sorghum - Oviposition by one female may last for up to three weeks - Larvae undergo six instars - FAW rarely displays the “armyworm” behaviour of larvae “marching” across fields - During the day, caterpillars hide deep in the whorls
Migratory behaviour	- Forecasting outbreaks is possible based on occurrence of favourable conditions - Seasonal, follows intertropical- tropical convergence zone	- Cannot be forecast because it is present throughout – there is no correlation between moth catches - Lays its eggs on the crop – mainly cereals like maize and sorghum - Occurs throughout the year, attacking different stages of the crop - A least 12 overlapping generations
Host range	Attacks weeds and crops of <i>graminae</i> family	FAW is polyphagous: there are more than 100 recorded host plants in 27 families, including none grass species
Signs and symptoms	- Mainly feeds on the leaf laminar, leaving the midrib - Windowing or skeletonizing of younger leaves and stems - Attacks young plants	- Extensive “window pane” damage - Ragged whorl leaves that appear like hailstorm damage
Management options	- Physical barriers to stop movement of larvae, such as furrows - Weed-free crops - Spraying a water suspension of NPV (SpexNPV) - Timing chemical control of early immigrants through forecasting - Use recommended insecticides registered in the country	- Scouting and crushing eggs - Early planting and avoiding staggered planting dates - Weed-free crops - Crop diversification - Intercropping - Habitat management: e.g. push-pull - Timing chemical control of early instar larvae through monitoring and scouting - Spraying botanical extracts or biopesticides

Source: Rose DJW; Dewhurst CF; Page WW (1995) The bionomics of the African armyworm *Spodoptera exempta* in relation to its status as a migrant pest. *Integrated Pest Management Reviews* 1(1): 49-64.

2.9 Signs and symptoms of FAW damage

The larvae prefer feeding on maize, but have also been reported to feed on other crops, including millet, sorghum, rice, wheat, sugar cane, wild grasses and vegetables. The pest can affect the crop at different stages of growth, from early vegetative to physiological maturity. It can cut down young maize plants, thereby causing the need for replanting, and it can also damage leaves, thereby disrupting the plant's grain filling ability.

After hatching, young larvae will migrate from the plant on which they hatched onto neighbouring plants. Leaf-feeding causes extensive “window pane” damage on maize and sorghum. “Window-paning” is the most common damage symptom at early whorl; however, this is sometimes indistinguishable from damage that is due to other stem borers. Usually many young larvae will be present on the same plant, but normally one or two older larvae may be found on a single plant, as others will migrate and feed on neighbouring plants. It is not uncommon to find one larva feeding on another of the same species, and they do not hesitate to attack larvae of different species.

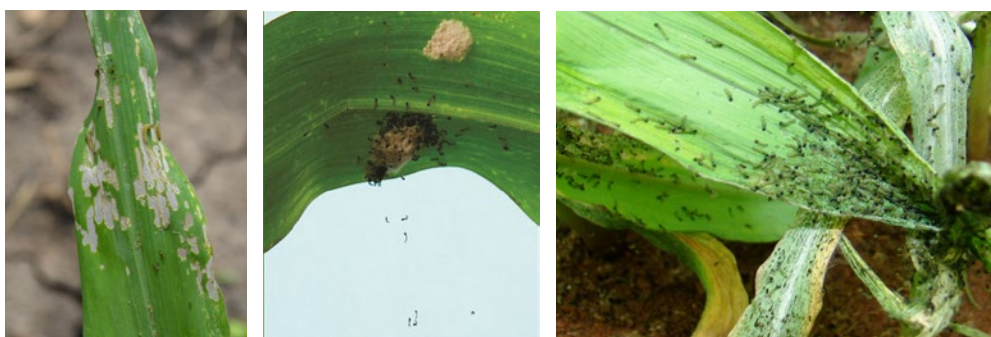


Figure 18: Window pane damage (extreme left), © CABI; larvae migrate to other plants (centre and extreme right), © Ivan Cruz, Empresa Brasileira de Pesquisa Agropecuária (Brazilian Agricultural Research Corporation) (EMBRAPA)



Feeding by young caterpillars results in semi-transparent patches on the leaves called windows.



Young caterpillars can spin silken threads which catch the wind and transport the caterpillars to a new plant.



Feeding through the whorl can cause a line of identical "shot" holes, when the leaf unfurls.



As they develop, Fall armyworm move permanently into the whorl. This means that it is difficult to detect early infestations.



Feeding can cause the whorl and upper leaves to be a mass of holes, ragged edges, and caterpillar poo (called "frass").



The caterpillars usually burrow into the side of the cob.



Fall armyworm infestation causes stunting and destruction of developing tassels and kernels, which reduces grain quality and yield.



When the caterpillars burrow into the side of the cob, damage to grains can lead to rot.



Holding a maize plant damaged by Fall armyworm.

Figure 19: FAW maize damage identification guide, for trainers and farmers 11-18 (CABI, 2018)

Later larval instars chew larger holes, causing ragged whorl leaves, and produce sawdust-like larval droppings, while fresh feeding produces big lumps. Badly infested fields may look as if they have been hit by a severe hailstorm. During the day, caterpillars hide deep in the whorls. They feed inside whorls and can destroy silks and developing tassels, thereby limiting fertilization of the ear. Larvae move to the ear zone and start feeding after tassel emergence because they get exposed to natural enemies (Figure 20). They also feed on the silks, interfering with pollination. Damage to cobs may lead to fungal infection and aflatoxins, and loss of grain quality (Figure 21). Emerging moths generally fly off to younger crops to oviposit.



Figure 20: FAW larva damage on maize cobs © CABI (left), Ivan Cruz, Embrapa (right)



Figure 21: Larval feeding can expose maize cobs to aflatoxin contamination © CABI

Module 3: FAW surveillance, monitoring and scouting

Module 3 FAW surveillance, monitoring and scouting	
Learning objectives	• To understand the centralized FAW early warning system through surveillance, monitoring and scouting and its limitations • To show the importance of the FAW Monitoring and Early Warning system (FAMEWS) and how it complements the national warning service • To discuss existing FAW control methods and the merits and demerits of each
Topics	• The national FAW early warning system in various countries • Surveillance, monitoring and scouting, and how this data is integrated within FAMEWS • The challenges and limitations of FAMEWS • Why there is a need for an alternative approach to monitoring and early warning of FAW attacks • FAW management and control (cultural, biological, physical, host plant resistance, chemical, habitat management, chemical, IPM)
Methods	• Presentation by the facilitators and plenary discussions • Debate regarding the challenges and limitations of FAMEWS and management strategies • Plenary discussion
Additional information	• See introduction and references (FAO technical hand book), Prasanna et al. (2018) <i>Fall Armyworm in Africa: A Guide for Integrated Pest Management</i>; and FAO (2018) <i>Integrated management of the Fall Armyworm on maize: A guide for Farmer Field Schools in Africa</i>
Activity	• Field visit • Demonstrate scouting methods

Rationale

Most extension staff and farmers do not know the difference between surveillance, monitoring and scouting. In order to be able to detect the presence of FAW, they need to know the right scouting protocols, including where to look for FAW and the type of data to record.

Time: 1.5 hours

Procedure

The facilitator will make a PowerPoint presentation using guidance notes in **Sections 3.1 to 3.6**.

The presentation will be followed by an actual demonstration in the field on how to look, what to look for and what to record, as described in **Section 3.1 to 3.6**.

The equipment for the early warning system will be explained and assembled (**see Annex 1**).

3.1 Importance of surveillance, monitoring and scouting

Monitoring, surveillance and scouting are necessary for the quick detection of the presence of FAW and in order to time interventions to effectively and economically guard against yield loss while preserving needed ecosystem services and minimizing harm to the environment. Surveillance of FAW should be done throughout the year because there are several generations, which attack maize at different stages; they also attack other host plants. During the dry season, irrigated areas become host reservoirs of FAW populations, from which migration occur at the beginning of the rain season. Monitoring and controlling the populations on off-season crops can be critical in reducing infestation on rain-fed crops.

- **Surveillance** is the informal, passive detection of pests in an area, mainly carried out at farm level. Farmers in the field are often among the first to identify emerging problems. The collective feedback of thousands of farmers can provide powerful information about the dynamics of pest infestation in an area.
- **Monitoring** means the active tracking of the presence, population and movement of a pest within a specified area or region. Monitoring may take place at various levels (community, district, country or regional), mostly facilitated by governments, through trained technical personnel who systematically gather data to inform policymakers and practitioners about the presence and severity of the pest across a given area.
- **Scouting** is the use of science-based protocols by trained individuals (extension staff or farmers) to observe the pest in their fields. Scouting allows the farmer to assess pest pressure (e.g. the intensity of FAW infestation) and crop performance in the field. Scouting is typically performed in order to evaluate both the economic risk of pest infestation and the potential efficacy of pest control interventions. Early detection of FAW infestations requires timely and regular field scouting. Timing may be aided by use of pheromone traps set up in the farmers' fields before planting throughout the growing season, to trap male moths; catches are recorded weekly.

To be able to carry out monitoring, farmers require knowledge on how to detect FAW, understand its lifecycle, understand the damage it causes to different stages of maize and know the threshold at which to apply insecticide.

3.2 How to scout and what to look for when scouting

The aim of scouting is the early detection of the egg batches or young larvae, which are easier to control. Scouting should begin early, at the seedling stage. FAW completes its lifecycle in 30–40 days and the first generation of FAW larvae generally attacks the seedlings, so fields should be rechecked weekly at the seedling and early whorl stages. Farmer scouts should look for signs of FAW egg masses (presence/absence of egg masses even in the absence of damage), egg hatch and feeding by early-instar larvae, such as leaf damage pin holes, “window panes”, frass, ragged and torn leaves, destruction of leaves in funnels, silk, tassel and ear damage, holes in the ear and pupae in the soil.

3.3 Scouting techniques and protocols

Scouting a maize field involves accurately assessing the level of FAW infestation, usually expressed as a percentage of infested plants. A quick visual assessment in the field can be used to identify “hot spots” of FAW damage while moving through the field. Generally, the field should be scouted at least once a week. A field should be scouted in a semi-systematic manner. A commonly used approach is the “W” pattern (Figure 22).

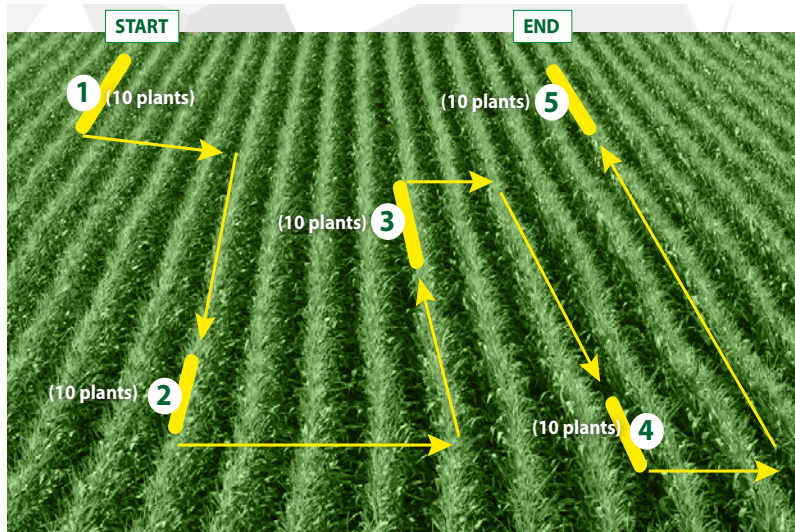


Figure 22: Field scouting (Source: FAO Guidance Note 2, FAW scouting)

- Randomly select five plots, each comprising 10 consecutive plants in a row; examine each selected plant within the plot for leaf-feeding damage symptoms
- Focus on the newest two to three leaves emerging from the whorl, as this is where FAW likes to feed and where FAW moths lay eggs. For the late whorl stage, examine the newest three to four leaves emerging from the whorl, plus the emerging tassel. Record the number of plants (out of 10) with fresh window panes or infested whorls
- At later stages, FAW larvae hide in the leaf axils, at the base of the developing ear/cob and/or in the tip of the ear and silks
- Use the FAMEWS mobile app to determine the percentage of infestation and calculate the mean plot infestation. Separately determine the number of egg masses and larvae per plant (or plot) and the respective means (zeroes should be written down against un-infested plants; omitting un-infested plants will overstate pest densities). Search for eggs, usually on the underside of the leaves of grasses and cereal crops. It is advisable to search for eggs immediately after trap catch. The egg masses are usually in layers or a batch of 100–200 in number, and are covered by white hairs
- Heavy rain showers can kill the first, second and third instar larvae, and even though damage is present in the field, many larvae may have died. Scouts should record any rainfall in the scouting form
- Searches for pre-pupae/pupae should be made by digging 2–5 cm into the soil
- Avoid sampling after spraying. The re-entry intervals on the pesticide labels should be adhered to, in order to avoid contamination by pesticides

3.4 Assessing infestation levels

Each selected plant will need to be examined carefully for the presence of egg masses and other pest stages.

