Surveillance Protocol for Fall Armyworm, *Spodoptera frugiperda* for Maize in Nepal

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Government of Nepal

Ministry of Agriculture and Livestock Development

Singhadurbar, Kathmandu

PQPMC

NARC Nepal Agriculture Research Council

CIMMYT International Maize and Wheat Improvement Center

iDE नेपाल Nepal

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Acronyms

CABI	Centre for Agriculture and Bioscience International
CIMMYT	International Maize and Wheat Improvement Center
DoA	Department of Agriculture
FAW	Fall Armyworm
HELVETAS	Swiss Interco-operation Nepal
iDE	International Development Enterprises
IPM	Integrated Pest Management
MoALD	Ministry of Agriculture and Livestock Development
NARC	Nepal Agriculture Research Council
PQPMC	Plant Quarantine and Pesticide Management Center
CTWG	Core Technical Working Group
TF	Task Force
USAID	United States Agency for International Development

Contents

Surveillance Protocol for Fall Armyworm (FAW, *Spodoptera frugiperda)* for Maize in Nepal

1 Introduction:

Surveillance is an official procedure conducted over a defined period of time to determine the characteristics of a pest population or to determine which pest species occur in an area (ISPM No. 5).

2 Target pest:

Preferred Scientific Name

- *Spodoptera frugiperda* J.E. Smith

Preferred Common Name

- English: Fall Armyworm (FAW)
- Nepali: American Fauji Keera (अमेरिकन फौजी कीरा)

Other Scientific Names

- *Caradrina frugiperda*
- *Laphygma frugiperda Guenee*, 1852
- *Laphygma inepta* Walker, 1856
- *Laphygma macra* Guenee, 1852
- *Noctua frugiperda* J.E. Smith
- *Phalaena frugiperda* Smith & Abbot, 1797
- *Prodenia autumnalis* Riley, 1870
- *Prodenia plagiata* Walker, 1856
- *Prodenia signifera* Walker, 1856
- *Trigonophora frugiperda* Geyer, 1832

Common Names

- **English:** alfalfa worm; armyworm; fall armyworm; buckworm; budworm; corn budworm; corn leafworm; cotton leaf worm; daggy's corn worm; grass caterpillar; grass worm; maize budworm; overflow worm; rice caterpillar; southern armyworm; southern grassworm; wheat cutworm; whorlworm
- **Nepali:** American Fauji Keera (अमेरिकन फौजी कीरा), Michaha Sipahi Keera (मिचाहा सिपाहीं कीरा), Khatarnak Fauji Keera (खतरनाक फौजी कीरा), Aakramak Fauji Kira (आक्रामक फौजी कीरा).

3 Surveillance purposes:

The Fall Armyworm (FAW), *Spodoptera frugiperda* JE Smith (Lepidoptera: Noctuidae), a destructive pest of maize crops is an insect native to tropical and subtropical regions of Americas. Fall armyworm (*Spodoptera frugiperda)* was recorded for the first time in Nepal from Nawalpur district (N 27°42'16.67", E 084°22'50.61") on 9th May 2019. The invasion of

this pest was officially declared on 12th Aug, 2019 by NPPO Nepal. From the time of its introduction in the country, the pest has been reported from different districts, including Chitwan, Sindhupalchowk, Sindhuli, Ramechhap, Udayapur, Khotang, Okhaldhunga, Dolakha, Kavrepalanchowk, Lalitpur, Bhaktapur, Banke, Rolpa, Pyuthan, Salyan, Dailekh etc.

FAW larvae can feed 353 different plant species (Montezano, 2018). While FAW has a preference for maize, it can potentially affect many other major cultivated crops, including sorghum, rice, sugarcane, cabbage, beet, groundnut, soybean, onion, cotton, pasture grasses, millets, tomato, potato, and cotton. In the context of Nepal, FAW has been reported in Maize and Sorghum so far. The yield losses from FAW in Africa have been reported ranging from 21 to 53% in Maize.[1] The fecundity of this pest is high (more than 1000 eggs/moth) and can have several generations per year. Adults typically use their natural pre-oviposition period of 3-4 days to migrate over 500 km before oviposition (CABI, 2019).

