Food and Agriculture Organization of the United Nations

REPORT

Fourth Meeting of the Technical Committee of the FAO Global Action for Fall Armyworm (FAW) Control

2 April 2021

FAW Secretariat, Global Action for FAW Control

Contents

1. Opening Remarks

[1] The Vice-Chairperson of the Technical Committee (TC) and FAO Chief Scientist, Ms Ismahane Elouafi, opened the meeting by welcoming all participants, and expressing her gratitude for their commitment and efforts to halt the spread of fall armyworm (FAW). She noted that FAW is now present in over 70 countries in Africa, the Near East, and Asia-Pacific, and threatens to destroy up to 80 million tonnes of maize, worth USD 18 billion per year, in those regions. This has severe implications for the food security and livelihoods of nearly 600 million people, particularly women who are already vulnerable due to crises.

[2] But progress is being made, including the Steering Committee (SC) endorsement in December 2020 of the General Guidelines for Developing and Implementing Regional Integrated Pest Management (IPM) Strategies (Generic IPM Guidelines), which were developed in collaboration with the TC. As well, National Task Forces (NTF) in the eight demonstration countries have been activated, and most have held workshops with technical experts in their regions to develop regional IPM strategies based on the endorsed Generic IPM Guidelines. Each demonstration country is also developing a two-year work plan that will include FAW monitoring, technology evaluation, demonstration and capacity building as well as regional information-sharing. Geographic zone meetings are being organized, linking each demonstration country with the scale-out pilot countries in its zone, said Ms Elouafi.

[3] At field level, training workshops on IPM, and on monitoring and surveillance for extensionists and farmers have been held in all demonstration countries. Examples from Egypt, Mozambique and Togo were cited. Furthermore, a new Working Group on Resource Mobilization to support the Global Action for Fall Armyworm Control (GA), chaired by DDG Bechdol, has been established; and a network on a Fall Armyworm Migration Monitoring and Early Warning System to be piloted in Asia is under development (Appendix 4).

[4] Ms Elouafi noted that the agenda ahead for the TC includes connecting TC members with NTFs to help with the IPM technology evaluation and demonstration as well as capacity development in national and regional forecasting and early warning systems. The present meeting is therefore focused on two objectives:

- Building consensus on linking TC members to activities at the country and regional levels, and
- Gathering input on design of the FAW Migration Monitoring and Early Warning System (Appendix 4).

2. Welcome Remarks

[5] The TC Chairperson, Mr Robert Bertram, welcomed all participants and conveyed his appreciation for the active engagement and contributions from all members of the TC. Mr Bertram reminded everyone of the TC's approach, which has been to validate technologies, policies on access and safe use of various technologies, and knowledge – especially important when dealing with a novel pest such as FAW. Such useful tools are being provided at regional, national and local levels to ensure farmers are better informed about the pest, he said while emphasizing the importance of ensuring any proposed tools should meet the criteria of efficacy, safety, cost, accessibility and scalability. These criteria support a better understanding of what is available and what can be useful to farmers. Mr Bertram highlighted a major goal of the TC meeting, which was to determine how best to support the rollout of FAW control activities in Asia and Africa – the two regions most vulnerable to the pest.

3. Adoption of the Agenda

[6] Ms Elouafi presented the agenda, which was accepted.

4. Update on Implementation of the Global Action for FAW Control from FAW Secretariat

[7] The Executive Secretary of the FAW Secretariat and NSP Director Mr Jingyuan Xia emphasized the severe risk that FAW poses to food security and warned that of 71 countries that are now reporting FAW, 16 have been designated as "Hunger Hot Spots" – that is, likely to face acute food insecurity – by the UN's World Food Programme. The situation is further worsened by the COVID-19 pandemic, he said, and reminded the meeting of three key objectives of the Global Action (GA): reduce crop yield losses through IPM strategies; prevent FAW spread; and conduct global coordination. Mr Xia also reminded the meeting of the severity and seriousness of the FAW problem, which is why FAO's Director-General launched the GA. Mr Xia noted that this is the first time in FAO's history that such an action has been initiated for a single plant pest.

[8] Mr Xia emphasized the major coverage that the GA provides for regions, disciplines and stakeholders, and described the various coordination bodies that have been set up under the GA. These bodies will oversee the planning and implementation activities of the GA. Mr Xia provided an example from Africa of national successes in implementation efforts: of 10 African countries involved in the GA, over 8 000 plant protection experts and extension agents have received technical training.

[9] He said that the way forward for the TC includes: sharing knowledge generated by its seven Technical Working Groups (TWGs) and advancing new technological information; advancing technical training through webinars and in person training wherever possible, particularly at country and farmer level; and providing technical support to all demonstration (and some pilot) countries to support development and implementation of IPM packages.

5. Update on Preparedness and Prevention from the TWG 7

[10] Mr Chris Dale, Chairperson of the TWG 7 (Preparedness and Prevention), and Assistant Director of Plant Health Surveillance and Diagnostics Programme, Government of Australia, outlined significant achievements to date by the TWG 7. He said experts from the International Plant Protection Convention (IPPC) and from the TWG have together developed globally harmonized FAW prevention, preparedness and response guidelines. These provide guidance for National Plant Protection Organizations (NPPO) in surveillance and response plans and protocols, FAW pest risk assessments and pathway assessments, and national contingency and communications planning. As well, IPPC/TWG experts held a FAW Quarantine and Phytosanitary Measures Virtual Webinar on 9 December 2020; successfully delivered a global FAW prevention, preparedness and response virtual webinar; and have held an interactive question-and-answer session with global participants.