Table 7: Example of scoring table for assessing FAW damage

Station 1		Station 2		Station 3		Station 4		Station 5	
Plant no.	Infested	Plant no.	Infested	Plant no.	Infested	Plant no.	Infested	Plant no.	Infested
1	x	1	x	1		1	x	1	x
2		2		2		2		2	
3	x	3		3	x	3	x	3	
4	x	4	x	4	x	4	x	4	x
5		5		5		5		5	x
6	x	6	x	6		6		6	x
7		7		7		7		7	x
8	x	8		8	x	8	x	8	x
9		9		9		9		9	
10	x	10	x	10	x	10	x	10	x
Total number of infested plants									
6			4		4		5		7

The total number of plants infested in the 50 plants observed is 6+4+4+5+7=26

As a percent = $26/50 \times 100 = 52\%$

The percentage of plants in a field showing typical damage symptoms as well as the presence/absence of eggs and larvae is calculated using the formula below:

$$\% \text{ FAW infestation} = \frac{(\text{no. of infested plants})}{(\text{total number of plants observed})} \times 100$$

Absence of plant damage symptoms DOES NOT imply that FAW infestation will be zero as only the egg stage may be present on the plant selected. Data on assessment of other pest species (e.g. stem borers) should be collected as well. Some aspects of this scouting protocol have been adapted from the FAO guidance note 2 (FAO, 2018b) and should be referred to for additional information.

3.5 Monitoring with pheromone traps

Pheromone traps may be used as an additional tool for insect monitoring. The pheromone attracts (usually) male insects. Because pheromones can travel by air over very long distances, their use is very useful for monitoring FAW presence. However, some pheromone lures also attract a limited number of non-target moths. The universal bucket trap is normally used. Adult moths will be attracted to the pheromone and will get stuck on the sticky pad when they enter the trap. Pheromones should be replaced about every four weeks. For more details about pheromone trapping, refer to the FAO guidance note 3: Fall armyworm trapping (FAO, 2018d).

Setting up pheromone traps

Below we describe the stepwise instructions the facilitator of the training module may use when instructing the participants on how to use pheromone traps.

The universal bucket trap will be used. (Figure 23) Establish the pheromone trap one month before planting. Place the trap in or next to the maize field so that the scent of the pheromone is carried across the tops of the plants by the wind. Hang the trap in a vertical orientation from a long pole (3–4 metres) so that the trap is approximately 1.25 metres off the ground. When traps are hanging, they should be oriented in the most vertical, straight up-and-down orientation possible, to prevent water from getting in from the side. Make sure that leaves and tassels do not block the entrance to the pheromone trap.

- Place the pheromone lure in the compartment in the basket on top of the bucket trap
- Replace the pheromone lure every four weeks
- Store extra lures in a freezer
- Unwrap the insecticidal strip (Vapor Tape) and place it in the trap to kill the moths once they enter the trap. Do not handle the insecticidal strip with bare hands – it is poisonous. Use gloves or some other tool.
- One strip should last for four weeks, after which it should be replaced
- Do not store extra strips with food – the strips are poisonous. Place them in a sealed air-tight jar and store in a cool, dark place. Make sure that leaves and tassels do not block entrance to the pheromone trap

3.6 Monitoring the pheromone trap and data recording

Check and empty the trap every week. There may be a number of moths other than the FAW in the trap. Sort out and count the FAW moths. As the maize plants grow taller, move the trap up the pole so that the bottom of the trap is always about 30 cm above the plants.

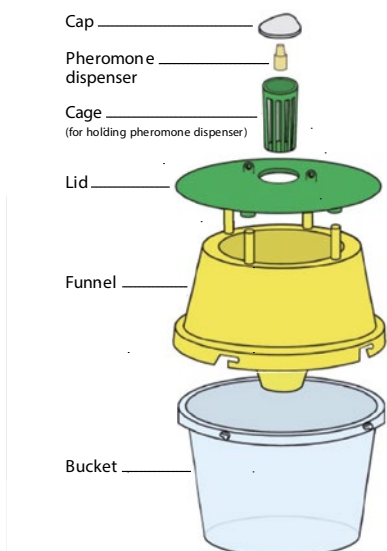


Figure 23: Pheromone traps, source: FAO Guidance Note 2-Fall armyworm scouting (left); © CABI (right)



Figure 24: Setting up a pheromone trap © USAID-CIMMYT FAW training of trainers

Use the FAMEWS mobile app to record the trap ID, location and number of moths confirmed to be FAW, the number suspected and the number of non-FAW moths, as well as the trap and lure type, and the date of last replacement.

There may be no moths in the field-side trap even though a significant percentage of plants are infested with FAW. Moth counts indicate the presence of FAW in the area but do not indicate the level of egg-laying intensity. Scouting is required to determine egg-laying intensity (percentage of infested plants).

Module 4: The community-based FAW early warning system (FAMEWS)

Module 4	Introduction to community-based FAW early warning system (FAMEWS)
Learning objectives	• To familiarize participants with the concepts, processes and practices of FAMEWS • To discuss the benefits of FAMEWS
Topics	• Origins of FAMEWS • Benefits of FAMEWS • How FAMEWS works • The steps of using FAMEWS
Methods	• Interactive presentation by facilitator • “<i>FAMEWS versus early warning for AAW</i>” – debating the statement, followed by plenary discussion • Question-and-answer session
Additional information	• CABI (2017b) How to identify fall armyworm. Poster. Plantwise; FAO (2018) <i>Integrated management of the Fall Armyworm on maize: A guide for Farmer Field Schools in Africa</i>
Material and equipment	• Low-cost Android v5 or higher purchased from FAO pre-qualified vendors – preferably from a local supplier; six lures per trap per season; 10 kill strips per trap per season; LCD projector, flip charts, marker pens

Origin of FAMEWS

The FAMEWS mobile app has been developed by FAO to be used on a low-cost smartphone for data collection and sharing within Africa.

Benefits of FAMEWS

This mobile app can be used by plant protection officers, agricultural extension agents, farmers, community focal persons and others to collect and record information when scouting fields and checking pheromone traps for FAW. FAMEWS data is used to understand FAW lifecycle, the percentage of FAW infestation in a field, population changes and the FAW risk map. It is meant to be utilized in all countries affected by FAW in Africa, whenever fields and traps are checked.

How FAMEWS works

When cell service or internet are available, data is transmitted to a centralized cloud-based server for validation by nationally designated FAW focal points before it is made available for mapping, analysis and early warning via a web-based global platform. There is an option for the app to provide immediate advice to users and a diagnostic tool that visually estimates the percentage of damage caused by FAW to maize. If it is used widely, the app can be essential in gaining a better understanding of the current distribution of FAW in different areas and how it is changing over time and space, to improve knowledge of FAW behaviour, and to enable extension agents to provide meaningful guidance and early warning to smallholder farmers so they can manage FAW sustainably in their fields. The new app Nuru will be included in FAMEWS as a scouting assistant and diagnostic tool that makes use of the smartphone camera to help in field scouting and to determine if a plant has FAW damage.

4.1 Data collection during monitoring and scouting

The data from traps can be recorded in the FAMEWS mobile app. The data that can be collected using the app includes: country, location, global positioning system (GPS) position, crop information (variety, planting date, irrigated or rain-fed, fertilizers used, crop stage), general health of the crop, the farming system, rainfall amounts and dates, field scouting data for at least 10 plants from five areas for different stages of FAW, AAW and stem borers and their damage and natural enemies observed (see Table 3 above). Moth counts can remain low (less than one moth per trap per day) even if the damage seen on the crop seems high.

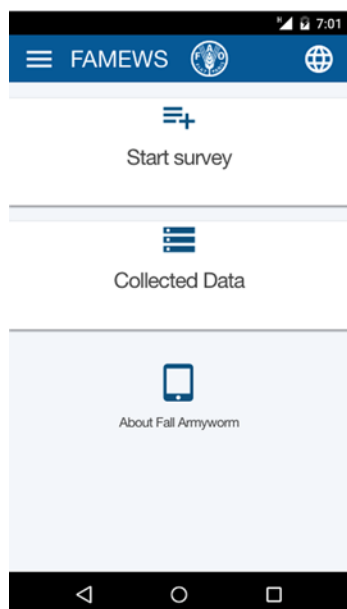
4.2 FAMEWS data collection app

Usually, farmers recognize the presence of FAW in their fields after the larvae have reached fourth instar, when it is too late to undertake control operations. A data collection and early warning system such as FAMEWS can enable farmers to monitor their fields on time and detect larvae when they are still young, before they hide in the funnels.

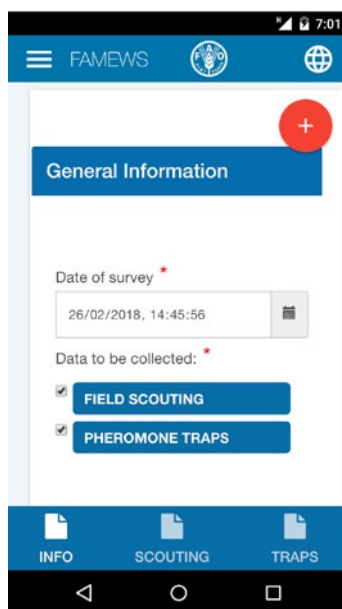
Steps in using FAMEWS

The facilitator should display and demonstrate the equipment required, as follows:

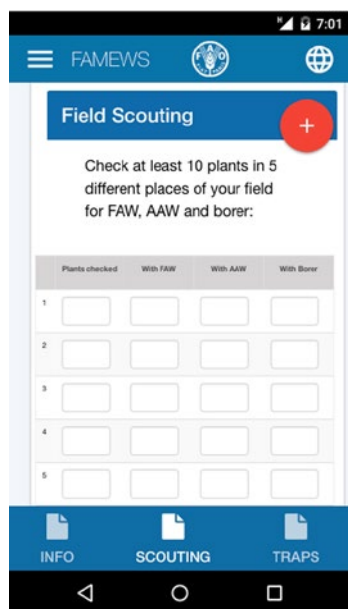
- a low-cost Android v5 or higher, purchased from FAO pre-qualified vendors, preferably from a local supplier; six lures per trap per season; 10 kill strips per trap per season
- The facilitator should briefly explain what they need to know about FAMEWS, as follows:
 - you do not need the internet or a cell network connection to use FAMEWS
 - but you do need at least a cell network connection to send data
 - FAMEWS only connects to the internet or cell service when it sends data; therefore, the cost is similar to a chat message
 - when you have a connection, always sync the app for the latest updates
 - make sure all data required is collected and submitted
 - do not log out so you will not need to log back in
 - if GPS is not working, go outside; location settings must be on; restart your smartphone
 - transmission of data is to be done by a registered FAMEWS National FAW Focal Point within 48 hours, via the internet
- The facilitator should then demonstrate how to use FAMEWS, using a PowerPoint presentation. Then divide the participants into groups of three to five, to practise using the smartphones



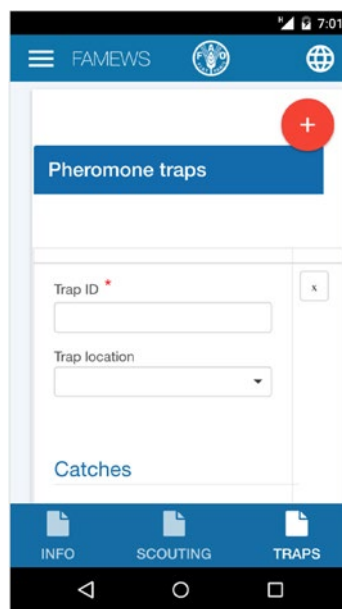
Step 1: Home page: Sync (to get latest version)