Though new agricultural pests are periodically introduced into agricultural environment and pose some degree of risk, a number of characteristic factors make FAW a more devastating pest than many others as it consumes many different crops including maize; spreads quickly across large geographic areas and may persist throughout the year in some warm climate areas. In addition to emerging economic and food security impacts, responses to the pest are potential for negative health impacts on human animal and environment as a result of extensive, indiscriminate, and unguided use of synthetic pesticides. Therefore, the purposes of this surveillance are :

- To early detect and manage FAW in a new area
- To determine pest status in an area and measuring changes in the characteristics of pest population or pest incidence
- To compile the pest distribution records and reporting the occurrence
- To compile the host lists in Nepal
- To design and implement pest management tactics
- To raise awareness about pests with growers and the wider community.
- To study changing pest status

4 Scope

The scope of FAW surveillance covers all the provinces and ecological belts with special preference to the maize growing areas. Other alternate hosts of the pest will also be covered and system to be used for conducting efficient surveillance.

5 Justification for surveillance

Maize is growing in 900,288 ha in Nepal, including Terai (147,824ha), Midhill (664,272ha) and High hill (88,192ha) regimes.[2] It is prone to attack by FAW and may potentially go upto

[1] Prasanna, BM; Huesing, JE; Eddy, R, and Peschke, VM (edited). 2018. Fall armyworm in Africa: A Guide for IPM. Accessed on Dec. 22, 2019 on https://www.usaid.gov/sites/default/files/documents/1867/Fall-Armyworm-IPM-Guide-for-Africa-Jan_30-2018.pdf

[2] MoALDC.Statistical Information on Nepalese Agriculture (2016/17). Monitoring, Evaluation and Statistics Division, Ministry of Agriculture, Land Management and Cooperatives (MoALMC), Kathmandu, Nepal.

epidemic level in its growing seasons. The pest has been reported from different maize production areas/districts, including Chitwan, Sindhupalchowk, Sindhuli, Ramechhap, Udayapur, Khotang, Okhaldhunga, Dolakha, Kavrepalanchowk, Lalitpur, Bhaktapur, Banke, Rolpa, Pyuthan, Salyan, Dailekh and so to manage the pest in time and minimize the economic loss. In the next upcoming spring and summer seasons, it will cover most of the maize growing areas as it migrates very rapidly from one place to other places.

6 Insect biology:

Taxonomic tree:

Domain: Eukaryota
Kingdom: Metazoa
Phylum: Arthropoda
Subphylum: Uniramia
Class: Insecta
Order: Lepidoptera
Family: Noctuidae
Genus: *Spodoptera*
Species: *frugiperda*

6.1 Life cycle and field identification

The life cycle is completed in 28-48 days depending on temperature and food availability but in laboratory conditions of Nepal (NARC, Khumaltar), it has been observed to complete in 27-32 days at an average daily temperature of 27°C. It may vary according to climatic conditions. Heavy rainfalls are reported to break the life cycle of FAW. FAW is not reported to have the ability to diapause. In Nepal, considering the low winter temperatures, migratory FAW are supposed to arrive if allowed by environmental conditions and may have variable number of generations. Reportedly, survival rate are around 10 or lesser percentage in case field temperature is between 4 to 14° C.

6.1.1 Eggs

Eggs are creamy white or grey in color covered by light brown wool like material imparting a moldy appearance. The egg is dome shaped: the base is flattened and the egg curves upward to a broadly rounded point at the apex. The egg measures about 0.4 mm in diameter and 0.3 mm in height. The number of eggs per mass varies considerably but is often 100 to 200, and total egg production per female averages about 1,500 with a maximum of over 2,000. The eggs are sometimes deposited in layers, but most eggs are spread over a single layer attached to foliage (Figure 1 A). Duration of the egg stage is observed to be 2 days during the warm summer months at laboratory conditions.

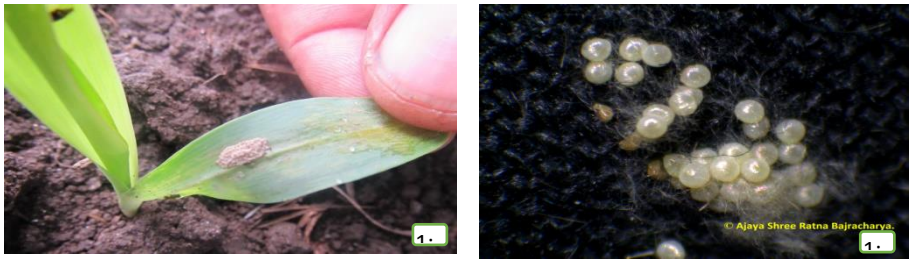

Figure 1: Egg masses of Fall Armyworm (1:A-Egg mass in maize plant in field, 1:B- Enlarged eggs laid in laboratory)
(Photo: 1:A- Dr. Hari K. Shreshta, CIMMYT, 1:B-Ajay Shree Ratna Bajracharya, Entomology Division, NARC)

