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ASEAN ACTION PLAN ON FALL ARMYWORM

BIOCONTROL PROGRAMME

CONCEPT PAPER

ASEAN FAW ACTION PLAN
Supporting IPM Across Southeast Asia

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Introduction

This document sets out the Biocontrol Programme for Fall Armyworm (FAW) across Southeast Asia as part of the ASEAN Action Plan on FAW. The ASEAN Action Plan on Fall Armyworm (FAW, *Spodoptera frugiperda*) sets out a regionally agreed multi-stakeholder model for supporting Southeast Asian countries to monitor and manage FAW based on integrated pest management (IPM) approaches. The Biocontrol Programme is a key component of that IPM approach to FAW management. The proposed programme will focus on five thematic activity areas:

- Information and knowledge-sharing
- Regulation and the enabling environment
- Research capability
  - Virtual ASEAN Bioprotection Research Centre
- Pilots, Demonstrations, and technology transfer
  - ASEAN Biocontrol Accelerator
- Farmer education and training

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Background

FAW was first reported in Southeast Asia in late 2018. It has since rapidly spread, and its presence is now confirmed across the region.

The pest can cause major damage, leading to significant loss of quality and yield, to crops like maize and sorghum. Other crops can also be affected by FAW as it has been recorded feeding on more than 350 different species of host plants. The impact of FAW damage on crop yield and to the livelihoods of smallholder farmers in Southeast Asia is a serious issue for food, feed, and income security in the region; this is further amplified by the severe impact of Covid-19 related implications on agricultural supply chains. Now that FAW is established in the region, management will need to be focused on sustainable control.

ASEAN farmers are in urgent need of effective, affordable, and regionally relevant FAW management solutions that cause no or minimal harm to humans and the environment. Appropriate, cost-effective, practical IPM methods need to be either developed or validated, and further piloted, promoted, and scaled up. This is especially true for biocontrol approaches to FAW control.

On 21 October 2020, Agricultural and Forestry Ministers of ASEAN agreed on a Regional Action Plan on Fall Armyworm Control.

This Action Plan has six objectives and six work programmes which set out a comprehensive plan to build capacity and capability within the region to effectively monitor, manage and control FAW. The Biocontrol Programme is a transversal project which runs mainly across work programmes 2, 3 and 6 of the Action Plan, related to:

Work Programme 2:
Knowledge Generation & Policy Support

2-1: Employ existing knowledge to pre-define IPM-compatible products and emerging 'Good Practices'

2-4: Build capability within the ASEAN research and policy community (to counter current and future invasive pest threats).

Work Programme 3:
Farmer Support & Learning

Development of Training-of-Trainer (ToT) training curriculum and related materials for FAW management

Work Programme 6:
IPM Toolbox (including Integrative Host Plant Resistance, Biological Control & Precision IPM)

6-8: Investigate and optimize biological control tactics.

Women as IPM Leaders

The Biocontrol Programme will also identify opportunities for women empowerment, gender integration and social inclusion across all its activities.

Definitions

This Biocontrol Programme includes classical, augmentative, and conservation biocontrol approaches, as well as bioprotection technologies that are used to manage agricultural pests utilizing specific biological effects (e.g., semiochemicals). These technologies, however, should originate from nature and either be sourced from nature or be nature-identical if synthesised and cause minimal negative effects to non-target organisms (including humans), ecosystems and the environment. Outside the scope of this work programme are any agents that are not able to pass Tier 1 safety evaluation after completion of standard toxicity tests [1].

Classical biological control is the introduction of a biological control agent, usually from the area of origin, to control the target pest in an area where it has invaded (Cock et al. 2010).

Augmentative biological control involves the production and release of natural enemies (parasitoids, predators or micro-organisms) in large numbers into specific crop situations to obtain immediate control of pests in crops with a short production cycle (inundative biological control) or for control of pests during several generations in crops with a long production cycle (seasonal inoculative biological control) (Cock et al. 2010, van Lenteren et al. 2018).

Conservation biological control consists of human actions that protect and stimulate the performance of naturally occurring natural enemies (Gurr and Wratten, 2000) and includes ecological engineering approaches.