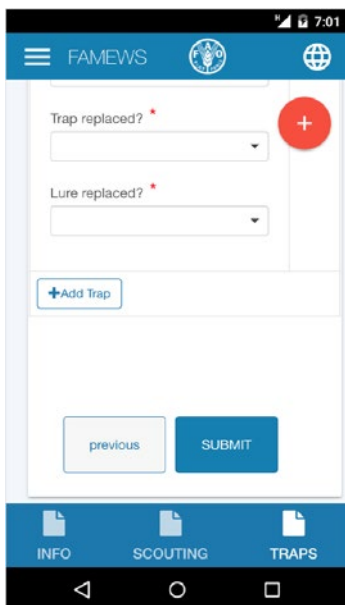
Step 2: Enter data on general information: date, location, name, training, main crop, variety, planting date, stage, fertilizer, irrigation, health, farming system, field size, rainfall



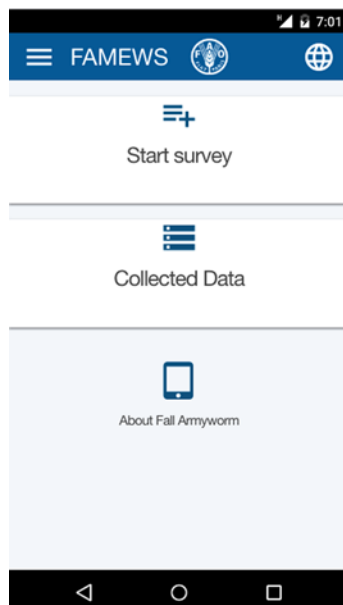
Step 3: Field scouting: enter the number of plants affected by FAW, AAW and stemborers; enter the stage, damage, natural enemies and management options used by the farmer



Step 4: Data on pheromone traps: each trap should be marked with a unique ID (e.g. KE-01-000001), location, catches, trap type and lure type



Step 5: Submit data



Step 6: Select collected data to see if data send is okay

More information about FAMEWS is available from the following links:

FAMEWS mobile app (Android v5 or higher) Google playstore

FAMEWS training kit (documents, presentations, video): tiny.cc/FAMEWS_kit

FAMEWS platform (maps and data): tiny.cc/FAMEWS_maps

4.3 Other FAW data collection tools that might be used

In CABI Plantwise clinics, plant doctors use tablets or smartphones to give timely alerts of FAW presence and advice to farmers on management options. Through Plantwise, plant doctors and farmers can regularly share pictures of pests and help each other diagnose and also get real-time diagnostics. The Pest Risk Information Service of CABI is another tool that provides actionable advice on FAW management. Farmers can receive timely warnings about the risk of FAW outbreaks and be advised on appropriate measures to protect their crops.

FAO and Pennsylvania State University also have the Nuru mobile app as an additional feature to FAMEWS, which helps farmers recognize FAW. Farmers can hold the phone next to an infested plant and the Nuru app can immediately confirm if FAW has caused the damage. Nuru uses cutting-edge technology involving machine learning and artificial intelligence to immediately spot if FAW has affected a plant. Nuru supports all stages of FAW management, from early warning and monitoring to response and risk assessment.

Module 5: FAW management and the role of the community

Module 5 FAW management and the role of the community	
Learning objectives	• To educate participants about the importance of community involvement in FAW management • To discuss the benefits of area-wide management of FAW • To plan for an area-wide FAW management strategy in the community • To promote farmer learning through regular field monitoring and observation
Topics	• How area-wide management of FAW works • How to manage FAW from the farm level to scale • AESA for decision-making • FAW management and control (cultural, biological, physical, host plant resistance, chemical, habitat management, chemical, IPM)
Methods	• Discussion in small focus groups of how each farmer in the community manages FAW • Discussion in groups of how one farmer not practising FAW management influences the FAW problem in neighbours' fields • Presentation by the facilitators and plenary discussions
Additional information	• Prasanna et al. (2018) <i>Fall Armyworm in Africa: A Guide for Integrated Pest Management</i>; FAO (2018) <i>Integrated management of the Fall Armyworm on maize: A guide for Farmer Field Schools in Africa</i>

Rationale

FAW is essentially a problem that farmers are responsible for dealing with on their own farms. The direct actions that can be taken to manage FAW are largely up to farmers, who live daily with the pest in their fields. Because this is a new pest, recommendations for management are evolving and farmers will need to seek information, advice, tools and resources on how to cope. Therefore, early detection and implementation of an IPM programme, through deploying biological and low-risk solutions, is critical for sustainable management of the pest. These processes are based on regular monitoring and prompt reporting, which are essential for effective control before outbreaks occur. The role of communities is therefore critical in the management of FAW, through applying a community-based approach following the model developed for community-based armyworm forecasting for villages in eastern and southern Africa for AAW (Negussie et al, 2010). Farmers selected by the community at community level will be trained on how to operate pheromone traps, diagnose and scout in order to monitor and manage FAW. For farmers to be able to manage FAW they need technical knowledge on the following areas:

- Farmers need to understand the different stages of FAW and how FAW attacks different growth stages. They need to know how to monitor FAW using appropriate scouting methods, and how to conduct AESA and make management decisions based on the observed biotic factors (pests, weeds, diseases and natural enemies) and abiotic factors that influence the health of the crop and pest incidence (e.g. soil fertility and weather conditions)

- Farmers should be aware of the various recommended IPM options and be able to select the most suitable in terms of efficacy, safety (for humans, livestock environment and natural enemies), availability and cost. Some of the most important management strategies include prevention measures, such as use of quality disease-free seed, avoiding late or staggered planting, and conserving natural enemies using crop diversity
- Farmers should be aware that unnecessary use of pesticides can be avoided by frequent scouting to assess the need for pesticide application, and that they should only apply pesticides when necessary, using the least toxic pesticides registered for FAW in their countries
- For various IPM options, refer to FAO's Farmer Field Schools Manual for FAW management that provides a simple guide for smallholders. Through observations in their own fields and field days organized within the community, farmers will be able to observe and select the most appropriate options, including their own indigenous technologies

Procedure: The facilitator will use the notes to prepare the PowerPoint presentations and follow the procedures for group exercises described in **Sections 5.1 to 5.4.**

5.1 Agroecosystem-based IPM approaches

Rationale

Most farmers practise some IPM practices but they are unaware that some of the practices they already apply can be part of an IPM approach. This module will increase their understanding of IPM and enable them to differentiate between pests and beneficial organisms, as well as to discover the importance of beneficial organisms.

Location: Maize field and location where insect zoos are kept (e.g. class room)

Time: Two hours

Materials

- Small plastic vials or empty water bottle containers
- Transparent plastic containers
- Maize leaves and stems
- Tissue paper/cotton wool
- Camel-hair or fine-hair brush
- Labels
- Muslin cloth or fine mesh screen
- Rubber bands/pieces of string
- Hand lens
- Flip chart and markers (in four different colours)
- Green and yellow lists for key pests, to serve as a reference

Procedures

The facilitator will ask the group what are some “good” practices which can be applied to avoid problems with the pest. The facilitator will introduce and discuss the concepts of IPM, pests (“enemies of the farmer”), natural enemies (“friends of the farmer”) and neutral elements (“visitors”) using a PowerPoint presentation.

Participants should go to the maize fields early in the morning to collect unknown and known insects from the field plot using a sweep net or plastic vials/bottles.

- The facilitator will set up the zoos, using transparent plastic containers, lined with tissue paper and moist cotton wool
- The facilitator will put maize leaves in a container and label each bucket with the local name of the insect you want to study. Place an expected predatory insect (a “natural enemy” or “farmer’s friend”) together with an expected prey insect in a zoo (for example, ladybird beetles with FAW)
- The facilitator should make sure that different species of predators are not put together as they might attack each other. Label each bucket with the local name and number of insects in each zoo
- The facilitator will divide the participants into groups to observe the zoos and the interactions between prey and predator for the following 10 minutes, and then daily for the next three to five days

Questions and discussion

- Did the insect feed in the zoo? If not, why not? How long did the insect survive in the zoo?
- Was the insect a “friend” of the farmer or an “enemy” of the farmer?
- How can farmers conserve their “friends” in the field?

The facilitator can make a PowerPoint presentation from the notes below and present it after the discussion

Notes for the facilitator

There are a number of low-cost cultural practices that can be implemented as part of an effective IPM strategy against FAW. Such approaches can be particularly relevant to smallholders who lack financial resources to initiate control strategies. These strategies include a combination of environmentally friendly approaches that make the environment less favourable for the increase of pests, and suitable for the survival of natural enemies, such as the following:

- Intercropping, companion cropping and crop rotation with non-grass species, such as cassava and other plants known to repel or confuse female moths from laying their eggs on maize plants can reduce crop damage and provide shelter and alternative food sources for natural enemies and reduce the ability of FAW to move to neighbouring plants. Some common intercrops include maize and legumes, such as beans, cowpeas, pigeon peas and other fodder crops
- Conservation agriculture (CA): combined use of no-tillage, residue retention, rotation and use of cover crops (such as mucuna and lablab) has been found to increase the numbers and diversity of natural enemies (spiders, beetles, ants) and to improve soil health



Maize - Cowpea



Maize - Gliricidia



Maize - Pigeonpea



Maize – Lablab bean

Figure 25: Intercropping © Christian Thierfelder, CIMMYT.

- Habitat management using a push-pull strategy. This involves intercropping maize with a “push” plant, such as Desmodium, that repels FAW from the field, and planting a crop along the field boundary (e.g. Napier grass or *Brachiaria* spp) that attracts or “pulls” the FAW away from the maize. Reductions of 82.7% in the average number of larvae per plant and 86.7% in plant damage per plot have been observed in climate-adapted push-pull, compared to maize monocrop plots. Similarly, maize grain yields are reported to be significantly higher, 2.7 times, in climate-adapted push-pull plots (Midega et al., 2018)



Figure 26: Push-pull (maize + Desmodium + Napier © Charles Midega, ICIPE)

- Handpicking and destroying egg masses and larvae, or collecting and dropping larvae in hot water. Killing one caterpillar prevents immediate crop damage and the appearance of more than 1,500–2,000 new caterpillars within less than four weeks
- Using good quality seeds can increase plant vigour and potentially reduce damage
- Eliminating grassy weeds in maize fields and nearby, as they provide shelter and food for the pest
- Planting at the recommended/optimal time. Do not delay planting: take advantage of planting with the first effective rains, as FAW populations build up later in the crop season
- Avoiding late planting and staggered planting: plant all maize fields at the same time at the onset of sufficient rains
- Putting a handful of sand (mixed with lime or ash), sawdust, soil, soap solutions or grit in the whorl of attacked plants to kill bigger caterpillars
- Improving plant health by use of recommended agronomic practices, such as appropriate plant spacing and soil management and crop nutrition through the use of organic or inorganic fertilizer or intercropping with nitrogen-fixing legumes helps boost plant vigour to better withstand pest attack or escape pest damage. In maize, the recommended fertilization rate is 200 kg of nitrogen phosphorous potassium at 15:15:15 per hectare – but this varies depending on the country
- Removing and destroying volunteer plants and infested crop residues
- Ensuring infested plant materials are not moved to areas where the pest has not been reported
- The use of botanical extracts, such as Neem products (dusts made from leaves and bark, extracts from whole fruits, seeds, or seed kernels, and oil expressed from the seed kernel). Neem is a feeding deterrent, a growth regulator and a repellent

5.2 AESA

AESA is the establishment by regular observation of the interaction between the crop and other biotic and abiotic factors coexisting in the field. It helps farmers learn how to make observations of aspects such as: growth stage of crop, insect pests/diseases, weed problems, weather conditions, soil conditions and plant health. AESA also helps farmers make management decisions. AESA can be used together with insect zoo studies to understand the dynamics between pests and their natural enemies within an ecosystem and to identify naturally occurring biocontrol agents.