6.1.2 Larvae

The FAW has six larval instars. The first instar larvae are whitish in color which later changes into greenish color with black head. Grown up larvae measure 30-35 mm long and color varies from brown, gray, yellowish, pinkish to greenish with granulated texture all over the body. The total larval period varies from 14 to 15 days at laboratory conditions. **Inverted 'Y' shaped** whitish marking is present in the head. The best identifying feature of the **FAW is a set of four large spots** (pinacula) that form a square on the upper surface of the 8th segment of its body (Figure2). The grown up larvae have three creamy yellow stripes on dorsal surface which run in parallel manner from thorax to last abdominal segment. Larvae tend to hide themselves during the sunny day (Figure 3).

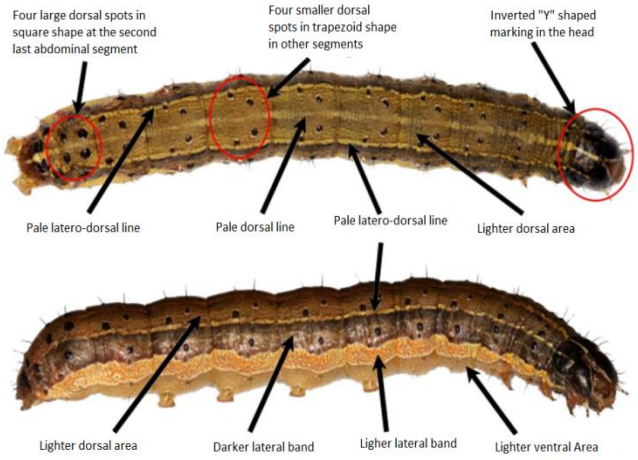

Figure 2: Fall Armyworm characterstic spots, bands and lines
(Adapted from D Visser ARC-VOP Roodeplaat)

Figure 3 : Larvae (3:A- First Instar (Magnified), 3:B- Grown up Larva)
(Photo: Ajay, NARC)

6.1.3 Pupa

The FAW normally pupates in the soil at a depth 2 to 8 cm. The larva constructs a loose cocoon by tying together particles of soil with silk. If the soil is too hard, larvae may web together leaf debris and other material to form a cocoon on the soil surface. The pupa is reddish brown in color (Figure 4), measuring 14 to 18 mm in length and about 4.5 mm in width. Duration of the pupal stage is 6-8 days at laboratory conditions in summer, but may vary according to the climatic conditions.

Figure 4 : Pupae (Left: Laboratory reared, Right: Field collected)
(Photo 4:A- Binu Bhat, Entomology Division, NARC, 4:B- Ram Krishna Subedi, PQPMC)

6.1.4 Adult

Adult FAW moths have a wingspan of 32 to 40 mm. Hind wings in both male and female are white with black line on inner margins. Adult male moth of the insect has distinct markings on the forewings whereas marking on female forewings are not distinct. In the male moth, the forewing generally is shaded gray and brown, with triangular white spots at the tip. Brown and oval shaped spot is present at the center of forewings (Figure 5, 6). The forewings of females are less distinctly marked, ranging from a uniform grayish brown to a fine mottling of gray and brown. Adults are nocturnal, and are most active during warm, humid evenings. Duration of adult life, as observed in the laboratory condition in Nepal is 5-7 days.

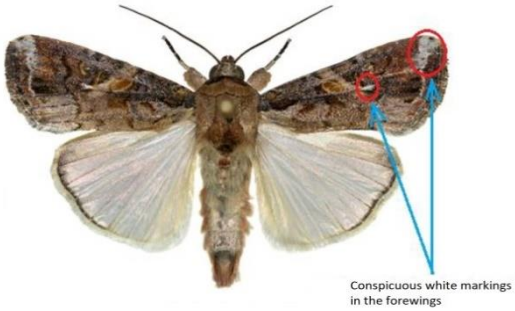

Figure 5: Male fall armyworm moth

(Photograph by G. Goergen)