Bioprotectants cover a wide spectrum of potential products that include an active ingredient or formulation to effectively manage pests, and which are derived from biological or natural sources. The major categories of biorationals include macroorganisms, botanicals, microbials, and semiochemicals.

Macroorganisms are invertebrate predators and parasitoids (e.g., carabid beetles, parasitoid wasps, entomopathogenic nematodes). Botanicals are plant-derived materials (e.g., pyrethrin and neem). Microbials are based on microorganisms, including but not limited to bacteria (e.g., Bacillus thuringiensis), fungi (e.g., Beauvaria bassiana), protozoans, viruses, viroids and mycoplasmas, and may include entire microorganisms, living and dead cells, any associated microbial metabolites, fermentation materials and cell fragments.

Semiochemicals are substances emitted by plants, animals and other organisms used for intra-species and/or inter-species communication and which have a target-specific and non-toxic mode of action (IBMA).

[1] Pesticide regulation processes in both the EU and US require that the predicted environmental exposure concentration is below a concentration considered safe for non-target organisms. This is formalized as a tiered framework that extends the standard toxicity tests (first tier) to more complex scenarios (higher tiers) which are required in cases where predicted environmental exposure concentration is over the safe concentration for non-target organism (Schäfer et al, 2019)

The Importance of Biocontrol for FAW Control

An effective IPM strategy for control of FAW will employ a variety of integrated approaches including host plant resistance (native and/or transgenic), biological control approaches, cultural control, and safer pesticides, to protect the crop from economic injury while minimizing negative impacts on people, animals, and the environment (Fall Armyworm IPM Guide for Africa, 2018).

IPM is an approach to suppressing pest populations below an economic threshold using a balanced combination of tools and methods and considering profitability, social requirements and the protection of the environment. It requires farmers to have access to multiple pest management tools and to base their actions on keen observations and sound decision making. The regular and systematic inspection of crops and plants for pests and diseases is an extremely important part of IPM and is necessary to identify and quantify pest and disease incidence and make judicious decisions on when and how to initiate controls.

IPM is the underlying approach of the ASEAN FAW Action Plan and, therefore, physical, cultural, and biocontrol methods to manage FAW in the region are prioritised. Chemical treatments are not excluded from the IPM toolbox, however, but they are to be used only when economically justified and needed to control pest populations, as a choice of last resort and selected based on safety, toxicity and effectiveness.

Initiatives in the Region

There is strong interest in the region on biocontrol evidenced by: significant regional participation in the ASEAN FAW Action Plan Biocontrol series (September 2020 to May 2021); pockets of valuable research undertaken in ASEAN universities and research organisations; and government programmes that seek to emphasise an IPM approach to crop management. There is also growing private sector interest in scaling up the use of bioprotectant-related technologies in the field. Significant blockages remain, however, to the effective upscaling, and even introduction and registration of technologies. Farmer access to biocontrol technologies, as well as information and training, is also an issue.

Substantive work to develop guidance on the regulation, use, and trade of biological control agents was carried out between 2013 and 2014 and resulted in the ASEAN Guidelines on the Regulation, Use, and Trade of Biological Control Agents (BCA). In addition, an ASEAN IPM Knowledge Network was set up around 2012 and brought together IPM knowledge resources in one centre; this was disestablished some years later after it had completed its mission.

ORGANISATION	DESCRIPTION
Regional BCA Expert Working Groups on Application and Regulation	Developed the ASEAN Guidelines on the Regulation, Use, and Trade of Biological Control Agents (BCA) has two primary goals: To form a framework for the better implementation of biological control agents (BCA); To provide a template for harmonisation of regulations and thus stimulate regional trade in BCA.
The Asia Pesticide Residue Mitigation through the Promotion of Biopesticides and for the Enhancement of Trade Opportunities Project	The objective of this work is to increase awareness of how pesticide residue issues impact trade and develop methods for overcoming these trade barriers. Project timeline: 2020-2023
IOBC-Asia and the Pacific Regional Section (APRS)	The International Organisation for Biological Control (IOBC) is a global organisation of biological-control workers to promote environmentally safe methods of pest and disease control. IOBC-APRS is one of six Regional Sections and encompasses countries from throughout Asia, Oceania and the Pacific. The IOBC also has a Global International Working Group of Ostrinia and other maize pests (IWGO), within which a subgroup for Fall Armyworm is being established.