Figure 27: Collecting data in the field for AESA © CABI



Example of data collected from 20 plants in one sampling station

Plant	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Larva	1	2	0	3	6	2	2	2	2	1	1	4	2	1	0	2	1	0	1	3
Pin Hole	2	2	2	3	3	2	2	3	2	2	2	3	2	2	1	3	3	3	3	3
Window pen	1	2	1	1	1	2	3	2	1	1	1	3	1	2	2	3	3	1	3	3
Egg masses	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Natural enemy	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

Pests and diseases 1. FAW 2. Stem borer <i>B.fusca</i>	Natural enemies 1. Spiders 2. Hymenoptera – Brachoniclae (wasp) 3. Ants 4. Earwig
General observations 1. Some weeds have started emerging 2. Presence of FAW 3. No egg masses were observed 4. The farmer sprayed late and did not use the recommended rates 5. Most of the larvae were found in the whorl/funnel 6. Previous crop was maize, indicated by maize stalks 7. Some natural enemies were present but too swift to be trapped 8. Most larvae were in the second instars	Recommendations 1. Weeding should be done soon 2. Regular field scouting for FAW and other pests and diseases 3. Spray with recommended pesticide 4. Spraying should be done late in the evening or early morning, when the pest is active 5. Target spraying in the funnels 6. Crop rotation with different crop families, especially legumes 7. IPM should be practised, to conserve natural enemies 8. Farmers should keep farm records for proper farm management 9. Should consult the technical team at the local government

5.3 Recognizing indigenous natural enemies in the maize agroecosystem

To better understand and use natural enemies, it is important first to distinguish between “natural” and “applied” biological control (biocontrol). Natural biocontrol is the reduction of a pest population by its natural enemies, without human intervention. Applied biological control is the reduction of the population of a pest species by natural enemies manipulated by man. Both types of biological control are important and desirable. Three forms of biocontrol are generally recognized, based on how natural enemies are manipulated. In “classical biocontrol,” exotic species of natural enemies are imported and released in the area where the insect pest occurs. Another way to increase the efficiency of biological control is to use techniques aimed at increasing the population of an endemic natural enemy. This is achieved by periodic releases of large numbers of natural enemies in the field, termed “inundative” biocontrol. Similarly, the objective might just be to enhance efforts that gradually increase the population of the natural enemies, termed “augmentative biocontrol”. A third form of biocontrol is through the “conservation” of natural enemies and, in contrast to the first two forms, works with the populations of the existing natural enemies in an indirect way, making the environment more favourable for them.

The insect species that are recognized as biocontrol agents are categorized as either “parasitoids” or “predators.” Parasitoids are biocontrol agents for which at least one of their life stages is completed in the pest. Predators, on the other hand, simply prey on the pest in its most susceptible stages, such as the eggs or larvae. We also have pathogens, which infect the larvae of FAW and can cause death in some cases.

Among the parasitoids, there are those that parasitize the eggs, larva and pupal stages and there are those that parasitize the pest during multiple life stages. The parasitoids lay their eggs inside FAW and prevent the further development of the host to adult. The paragraphs below give a few examples of parasitoids and predators of FAW that might be encountered, and discuss how the farmer might be able to recognize them.

5.3.1 Parasitoids

Trichogramma

These are very small insects. The female lays her eggs inside the eggs of FAW. Within a few hours the larva of *Trichogramma* starts to feed on the FAW egg. The parasitoid will complete its lifecycle inside the FAW egg and after emergence the farmer may observe egg masses on the leaves, with tiny holes from which *Trichogramma* emerged. Soon after emergence, the *Trichogramma* immediately begins the process of searching for new egg masses to continue multiplication.



Figure 29: Egg parasitoids (*Trichogramma*) © Ivan Cruz, EMBRAPA

Telenomus

This parasitoid is larger than that of *Trichogramma* and has a black, shiny body. After the complete development of the immature phase of the parasitoid, the adult perforates a small hole in the FAW egg, through which it emerges. After emergence, the farmer may find the parasitoids roaming around the mass of eggs from which they emerged or they may fly away to seek other parasitized masses.



Figure 30: Egg parasitoids (*Telenomus*) © L.Buss, UF

Chelonus

The female parasitoid oviposits inside her eggs inside those of FAW, but unlike *Trichogramma* and *Telenomus*, the parasitized FAW egg hatches to larval stage, but will be carrying within it the parasitoid species. In a very short time, the parasitized larva gradually decreases feeding, until it dies. When the parasitoid development finishes, the FAW caterpillar leaves the plant and moves to the soil, where it weaves a chamber as if preparing to become a pupa. To leave the body of the FAW caterpillar, the larva of the parasitoid perforates the abdomen. The parasitoid immediately weaves a cocoon and in a few hours changes into the pupa, and subsequently into an adult.



Figure 31: Egg parasitoid (*Chelonus*) © Ygor Tiago (left), Harman Patil (right)

Campoletis

The female lays its eggs inside the first and second instars of FAW and the larva completes its entire cycle feeding on the internal contents of the pest. The parasitized caterpillar changes its behaviour and, as the larval stage of the parasitoid approaches the fifth instar, the larva of FAW leaves the maize whorl, moving towards the higher leaves, remaining here until death. Shortly before pupation, the larva of the parasitoid leaves the caterpillar's body through its abdomen, killing it, in order to build its cocoon outside on the leaf next to the dead caterpillar. Therefore, by parasitizing small size caterpillars, in addition to causing the death of the host insect, the parasitoid greatly reduces the leaf consumption by the caterpillar, thus reducing the damage in the field.

Cotesia

These are small wasps whose adults deposit multiple eggs in the body of FAW. After about three days the parasitoid larva emerges; it feeds inside the body tissue of FAW. Soon after leaving the host, the parasitoid larvae will weave a cocoon on the leaf and turn into a pupa, which hatches within a week. Some *Cotesia*, like *Cotesia marginiventris*, are FAW co-evolved parasitoids that could for instance be introduced into Africa. *Cotesia* are mainly larval endo-parasitoids, and are better competitor than *Chelonus insularis*. In Africa, *Cotesia icipe* is a newly described species that has exhibited up to 65% parasitism in the laboratory.



Figure 32: *Cotesia marginiventris* © Matthias Held, UniNE (left), *Cotesia icipe* (right)

5.3.2 Predators

Ladybird beetles

Adults of ladybird beetles can feed on eggs and young larvae of FAW. The size and colour of adults can vary among species. Normally, the larva of the predator will become a pupa in the plant itself, where the larva was found. Pollen and fungal spores are important components of this species' diet. They can be efficient predators both in the larval and adult stages. Farmers who recognize the beetles in their fields can conserve them by using fewer pesticides in FAW control.



Figure 33: Predators © Ivan Cruz, EMBRAPA, **Right: Ladybird beetle larva and adult**

Earwigs

These insects have long mandibles/mouthparts and well-developed compound eyes. The antennae are long, filiform and with many segments. They are important natural enemies for FAW as their body structure can enable them to penetrate the hiding places of FAW, such as the whorl or the ears. They are usually found in many numbers on a plant as they exhibit maternal care in the protection of hatched eggs and nymphs.



Figure 34: Earwigs © Ivan Cruz, EMBRAPA

Predatory bugs

There are several predatory bugs that can feed on FAW. Predatory bugs have high searching efficiency, an ability to increase population and aggregate quickly when there is abundant prey, in addition to surviving in low-prey density that makes them quite effective. Other predatory bugs can simply prick the FAW larvae and inject a toxin that causes paralysis in a relatively short time; the larva is then killed when its internal fluids are sucked out by the predator. Farmers should take some time during field scouting to observe any predatory bugs that may be present on the plant and seen to be attacking any of the FAW life stages. It should not be assumed that any bug found on the plant is a predator of FAW. Farmers can use different options, such as sugar solutions on the plant, as a food source to enhance the activity of predatory bugs in their fields.



Figure 35: Predatory bugs © Ivan Cruz, EMBRAPA

Soil surface beetles and ants

These beetles live on the surface and are mostly nocturnal and generally black or brown in colour. They are essentially carnivores, and can feed on FAW larvae when they drop to the soil to pupate.



Figure 36: Soil surface beetles © Ivan Cruz, EMBRAPA



Figure 37: Ants feeding on early instar larva © CABI

5.3.3 Pathogens

FAW larvae can be affected by a wide range of pathogens, which can cause mortality in some cases. These include viruses such as *Spodoptera frugiperda* granulovirus and *Spodoptera frugiperda* multiple NPV, which can be developed into commercial products for wider field use. Once infected, the virus spreads to the entire insect body. Infected caterpillars consume less than 10% of the food normally eaten by a healthy caterpillar. An infected larva moves to the higher parts of the plant, where it dies, while hanging its head down. The dead larvae dissolve and produce fluids, which when consumed by other larvae spreads the infection. Other pathogens include entomopathogenic fungi. These infect the FAW larva through the body and kill the insect due to destruction of tissues and by production of toxins. Diseased insects stop feeding, change colour (white, cream, green, reddish or brown), and eventually die. The common genera are *Beauveria* and *Metarhizium*. There are also some bacteria that can infect FAW and cause death of the insect, and that have been developed commercially into, biopesticides such as *Bt*. There is some evidence that FAW larvae may also be affected by entomopathogenic nematodes. Farmers should look out for dead or infected larvae in their fields to understand the role that pathogens play in FAW control.



Figure 38: FAW fungus © CABI



Figure 39: Virus infection © CABI

5.4 Other management practices that minimize build-up of pest population and conserve natural enemies

Prevent

Sustainable management of FAW starts with prevention. While it is very difficult to completely eliminate FAW from fields, there are actions that farmers can take before or when planting their fields to reduce infestation by, and the impact of, FAW in their crops. Some key first steps include the following:

- Use **high-quality seed**. The seed should germinate well, be disease-free and be of the variety the farmer wants to plant. Good pest management depends on healthy plants
- **Avoid late planting or staggered planting** (plots of different ages). Female moths have a favourite stage of maize to lay eggs on. If your field is one of the few late-planted plots, all the female moths in a region will come to your plot, where she will lay her eggs
- **Increase plant diversity** in your plots. Some plants emit chemicals that can attract or repel FAW moths. If a plot of land has a mixture of varieties or crops, the adult moths may not land on maize plants to lay her eggs. Plants that are unattractive to FAW moths include crop plants, such as cassava, beans, soybeans and groundnuts, but also non-crop plants: their sole function in the cropping system is to repel FAW moths from maize plants. The “push-pull” technology promoted by ICIPE is one example of the use of plant diversity, using one plant species that “pushes” (repels) FAW away from maize and another plant species that “pulls” them (attracts them), where they can be controlled easily. The risk of *Desmodium* potentially becoming a weed, should, however be closely monitored

Plant diversity can also increase the populations of farmers’ friends – those organisms that are naturally in the environment and that can kill a high proportion of FAW eggs and caterpillars. Predators (ants, earwigs, etc.), parasitoids (wasps that kill FAW), and pathogens (virus, bacteria, fungi, etc. that kill FAW) are in and around farmers’ fields. Plant diversity can keep them close to your maize so that they can find and kill the FAW.

Monitor

- As a farmer, you should **visit your fields frequently** to observe, learn and take action. Beginning one week after planting and at least once a week, you should walk through your fields every three to four days. While doing this, you should observe the following:

The general health of the plants:

- Do they have a nice dark-green colour (indicating good nutrition)?
- Do they appear moisture-stressed?
- Are there signs of damage (from FAW, other insects, or diseases)?
- Are there weeds (especially *striga*)?

If there is FAW damage, you should check 10 consecutive plants in five locations of the field. See FAW Guidance Note 2 – Scouting, for details.

- You may look into the whorl (three to five young leaves) and see if there are holes in the leaves in the whorl and fresh frass
- You should look for creamy or grey egg masses located on leaves – and sometimes the stem
- You should look in early morning or evening hours for young larvae and larvae with the inverted “Y” and four dark spots forming a square (on the second-to-last body segment)

If you have access to the FAMEWS application, input data on the percentage of plants currently infested with FAW (follow FAW Guidance Note 2 – Scouting) while scouting your fields.

Look for the presence of farmers' friends (ants, wasps, larvae killed by pathogens).

Know

Maize plants can **compensate for certain levels** of foliar damage without losing much yield. Not all FAW damage results in lower yields. **Farmers' friends** (the natural enemies of FAW) can be very important in naturally controlling FAW – studies have found up to 56% of FAW larvae naturally killed by farmers' friends. Key to good FAW control is attracting and keeping farmers' friends in the fields.

There are actions that can be taken to attract farmers' friends to your fields, keep them there, or harvest and use them. Effective control **does not have to be fast**. Parasitized infected larvae may be alive, but stop feeding. If FAW are not feeding, they are not causing damage to your crop.

Chemical insecticides are expensive. Their use is probably not economically justifiable for smallholder African maize farmers. Although pesticides provide a level of crop protection which cannot be guaranteed by other approaches, they should be used with **extreme caution**. Some also present high human health risks. Some older types of pesticides, which have been banned from use due to human health risks in many countries, are being used by smallholder maize farmers. Many pesticides kill farmers' friends, those predators, parasitoids and pathogens that can naturally kill a large proportion of FAW eggs and caterpillars. In general, pesticides use should adhere to national legislation and international norms, use of nationally registered (and labelled) pesticides and a preference for pesticides that are target specific, degrade rapidly, and are a low health risk. You should use the proper personal protection and equipment, and follow the guidance that is provided on the pesticide label, and also avoid using counterfeit products. More detail on the safe use of pesticides can be found in the 'FAO guidance note 1: Reduction of human health and environmental risks of pesticides used for control of fall armyworm' (FAO, 2018).