6. Update on FAW Damage in Africa and Asia

[11] Mr BM Prasanna, Director of the Global Maize Program, CIMMYT, reviewed the literature and evidence available on FAW, all of which has helped to demonstrate the severe impacts of the pest. Based on estimates from 12 maize-producing countries in sub-Saharan Africa, FAW has the potential to cause maize losses between 4.1 million and 17.7 million tonnes annually, valued at USD 1.1 billion

to USD 4.7 billion.

[12] Mr Prasanna noted that data shows farmers have not stopped planting maize or shifted to other crops, but they have been suffering significant distress. Further studies are needed to understand the dynamics of FAW infestation and how its impacts over time. The magnitude and dynamics of these impacts will vary across countries and regions. Further studies are also needed on changes in pest management practices by farmers, institutions and the government over time. Research must also relate economic impact with the threshold level of infestation; and which specific individual or combination of control strategies are particularly important in mitigating the FAW-induced income and food security shocks, and provide cost-effective, safe and environmentally sustainable FAW control.

7. Working Mechanisms for TC Members to Support the Implementation of the GA for FAW Control

[13] Mr Bertram suggested that TC members consider two pathways as in work supporting the GA. Path A would continue with global training webinars, knowledge sharing, and dissemination platforms. He also called for input into the development of global platforms, materials and factsheets on topics such as FAW monitoring and early warning, research protocols, analyses of research/demonstration plot data, pesticide selection, policy engagement, and FFS curricula.

[14] Path B would involve in-country collaborations, supported by the FAW Secretariat, and would potentially connect each TC member with FAO FAW Regional Coordinators, FAO Country Office focal points, National Focal Points (NFP)s and NTFs. To this end, FAW Secretariat will circulate a survey to identify the expertise and regional or country foci of individual TC member. Based on this survey, FAW Secretariat will link individual TC member with the NFP and NTF in the chosen demonstration country. TC members would then liaise directly with NFPs and NTFs, facilitated by FAO regional offices.

8. FAW Migration Monitoring and Early Warning System in Asia

[15] Mr Maged Elkahky, Agricultural Officer in the FAW Secretariat, presented a proposal to establish a Fall Armyworm Migration Monitoring and Early Warning System in Asia that would provide benefits for the region by facilitating implementation of an area-wide IPM strategy. The system would provide guidance and early warning messaging for stakeholders for FAW control, and help to reduce crop losses due to FAW. It would also support regional coordination and effective multistakeholder communication to minimize the threat of FAW to food security and farmer livelihoods. Please see Appendix 4 for more information on the Migration Monitoring and Early Warning System in Asia.

[16] A **steering group** on FAW Migration Monitoring in Asia was proposed to coordinate country agreements to join the network as well as joint activities between member countries,mobilize financial and human resources within member countries, develop the workplan with support of the technical group, and follow up on its implementation. The group should also identify gaps in monitoring procedures and report on progress in establishing the FAW migration monitoring network.

[17] A **technical working group** was proposed to create standard protocols for collecting data; provide training on lab analysis of collected FAW samples; develop simulation and predictive models; develop a FAW platform to analyze, map, and visualize the collected data; and develop an early warning bulletin to advise member countries on FAW threats.

[18] The initial project budget is estimated at between USD 4 million and USD 6 million to establish the monitoring sites in pilot countries, conduct capacity building for the monitoring site staff and develop the forecasting model(s).

9. Example for FAW Migration Monitoring and Early Warning System in China

[19] Mr Kongming Wu, Steering Committee Vice-Chair and Vice-President, Chinese Academy of Agricultural Sciences (CAAS), described work that has been done in China with regard to FAW migration monitoring and early warning systems. He reported that after FAW arrived in the Bohai sea area in early September 2019, a migration monitoring system was established, with several elements implemented. That system included **radar observation** that tracked many elements of FAW behavior such as wingbeat frequency, body weight and size, movement direction and flight data. All information collected was analysed as part of the monitoring process.

[20] As well, **pheromone traps** were used and major migration routes of the insect pest were studied. The second element of China's FAW strategy included an early warning system as a part of the Fall Armyworm Management Information System. The early warning system included application and data resource systems and support that would inform farmers what to expect in terms of FAW populations and guide the appropriate responses. Mr Wu said the system is working very well. The early warning system included a regional joint prevention and control strategy, and population prediction, field investigation and control guidance.

[21] These systems helped to hold the yield loss and FAW damage in maize to under three percent. Mr Wu suggested that the GA should consider developing a global monitoring and early warning platform that could include early warning systems in Asia, the Near East, and in Africa.

10. General Discussion

[22] Questions were asked on the process to develop the General IPM Guidelines and Mr Hadi reviewed the processes starting with the agreement at the second TC meeting in July 2020 to collect evidences and peer-reviewed papers on various IPM interventions. At the third TC meeting in October 2020, the TWG chairs were tasked to distill the collected evidence into the Generic IPM Guidelines. The resulting document was submitted in December 2020 to the GA Steering Committee (SC). The SC partially endorsed the document, on the understanding that a few concerns on integration of various interventions would be resolved. Following this decision, rounds of consultation were conducted with the TWG chairs that resulted in a finalized Generic IPM Guidelines. The document is now being shared with NTFs in demonstration countries that have requested such guidance.

[23] Concern was expressed on the way forward for the TC. Mr Xia pointed out that the proposed renewed mechanisms for TC members to contribute to the GA were meant to link TC members to NTFs and thus channel TC members' expertise to practical action on the ground. TC members were asked to submit their comments concerning the proposed renewed mechanisms for TC members to contribute to the GA (Appendix 3) and the concept note on FAW Migration Monitoring and Early Warning System in Asia (Appendix 4) by 9 April 2021. Their inputs will be consolidated in the report to the Steering Committee meeting on 16 April 2021.