6.2 Mode of Dispersal:

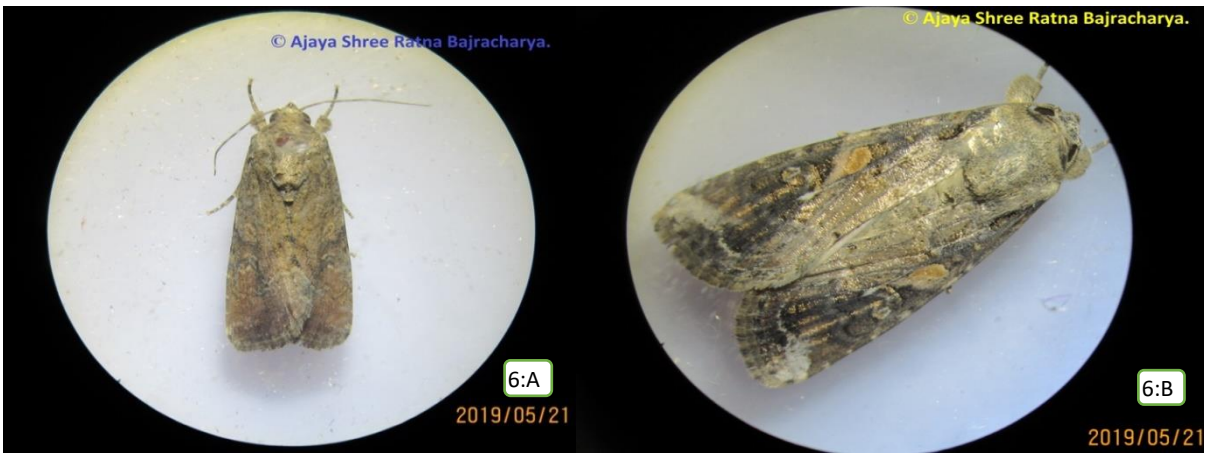

Figure 6 : Adult Moth (6:A - female,6:B- Male)

(Photo: Ajay, NARC)

- Adults typically use their natural pre-oviposition period of 3-4 days to migrate over 500 km before oviposition
- FAW affected plants and plant parts inside the same location; however, it can be transferred from green cobs also.
- This insect is polyphagous in nature therefore it can migrate one crop field to another field for its survival.

6.3 Host range:

FAW is a polyphagous pest. FAW larvae can feed 353 different plant species (Montezano, 2018). However, this pest gives high preference to maize and other Poaceae family (Casmuz et. al, 2010). In the context of Nepal, FAW has been reported in Maize and Sorghum so far.

Major hosts: Maize, Sorghum, Sugarcane

Alternate hosts: Rice, cabbage, beet, groundnut, soybean, onion, cotton, pasture grasses, millets, tomato and potato.

6.4 Feeding behaviour and damage:

The larvae feed and damage the entire plant including leaves, whorls, tassels, silk and ears.

Figure 7: Papery Windows of FAW feeding
Photo: Mahesh, PQPMC

Figure 8: Pinhole symptoms of FAW damage
Photo: Lalit Sah, iDE Nepal

Early (1^{st} -2^{nd}) instars feed by scrapping on the leaf surface leaving the epidermis intact which results in the appearance of elongated papery windows of different size (Figure 7). They also bore into the whorl resulting into small pin holes in the leaves (Figure 8).

Larvae of 3^{rd}-4^{th} instars voraciously feed on the foliage showing ragged and elongated holes on the plant and the size of the holes increases with the growth of the larvae (Figure 8).

After the larva enters the 5^{th} instar, it feeds voraciously, loosing large area of leaves. 6^{th} Instar larvae extensively defoliate the leaves. Severe feeding gives the appearance of maize that has been damaged by hail (Photo 8 and 9). After feeding, the larvae leave behind large amounts of moist saw dust like frass near the whorl and upper leaves (Figure 10).

In the reproductive stage of maize, tassel and ear are the vulnerable parts. Tassel damage is most common which would not lead to economic damage but boring into the corn ear directly affects the yield resulting unmarketable corn ears (Figure 11)

Figure 8 : Foliage damage due to 3-4th Stage larvae
Photo: Madhav Bhatta, MoALD

Figure 9: Damage caused by mature larvae
Photo: Lalit, iDE Nepal

Figure 10: Frass excreted by the larvae
Photo: Hari, CIMMYT

Figure 11: Damage caused on the ear
Photo: S.P. Humagain, PQPMC

7 Design of surveillance program:

7.1 Detection survey:

7.1.1 Introduction

The survey conducted in an area to determine the presence or absence of pest is known as detection survey. Early detection of FAW is important, because of its migratory and invasive nature. Pheromone traps are used to detect and monitor the presence of FAW. In addition, typical damage symptoms detected in the field indicate the potential invasion of the pest. Such fields should be observed to collect and identify the specimens of eggs and larvae of FAW.