Act

Effective and sustainable FAW management requires **action**. Some of the actions prevent FAW, others are required when something goes wrong in the system and there are high levels of FAW infestation in the field.

- One of the simplest actions that farmers can take is **mechanically killing FAW eggs and young larvae**. This is best done as soon as possible, beginning a week after planting. Eggs are laid in a mass, and can be easily found on maize leaves. They can be immediately crushed. Likewise, young larvae can be picked off the leaves, before they penetrate deep into the whorl. Some farmers feed the caterpillars to chickens

Many smallholder farmers try **local solutions** and report some satisfaction with these tactics. In addition to the preventive actions, some farmers report success in using the following practices:

- **“Recycling” pathogens**. When dead caterpillars that were killed by virus, fungi or bacteria are observed in the field, they can be collected, taken home, ground (or put through a blender) and strained. The liquid that strains through may be full of fungal spores, bacteria or virus particles that can be diluted and sprayed back into infested plants. This is a free, effective natural bio-pesticide. Many farmers spray only into the whorls of infested plants, so as not to waste the natural insecticide
- **Attract predators and parasitoids**. Ants are important natural predators of FAW larvae. They crawl up the plants, into the whorls, and find and drag out FAW larvae. Some farmers have found that they can attract ants to their maize fields by putting lard, grease from cooked meat, or fish soup into their maize fields. These substances attract ants to their maize fields, and then they stay and find and eat FAW larvae. Some farmers use sugar water to attract and feed wasps that can eat or parasitize FAW
- Other farmers try, and have reported satisfaction with, using a number of **local substances, applied directly to the whorl of infested plants**. Some of the substances that have been tried include: soil, ash, sand, lime, salt, soaps, oils and extracts from local plants (hot peppers, Tephrosia, Marigold flowers, neem, etc.). Farmers can try these and other local solutions and then compare and share the results, to see which work best under local conditions
- Such traditional methods may have some potential for FAW management from the farmer's perspective. Scientists should not dismiss farmers' experiments, but they should conduct their own research to understand the underlying mechanisms behind the reported effectiveness of some of these methods, including the degree to which they actually work to control FAW. A farmer that chooses to deploy such methods on their fields needs to be armed with the right knowledge

There are many ways to sustainably manage FAW in Africa. Good management will depend on good knowledge, observations, innovation and action. Farmers and extension workers are encouraged to learn about FAW biology and ecology, closely observe what happens in their fields, try some of these practices, develop new ones and share their knowledge and experiences.

Module 6: Participatory training, adult learning and communication

Module 6	Participatory training, adult learning and communication
Learning objectives	• To acquaint participants with the concepts, principles and benefits of participatory approaches • To familiarize participants with the basic concepts and roles of participatory communication • To create awareness about the use and importance of group dynamics
Topics	• Participatory training approaches – What is participation? – Principles of participation – Benefits of participation – Challenges encountered in participation – Participatory training approaches and techniques – Uses and types of group dynamic activities • Participatory communication • A new understanding of communication • Participatory communication in FAMEWS
Methods	• Visualized brainstorming • Interactive presentation by the facilitator • Group discussion and presentation • Role-play and other dynamic group activities

Rationale

Top-down one-way transfers of technology and flows of information have received much criticism because they undermine the community's role in generating, adapting and disseminating information and technology. As a result, many past interventions received limited acceptance, made little impact and were not sustainable. This dissatisfaction necessitated the search for alternative approaches, which led to the emergence of participatory methods in research and extension education (Negussie et al., 2010). Participatory training approaches and techniques have rapidly gained popularity in recent years. In participatory training approaches and techniques due consideration is given to the knowledge, experience and needs of adult learners. Participatory tools and techniques are specific activities that are designed to encourage joint analysis, learning, and action. No single tool or technique is applicable to all situations. Each tool encourages different levels of participation. Participatory approaches and techniques are specific to a particular situation, which means there is no blueprint. Participatory training is constantly adjusted and adapted based on the local setting. Genuine participation implies active engagement: it is a process of interactive dialogue, collective analysis and joint action. Participation involves progressively handing over power and control to local partners so that they can set their own development agenda.

Training lead farmers in communities as farmer-trainers is a more sustainable approach because they will be able to communicate in the local languages; they understand the local cultures, farming practices and farmers' needs; and they have the agricultural expertise and/or the leadership ability to manage the activities in the communities. Participatory training considers the fact that adults learn differently to children because they already have their own experience, skills, knowledge and perceptions, which training facilitators should take advantage of by motivating and encouraging farmers to share their local knowledge and learn from each other, and they should use hands-on exercises to practise. It is also important for facilitators to ask participants what they learned, discuss and summarize.

6.1 Planning training sessions

- This will involve two lead farmers, village leaders and the village extension officers in each village, and it will be conducted by agricultural officers who were trained in the training of trainer's course
- Each training course will last two days. 50% of the training time will be devoted to practical and field demonstrations
- Backstopping field visits to address challenges faced by community scouts and field days will be conducted to create awareness and to demonstrate the benefits of community-based FAW surveillance, monitoring, scouting and reporting



Figure 40: Data collection training session © CABI

6.2 Selection of sites and participants

A public meeting will be held to engage the community and discuss the key components of community-based monitoring, surveillance and management. The meeting will be organized by the district agricultural office, the village headman and the village extension officer, supported by the national coordinating unit. During the meeting the criteria for the selection of two farmers to be trained as scouts will be discussed and agreed, including the suitability of a female monitor, and an election will be held using whichever method the people decide (such as secret ballot, queuing or acclamation).

Criteria for selection of local farmer scouts

- The criteria for selecting the lead farmers will include skills in crop production, interest in knowledge sharing, willingness to serve on a voluntary basis, availability, accessibility (especially for the traps), trainability, acceptability, ability to read, write and communicate, as well as gender
- It may be necessary to conduct elections
- Farmer groups and village elders and chiefs will play a big role in the selection of the community trainers in order to increase local ownership
- The farmer-trainers will be trained and backstopped by the technical staff from the ministry of agriculture in the respective regions/districts/locations
- A discussion will also be facilitated to begin developing the communication strategy for the early and rapid detection of FAW presence and wide dissemination of this information (e.g. farmer-to-farmer verbal communication, farmer informs local extension staff, announcements in schools to pupils and pupils to their parents, local churches and mosques, local radio stations using local dialect, SMS, written announcements using posters in the local market areas, public barazas, health centres to be used within the village)
- The role of pest control product suppliers and traders will also be discussed as part of the response to positive prediction
- The facilitator should make it clear that recommending a control method is not a prescription; they will be able to select the most suitable strategy for communicating to the wider community

6.3 The role of trainers (skills and qualities of a good trainer)

The facilitator will request the participants brainstorm on the skills and qualities of a good trainer and training tips, and list these on a flip chart. He/she can add those that are missing. Examples are:

- avoid scientific jargon
- avoid long lectures
- use open-ended questions
- respect and listening to all learners and their opinions
- allow trainee participation, promoting lively discussions and finding ways to encourage silent participants to contribute
- being able to improvise

The facilitator can conclude by giving reasons why good facilitation skills are important when training adults. For example:

An adult trainer plays several roles to ensure that the learners and the learning process are at the centre of all the training. Generally, adult trainers adopt a facilitation role.

Adult learners need opportunities to think, to understand and to apply. To facilitate these changes, experiential learning activities are more effective. Facilitators need to apply active learning methods that incorporate the direct participation of the learners and that create an atmosphere for sharing knowledge and experiences.

Tools that can be used include: semi-structured interviews, focus group discussions, key informant interviews, timelines and transect walks.



Figure 41: Demonstrating parts of a pheromone trap © Elias Felege DLCO-EA

6.4 Training methodologies and performance measurement

District meeting

- To introduce the community-based monitoring and explain the different steps involved
- To discuss the roles of the different stakeholders
- To discuss how to select villages for the initiative

Those who attend the district meeting will include:

- national FAW coordinator
- district agricultural development officer
- specialists in crop production, crop protection, agricultural extension work and monitoring and evaluation
- other relevant staff from the district

Village/community meeting

The village meeting will follow the district meeting to engage the community and will allow detailed discussions and explanations about community-based monitoring.

Participants in the village meeting will include:

- village leaders
- village extension officers
- district representative
- national FAW coordinators
- pesticide dealers

The issues discussed and activities carried out at the village meeting will include:

- introduction of the participants and the objectives
- the risks of FAW, its lifecycle, and its migratory behaviour
- the FAMEWS system and its benefits
- the election of two community scouts – a leader and an assistant

Training of scouts

Training of scouts will take place as soon after the village meeting as possible.

The training will include the following people:

- elected scouts from each village (lead and assistant)
- village extension officers
- village leaders
- district representative
- NGO representatives, where available

The programme and topics to be covered during the training of the scouts are as provided in the programme provided at the start of this manual. At the end of the training session, each participating village will be provided with an early detection pack.

Supervision and monitoring

Local extension officers should monitor whether the early warning system in a community is working well, and keep the village authorities informed. In addition to the regular supervisory and monitoring activities, a mid-season assessment can be carried out by district or national staff. The aims of the assessment will include the following:

- assessing the knowledge, interest and performance of the scouts
- assessing the effectiveness and progress of the early warning activities
- assessing acceptance of FAMEWS by the community
- examining the effectiveness of the communication of FAW detection information and the community's response to warnings and outbreaks
- evaluating the roles, actions and interactions of the different stakeholders
- identifying areas requiring revision or modification

Assessment methods

A mid-season assessment should be carried out in a participatory manner. This assessment should be carried out by trainers internally to check progress, using the following tools:

- key informant interviews (questionnaire)
- group discussions with farmers and other stakeholders using a checklist (e.g. asking questions such as: Have you been receiving information from the scouts? Is the scout accessible? Are you getting the products from agro-dealers? Are the recommended pesticides effective? Is the trap catching moths and does it belong to the community? What is working well and what needs improvement?)
- trap observation (moth catches for early detection)
- field days – one field day per season per community:
 - these are an opportunity for community scouts to explain their job to the community, and present successes, and for scouts and other input suppliers to get feedback
 - can be used for demonstration of some technologies, e.g. safe use of pesticides
 - can display the stages of the FAW and other similar pests in order to help farmers diagnose and understand the life stages of FAW
 - it is also important to have a big list of all crops susceptible to attack by FAW and display all crops attacked, including the alternative hosts
 - field days can be used to gather information on community response and create awareness

- review of early detection records and other documents:
 - look at the records that the scouts keep
 - lead extension staff should sit with the scouts to make sure that the records kept are the correct ones
 - check if the records sent are the correct ones and whether the traps are catching the right moths
 - are they good records which can lead to correct decisions
 - check if the scouts communicate to the farmers in a timely manner
- field days are useful in monitoring progress, encouraging the community and raising awareness
 - During field days, FAW detections can be validated with the rest of the community
 - During field days community scouts can explain what they have been doing. This is a chance to assess their understanding of the process
- exchange visits can also be organized to facilitate sharing of information and experiences

Participatory end-of-season evaluation

This evaluation is important to understand how knowledge and practices have changed as a result of community-based monitoring and early warning. It may be done formally, or as part of regular monitoring of agricultural activities. The end-of-season evaluation will often be participatory and so will be carried out by the relevant stakeholders (e.g. district crops officer, all those involved, including programme managers and farmers). It will also help to check if the community-based monitoring and early warning approach was effective. A comparison can be made between districts with community scouts and without, to assess the level of awareness.

The main objectives of the end-of-season evaluation are similar to the mid-season monitoring, and include the following:

- to assess understanding and perception of the early detection process by the farmers
- to assess the knowledge, competence and performance of FAW scouts
- to examine the process, flow and effectiveness of early detection information among different stakeholders
- to document the response of farmers and other stakeholders to early detections, and the actions taken manage FAW
- to assess the roles, participation and collaboration of the relevant stakeholders
- to examine the procedures and accuracy of the early detection
- to assess the integration and sustainability of the community-based monitoring and early warning systems such as FAMEWS and others
- to identify any constraints and suggest solutions for improvement

Monitoring and setting performance indicators

Performance indicators will be developed together with the communities and performance tracked based on the agreed-on indicators. Data collected by community scouts will be verified fortnightly to check for any inconsistencies. Examples of output and outcome indicators that can be monitored include the following:

Output indicators

- Correct identification and diagnosis of FAW
- Distribution maps of FAW
- Number of males and females trained
- Number of modules covered by the community trainer
- Number of countries covered
- Number of stakeholders involved
- Number of communication channels used to disseminate FAW infestation

Outcome indicators

- Number of trainees carrying out scouting and engaging in communication
- Reduction in infestation by FAW through scouting and early warning
- Instances of timely intervention and mitigation of FAW infestation by policymakers
- Instances of participatory involvement of several stakeholders

Evaluation methodologies

- Semi-structured interviews and discussions with farmers, scouts and other stakeholders
- Key informant interviews with selected stakeholders
- Focus group discussions with farmers and other stakeholders
- Observation and data review

6.5 FFS and Community based FAW Monitoring, Early Warning and Management

FAW is likely to stay in Africa for a long time, so it is important to equip smallholder farmers and field trainers with the necessary knowledge and skills to manage the pest in a sustainable and cost-effective manner over the long term.