11. Concluding Remarks

[24] Mr Bertram concluded by noting that the work of the TC is shifting into a new phase focused on action in the field as well as novel means of sharing information and ideas, such as webinars and symposiums.

Appendix 1: Meeting Agenda

AGENDA ITEMS		DOCUMENTS	PRESENTER	PROPOSED TIME
1	**Opening Remarks**		Ismahane ELOUAFI TC Vice Chairperson, and FAO Chief Scientist	5 minutes
2	**Welcome Remarks**		Robert BERTRAM TC Chairperson, and USAID Chief Scientist	7 minutes
3	**Adoption of Agenda**	01_GA-4thTC_Apr2021	Ismahane ELOUAFI	3 minutes
4	**Update on Implementation of the GA for FAW Control from FAW Secretariat**	PPT Presentation	Jingyuan XIA Executive Secretary of FAW Secretariat, and NSP Director	15 minutes
5	**Update on Preparedness and Prevention from the TWG 7**	PPT Presentation	Chris DALE TWG 7 (Preparedness and Prevention) Chairperson, and Assistant Director of Plant Health Surveillance and Diagnostics Program, Australian Government DAWE	10 minutes
6	**Update on FAW Damage in Africa and Asia**	PPT Presentation	BM Prasanna Director of Global Maize Program, CIMMYT	10 minutes
7	**Renewed Working Mechanisms for TC Members to Support the Implementation of the GA for FAW Control**	PPT Presentation 02_GA-4thTC_Apr2021	Robert BERTRAM	10 minutes
8	**FAW Migration Monitoring and Early Warning System in Asia**	PPT Presentation 03_GA-4thTC_Apr2021	Maged ELKAHKY Agricultural Officer of FAW Secretariat	10 minutes

9	**Example for FAW Migration Monitoring and Early Warning System in China**	PPT Presentation	Kongming WU SC Vice-Chair, and Vice-President of CAAS	10 minutes
10	**General Discussion** - Renewed working mechanisms for TC members - Advice and/or Endorsement for establishment of FAW Migration Monitoring And Early Warning System in Asia - Other related issues		Ismahane ELOUAFI	30 minutes
11	**Conclusion Remarks**		Robert BERTRAM	10 minutes

Appendix 2: List of Participants

	Name, Last name	Organization name, Address
		Technical Committee Members
1.	Ms Ismahane Elouafi, FAO Chief Scientist Vice-Chairperson of the Technical Committee	FAO DDCC
2.	Mr Jingyuan Xia Director NSP	FAO Plant Production and Protection Division (NSP)
3.	Mr Rémi Nono Womdim Deputy Director NSP	FAO Plant Production and Protection Division (NSP)
4.	Mr Robert Bertram Chief Scientist, Chairperson of the Technical Committee	United States Agency for International Development (USAID), Washington, D.C., United States of America
5.	Mr Buyung Hadi, Agricultural Officer	Plant Production and Protection Division (NSP)
6.	Ms Elisabetta Tagliati Chief Technical Advisor	Plant Production and Protection Division (NSP)
7.	Mr Ivan Cruz Senior Researcher (Entomology)	Brazilian Agriculture Research Corporation (EMBRAPA), Brasília, Brazil
8.	Mr BM. Prasanna Director of CIMMYT's Global Maize Program and the CGIAR Research Program on Maize	International Maize and Wheat improvement Center (CIMMYT), Mexico
9.	Mr Malick Ba Country Representative – Niger, West & Central Africa Program	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Niger
10.	Ms Regina Eddy Coordinator, Fall Armyworm Interagency Task Force	United States Agency for International Development (USAID), Washington, D.C., United States of America
11.	Mr Kongming Wu Steering Committee Vice-Chair and Vice-President,	Chinese Academy of Agricultural Sciences (CAAS)
12.	Ms Roma Gwynn Vice-President	IBMA International Bio-pesticides Manufacturers Association, Brussels, Belgium
13.	Mr Ken Wilson Professor	Lancaster University - Insect & Parasite Ecology Group – iPEG, Lancaster, United Kingdom
14.	Mr Johnnie van den Berg Professor; Program Manager: Integrated Pest Management	North-West University, South Africa
15.	Ms Vera Ros Assistant Professor	Wageningen University & Research, Wageningen, Netherlands

16.	Ms Sheila Willis Head of International Programmes	Pesticide Action Network (PAN UK), Brighton, United Kingdom
17.	Mr Chris Dale Assistant Director	Plant Health Surveillance and Diagnostics Program, Plant Health Policy Branch, Biosecurity Plant Division Australian Department of Agriculture, Water and Environment
18.	Mr Emmanuel Okogbenin Director of Technical Operations	African Agricultural Technology Foundation, Nairobi, Kenya
19.	Mr Georg Goergen Entomologist / Biocontrol Specialist	International Institute of Tropical Agriculture (IITA), Benin
20.	Mr Rhett Harrison Tropical Forest Ecologist & Conservation Biologist	International Centre for Agroforestry Research (ICRAF), Zambia
21.	Mr Gregg Nuessly Professor, Director of the Everglades Research and Education Center	University of Florida, Belle Glade, United States of America
22.	Mr David Hughes Associate Professor of Entomology and Biology	Penn State University, Pennsylvania, United States of America
23.	Mr Andy Ward Stewardship Director	Crop Life International, Brussels, Belgium
24.	Mr Mel Oluoch Regional Director	SASAKAWA Africa Association, Kenya
25.	Ms Bruna Takara South-South Cooperation Specialist	Office of South-South and Triangular Cooperation (PST)
26.	Mr Chado Tshering Programme Officer	Office for Small Island Developing States (SIDS), Least Developed Countries (LDCs) and Land-locked Developing Countries (LLDCs) (OSL)
27.	Mr Puyun Yang Agricultural Officer	FAO Research and Extension Unit Office for Innovation (OINR)
28.	Ms Rosanne Marchesich Senior Emergency and Rehabilitation Officer	FAO Emergency and Resilience Division (OER)
29.	Mr Zhongxin Chen Senior Information Technology Officer	FAO Information Technology Division (CSI)
		Observers
30.	Ms Alison Watson Head of the Fall Armyworm Action Plan Secretariat	Grow Asia
31.	Mr Maged Elkahky Agricultural Officer	Plant Production and Protection Division (NSP)
32.	Ms Anne Sophie Poisot Agricultural Officer	Plant Production and Protection Division (NSP)