7.1.2 Methodology

- Detection surveys must be carried out by the trained professionals at the maize production areas.
- Trapping is a seasonal task; therefore it should be carried out during maize growing season. However, it is also important to ensure monitoring throughout the year to detect the arrival of pest in the locality.

7.1.2.1 Materials

- In total, four hundred and sixty two bucket or funnel trap with FAW lure, gloves, disposable plastic bags, GPS/phone, notepad and pencil.
- Specimen collection vials/jars, cotton, ethyl acetate or carbon tetrachloride, forceps, camel hair brush, spatula, hand lens, paper envelops (butter paper), petridish/small plastic/paper box and zip lock polythene bags.

7.1.2.2 Installation of trap

- Select 2 maize growing clusters purposively in each district of the provinces.
- Setup 3 traps per cluster. The distance between two traps should be at least 50 m.
- In total, 462 traps (77 districts * 2 clusters in each district * 3 traps) should be surveillance in Nepal. If the FAW is detected, then it is not necessary to repeat for the FAW detection surveillance.
- Trap should be installed in an upright position at 0.3–1 meter above the crop canopy using a supporting pole and to avoid barriers at the entrance.
- The lower portion of funnel trap must be tied up with pole to protect from wind.
- The lures have longevity of 4 – 6 weeks so they must be replaced every 4 weeks, and the replaced Septa must be disposed away from the monitoring area.
- A FAW lure septa should be placed in the Bucket or Funnel Trap (Fig. 13).
- The Septa should not be handled with wet hands.
- Mark the trap with a unique number and record its GPS location.

Figure 12 Funnel trap, Lure septa and Bucket Trap with

7.1.2.3 Sample collection

A. Pheromone Traps

- Check and monitor the traps periodically on every Monday morning with FAW catch number recorder. If there are suspected moth in the trap, collect the samples in the early morning with maximum of a weekly interval.
- Collect data using tablets/mobiles with GPS of field locations that will be automatically uploaded to a centralized database by each participating field data collection team. If tablet/mobile-based App is not available data can be collected using paper-based format.
- The mobile numbers of the responsible persons in the local government/AKC/Plant Protection Lab/NARC/other supporting institutions will be recorded centrally so that in any misshapen or delays can be tracked.
- The data will be maintained by PQPMC, NARC, CIMMYT, IDE, FAO….. The access of the final data will be open to all.
- The tablet/mobile users will receive automatic messages during use and by email reminding them to change trap lures every month,

Sample preparation

- Killing insect: Use cotton soaked with 2-3 drops of Ethyl acetate or Carbon tetrachloride for killing insect or press the thorax of insect with thumb and forefingers.
- Packaging: Specimen with folded wings are kept in paper envelops, preferably butter paper.
- Moths must be handled very carefully to have legs, antennae and wings intact.

B. Field

- Collect the suspected specimens of eggs, larvae and pupae from the field.
- Check the lower side of the leaves (more possibility of finding the eggs masses at the early stage) of maize plant.

Sample preparation

- Packaging: The eggs should be kept safely in petri dish/ small plastic/paper box.
- The live larvae should be kept (ages group wise to prevent from cannibalism) in the separate aerated plastic/paper box with fresh and tender leaves.
- The pupae should be wrapped with cotton, tissue paper or soft muslin cloth and kept in the petridish/vials/box.

7.1.2.4 Submission of specimen

- Send specimen to the nearest provincial plant protection laboratory, NARC Station or Agri. Knowledge Centre as soon as possible with sample slip (Annexure 2).
- If the above-mentioned institutions cannot identify the specimen, they must be duly packed with label, and submitted to Entomology Division, NARC or Central Agricultural Lab., DoA.

7.1.2.5 Sample analysis and reporting

- Concerned laboratory, if analyses and identifies the specimen, should submit the report to the NPPO, Entomology Division, NARC, and supporting institutions (CIMMYT, IDE-Nepal, FAO etc.).
- If the specimen is analysed and identified by Entomology Division or Central Agricultural. Laboratory, they have to report to NPPO for the reporting / declaration of insect-pest.

7.1.2.6 Record keeping

- NPPO, in collaboration with responsible laboratories, should preserve the specimen and keep all the record safely. The documentation system should be well maintained by the NPPO and member institutions should have easy access to it.

8 Monitoring Survey

8.1 Area or site selection:

In consultation with the Agriculture Development Directorate of the respective provinces, FAW monitoring surveys will be conducted in all the 7 Provinces representing the Terai, Inner Terai, River basins, Midhills and Upper Midhills/mountains (Table 4).