If possible – and if the FAW is already a serious issue in your area – do consider providing trainers and farmers with a longer-term, solid training programme on FAW and maize management, and creating a platform for testing management options first hand in communities.

Farmer Field Schools offer such a practical training approach, which is not done “with farmers” but “by farmers”. Typically in a FFS, a group of 20–25 farmers meets in the same field once a week throughout the cropping season, to observe their agroecosystem, exchange ideas and run practical experiments on potential solutions in dedicated plots, with the support of a trained facilitator.

FFS can be a great way to strengthen community monitoring and management of the FAW, because scouting can be conducted and traps monitored weekly at every FFS session. FFS participants can engage over a full season, and help share their knowledge and mobilize other community members.

Detailed information on setting up an FFS programme and on FAW management options and field studies are available in the publication *Integrated Management of the Fall Armyworm on Maize: a Guide for FFS in Africa* (FAO, 2018), which is a companion guide to this Training of Trainer Manual.

In this following section, we highlight key features of FFS, decision-making for establishing an FFS, advantages of the FFS, key activities in FFS, and the identification/training of FFS facilitators.

Key features of FFS

- IPM skills and concepts are best learned, practised and debated in the field. The field is the best teacher
- Season-long FFS training courses allow all plant, insect, disease and weed development processes and management to be observed and validated over time. IPM training should be carried out over all crop stages
- Farmers must be allowed to actively participate and share their experiences during training to achieve maximum interest and effectiveness. Local or indigenous knowledge of the environment, varieties, pests, etc. must play a major role during decision-making

Deciding when to establish FFS

Besides cost and time considerations, here are some elements to help decide on the kind of training needed, and when FFS might be appropriate.

Presence of FAW	Kind of trainings to gain knowledge on FAW IPM	Modalities
FAW is already established in the community, farmers have some basic knowledge and are concerned about management of the pest	FFS useful to deepen knowledge on IPM and to initiate community monitoring and action. Short courses for larger number of farmers on FAW IPM	If FFS are planned or ongoing, integrate FAW IPM into curriculum. If no FFS are planned, explore possibility of starting FFS or organize short courses for farmers, using discovery-based learning in the field to better understand FAW and to develop community monitoring. Some handouts on FAW at the end of the session can be useful
Some FAW present, but new to farmers; concerns about the new pest	FFS can be useful to learn more about FAW and IPM. Short courses might be useful for farmers to get an understanding on FAW and IPM quickly	If FFS are planned or ongoing, integrate FAW IPM into curriculum Or organize short courses for farmers, using discovery-based learning to better understand FAW and to develop community monitoring. Some handouts at the end of the session can be useful. Then explore whether FFS can be organized in the future
No FAW present yet, some awareness might exist that a new pest is spreading	Farmers might be curious/ anxious about FAW, but they might not want to spend too much time learning about a problem that has not yet occurred. FAW IPM can be integrated in ongoing FFS, but in appropriate, more limited way. Community awareness raising on FAW necessary	If FFS are planned or ongoing, integrate FAW IPM into curriculum focusing on some basic awareness. If the pest cannot be found, discovery-learning will be challenging. Explore whether it is possible to visit a nearby area where FAW is present, or whether a farmer from that area with FAW can share experiences with FFS group. Organize awareness sessions on FAW in the community, and agree on what needs to happen once FAW is found

Source: *Integrated Management of the Fall Armyworm on Maize: a Guide for Farmer Field Schools in Africa* (FAO 2018)

Farmers are expected to gain the following technical knowledge and skills on FAW after an FFS

- Describe the different crop-development stages
- Know IPM principles and why they are important for good management
- Know how to monitor all elements of the agroecosystem, understand relations and interactions between the elements, as a basis for decisions on field management AESA
- Describe plant compensation and its importance for leaf-eating pests
- Know ecological function and life cycles of main pests and natural enemies; be able to recognize and distinguish different pests and natural enemies
- Recognize major diseases, the conditions that favour their development, and possible damage they can cause

- Understand toxicity of different pesticides and how to reduce exposure and use
- Describe effects of pesticides on human health, natural enemies, environment
- Know how to collect information for economic analysis comparing farmers' local practice and IPM practice

Key activities in FFS

A range of tools are used in FFS to enable farmers to learn. The five major activities carried out in the FFS learning process are:

- field studies
- AESA
- special topics (short practical exercises or brainstormings)
- group dynamics and ice breakers
- monitoring, evaluation and learning

Field study designs will be fine-tuned with a FFS group to reflect the local FAW situation (and other challenges in growing maize) and to compare different management options. For example, setting-up a crop compensation study will be an opportunity to better understand how plants can compensate for damage at different stages of the crop.

AESA is a core activity of the FFS (see section on AESA in the Guide for Farmer Field Schools). Field observations are done regularly in the different FFS plots. This is a good time to collect different insects, to see where on the plants they can be found, to discuss which insects are found and their functions (pest versus natural enemy). It can also be useful to go to fields with other crops and to natural vegetation to see if the FAW can be found there. During AESA, farmers also collect data for instance on crop development or on costs of production under different management options, to generate comparisons.

Special topics are experiments which facilitators can conduct with farmers. For instance, “insect zoo exercises” are well suited to learn about functions of insects – pests and natural enemies, about predation and parasitism. Other special topics can contribute to improve understanding of economic threshold levels, or to develop a plan for community monitoring.

Season-long, comparative field studies you can set-up with farmers in an FFS

- Study of the effects of different maize production practices on FAW management
- Comparative maize intercropping studies
- Studies on push-pull intercropping in maize
- Effects of planting dates on FAW infestation and yield loss
- Effects of nitrogen fertilization rates and manure on levels of FAW infestation and yield loss

Short practical exercises you can test with farmers in an FFS

- Insect zoos: observing the lifecycle of the FAW in the field
- Insect zoo: observing the role of natural enemies (farmer friends) in the field
- Testing how to invite local FAW natural enemies in your field
- Community awareness and monitoring for the FAW
- Transect walk: observing various host plants for the FAW in your community
- Scouting and use of traps for FAW monitoring
- Setting up a compensation experiment on maize attack by the FAW
- Testing the use of local controls (ash, soil, sand, lime, soaps, salt, oil)
- Testing the recycling of FAW pathogens (fungi and viruses)
- Preparation of some botanical pesticides
- Spraying pesticides: a practical exercise on pesticide hazards and pesticide risk reduction
- Testing the effects of pesticides on natural enemies and beneficials
- Calculating economic threshold levels and their relation with AESA
- Record-keeping for economic analysis and decision-making

Identification/training of facilitators

The FFS facilitator can be an extension worker or a literate, dynamic farmer. He/she receives training on both technical and soft skills.

Many programmes, projects and government interventions have been conducted using FFS in many African countries in the past two decades. If there are already trained FFS facilitators in the area, they will already know the FFS methodology based on non-formal education but will benefit from a two to four day “refresher course” covering the FAW biology, ecology and management options and exercises and studies you can run in an FFS.

If there are no trained FFS facilitators available, you would need to invite experienced FFS Master Trainers and FAW IPM experts to train a group of 20–25 facilitators through a season-long Training of Facilitator process (TOF) – for example five days per month throughout the cropping season. This would equip facilitators with IPM and FAW knowledge and skills to run FFS and to identify and implement field experiments together with farmers. In between the monthly sessions of the TOF, the facilitators will practice by setting up FFS in their villages every week, and then go back to their TOF at the end of the month to report progress, share any difficulty and explore the steps for the following few weeks of FFS.

6.6 Principles of participation

A participatory approach is based on inclusion and joint learning. Good training courses include a variety of learning activities. Some popular participatory training activities include (but are not limited to) the following:

- interactive lecture/presentation; demonstrations using live specimens to construct/ show the lifecycle, natural enemies or alternative hosts; drawings, pictures and other illustrations; posters and video clips
- introduce the topic, let participants collect the alternative hosts; let them select the hosts
- buzz group sessions: facilitator explains what a buzz group is and demonstrates this – can be used by small groups (two to three people), for example, to differentiate between FAW and AAW. The trainer can pick any of these insects, depending on the situation, and explain to the participants, with examples of when they can be used
- group discussions and presentations
- brainstorming
- demonstrations
- plenary discussions
- problem-solving activities
- debates – one topic, with opposers and supporters and a judge
- simulation
- role-play
- case study
- games and exercises
- equal partnership
- facilitation
- iterative action
- transparency – can be used to level out expectations by communities (e.g. traps are not for management and scouts are not on a paid salary). An opportunity to tell participant things – exactly how they are to avoid expectations (e.g. the number of days to collect data; once given prescription of a pesticide it is not the project paying and the project will not go on forever)
- flexibility
- sharing power and responsibility
- empowerment

Benefits of participation

- Assists in recognizing, tapping into and capitalizing on local knowledge, technologies and capacities
- Encourages community members to voice and find solutions to their issues
- Enhances relevance and applicability of interventions
- Increases effectiveness
- Builds technical and interactive capacity at the local level, fostering self-confidence.
- Develops local leaders and role models
- Generates enthusiasm and enhances sense of ownership and responsibility, creating conditions that are suitable for sustainability

Participation challenges

Participation is not quick, easy or simple. Those who use a participatory approach in training need to be genuinely committed and ready to face various challenges.

The major challenges encountered in a participatory approach include the following:

- social and cultural obstacles, since participation requires attitudinal and behavioural change of all stakeholders
- structural and administrative obstacles
- the nature, mission and policy of the implementing agency
- time, human and financial resources.
- scaling up of participatory initiatives
- learning new facilitative skills

Participatory training approach and techniques

Participatory training is different from traditional teaching in that it encourages participants to be a source of information and knowledge. They actively participate in the learning process.

Many of the principles of participatory training draw on theories of adult learning, which stress that adult learners need opportunities to *think*, to *understand* and to *apply*. To facilitate the desired change in adult learners, experiential activities are more effective than lectures.

Making a training process participatory

Participatory tools and techniques are specific activities designed to encourage joint analysis, learning and action. No single tool or technique is applicable to all situations.

Each tool encourages different levels of participation. That participatory approaches and techniques are specific to a particular situation means there is no blueprint. Participatory training is constantly adjusted and adapted based on the local setting.

Participatory communication

- Communication is a basic tool that helps communities to be involved at different stages of a development process. Extension work is basically an act of communication. Sharing of ideas and of information by extension workers is a large part of their duties. The communication skills of an extension worker are thus the basis of all their extension activities
- Communication was previously largely viewed as the process of passing messages or information from one person to another, but many now view communication as the act of exchanging rather than transmitting information. The purpose of communication is to develop a common understanding
- During communication, the message received is not always the one that the source intends to pass on. The message may be distorted because receivers may interpret or understand the message differently, depending on their experiences and environment. The more channels a message passes through, the more the chances of distortion
- The probability of message distortion is reduced if the source is receiver-oriented, and if feedback is used to know whether or not the message has been correctly interpreted

- Different communication channels also have different effects on the information exchange but there is no perfect medium for communication. An effective medium is one which is accessible to and suitable for the people taking part
- Generally, information should be communicated in a way that suits the needs, levels of understanding and expectations of the audience

A new understanding of communication

Most development programmes use communication strategies that help them to inform and persuade the target community. This top-down approach emphasizes dissemination of information, without paying much attention to indigenous knowledge and local social systems. However, today, communication is no longer a one-way flow of information. It is a process of creating and stimulating understanding rather than just transmitting information. The emphasis is now more on interaction, dialogue and information exchange rather than on attempting to persuade the other party.

Participatory communication aims to facilitate the expression of people's needs and priorities through effective communication processes. It includes giving people access to communication channels and enabling them to participate freely and equally in dialogue, debate and information sharing.

Participatory communication is an empowering and transforming process characterized by a horizontal flow of information based on dialogue. It emphasizes interpersonal, traditional and community-based forms of communication methods and media.