33.	Mr Baogen Gu Senior Agricultural Officer	Plant Production and Protection Division (NSP)
34.	Mr Qingpo Yang Associate Professional Officer	Plant Production and Protection Division (NSP)
35.	Ms Sarah Brunel Implementation Officer	International Plant Protection Convention (IPPC) Secretariat
36.	Mr Haekoo Kim Programme Officer	Plant Production and Protection Division (NSP)
37.	Ms Verena Wilke Programme Specialist	Plant Production and Protection Division (NSP)
38.	Ms Sandra Cordon Information Management Specialist	Plant Production and Protection Division (NSP)
39.	Ms Svetlana Velmeskina Office Assistant	Plant Production and Protection Division (NSP)
40.	Mr Abera Haile IPM/Entomology Specialist	FAOSFE
41.	Mr Adin Bloukounongoubalan Agricultural Officer	FAO SFW
42.	Mr Tristan Nondah Plant Protection and Production Officer	FAO SFC
43.	Mr Mohamedelhady Sidatt Plant Production and Protection Officer,	FAO SNE
44.	Mr Mathew Abang Plant Production and Protection Officer	FAO SFS

Appendix 3: Renewed Working Mechanisms for TC Members to Support the Implementation of the GA for FAW Control (Updated: 12 April 2021)

Background

The Technical Committee (TC) for the Global Action for Fall Armyworm Control (GA) was first convened on 18 March 2020 to provide technical advice to the Steering Committee (SC) for the GA. Since then, the TC has met three times, and collaborated on a global inventory of integrated pest management (IPM) options. This ultimately produced a set of 'General guidelines for developing and implementing regional IPM strategy' (the IPM guidelines). The IPM guidelines are now being used to develop regional IPM strategies in the eight geographic zones with the work focus on the demonstration countries (Annex 1). Each demonstration country is also developing a two-year work plan that will include FAW monitoring, technology evaluation, demonstration and capacity building, as well as regional information-sharing components.

While the general ToR of the TC has not changed significantly, the specific contributions of the committee may evolve, according to progress of the GA in the field. This short note describes a proposal concerning TC contribution to the GA, given the ongoing activities in the demonstration countries and geographic zones.

TC contributions: the way forward

At the 3rd TC meeting, a proposal was made that the TC can have two lines of contributions: at a global level and at a country level. This proposal is now up for discussion and endorsement of the TC.

A) Global-level contributions

Contributions at the global level are made through the TC meetings, previously held quarterly but under this proposed, held twice a year; and through intersessional work. These contributions are global in coverage and nature. Examples include:

- Development and delivery of global training webinars in collaboration with FAW Secretariat (held four to five times a year on various topics, e.g. host plant resistance, nature-based solutions, FAW monitoring and early warning, pesticide risk reduction);
- Input on, and development of, global platforms, materials and factsheets to support the GA developed in collaboration with FAW Secretariat, e.g. FAW monitoring and early warning, analysis of demonstration plot data, pesticide selection, policy and FFS curricula;
- TC members are invited to propose ideas for the webinars, platforms, materials and factsheets; further development (including resource mobilization, if needed) can be done in collaboration with FAW Secretariat.

B) Country-level contributions

Under this rubric, TC members will be connected and can contribute directly to work in-country.

- FAW Secretariat to take stock of the expertise and target countries of FAW TC members and develop a database;
- FAW Secretariat to connect every TC member with information in the database and with relevant FAO FAW regional coordinators, FAO Country Office focal points, National Focal Points (NFPs) and National Task Forces (NTFs); and also connect TC members with the development and implementation of the regional IPM strategy and work plan;

- TC members to liaise directly with the NFPs and NTFs, facilitated by FAO decentralized offices in the target regions and FAO Country Office Focal Points to support the GA in country;
- Activities to be included in the national work plans and budgets (with resource mobilization in national level to be done collaboratively).