ORGANISATION	DESCRIPTION
Centre for Agriculture and Bioscience International (CABI)	CABI is a not-for-profit inter-governmental development and information organisation focusing primarily on agricultural and environmental issues in the developing world, and the creation, curation and dissemination of scientific knowledge. Along with advisory services and information on FAW and IPM, CABI also runs a network of PlantClinics under its PlantWise programme across Southeast Asia and works on various related IPM programmes in Cambodia, Lao PDR, Malaysia, Myanmar, and Viet Nam.
Asia & Pacific Plant Protection Commission (APPPC)	The APPPC is one of several sister international organizations of IPPC responsible for cooperation and harmonization in plant protection. The IPPC boasts a network of international partners from all over the world. These include ten Regional Plant Protection Organizations (RPPOs) working to secure plant health and environmental protection in their regions. The IPPC specifies the functions of RPPOs as: • coordinating National Plant Protection Organizations (NPPOs) and participating in activities to promote and achieve the objectives of the IPPC. • cooperating with other regions to promote harmonized phytosanitary measures. • gathering and disseminating information, in particular in relation to the IPPC. • cooperating with the CPM and the IPPC Secretariat in developing and implementing International Standards for Phytosanitary Measures.
Convention on Biodiversity	The CBD is implemented through the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity is an international agreement that aims at sharing the benefits arising from the utilization of genetic resources in a fair and equitable way.

Attendance in the ASEAN FAW Action Plan Biocontrol Workshop Series has noted significant interest from stakeholders across the region in learning more about the potential of biocontrol for FAW management. Over 4000 people registered for eleven learning events, with over 4000+ views of videos post-event, and growing. There is also increasing attention from the private sector in the potential for registering new bioprotection controls for FAW management in Southeast Asia. A summary of ASEAN Countries' gaps and opportunities related to biocontrol of FAW approaches is provided in Annex One. The goal is to add to this considerably over the coming months to ensure a better understanding of strengths, weaknesses, opportunities and threats to the development and implementation of biocontrol across Southeast Asia. Annex 2 also provides an initial list of known parasitoids, predators and approved microbials for FAW control identified in the wider region, noting that this list will also be further refined over the coming months.

The Project Plan

The work programme is divided into five thematic activity areas.

A. Information and knowledge-sharing

This component will develop and/or share advice, information, and recommendations on biocontrol technologies and practices (based on work done in other regions if applicable) across the region. It will also communicate the results of the whole work programme to the wider community in a coordinated way, to ensure the effective uptake of all outputs of the Biocontrol programme.

Activities include:

- Developing and maintaining a current short (1-2 pages) summary of the programme highlighting key projects and activities and opportunities for joint support and approaches with interested partners and donors.

- Developing a set of informative communication materials for encouraging the effective use of biocontrol, the judicious use of low toxicity pesticides and benefits of biocontrol to existing crop/natural ecosystem compared to conventional practices with conventional chemical pesticides.

- Running workshop/webinar series focusing on new research, products, protocol development, and dissemination of the results of the Programme, including on the outcomes of pilots and field demonstrations. Tracking on new technologies and innovations used in other regions will be undertaken.

- 8 Internships for ASEAN-based young graduate students/scientists/officials, with at least 50% of those internships offered to female candidates, to contribute to ASEAN FAW Action Programme on a part-time basis along with short-term placements with companies/government/and civil society organisations and other partners of the ASEAN FAW Action Plan.

- Knowledge exchange and sharing of experiences/findings as well as awareness-raising to promote uptake of biocontrol in the region, including presenting at meetings, conferences, exhibitions, and relevant events to disseminate programme knowledge/outputs.

- Developing and communicating on a network of biocontrol stakeholders across the region helps to facilitate communication and support joint efforts.

- Linking into, and leveraging off the work of other relevant organisations across Southeast Asia (e.g., IBMA)

- Communicating the results of the Programme to all stakeholders using the Knowledge and Innovation Hub and other relevant forums, where possible.