Community and interactive radio programmes facilitate participatory communication. Core elements of participatory communication include the following:

- listening
- dialogue
- action, reflection and reaction
- giving voice to the community
- ownership by the community
- respect for local knowledge, languages and culture
- integration with local communication systems

Community-based FAW taps into and capitalizes on participatory communication and its strengths, views the community as key partners and actively involves them in decision-making processes (such as selection of scouts, selection of villages and selection of strategies and channels of communication), uses local communication channels to disseminate information, uses folk media to sensitize and inform the community, and employs participatory training sessions and meetings

6.7 Non-formal adult education and the role of adult trainers

	Non-formal adult education and role of adult trainers
Learning objectives	• To introduce the basic concepts and principles of adult learning • To understand the factors encouraging adult learning and the roles and functions of a trainer in adult learning • To familiarize participants with a basic understanding of facilitation functions, techniques and skills
Topics	• Non-formal adult education • Basic features and key concepts of adult education • Characteristics of adult learners • How do adults learn best? • The roles and functions of a trainer in adult learning • Facilitation skills • Definition of facilitation • Facilitating functions • Key facilitation skills and qualities
Methods	• Interactive lecture • Visualized brainstorming using cards • Plenary participatory discussion
Additional information	• Pretty, Jules N et al. (1995) <i>Participatory Learning and Action</i> • Financial Literacy Foundation (2006) <i>Adult Education Guide</i>
Material and equipment	• LCD projector, flip charts, marker pens

Rationale

Adult education is different from the normal school system. This section looks at various unique aspects of non-formal adult education.

Non-formal adult education and adult trainers

Extension workers deal with farmers who are adults, and thus have a wealth of knowledge, skills and experience. Adult learning is based on principles and conditions different from those of normal schooling. Unlike children, adults are not as affected by the expectation and influences of teachers and parents. Adult learners have a higher degree of motivation, more experience, are usually more engaged in the learning process and apply the learning more than children.

Adult education is best facilitated in an atmosphere that:

- encourages the adult learners to be active
- promotes and facilitates discovery
- recognizes that mistakes are normal
- accepts differences of the learners
- encourages openness, self-respect and respect of others
- makes learning a cooperative process
- encourages peers to learn together

There are several important characteristics of adult learners:

- **Adults are autonomous and self-directed**
They enter any learning situation as self-directing, independent and self-reliant people. Thus, they must be actively involved in the learning process and need to be free to direct themselves
- **Adults have a wealth of skills, knowledge, and experiences**
They want to contribute and to relate the learning to their skills, knowledge and experiences. Adults learn best when new information builds on their past skills, knowledge and experiences
- **Adults are goal-oriented**
They need to be convinced and to know why they should learn something before they invest their time in it. Trainers must show the adults how the course will help them attain their goals and how it is related to their lives
- **Adults are practical and relevancy-oriented**
The learning has to be applicable to their work or their life to be of value to them. Adults have a strong readiness to learn those things that help them to effectively cope with daily life, to perform a task or to solve a problem. Trainers should show how the course will help the participants in their day-to-day life
- **Adults need respect**
Trainers must acknowledge the experience that adult participants bring to the learning. Adults are more responsive to such internal motivators as increased self-esteem than to external motivators. Trainers need to ensure that this internal motivation is not blocked by such barriers as a poor self-concept or time constraints
- **Adults have different levels and styles of learning**
Trainers of adult learners should identify and adopt different paces and techniques during training

Adult trainer as a facilitator

In facilitating the learning of adults, the trainer has the following roles:

- facilitates group processes to keep the group together and to let it grow as a group and individually
- initiates discussions, articulating unresolved group issues
- manages the heterogeneity within the group
- summarizes and synthesizes information
- appreciates and encourages the group and individuals
- creates a suitable learning environment by pursuing, nudging, pushing and building the learner's confidence

Adult trainer as an educator

In educating adults, the trainer plays the following roles:

- provides new information and concepts
- elicits the experiences and analysis of the learners by setting up structures, asking questions and encouraging discussions
- synthesizes, consolidates and conceptualizes new information and analysis
- directs and manages the structured learning experiences
- uses learning aids effectively

Facilitation skills

Facilitation skills are essential for anyone seeking to guide a group of people through a process of learning or development in a way that encourages all members of the group to participate. Facilitation is the act of encouraging more participation in the learning and development process. It is the creation of an environment that enables participants to exchange ideas, concepts, questions and problems. Many view facilitation as the art of drawing ideas out from, rather than putting ideas into, people's heads. A facilitator is a moderator of participatory learning and the development process. The facilitator's role is to draw out and build on the knowledge and ideas of the different members of a group. The facilitator helps the learners to learn from each other and to think and act together.

Skills and qualities of a good facilitator

The following are some of the key skills and qualities a good facilitator should have:

- strong belief in the capacity of people to learn
- open to change – the facilitator must be willing to learn too
- empathetic, to understand the learners
- sensitive to the needs of others
- a good communicator and observer
- well-prepared for the learning process yet flexible
- creative thinker and doer
- able to deal with sensitive issues and to manage people's feelings
- encourages humour and respect
- keeps time, without being driven by it

Group dynamics exercises

Group dynamics and ice breakers should be interesting to adult learners and do not need to be specific to FAW management but should be relevant to building group dynamics. The facilitator can choose any of the following exercises and explain them to the participants.

1. Getting to know each other

Objectives

- To introduce each participant
- To establish a rapport among participants
- To develop a cohesive working group

Time: 5–10 minutes

Procedure

- Place cut halves of drawings into an envelope/bag
- Let participants pick one each
- Let participants locate the persons who have the other halves
- On locating the person, the partners sit together and get the following information from each other:
 - name
 - occupation
 - job-related information (like specialized skills)
 - previous job experience
 - training schools attended
 - hobbies, etc.
- Give sufficient time for partners to interview each other
- Ask each participant to introduce his/her new friend to the group

Helpful hints

- Make the activity lively.
- All persons present, including guests, must take part
- Introductions should be limited to two to three minutes for each pair
- Participants must learn to introduce partners within the time allocated

2. First-name introductions

Objectives

- To start proceedings on an informal note
- To introduce each participant

Materials: None

Time: Five minutes

Procedure

Each participant is asked to introduce him or herself in turn by simply adding an adjective before their names that begins with the same letter, for example: "I am smiling Sarah"; "I am lucky Lucy"; "I am joking Joe". This can be done when seated, but becomes more fun and active if the participants stand in a circle. Ask each person to accompany their name with a movement or gesture (jumping, shrugging shoulders, smiling, etc.) while stepping into the circle. When they step back it is the next person's turn.

Comment

There is no need to debrief after this exercise. Participants will remember amusing adjectives. The physical movement relaxes participants and puts them at ease with others, while an atmosphere of informality is established.

3. Drawing together

Objective

To raise awareness about the importance of communication within a group.

Materials

- Newspaper
- Felt-tip markers
- Watch

Duration: 5–10 minutes

Procedure

- The participants are divided into small groups of five members. Each member is given a number from one to five
- Each group is asked to make a collective drawing with a marker on a sheet of newsprint paper. They are, however, not allowed to speak and each member is given only one minute for his/her part of the drawing
- The facilitator gives the starting signal for the number ones. After one minute, number twos are signalled over and so on until all the members of each group have contributed to the drawing. The results of the various groups are compared and members should explain what they tried to draw

Discussion

- How many small groups made a coherent drawing?
- How did they feel about collaboration within the group?
- How could they have made a better collective drawing?

4. My corner

Objective

To highlight that individual and group objectives and goals can be combined.

Materials: None

Time: Five minutes

Procedure

- Ask the group to form a circle holding hands
- Ask everyone to choose a corner of the room that is “theirs” but not to tell anyone
- Explain that the objective of the exercise is to ensure that you visit “your corner”
- Discussion and debriefing

Comments

What often happens in this exercise is that individuals doggedly try to persuade everyone to go to their corner and their corner only. As most participants assume they are to visit and stay in their own corner, groups rarely decide collectively to go to everybody's corner in turn, thus satisfying every individual's objective through group cooperation.

5. Folding paper game

Objective

To demonstrate that it is easy for even simple instructions to be misinterpreted by the recipient, especially if ambiguous words are used, or the recipient does not (or cannot) ask for clarification.

Materials

Several sheets of paper (square sheets are most interesting, as ingenious participants could choose to fold it from corner to corner, thus creating a triangle).

Time: 5–10 minutes

Procedure

- Select four participants (ask for volunteers) and ask them to stand in the front of the room facing the remaining group
- Give each of the four participants A4 sheets of paper and these two rules: 1. each person must close their eyes during the exercise; and 2. they may not ask a question
- Instruct them to fold their paper in half and then to tear off the bottom-right-hand corner of the paper. Tell them to fold the paper in half again and then tear off the upper-right-hand corner. Tell them to fold the paper in half again and then tear off the lower-left-hand corner
- Instruct them to open their eyes and display the unfolded paper to each other and the audience

Comments

There is a great probability that the final form of the pieces of paper will not all be the same. Use the following questions to start the debriefing.

- What words in the instructions could be interpreted in different ways?
- How could the directions have been clearer to reduce ambiguity?
- How can we encourage people to ask for clarification when they do not understand something?

6. Handclasp

Objectives

- To show how difficult it is to change ingrained behaviour
- To show how forced change may cause discomfort and therefore resistance

Materials: None

Time: Five minutes

Procedure

- Ask participants to clasp their hands. Each person will have a specific position for his or her fingers
- Now ask them to clasp their hands again, this time putting their fingers in a different position, shifting it one position along

Comments

For the debriefing, ask them:

- How did it feel to have your hands in a different position? (weird, unpleasant, etc.)
- “People resist change.” Do you agree? What is the relevance of this to your daily work?

The main learning point to make is that we all resist change and that therefore we should not expect change to happen automatically or that a new type of behaviour will be sustained.

Module 7: Stakeholder analysis and engagement for effective FAW management

Module 7 Stakeholder analysis and engagement for effective FAW management	
Learning objectives	• To identify key community-based monitoring, early warning and management stakeholders for effective FAW management and understand the role of each stakeholder • To understand the importance of involving the stakeholders and to look into ways of strengthening their involvement • To acquaint participants with concepts and practices of stakeholder and related issues
Topics	• Stakeholder analysis and its uses • Key partners or boundary partners • Techniques for stakeholder analysis
Methods	• Introduction by facilitator • In small groups, identify the key stakeholders, their roles and the linkages. Also look at the challenges facing the stakeholders and ways to overcome these • Presentations and plenary discussions
Activity	• As indicated in methods above
Material and equipment	• LCD projector, flip charts, marker pens

7.1 Stakeholder analysis

Stakeholders are persons, groups or institutions with an interest in a project or a programme or who are affected by it. Stakeholder analysis is an important first step in implementing community-based monitoring, early warning and management of FAW. Stakeholder analysis adds value to the early orientation, analysis and planning of a project. It improves the targeting and timeliness of the intervention to solve the problem or apply appropriate interventions for the right people in a timely manner.

Based on the stakeholder analysis, a plan on how to involve each group in the subsequent stages of the project is developed. The analysis is enriched by the following tools:

- focus group discussions
- matrix ranking (ranking and prioritization of problems and coping strategies)
- Venn diagram (identify proximity to service providers)
- actor linkage matrix (roles and responsibilities of different actors)
- problem trees analysis (understanding cause and effect)

Identifying key stakeholders or boundary partners, mapping their linkages and roles and potential partnerships can be critical in future for sustaining monitoring, surveillance and data collection for sustainable FAW management.

Suggested technique for community-based FAW monitoring, early warning and management stakeholder analysis

The following are some useful techniques that can be used in community-based monitoring, early warning and FAW management stakeholder analysis:

- Participants identify the individuals and institutions involved in or influencing FAW early detection and management. The identified stakeholders can be listed in the first column of a matrix table
- Establish the roles/interests, influences and importance of each stakeholder
- This could be through focused discussions or idea cards. Use a simple description or a scoring method, recording these in subsequent columns in the matrix table
- Additional descriptions, such as the relations and linkages of the stakeholders, can be added. Separately indicate the stakeholders that need to be encouraged to change, those that are to be influenced directly and those that could help or hinder the project

The purpose of stakeholder analysis is to identify all the people and/or institutions who have an interest in, or who can contribute to, the implementation of a project. It also establishes the relative importance and influence of people, groups and/or institutions.

Once the table is complete and the information is synthesized, with the help of a facilitator, the group can map the results into a matrix.

The facilitator will use open questions to check the reasons and logic for the group's decisions: e.g. who are the stakeholders and how are they affected? What are their roles? How can they influence?