Annex 1: List of geographic zones and demonstration countries in the GA

Geographic Zone	Demonstration Country
Northeast Asia	China
South Asia	India
Southeast Asia	The Philippines
Near East and North Africa	Egypt
West Africa	Burkina Faso
Central Africa	Cameroon
East Africa	Kenya
South Africa	Malawi

Appendix 4: Concept Note: The Fall Armyworm Migration Monitoring and Early Warning System in Asia (Updated: 12 April 2021)

1. Background

1.1 Fall armyworm's significance and threat

Fall armyworm (FAW, *Spodoptera frugiperda*) is a migratory pest that is spreading rapidly across countries' borders. In 2016, the first report that FAW had spread out of the Americas came from West Africa. Since then, it has invaded almost all sub-Saharan countries in Africa before extending its geographical range to the Near East and the Asia and Pacific regions, causing a significant yield losses in maize and other crops. It can cause significant damage to crops in the absence of natural control, good agronomic practices or resistant plant varieties. FAW feeds on over 80 hosts, and a female moth can lay 1 000 eggs during its life. Once established in an area, FAW is almost impossible to eradicate, and it is very difficult to prevent the pest from spreading. Currently, FAW presence has been confirmed in almost all Asian countries including India, Pakistan, Sri Lanka, Nepal, Bhutan, Bangladesh, Myanmar, the Lao People's Democratic Republic, Thailand, Viet Nam, Cambodia, Malaysia, the Philippines, Indonesia, Brunei Darussalam, China, Japan and the Republic of Korea (South Korea).

Preliminary studies from the Indian subcontinent have reported infestation level up to 49.2% on maize (Deole et al. 2018, Chormule et al. 2019, Babu et al. 2019, and Dhar et al. 2019), while Mallapur et al. 2019 reported infestation level up to 100% from Karnataka. One year after the first appearance of this pest in West Africa in 2016, the potential yield loss in 10 maize producing countries in the region excluding South Africa and Kenya was estimated to be around 8.3 M to 21M tons per year which worth between US$ 2.5-6.3 billion. Any official estimation of losses due to FAW in South Asian countries has not been made yet. In Tamil Nadu, India, the state government distributed IRS. 1.86 billion (USD 249 million) as compensation to 239 thousand farmers following pest attack in 2018 [Lamsal et al. 2019].

A range of 11-26% yield losses due to FAW infestation has been reported in the last few years from various countries (Baudron et al. 2019, Kassie et al. 2020, Tambo et al. 2019). Estimating a median 18% yield loss, the yield-at-risk approximately worth USD 13 billion per year in Asia (based on three-year average data in FAOSTAT). It is thus likely that the food security and livelihoods of millions of small-scale farmers in Asia are at serious risk due to this pest.

1.2 Regional challenges

FAW is a major transboundary pest with long-range migration. Year-round survival and breeding typically occur in the warmer regions where host plants are always available and temperatures rarely or never dip below certain thresholds. As a region, Asia is one of the largest producer of maize globally and provides a large area suitable for FAW breeding. Several studies found 13.8°C was the minimum threshold for development below which egg, larval and pupal development stops (Early et al., 2018, Li et al., 2019). Long-range seasonal migration towards new regions that allow FAW survival occurs in spring and summer months. Such seasonal migration can take multiple generations. This means that FAW can arrive in an area along a seasonal migration pathway. It can then establish itself, with new generations of individual ests continuing the migration to new areas as a function of host plant availability and climatic factors. In Asia, for example, modelling studies have predicted trajectories and timing of such seasonal migration from year-round breeding areas in southern China to the northeastern part of the country (Li et al., 2019,

Wu et al., 2019). Another modelling study identified Central Asian regions, such western Afghanistan, southern Kazakhstan and southern Turkmenistan, as potential areas affected by seasonal FAW migration.

Thus, there are at least two major regional challenges in relation to FAW migration monitoring and early warning systems:

(1) **For countries in which year-round breeding occurs**, there is a gap in knowledge, tools and technologies to monitor and predict population and activity peaks of the adult moth; such information could be used to tailor integrated pest management (IPM) actions, such as timing of planting and application of biopesticides.

(2) **For countries along the migration pathways**, there is an information gap in the timing and size of migrating population; such information could be used to prepare for the mitigation actions in anticipation of the arriving populations.

Indeed, in many Asian countries, there is a general gap in FAW monitoring and surveillance which, in turn, hinders effective area-wide IPM efforts in FAW breeding grounds as well as along its migration pathways.

1.3 Proposed solution: monitoring and early warning system

Since FAW eradication is not practically possible, the only efficient approach to manage FAW is by applying area-wide IPM strategies, which is not feasible without a well-structured global/regional FAW monitoring system. FAO has launched the three-year Global Action for Fall Armyworm Control and selected eight demonstration countries to implement an IPM strategy for FAW control. There are three demonstration countries in Asia, including India, the Philippines, and China which will develop IPM packages and facilitate outreach to the pilot countries in Asia. However, as mentioned above, a regionally coordinated monitoring and early warning system is currently absent. This concept note delineates an idea for a FAW monitoring and early warning system, to be piloted in Asia as a component of the Global Action in collaboration with member countries.

The proposed system will complement and strengthen the proactive implementation of IPM measures. The FAW forecasting and early warning information will enable farmers in both FAW breeding areas and along migration pathways to mitigate the FAW infestation by applying the proper measures at the proper time.

In implementing area-wide IPM against transboundary pests, the investments from applying preventive measures across the region – including monitoring and early warning systems – is typically more cost-effective than responding to an outbreak. For instance, in the case of Desert Locust, the 2003-2005 emergency in West and Northwest Africa cost USD 570 million to bring under control. The annual cost of prevention in the emergency area was USD 3.3 million. So, the money spent in the 2003-2005 emergency was the equivalent to the cost of 170 years of preventive control. It is difficult to estimate the cost-benefit ratio of the proposed FAW system; however, the large annual cost of losses in the region above makes the initial investment delineated below seem much smaller in comparison.