- Holding an annual Biocontrol Programme conference (1-to-3-day event) that brings together different stakeholders (public and private sector), lead partners, and the latest research to share progress and learnings under the Programme, with potential training side-events.

B. Policy, regulation and the enabling environment

Policy and regulatory systems are key enablers of the development, registration, distribution, and use of biocontrol solutions in the field. Yet, they can also represent significant blockages in the biocontrol system. This component will aim to build trust between private and public sector stakeholders and to encourage collaborative efforts to help design and implement effective policy.

Activities include:

- The involvement of regulators and policy representatives in the pilot and demonstration field activities to help build effective efficacy and testing systems for the development, distribution and use of biocontrol tools in the field.

- Encourage and promote the participation of ASEAN countries in the CABI Bioprotection Portal (https://bioprotectionportal.com/), a free, web-based tool that enables users to discover information about registered biocontrol and biopesticide products around the world.

- A Policymakers and Regulators' Masterclass Biocontrol Training Series to provide opportunities for training, capacity-building and sharing of approaches between regulators in ASEAN (regulator to regulator activities) and the private sector (regulator and private sector interaction) to understand biocontrol systems and their potential to manage FAW in the field.

- Regulator/policy exchange visits to other countries to observe other regulatory systems in practice.

- Support the publication and dissemination of biocontrol-related regulations and contacts for each ASEAN country in a way that can be easily accessed by different stakeholders.

- Production of a discussion paper examining the use of incentives, including short and long-term financial mechanisms and support, to ensure development and implement enabling policies to promote the uptake of biocontrol solutions as part of IPM in the region.

- Promote current FAO/WHO Guidelines on microbial, botanical and semiochemicals as well as the ASEAN Guidance on Biopesticides and understand how these can be better integrated and applied, as well as understand how regulation for fast-track import/registration of BCA or bioprotectants within ASEAN countries could be improved. Guidance on fast-track approaches for adoption and compliance mechanisms for IPPC and CBD implementation will also be considered.

- Incorporating the results of the APAARI/USDA-managed project on "Increasing awareness of how pesticide residue issues impact trade and develop methods for overcoming these trade barriers," into policy and regulatory training and awareness-raising

- Investigate opportunities from pilots, demonstrations, and trials in one country to inform other countries to help streamline, where relevant, approaches to accept biocontrol solutions across the region.

Activities include:

- Evaluate the potential of the "East African Community Harmonized Guidelines for the Registration of Biopesticides and Biocontrol Agents for Plant Protection" and "Guidelines for evaluating and reporting the efficacy of pest control products for plants" as a potential model for enhancing processes for accepting efficacy data and bioprotectants in ASEAN.

- A review of the current legislation and prevailing practices across ASEAN member countries for registration of biocontrol crop protection products (including, biopesticides, and semiochemicals). This includes a review of opportunities to establish 'fast-track' registration channels for low-risk products (e.g., biopesticides, semiochemicals, biological control agents).

- The development of a list for biocontrol products against FAW, including contact information for further information on any such product/s such that stakeholders, including officials, can understand the availability and deployment potential of different biocontrol tools, technologies and approaches.

- Develop protocols to promote and facilitate the exchange of biocontrol agents in the context of the Nagoya Protocol.

C. Research Capability

Research is a necessary component needed for identifying and understanding prospects for improved biocontrol approaches and technologies, as well as to support the sustainable implementation of IPM approaches in the context of Southeast Asia agricultural systems. There are significant opportunities for strengthening research networks, building research capability in the region, and leveraging efforts outside the region to build connectivity and capacity - by connecting ASEAN researchers to outstanding research centres in other countries with specialist expertise in biocontrol.

The Virtual ASEAN Bioprotection Research Centre proposed as part of this programme aims to set up a virtual research centre, modelled on other virtual networks (e.g., the New Zealand Bioprotection Research Centre/Bioprotection Aotearoa). The centre will bring together research organisations based in ASEAN to create a virtual centre of research excellence to accelerate research capability and capacity within the region.

The aim is to connect the ASEAN Virtual Centre to other leading research organisations such as the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO), Chinese Academy of Agricultural Sciences (CAAS), French Agricultural Research Centre for International Development (CIRAD), Japan International Research Center for Agricultural Sciences (JIRCAS), and universities (e.g., US universities affiliated with USAID IPM Innovation Labs).