Table 8: Example of stakeholder analysis

Stakeholder	Interests	Influences	Importance
Farmers	Reduce crop loss due to FAW	Other farmers in the neighbourhood?	High?
Community extension workers	Consistent and correct information for FAW control is provided to farmers	Other extension officers, farmers, agrovets?	High?
Crop protection researchers working to solve the problem	Sustainable low cost IPM methods for FAW control are developed and made available to the farmer	Extension workers, local government?	High?
Agrovets	Improved availability and access to low risk FAW control products	Farmers, extension workers, local government?	Medium?
Local government (policy makers)	More of the lower risk products are used for FAW control in the community	Agrovets, farmers, extension workers?	Medium?
Maize traders	Continuous supply of maize at the farm level for the wider market	Farmers, consumers?	Low?

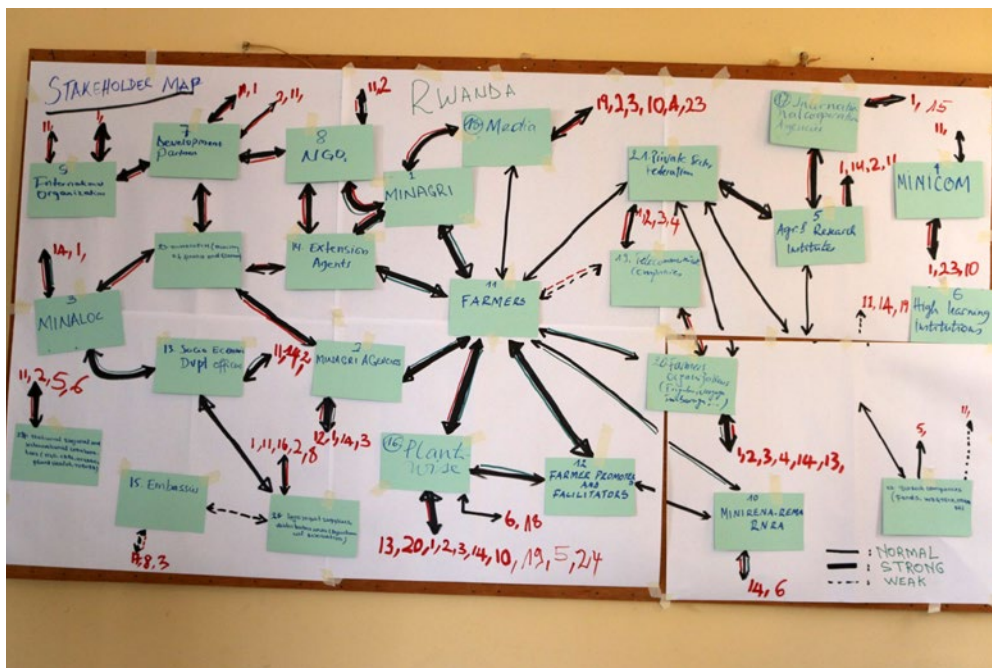


Figure 42: Examples of stakeholders and their linkages © CABI

Module 8: Action planning, training evaluation and closing

Module 8	Action planning, training evaluation and closing
Learning objectives	• To encourage each participant to develop an action plan for scaling up FAMEWS • To familiarize participants with ways of obtaining feedback on the strengths and limitations of the training sessions
Topics	• Action planning and presentation • Final evaluation (e.g. simple questionnaire or plenary feedback) • Training workshop closure
Methods	• Work plan preparation and presentation • Participatory discussion on workshop evaluation techniques • Close of workshop
Material and equipment	• LCD projector, flip charts, marker pens

Rationale

In order to have a similar methodology in scaling up trainings, FAMEWS, monitoring and reporting, it is important that participants are given the opportunity to give feedback on their suitability and modifications that may be required in their situations. Action plans developed will be used to guide implementation and monitoring.

- The facilitator will divide participants in groups of four to five and request them to develop their own activity plan based on the training
- The key activities to plan for will include: district meetings, village/community meeting, training of scouts, monitoring and evaluation indicators and reporting
- The facilitator will design a template that will include: date, venue, number and type of stakeholders to involve and the reporting format for each activity
- Each group will present. All will review and agree on a common format to be used by all for each activity

At the end of the workshop participants will evaluate the workshop (see appendix 6) and the workshop will be officially closed.

Annex 1: Frequently asked questions on FAW

1. Where did FAW come from and how did it reach Africa?

Native to the tropical regions of North and South America, this invasive pest was first detected in Africa in early 2016 in the rainforest zones of Central and Western Africa. Its introduction is not well understood but it is known to fly long distances.

2. What is FAW?

FAW (*Spodoptera frugiperda*) is an insect pest of more than 80 plant species, causing damage to economically important cultivated cereals, such as maize, rice and sorghum, and also to vegetable crops and cotton. It is native to tropical and subtropical regions of the Americas. It is the larval stage of the insect that causes the damage. FAW reproduces at a rate of several generations per year, and the moth can fly up to 100 km per night.

2. What is the difference between FAW and the African armyworm (AAW)?

They are closely related, but have different behaviours and ecologies. FAW rarely displays the “armyworm” behaviour of larvae massing and “marching” across fields. As a native to Africa, the AAW faces a complex of natural biological enemies (predators, parasitoids, diseases). The FAW probably arrived in Africa unaccompanied by its natural enemies, allowing its population to increase even more unchecked than normal.

3. Is maize affected by FAW safe to eat?

FAW mostly eats the leaves of maize. Occasionally it will infest ears as well. Usually such ears are not consumed by humans. While direct damage from FAW does not affect the food safety of the maize, it could make the maize more susceptible to aflatoxin presence, which is harmful to humans and livestock when consumed.

4. Is the current situation going to get worse?

The adult female moth of FAW is a strong flyer and will continue to spread across the continent, and possibly beyond. Populations of FAW may continue to build, as they find more host plants to multiply on, and in the absence of the complex of natural biological enemies (general predators like ants and earwigs, and specialized parasitoids) and a host of entomopathogens (virus, bacteria and fungi).

5. Is there an impact on trade?

Exports of crops that are host plants for FAW from African countries with a confirmed presence of FAW will come under new scrutiny from importing countries that haven't reported FAW.

6. What can be done (by extension workers, agriculture departments, farmers, etc.)?

There are many experiences of, and recommendations for, managing FAW from the Americas. African farmers will need access to information and resources to sustainably manage FAW.

7. What alternative crops can farmers be advised to grow?

Maize is the crop that is most infested now in Africa. As a staple crop, it is unlikely that farmers and their families will want to abandon maize. There are ways of managing FAW in maize, as demonstrated in the Americas.

8. What products can be used to control FAW, and when and how should they be applied?

Some pesticides are effective, yet with low risks to humans and the environment and only those nationally recommended may be used. Other low risk products based on neem and the bacteria Bt may also be used. Anyone applying pesticides should use the proper personal protective equipment.

9. Can FAW be eradicated from Africa?

Unfortunately, no. The adult female moth of FAW is a strong flyer and has rapidly spread across Africa, infesting crops (maize has been the most important to date) in probably millions of hectares of crops. It is far too widespread and numerous to be eliminated.

10. If the FAW is native to the Americas, aren't there experiences and practices that can be applied in Africa?

Definitely. There is a wealth of management experience and research from the Americas that can be shared and tried in Africa. South–South cooperation is important to bring this experience and knowledge to Africa.

11. What pesticides should be used to control FAW?

Pesticides may be needed to control FAW locally. The most effective, lowest-risk, economical, accessible and easily used by smallholders (without sophisticated machinery) need to be determined within each country and across the continent. It's not just a question of the most effective pesticide in a research station; the specific recommendations (active ingredient, formulation, type and timing of application), and their costs and benefits to smallholder farmers must be determined.

12. When should pesticide applications begin in maize to protect it from FAW?

Only when justifiable. Low levels of infestation at certain stages of maize growth may not cause much yield loss. The economic or action threshold must be determined and recommended for each stage of maize growth and for each type of pesticide and application techniques. Costs can vary tremendously. To economically justify their use, the costs of pesticide use must be equal to or less than the value of the additional yield that farmers receive for taking action. The prices that farmers receive for their harvest must also be correctly valued.

13. Are aerial applications of pesticides recommended for FAW?

No. The destructive life stage (the larva) occasionally digs deep into the whorl of maize, making aerial applications of very low efficacy, while spreading pesticides over large areas of non-target habitat.

14. Is the use of biological control a possibility for FAW in Africa?

There are many biological organisms that can help control FAW. Some may be naturally occurring in Africa (general predators, parasitoids and some entomopathogens), and some might need to be introduced from the Americas (specialized parasitoids, predators and certain strains of entomopathogens). The use of botanicals is also an attractive option.

15. What are the next steps for FAW work in Africa?

The first steps are to look at experiences of farmers and researchers from the Americas. The best recommended practices will then be tried and adapted in the field via farmers' field schools. The best recommendations will then be communicated and shared with farmers, farmers' organizations and governments across Africa

Annex 2: FAW monitoring and surveillance tools

- FAW moth trap
- FAW pheromone lure
- FAW moth trap instruction sheet
- Early warning instruction sheet
- Smartphone with FAMEWS
- FAW posters
- FAW leaflets

Using the FAW moth trap

1. Setting up the trap

- Select a secure area that is not too close to a building
- The selected site should be inside or on the edge of a maize field, or in an open area nearby
- Hang the trap up about 1–1.5 metres from the ground using a suspended pole or branch
- Make sure the trap will not be disturbed by animals or children
- Put one of the pheromone lures inside the trap
- The pheromone lure usually needs to be replaced every four weeks to achieve optimum results, depending on temperature, pheromone components and release characteristics
- Five lures will be required for one trap for a single maize growing season

2. Check the trap every week

- Look inside and count how many moths there are
- If in doubt as to whether a moth is FAW, compare with the leaflet
- Record the date and the number of moths
- Throw the moths away
- Leave the trap ready again

3. Change the bait after two months

- Keep the spare pheromone in air-tight bags or an airtight bottle
- Keep the bottle in a cool, dry and safe place
- Replace the bait after two months of use
- Throw away the old bait
- Record that the bait was changed
- Leave the trap ready again

4. Pack up equipment at the end of the season

- Early warning and monitoring stops at the end of the growing season
- Store the trap with the village leaders
- Record that the trap was stored

Annex 3: Training workshop material and equipment

- Early detection and monitoring packs, one per village
- Stationery, including notebooks, pen, pencil, chalk, etc.
- Flip charts, blackboard and/or white board
- Moths and larvae specimens
- Spare traps for practice
- Buckets
- Smartphone and FAMEWS mobile app
- Overhead/LCD projector
- FAW posters
- FAW leaflets

The following link is quite useful for additional resource materials:

FAO Food Chain Crisis – FAW (information resources)

<http://www.fao.org/food-chain-crisis/how-we-work/plant-protection/fall-armyworm/en/>

Annex 4: Examples of stakeholders for FAW community-based monitoring, early warning and management

- National FAMEWS coordinator
- Farmer scouts
- Farmers in village communities
- Researchers
- Agricultural extension workers
- Village leaders
- Pest control product dealers
- NGOs
- Pesticide registrars
- Ministry of Agriculture Migrant Pests Coordination Unit
- National Plant Protection Advisory Committee
- Mass media

Annex 5: Example of exam questions after training

- What are the major differences between FAW and AAW?
- Which crops does FAW attack?
- Which stages of maize does FAW attack?
- How many eggs does FAW lay?
- How many larval instars does FAW have?
- When does a scout begin monitoring for FAW?
- What are the methods for controlling FAW?
- Why is IPM for FAW better than using chemical pesticides?

Annex 6: Example of workshop evaluation

Please assist us in evaluating the training workshop. Please circle the number that best represents your views: 1 being negative, 4 being positive.

1	Were the course objectives clearly evident to you?	1	2	3	4
2	Did you learn what you expected to learn?	1	2	3	4
3	Was the material relevant and valuable to you?	1	2	3	4
4	Was there adequate time allotted to the topic ?	1	2	3	4
5	Were the visual aids (posters, flip charts, specimens, etc.) helpful?	1	2	3	4
6	Was the course valuable?	1	2	3	4
7	How were the presentations/training methods and approaches?	1	2	3	4
8	Was the atmosphere conducive to participation?	1	2	3	4
9	Was the course well-organized, allowing progression from one topic to another?	1	2	3	4
10	Overall, how do you rate this course?	1	2	3	4
11	Were your expectations for the training met?	1	2	3	4

12. If no, why not?

13. Which part of the training did you find most useful?

14. What did you enjoy most about the course?

15. Additional suggestions for improvement?

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