2. Goals and objectives

The goal of this initiative is to set up a FAW migration monitoring and early warning system in Asia with three specific objectives:

1. Establish the network and governance on FAW migration monitoring and early warning system in Asia;

2. Develop the required system and strengthen the national capacities of participating Asian countries on FAW monitoring and early warning to suppress the risk factor for outbreaks;
3. Coordinate the regional and national policies, standards and measures to reduce the risk of FAW outbreak by leveraging FAW early warnings and IPM recommendations.

3. Outcomes and outputs

Three outcomes, corresponding roughly to three objectives above, are envisioned with further indicators given in Annex 1:

1. Regional and national coordination mechanism in Asia established to facilitate the implementation of FAW monitoring and early warning;
2. FAW outbreak risk factors in Asia suppressed;
3. FAW-induced crop yield losses in Asia reduced.

Two major outputs are expected from the initiative (Annex 2):

1. The FAW migration monitoring and early warning system coordination structure and mechanism is developed with both steering and technical groups from participating countries. Countries will be brought on board on a voluntary basis through a series of consultation meetings.
2. The FAW migration monitoring and early warning system including data collection, analysis and results delivery sub-systems and supported by monitoring sites in a number of countries in the region. The development of the system will be done in full collaboration with the participating countries and technical partners. The technology platform development will be done in an inclusive manner. Capacity development for monitoring site staff, and on the use of the data collection, analysis and result delivery system, will be conducted.

4. Planning and implementation time frame

We propose to plan and initiate the implementation of the initiative during the next three years (2021-2023). An annual work plan will be elaborated in the future and broad tentative milestones are listed below:

Time	Milestones
2021	• Consultations with key stakeholders • Country on-boarding • Establish governance structure (steering and technical groups) • Survey on pest monitoring infrastructure, identify gaps, identify monitoring sites within on-boarded countries • Develop standard method for data collection agreed upon among on-boarded countries • Develop technical specifications on monitoring tools • Initiate development of the platform in collaboration with CSI and other technical partners (e.g. CAAS, RDA, NIBIO, icipe, etc.)

	• Elaborate budget, write full annual work plan
2022	• Establish monitoring sites (procurement of the tools and technologies); 4-6 country pilot • Build capacity among monitoring sites' staff (training workshops, etc.) • Dry run for data collection • Validate forecasting model(s) in the platform • Dry run for platform outputs • Initiate the design of early warning message delivery to reach farmers
2023	• Routine data collection at the monitoring sites, continue capacity building as needed • Fully functional data analysis and results delivery platform, deliver reports and forecasts routinely • Monitor the impacts of early warning messages on farmers' control of FAW

5. Tentative budget

The initiative is tentatively estimated to cost approximately USD 5 500 000 for the next three years, with the bulk of the spending for establishment of the monitoring sites and capacity building in the participating countries (Annex 3).

The financial resources will be mobilized through multiple channels including FAO FAW Action Fund supplied by FAO FAW Secretariat, the Lancang-Mekong cooperation special fund of China, ASEAN FAW Action Fund supplied by the Secretariat of ASEAN, the FAW research fund from Chinese Academy of Agricultural Sciences and FAO-China YanBao Fund, among others.

Once the cost of operations in each country becomes clear, the steering group – in collaboration with participating countries – will draw up a sustainability plan for the long-term operation of the system. In the future, each participating country is expected to make investments to strengthen their national capacity for FAW monitoring, complying with IPM strategy. This will be the key mechanism for the system's long-term sustainability.

Annex 1. Outcomes and their indicators

The expected outcomes and their indicators include:

Outcome 1: Regional and national coordination mechanism in Asia established to facilitate the implementation of FAW monitoring and early warning.

Indicator 1: A regional network with effective communication and cooperation strategies for Asian countries on FAW migration monitoring established.

Indicator 2: Monitoring sites established in pilot countries and all four components of the migration monitoring and early warning system operational.

Indicator 3: FAW monitoring and early warning capacities of all participating countries enhanced.

Outcome 2: FAW outbreak risk factors in Asia suppressed.

Indicator 1: Forecasts on possible outbreaks as well as timing and magnitude of migration delivered to policy-makers and farmers.

Indicator 2: Pesticide resistance level monitored and acted upon in Asia.

Outcome 3: FAW-induced crop yield losses in Asia reduced.

Indicator 1: Recommendations and IPM technology bank are disseminated to and acted upon by farmers.

Indicator 2: Reduction in maize yield losses in target countries, which have benefitted from the network on FAW migration monitoring and early warning system.

Annex 2. Outputs

Two major outputs are expected in the initiative: 1) the FAW migration monitoring and early warning coordination structure and mechanism developed; and 2) the FAW migration monitoring and early warning system implemented.

1. Coordination structure and mechanism

FAO FAW Secretariat will host and coordinate the establishment and management of the FAW migration monitoring and early warning system. All pilot countries will designate a national focal point to facilitate the establishment of the monitoring system. The secretariat of ASEAN Action Plan for FAW Control, CAAS and NATESC will provide support for FAW Secretariat.

1.1 Regional working groups

Two FAO FAW monitoring working groups will be established. The first working group will be a FAO FAW **steering group** for migration monitoring system in Asia. This group will focus on the following tasks:

- Coordinate the countries' agreement to join the network as well as joint activities between member countries;
- Agree on the work plan with support of the technical group;
- Mobilize the needed financial and human resources within the member countries;
- Follow up the implementation work plan (the needed equipment, training workshops etc.);
- Identify the gaps in the monitoring procedures and propose how to fill those gaps;
- Periodic reports on the progress in the establishment of the FAW migration monitoring network.