A more detailed proposal setting out the possible structure, mode of operation and management of the virtual ASEAN Research Centre on Bioprotection will be developed as part of a co-design process.

Activities include:
Development of the virtual ASEAN Research Centre on Bioprotection, which could include:

- Formation of a virtual research hub hosted by an organisation with the appointment of a director and necessary staff to coordinate all activities and contracts managed under the Centre's activities.

- The establishment and strengthening of a bioprotection research network across ASEAN (+ Asia/Pacific) to facilitate better capability and capacity on research on FAW and other economically important plant pests, weeds, and diseases.

- Research exchange programmes between ASEAN researchers and other countries/ASEAN research organisations working on biocontrol, e.g., potential to apply for Talented Young Scientist Programme research opportunities in China.

- PhD and post-doctoral studies within ASEAN-based universities but also with institutions from outside the region (e.g., Australia, China, Japan, NZ, US-based universities)

- Training workshops and webinars for researchers to share information, work, results and improve research skills

- Development of a strategic research programme with funding for priority research topics to include the consideration, amongst other topics, of:

    - Assessment of natural enemies (incl. parasitoids, predators, and entomopathogenic microorganisms) currently present in the field to identify the dominant parasitoids or predators in different cropping seasons/country, and research their effectiveness attacking FAW, artificial rearing and release techniques.

    - Risk factor analysis to help in the formulation of the decision guide in the management of FAW and other plant pests and diseases.

    - Applied and participatory research to improve knowledge of current farming systems and trial different ways to embed IPM thinking into maize and other crops and mixed farming/rotating/landscapes to help manage FAW and other plant pests and diseases.

    - Determining factors affecting the abundance of natural enemies, including production practices such as intercropping and weeding, pesticides, pest density, etc, and development of conservation biocontrol practices accordingly through farmer participatory research approach.

    - Carrying out host-specificity tests of classical biocontrol agents in a quarantine facility for potential importation and release for a permanent establishment in the field and long-term pest control.

    - Evaluation of side effects of pesticides on natural enemies, including sublethal effects.

D. Pilots, Demonstrations, and the ASEAN Biocontrol Accelerator

Undertaking pilots and demonstrations in the field are necessary to help prove biocontrol approaches and technologies as effective tactics in the IPM toolbox. Providing clear pathways to market for biocontrol technologies, to ensure that safe and effective products are accessible to farmers for use, is also important. This component will support efficient process pathways for product development, acceptance, and distribution of solutions by the formation of an incubator. This incubator will use selected exemplar products to provide regional-level case studies for improving the biocontrol supply chain to accelerate biocontrol uptake across Southeast Asia.

The ASEAN Biocontrol Accelerator will purposefully bring together the private sector with public sector stakeholders, farmers, and agronomists to catalyse new relationships, develop pathways to registration, and identify scale-up opportunities in the field. It is envisioned that the Accelerator will also be used to identify current blockages in the system that slow down or prevent the introduction, deployment and use of bioprotection technologies in the field in Southeast Asia. Once identified, the accelerator will attempt to find solutions to address barriers, accelerate progress and inform future modifications to the technology pathway –through the creation of model exemplars/pathways for the region to learn from collectively.

A more detailed proposal setting out the possible structure, mode of operation and management of the ASEAN Biocontrol Incubator will be included as part of the co-design process of the Virtual Centre.

Activities include:

- Development of an ASEAN Bioprotectant Accelerator organisation that will develop:
    - Exemplar process pathways to market: Identify priority products/approaches, that will act as regional case studies, and that has shown proven effectiveness in other regions for FAW control (to include a selection of biocontrol strategies e.g., a natural enemy, microorganism, botanical, semiochemical) and as part of a joint country/company/research initiative, move the product through the import/export/plant health/efficacy testing/dossier submissions/evaluation over 2 years, so that products are ready for farmer distribution and field-use. The products will be chosen with an open call for submissions based on criteria, including the need for the technology for IPM, maturity of the product, proven efficacy data, funding from the company, cost-effectiveness for farmers, country-partner agreement, business plan, etc..
    - Exemplar process pathways to market development case studies: Identify 2-3 products/approaches that demonstrate some effectiveness but need further testing and efficacy for FAW control where incubation needs a longer time to achieve market readiness. Selection will be through an open call with criteria.
    - Exemplar process pathways to the development of regional production from new or novel formulations: identify new formulations/tools that are emerging from local Southeast Asian research laboratories or organisations that need support or help (matching making) to achieve scale-up and/or commercialisation