Table 1: Province wise list of sample clusters FAW Surveillance

No. of districts in a province	Agro-ecological zones			Total	FAW affected districts			Total	Sample districts			Total
	Mt.	Hills	Terai		Mt.	Hills	Terai		Mt.	Hills	Terai	
Province 1	3	8	3	14								
Province 2	-	-	8	8								
Province 3	3	9	1	13								
Gandaki	2	8	1	11								
Province 5	0	6	6	12								
Karnali	5	5	0	10								
Far-west	3	4	2	9								
Total	16	40	21	77								

- Select 2-3 cluster purposively representing different Agro-ecological Zones (AEZ) considering major maize growing areas from the selected sample district.
- Select 5 farmers' field randomly in each cluster.

8.2 Methodology

8.2.1 Sampling frame

1. The FAW surveillance will adopt the multi-stage systematic random sampling.

2. Based on the maize field, compile the list of FAW detected districts for monitoring surveillance of FAW.

8.2.2 Sample size

After detecting, select 30 per cent affected districts purposively from all provinces and Agro-ecological Zones (Table 2).

8.2.3 Field monitoring/scouting

- **When to monitor/scout**
- Begin scouting when the maize plants are small. Scout every 7-14 days.
- Scout one week after an insecticide application; may need to spot-spray to clean up "escapes" (whorl feeders).
- Scout after a rainstorm; may not need to spray today.

- **Preleminary evaluation:**
- Check the worm and its size, and signs of feeding (Table 2).
- Identify maize growth stage that helps to decide for treatment (Table 3).
- Generally, maize has vegetative (seedling/early whorl and late whorl), reproductive (tasselling and cob) stages (**Table 3**).
- Identify the action threshold that depends on the growth stage of maize (**Table 3**).
- Check the weather data (warm/cold, wet/dry, sunny/cloudy, non-windy/windy).
- Nepalese farmers are smallholders. Therefore, they should apply control measure early, but based on Action Threshold (**Table 2 and 3**), when the FAW larvae are small and easy and effective to control. In addition to being the safest time of application, this timing will reduce the FAW larval load as the plants begins to form ears/cobs. Therefore, scouting is stop at tasselling stage and they are not recommended to apply insecticide to apply insecticides at or post-VT because it is too dangerous for the applicator and for his or her family. In addition, if the green cobs are used for human consumption, it is not recommended to use pesticide.

Table 2. Stages of larvae, their damages and control measure (spraying) needed

Growth stage of FAW larvae	Damage symptoms	Susceptive to insecticide	Application methods	Nozzle type	Action threshold	Remarks
Small worms (1-2 instars) and the third instar moves into the whorl	**Feeds on leaves, cluster of small, fresh windowpanes**	**Vulnerable and physiologically more susceptible**	**Foliar at vegetative stage**	**Hollow cone spray nozzle and an appropriate adjuvant for good penetration and coverage**	% SFW	A well-timed rainstorm kill most of 1-2nd instars FAW larvae. If rain forecasting delay your application.
Large worms (4-6 instars)	**Infest the whorl, silk and tassels signs of**	Protected in the whorl and from insecticide	**SPOT**-spray directed at whorl, and approaching	**Hollo cone spray nozzle and appropriate**	% IW	

	horizontal series of holes across a pinch in the leaf, scraping, cutting, tearing and fecal materials ("frass"). When maize is at VT-R3 stage, it is vulnerable to cob damage.	exposure, physiologically resistant to insecticides	pupation	**adjuvant for good penetration and coverage**		
Cob worm (4-6 instars)	Plants with any worms and/or sign of fresh feeding.	Tassel pushes the worms out of the whorl and larvae go to the base of cobs. physiologically resistant to insecticides	**Spot spray the cobs (focusing on base) before they inter cob**	**Hollow cone spray nozzle and appropriate adjuvant for good penetration and coverage**	**% IP**	

Table 3: Plant age-based action threshold (to be revisited)

Growth stage of maize	Action threshold	Measures
Vegetative		
Seedling/ early whorl (VE-V6)	Low: 20% (10-30%)	% SFW, % IW
Late whorl/ mature plant (V7-V12)	High: 50% (30-50%)	% SFW, % IW
Reproductive		
Tassel (VT)	Low: 20% (10-30%)	% IP
Cob (R1-R3)	Low: 20% (10-30%)	% IP

Note: V=vegetative, E=emergence, T=tasseling, R=reproductive, SFW=small fresh window, IW=infested window, IP=infested plant.

- **Scouting pattern**

"W" pattern: When scouting a maize field at seedling stage use "W' pattern, and when maize plants are tall use a "ladder" pattern.