The second working group will be the FAO FAW **technical group** for migration monitoring and early warning in Asia, reporting to the FAO FAW steering group. This technical group will focus on the following tasks:

- Create standard protocols for collecting data (data collecting tool, TS of the used monitoring tools, distribution of monitoring sites, etc.);
- Provide training on lab analysis of FAW collected samples;
- Develop simulation and predictive models (simulation of population, simulation of migration pathway, etc.);
- Develop a FAW visual platform to analyse, map, and visualize the collected data;
- Develop EW bulletins to advise member countries of future FAW threats.

1.2. Country participation

Participating countries along the theoretical migration pathways of FAW will be recruited by self-nomination through a consultation process. Attention will be given to countries with capacity development needs for FAW monitoring and early warning.

1.3 Data ownership and privacy

FAO FAW Secretariat will play an important role in communication and dissemination of all resources for the establishment of the system. Data collected from all member countries will be hosted, stored and secured on FAO servers with support from FAO-CSI (FAO-IT service). Participating countries will own their collected data with an agreement it is to be used for research and analysis purposes to develop the predictive models and EW advice. Each country will have full access to its own data, which it could download and use for its own purposes.

1.4 Partnership

Given the complexity of the serious threat that FAW represents, collective regional action is needed, especially for the countries along FAW migration pathways. FAO will work together with Asian regional working groups and all the national task forces to produce and disseminate information and knowledge products and makes these easily available. Universities and research centers within Asia will be encouraged to become involved in the system. Additionally, leading North and South American, Japanese, South Korean, Indian, Australian, U.K. and European research institutions and universities will be invited to collaborate in the initiative.

2. Fall armyworm migration monitoring and early warning system

The initiative will establish a FAW migration and monitoring system in Asia. This system will provide a real-time overview based on GIS technology and analytics of FAW infestations data in Asia. The framework (Figure 1) shows the components of the entire system, split into four main modules: data collection, data warehousing and security, data analysis and result delivery.

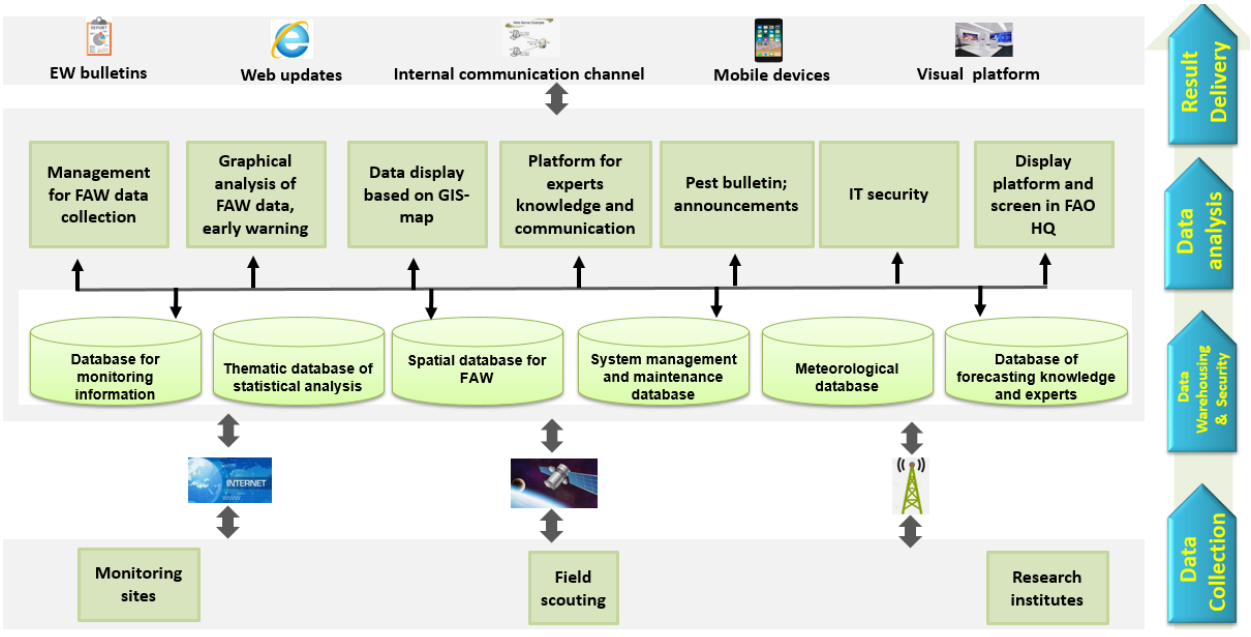

Figure 1. The modules and components of FAW migration and monitoring system

2.1 Data collection and submission

The Asian region will be divided into three areas, with regard to FAW migration cycle: annual breeding areas, transition areas along migration pathways, and migration areas. One to four countries in each area are expected to participate in the initiative. Monitoring sites will be established in the participating countries. One to two monitoring sites per 200 000 to 500 000 hectares are anticipated in annual breeding countries, and one to two monitoring sites per 1 million hectares in countries along the migration pathway. These monitoring sites need to be set on key migration channels, national borders and ecological zoning boundaries. Each monitoring site will be equipped with one high-altitude searchlight, 5-10 sex pheromone traps, as well as corresponding specimen collection and storage equipment. In addition, technical training will be delivered for the staff and workers in the monitoring sites. The monitoring sites will be equipped with monitoring technologies that can collect, and submit data, including pest status and meteorology. Five types of data are envisioned for submission by the monitoring sites:

1. Regular field scouting data, which will focus on development stages of larvae, numbers of larvae per each 100 plants, damage level on leaves and development stage of crop.
2. Vertical searchlight trap data, which will focus on the number of FAW adult moths, the proportion of females and males, and the development stage of ovaries.
3. Sex pheromone trap data, which will focus on numbers of FAW male moth, and the development stage of testes. In this category, it is also recommended that FAW female moths are collected from common light traps or food traps and the development stage of ovaries identified.
4. Types of pollen carrying by trapped moths.
5. FAW strain and pesticide resistance level.