Activities include:

- Provide or help disseminate analysis and overview of the ASEAN biocontrol industry drawing on the work of other programmes and or organisations where possible.

- Engage manufacturers to develop pilots and demonstrations in the field of biocontrol solutions and to share results with the Biocontrol Programme

- Collaboration with IBMA, including the potential to form a possible Southeast Asian chapter of IBMA.

- Case-study development of the benefits of biocontrol as part of a resistance management plan, drawing on field studies and experiences from other regions and potential field pilots in ASEAN.

- Communicate the learnings and results of pilots, demonstrations and incubation activities into policy and regulator training and learning sessions (component 2) as well as contribute and apply knowledge in the context of the ASEAN Resistance Management programme.

E. Farmer education and practitioner-based training

Farmer education is a critical element to the effective use of biocontrol solutions in the field and their long-term uptake by farmers in the region. This is often an overlooked activity but is important to ensure that biocontrol approaches are well implemented, accessible, effective and meet the needs of farmers to effectively manage fall armyworm and other plant pests, weeds and diseases. Furthermore, farmers need strong support when changing behaviours and incorporating biologicals into business-as-usual practices. This includes being able to use the products properly and to be convinced of their performance. The training of agronomists and agricultural extension advisors, who are advising farmers, is also a key element of this component.

Activities include:

- Survey farmers and agronomists to understand where they get their technical information from.
- Survey farmer's knowledge, attitudes, and practices (KAP) towards, and uptake of IPM and bioprotection approaches in maize crops and understand barriers to use.
- Understand the potential for community-based approaches for capacity building and awareness-raising on managing FAW through an IPM approach and make linkages to the Women as IPM Leaders Programme under the ASEAN FAW Action Plan.
- Develop, implement and evaluate Trainer-of-Trainers programme targeted at extension staff at the local level or through plant doctors, on the use of biocontrol for FAW control, in at least 3 regions/countries. These extension agents could be from the public or private sectors operating in the country.
- Investigate the feasibility of appropriate business models for a natural enemy mass production unit adapted to local conditions.
- Investigate the potential use of demonstration fields to model biocontrol approaches for farmer learning.
- Online and in-person training of local partners, practitioners, agronomists on specific methodologies/subjects where this is needed, for example, sampling of natural enemies, host specificity testing, insect rearing, impact assessment, etc. An analysis of training needs will be conducted.
- Online and in-person training of local partners, practitioners, agronomists on specific biocontrol technologies where this is needed, for example, use of semiochemicals for FAW control, efficacy trials and interpretation, etc. An analysis of training needs will be conducted.

Project Duration

Five years aligned with the ASEAN FAW Action Plan (2021-2025)

Partners

A multi-stakeholder and cross-disciplinary approach will be taken to mobilize all the relevant stakeholders/institutes at different levels in the target ASEAN countries to ensure local ownership and effective implementation of the project. The ASEAN FAW Action Plan Secretariat will seek to work inclusively with a broad range of stakeholders from across ASEAN including Government regulators/Department of Agriculture/Plant Protection Extension Agencies/Research Institutes. In addition, key partnerships will be pursued with CABI, IPP-CAAS/MARA-CABI Joint Lab (China), CIRAD, CSIRO (Australia), CGIAR, GIZ, JIRCAS, Bioprotection Centre/ Plant and Food Research (New Zealand), USDA, USAID, SEARCA, APAARI, and farmers groups. The private sector is invited to play a key role in the programme through sponsorship of the Programme as well as through joint projects, demonstrations, pilots, and participation if selected in the ASEAN Bioprotection Accelerator.