Scouting at vegetative stage: to determine the risk of yield depression associated with foliar feeding and density of small and large larvae.

- Move in a "W" pattern from the first point to the last point.

- At each stop, examine 10 plants either in a row for row planting, and periphery of central point at a clockwise direction in a point. Examine the newest 3-4 leaves that are emerging from the whorl. Focus on current (fresh) feeding damage.
- Record the number of plants (out of ten) with clusters of small fresh windowpanes (FSW).
- Record the infested whorls (IW) out of 10 damaged by large larvae. Examine infested whorl and feeding sigh such as scraping, cutting, tearing and fecal materials (frass).
- Move to next point and record the data similar to the previous point and repeat the same for 5 times in a hectare of field.
- Calculate the %age of plants with SFW and IW.

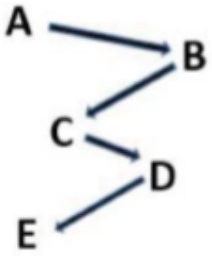

Figure 1. "W" pattern of field monitoring of FAW

Ladder Pattern: to determine the risk of yield loss associated with cob damage. Large worms attack the developing cobs.

- Move in a "Ladder" pattern from the first point to the last point, up to 5 points/location in a ha.
- Examine and record damage symptoms by FAW larvae at first tassel stage.
- Examine the base of the ears and the leaf axils immediately above and immediately below the ears.
- Record damaged plants that have worm or any sign of fresh feeding.
- Calculate the % age of IP.

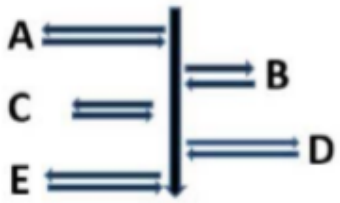

Figure 2. "ladder" patter of maize field monitoring (scouting)

Table 3: FAW Monitoring (Scouting) Data Sheet

Name of the farmer: Address: Contact phone:
Crop: Maize Variety: GPS:
Date of sowing (if staggered/uniform): Fertilizer application: NPK
Time of irrigation: Pesticide use: Inter-cropping:
Sowing methods (Line/scattered):

Pheromone trap data	**Scouting**							Scouting							**Scouting**						
Today's date (observation date)																					
Date last checked																					
Days since last checked																					
FAW moth count																					
FAW moth/trap/day (MTD)																					
Average regional FAW (MTD)																					
Maize growth stage																					
Insecticide application/date																					
Recent rain storm/date																					
Rain forecast (Yes/No)																					
Natural enemies																					
Other insects																					
No. of field scouting data																					
Five stops	**A**	**B**	**C**	**D**	**E**	**Sum**	**%**	**A**	**B**	**C**	**D**	**E**	**Sum**	**%**	**A**	**B**	**C**	**D**	**E**	**Sum**	**%**
No. of plants with small fresh windowpanes (SFW)																					
No. of plants with infested whorl (IW)																					
No. of plants with worms or any feeding																					
Worm head capsule size (s), pls check																					
Note (please condition of plant)																					

*= if insect is not observed on the outside of damaged plant, closely observe inside the whorl

8.2.4 Data Analysis and report writing

The monitoring data will be analysed as appropriate and the results will be utilized for decision making and educational purposes at local, provincial and national level.

8.2.5 Spray or no spray decision: Four Steps Repeat (Prasanna et. Al., 2018)

The combination of monitoring and scouting gives the most reliable guide to spray or no spray decision. A Four Steps Repeat decision making sequence should be considered before taking this decision.

i. Before arriving at the field:
   Step 1: Check the regional moth count
   Step 2: weather report

ii. At the field:
   Stem 3: Check the pheromone trap
   Step 4: Scout the field and apply and action threshold

iii. Repeat:
   - No-spray decision: Scout the field again in 4-7 days
   - Spray decision: Scout the field again in 7-10 days

8.3 Note: In all cases respect the proper re-entry restrictions. Household Survey

Household surveys will also be conducted for assessing the loss caused by the FAW, along with the other social and demographic information. The number clusters and the House Holds Surveys to be covered will be decided in consultation with the stakeholders and based on the resource availability. Plant Quarantine and Pesticide Management Centre (PQPMC) will take a lead role collaborating with related stakeholders.

A set of questionnaire will be developed by PQPMC in coordination and cooperation with relevant DP including CIMMYT, IDE-Nepal and other stakeholders. To perform field survey for FAW, the field staffs of stakeholders and hired enumerators will be trained and used for this survey.