Monitoring sites can submit data by logging into the PC and/or using mobile phone at the field. Training will be provided to the pilot countries, on both the use of monitoring technologies and the conduct of data collection and submission.

2.2 Data warehousing and security

This module collects and integrates data from various sources and keeps them secured. Different kinds of information and data will be stored in related databases, which include monitoring information (i.e. the five types of data submitted by monitoring sites, as above), metadata, and spatial data. The system will provide different security levels for users to authorize their access to the database. With FAO's authorization, the users can review and download their own data (see data ownership and privacy section below).

2.3 Data analysis

This component will include real-time analysis of monitoring data, spatial interpolation analysis of FAW occurrence and population dynamic, simulation of FAW occurrence and analysis of migratory paths. The analyses will be designed to develop forecasts on FAW population status, including possibility and magnitude of outbreaks, and simulations of migration path, according to a number of forecasting models.

Spatial interpolation enables visualization of the distribution and damage severity of FAW, which is convenient for getting a regional overview on FAW status. The simulation function provides insights on how FAW populations change over time with ecology in order to better understand its behavior and guide best management practices. One of the forecasting models is developed by CAAS to simulate the FAW

migration path during a time-period combining the meteorological data. Other models for forecasts on the likelihood and timing of FAW outbreaks can be developed by other technical partners.

2.4 Result delivery

The results of data analyses will be presented as several products:

2.4.1. Visual platform on FAW status and forecast

A visual platform on FAW regional status and forecasts will be developed. This platform will present the FAW status and forecasting to help the FAW Secretariat in coordinating regional IPM strategies on FAW control. It is also designed to assist senior government officials and policy-makers in the participating countries in decision-making.

2.4.2. Early warning information and information dissemination platform

Early warning information will be distributed through multiple channels, such as FAW early warning bulletins, official announcements, mass emails/SMS as well as social media messages to the monitoring sites and extension centers. The multiple ways to deliver early warning information will expand the coverage of messages and meet the needs of farmers, extension workers and decision-makers.

2.5 Technology bank and Expert Roster for FAW monitoring and IPM

This component is designed to store data and photos on the FAW morphological characters, characteristic injury symptoms, distribution, and IPM methods – all of which can be searched by keywords. FAW experts and researchers will be invited to join in the system to communicate with each other and reply to questions on FAW monitoring and control. These experts can also participate in the online diagnostics to facilitate the monitoring sites' work to monitor FAW status and submit data.

2.6 Management and evaluation of the monitoring sites

This component is designed to record, analyse and visualize the performance of monitoring sites in submitting data. The system will also automatically remind the monitoring sites to submit data on a regular basis. At the end of each year, the FAO FAW Secretariat can evaluate the performance of all the monitoring sites, according to the submitted records.

2.7 Information dissemination system

As part of the activities in the initiative, we will review existing rural information dissemination systems, and build or enhance the information dissemination systems in the pilot areas. FAW information dissemination systems will be strengthened by utilizing mobile devices or TV in the pilot areas. The efficiency of the FAW information dissemination to farmers will be improved, to support and promote farmers' adoption of area-wide FAW technology.

Annex 3. Tentative budget breakdown per anticipated activities

Activities and tasks	Funding source	Entity in charge	Estimated budget (USD)			
			2021	2022	2023	**Total**
1. Establish FAW migration monitoring and early warning coordination structure for Asia						
1.1 Establish the steering and technical group		FAW Sec with FAW MMEWS Steering and technical groups	25k	25k	15k	65k
1.2 Evaluate and finalize the selection criteria of pilot countries		FAW MMEWS technical group	10k	--	--	10k
1.3 Develop the criteria and manual for establishment of monitoring sites		FAW MMEWS technical group	20k	--	--	20k
1.4 Survey on the pest monitoring infrastructure, identify gaps, identify monitoring sites within on-boarded countries		FAW MMEWS technical group	20k	--	--	20k
1.5 Coordinate the on-boarding of pilot countries and communication with them		FAW MMEWS steering group	10k	100k	--	110k
2. Establish FAW migration monitoring and early warning system for Asia						
2.1 Establish the technology platform for FAW migration monitoring and early warning system at FAO with technical partners (e.g. CAAS, RDA, Nibio, etc.)		FAO CSI with FAW MMEWS steering and technical groups	600k	400k	100k	1100k
2.2 Issue a call for FAW migration monitoring and early warning system expertise and online diagnostic		FAO CSI with FAW MMEWS steering and technical groups	5k	--	--	5k

Activities and tasks	**Funding source**	**Entity in charge**	**Estimated budget (USD)**			
			2021	2022	2023	**Total**
2.3 Establish a mechanism to host a roster of FAW migration monitoring and early warning system expertise and maintain this roster in a sustainable way		FAO CSI with FAW MMEWS steering and technical groups	5k	--	--	5k
2.4 Coordinate establishment of monitoring sites in pilot countries		FAW MMEWS steering and technical groups	10k	2000 k	--	2010k
3. Training for the monitoring sites						
3.1 Develop manual(s) and protocol(s) for data collection and submission		FAW MMEWS technical group	10k	10k	--	20k
3.2 Organize training workshop for staff and workers in the monitoring sites		FAW MMEWS technical group	10k	1500 k	500k	2010k
Total			725k	4035 k	615k	5375k