Project Management

The programme will be coordinated by the ASEAN FAW Action Secretariat. It is proposed that CABI will be appointed as a technical advisory partner of the Biocontrol Programme and help lead specific themes or activities (e.g., farmer education and training, certain specialised communications) along with the appointment of a host institution for the Virtual ASEAN Research Hub on Bioprotection. The Virtual Hub will be run autonomously by the host and partners - but connect to the Biocontrol Programme to ensure a joined-up approach. Other consultants and organisations may be called upon to help deliver activities under the Programme. These will be chosen based on capability, experience, funding support and must have a substantial footprint already established in Southeast Asia.

A project committee will be drawn from organisations and experts involved in delivering activities under the Programme, supplemented by additional private and public sector stakeholders by nomination by the Secretariat. Substantive donors to the programme will be invited to participate in the committee. The Secretariat will make the final decision on members of the project committee, although the approach taken will be as inclusive as possible in the initial development of the programme.

Drawing on considerable resources and networks of existing organisations in the region is important. The project committee should consider carefully how to utilise existing organisations and structures in the region to work on various activities. Further, it is envisioned that the resources, learnings and outputs of the Biocontrol Programme actively inform other Programmes under the ASEAN FAW Action Plan, in particular the Resistance Management Programme.

Where possible, projects requiring partners, including country-level participation, will be advertised in open calls which will seek collaborators for activities and funding. Interested stakeholders, including government and private sector representatives, are also encouraged to approach the ASEAN FAW Secretariat to suggest interest in developing activities and projects that align with this programme.

The Biocontrol Programme will also identify opportunities for women empowerment, gender integration and social inclusion across all its activities and report annually on progress.

Annex 1: Summary of ASEAN Countries' Gaps and Opportunities in Biological Control of Fall Armyworm (drawn from ASEAN Action Plan on Fall Armyworm) - Incomplete

Country	Gaps/Opportunities in FAW Biocontrol
Brunei Darussalam	• The Plant Entomology Unit has an inventory of natural enemies in Brunei Darussalam that could be explored for a project on the production of biological control in the country. • Lack of research currently on biological control measures and underutilization of pheromones, biopesticides and natural enemies.
Cambodia	• Lack of Research on how to control FAW and implementation of a FAW Management Strategy Plan • Survey and monitor FAW parasitoids such as *Trichogramma* sp., *Telenomus* sp., *Cotesia* sp.
Indonesia	• Conduct more research on biological control based on IPM. Monitor natural enemy population dynamics, evaluation of different pesticide practices and biopesticides; using sentinel prey to evaluate effectiveness of existing biocontrol agents.
Lao PDR	• Apply new experience (use of biocontrol agents). • Provide biopesticides.
Malaysia	• Combination of control measures to reduce the FAW population instead of depending on pesticides.
Myanmar	• Raising awareness and approval for the control action for different stages of Maize plant and pest stages by using different types of pesticides (e.g., Biopesticides, Natural enemies, soft pesticides, safe crop protection pesticides). • Mass production of effective biocontrol agents at the country level.
Philippines	The Bureau of Plant Industry is currently developing the National Fall Armyworm Action Plan, with the following activities: • Use of biological control agents and lures. • Need to strengthen programs for insecticide resistance monitoring and farmers' awareness on the importance of window-based insecticide rotation to lengthen the effective insecticides against FAW since only a few numbers of commercially available insecticides with proven high efficacy. • For FAW initiatives, the Department of Agriculture, and its sub-agency (FPA, BAFS, BPI) and National Crop Protection Centre formed the FAW task force. Through this task force, morphological and molecular identification of FAW was confirmed and validation of its presence was confirmed to almost 200 municipalities from Luzon, Visayas and Mindanao. • On-going projects related to integrated pest management of FAW implemented by National Crop Protection Centre: (1) Biological Control of FAW using entomopathogens; (2) Identification and Evaluation of Natural Enemies against FAW; (3) Development of an Early Warning System against FAW, Phenology, and Distribution Modelling; (4) Insecticide Management and Susceptibility Studies on FAW.
Singapore	• The concern is the impact of FAW on the garden city and edible crops currently grown in Singapore i.e., leafy & fruited vegetables, under which scenario biological control will be actively explored
Thailand	• Make biopesticides and biocontrol agents available.