The household survey will be administered to household heads/primary decision-makers at community level in the sample districts based on the sampling frame describe above. The individual questionnaire for HHs will cover the information given in table 3.

Table 3: Information to be collected in HH Survey

Section A: Household information
Section B: Information on all the HH members
Section C: Questions on land utilization, plots cultivated and inputs used
   Part 1: Area of agricultural land
   Part 2: Plots cultivated
   Part 3: Inputs used
Section D: Information on maize (OP/Hybrid)
   Part 1: Types of varieties grown

Part 2: Information on types of maize grown
Part 3: Maize production and sales

Section E: Information about Insect-pest of maize
Part 1: Types of insect-pest observed in the field
Part 2: Information on FAW in maize field
Part 3: Information on FAW in other crops
Part 4: Damage information on maize crop by FAW
Part 5: Yield losses by FAW

Section E: Information on insurance of maize crop

Section F: House Hold Income

8.3.1 Time of survey

After main crop season of maize, the data will be captured from the target HH from winter 2018 to summer 2019. The appropriate time will be on Sept. in each year.

8.3.2 Data collection, cleaning and compilation

1. Data will be collected using standard questionnaire by the staff of USAID and other project partners, enumerators and other stakeholders.
2. Open Data Kit (ODK) survey system will be used in collecting data. The data will be submitted to the Supervisor in each evening for protecting and quality monitoring of data.
3. Data will be cleaned if not meet the standard.
4. All the data will be compiled in a standard format for its analysis.

9 Timing

The surveillance will be carried out round the year. Based on the maize based cropping patterns in the field, the following schedule will be followed.

S. N.	Ecological Region	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Remarks
1.	Terai/Inner Terai													
1.2	Winter													
1.1	Spring													
1.3	Summer													
2.	River Basins and Tars													
2.1	Spring													
2.2	Summer													
3.	Mid Hill (Summer)													
4.	Upper Mid-hill (Summer)													

Note:
= Planting time; =Harvesting time

10 Acknowledgement

The team highly acknowledges the guidance and support provided by the Secretary, MoALD as a chair of the High Level Task Force, to prepare this document. The support provided by the reviewers for their inputs to prepare the document in this is highly appreciated. The guidance and support provided by the members of the Core Technical Working Group and the Development Partners especially CIMMYT and iDE Nepal are also highly acknowledged.

Annexure 1: Pheromone Trap monitoring record sheet

Trap No:

Name of Observer: Designation: Organization: Contact no:

Farmers Name: Address: Contact no:

GPS Co-ordinates : Longitude: Latitude: Altitude:

Trap Installation Date:

Date of Lure replacement:

S. N.	Date of Observation (Weekly Interval)	No of Suspected FAW moths observed	No of other moths observed	No. of other insects observed (if any)	Weather (Warm/cold)	Weather (Wet/dry)	Weather (Sunny/cloudy)	Weather Non-windy/windy	Remarks

Annexure 2: FAW detection record sheet for the specimens received from the field

Name of Organization/Laboratory: Address:

Reporting Date: Contact no.

Farmers Name	Address	Specimen Collectors Name and Address	Date of Specimen collection	GPS coordinates		Altitude (masl)	Date of specimen received	Type of Specimen				Identification result (Y/N)	Date of identification	Identified by	Host	Reported by	Reporting Date	Contact no (Farmer/ Collector)
				Longitude	Latitude			Adult Moth	Egg	Larva	Pupa							

Annexure 3: FAW detection record sheet for the specimens collected from the Pheromone Trap

Name of Organization/Laboratory: Address:

Reporting Date: Contact no.

Trap No.	Farmers Name	Address	Specimen Collectors Name and Address	Date of Specimen collection	GPS coordinates		Altitude (masl)	Date of specimen received	Identification result(Y/N)	Date of Identification	Identified By	Reported by	Reporting Date	Contact no (Farmer/ Collector)
					Longitude	Latitude								

Annexure 4: Sample slip

1. Trap number:
2. GPS coordinate:
3. Altitude:
4. Location name:
5. Collection date:
6. Collector's name:
7. Signature:
8. Address:
9. Contact email and phone:

Annexure 6: Name of HHs in selected clusters of ……district in Province …….

SN	No. of FAW affected clusters	Name of farmer (HHs) affected by FAW	Address	Contact mobile no.	Age	Ethnicity	Male/Female (M/F)
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
…							
40							
Total							

Annexure 7: Conceptual organization of a management structure for a Fall Army Worm National Surveillance Programme