Annex 2: Parasitoids, Predators, Microbials of Fall Armyworm in Asia - Draft List

Country	Parasitoids	Type	Predators	Microbials
India (Sharanabasappa et al. 2019)	*Coccygidium melleum* (Hymenoptera: Braconidae) *Campoletis chlorideae* (Hymenoptera: Ichneumonidae) *Eriborus* sp. (Hymenoptera: Ichneumonidae) *Odontepyris* sp. (Hymenoptera: Bethylidae) *Exorista sorbillans* (Diptera: Tachinidae) *Cotesia flavipes* (Hymenoptera: Braconidae) *Chelonus formosanus* (Hymenoptera: Braconidae) *Telenomus* sp. (Hymenoptera: Platygastridae) *Trichogramma* sp. (Hymenoptera: Trichogrammatidae)	Larval parasitoids, Egg-larval parasitoid, and Egg parasitoids	*Forficula* sp. (Dermaptera: Forficulidae) *Harmonia octomaculata* (Coleoptera: Coccinellidae) *Coccinella transversalis* (Coleoptera: Coccinellidae)	*Nomuraea rileyi* (Ascomycota: Clavicipitaceae)
China (Wan et al. 2021; Cheng et al., 2019; Li et al. 2019; Ning et al. 2019; Huang et al. 2020; Tang et al. 2020; Wang et al. 2020)	*Telenomus remus* (Hymenoptera: Platygastridae) *Trichogramma pretiosum* (Hymenoptera: Trichogrammatidae) *Trichogramma dendrolimi* *Trichogramma chilonis* *Chelonus munakatae* (Hymenoptera: Braconidae) *Cotesia glomerate* (Hymenoptera: Braconidae) *Microplitis similis* (Hymenoptera: Braconidae) *Diadegma semiclausum* (Hymenoptera: Ichneumonidae) *Euplectrus laphygmae* (Hymenoptera: Eulophidae) *Exorista japonica* (Diptera: Tachnidae)	Egg parasitoids Egg-larval parasitoids Larval parasitoids	*Sycanus croceouittatus* (Hemiptera: Reduviidae) *Chlaenius bioculatus* (Coleoptera: Carabidae)	*Beauveria bassiana* (Hypocreales: Cordycipitaceae) *Metarhizium rileyi* (Hypocreales: Clavicipitaceae)
Nepal (Khatri et al. 2020)	*Telenomus remus* *Trichogramma chilonis*	Egg parasitoids	Ladybird Earwigs Ground beetles Assassin bugs	
Pakistan	*Chelonus formosanus* (Hymenoptera: Braconidae)	Egg-larval parasitoid		
Bangladesh	*Trichogramma chilonis, Telenomus remus* *Habrobracon hebetor*	Egg parasitoid Larval parasitoid		
Cambodia	*Trichogramma* sp. *Telenomus remus*	Egg parasitoids		
Indonesia Parasitoids and predators (Tawakkal et al. 2020) Microbial agents. (Herlinda et al., 2020)	*Apanteles* sp. (Hymenoptera: Braconidae) *Charops sp.* (Hymenoptera: Ichneumonidae) *Euplectrus sp* (Hymenoptera: Eulophidae) *Microplitis* sp. (Hymenoptera: Braconida) *Telenomus* sp. (Hymenoptera: Platygastridae) *Trichogramma sp.* (Hymenoptera: Trichogrammatidae)	Larva parasitoids Egg parasitoids	Assassin bugs (Hemiptera: Reduviidae) Larva of ground beetle (Coleoptera: Carabidae)	*Metharizium* sp. (Hypocreales: Clavicipitaceae)
Malaysia				
Myanmar	*Trichogramma* sp. *Telenomus remus*	Egg parasitoids	*Eocanthecona* sp	
Philippines	*Trichogramma chilonis*; *Chelonus* sp. *Charops brachypterum*	Egg parasitoid Egg-larval parasitoid Larval parasitoid	Earwigs, *Euborella* sp	
Vietnam	*Trichogramma* sp. *Telenomus remus*	Egg parasitoids		

ASEAN FAW ACTION PLAN

Supporting IPM Across Southeast Asia

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