**Introduction:** Native to the Americas, the fall armyworm (FAW) (*Spodoptera frugiperda*) reached Africa in 2016 and Asia in 2018. Since then, it has rapidly spread throughout the southern and northern hemisphere. The pest has four life stages - egg, larva, pupa, and adult - and can reproduce quickly. It attacks more than 300 plant species, with a preference for maize. FAW can lay up to 1,000 eggs in its lifetime and adult moths can fly 300km a night.

FAW is an incredibly resilient pest. In addition to its rapid spread, the pest's resilience to harsh conditions and chemical pesticides is setting unprecedented challenges for farmers worldwide. It is estimated that maize losses caused by FAW could amount to 80 million tonnes per year, or USD $18 billion per year.

**An IPM Approach:** The IPM Innovation Lab (IPM IL) currently works in seven countries in Asia and Africa, with a major focus on invasive species, FAW included. In 2018, IPM IL initiated **augmentative biological control** to combat the pest, a process that requires releasing natural enemies - or parasitoids - that search for and lay eggs on FAW egg masses, killing the pest before it reaches its destructive larval stage. Since the parasitoids do not occur naturally in high enough numbers, IPM IL collaborators at “satellite-centers” mass-produce and release the natural enemies into maize fields, including egg parasitoids *Trichogramma mwanzae* and *Telenomus remus* in East Africa and egg parasitoids *Trichogramma chilonis* and *Telenomus remus* in Nepal and Bangladesh. FAW natural enemies are also surveyed in Cambodia. In addition to egg parasitoids, IPM IL is promoting use of larval parasitoids *Cotesia icpe* in East Africa and *Bracon hebetor* (brevicornis) in Africa and Asia.

Benefits of an augmentative biocontrol approach include:
- No exotic organisms introduced.
- Mass-production technique/knowledge easily transferrable.
- Human and institutional capacity built.
- Sustainable, effective, economical, socially acceptable, and safe to human and environmental health.
- Natural enemies control FAW as well as other caterpillar pests on maize and other crops.
- Compatible with all IPM tactics - including the IPM Package for Maize - except toxic chemical pesticides.
- Developed for an entire cropping system.

**Objectives**
- Reduce crop loss due to FAW by 95 percent in participating countries in three years.
- Reduce use of toxic chemical pesticides, enhance biological control efforts, and protect human and environmental health.
- Integrate FAW management activities with IPM packages of crops affected by FAW.
- Build human and institutional capacity in IPM IL host countries.

**Outcomes**
- Significant improvement of quality and quantity of crop yields affected by FAW.
- Increased income and improved human and environmental health benefits.
- Enhanced collaboration between countries.
- Augmentative release of parasitoids will increase parasitization of both FAW and other caterpillar pests that already exist in the cropping system.
FAW Biocontrol Progress and Scaling Up: A Global Collaboration

IPM IL survey, mass-production, and release of FAW natural enemies is a collaborative effort between a number of institutions including International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)-Niger, International Center of Insect Physiology and Ecology (icipe), National Biological Control Program-Tanzania, International Development Enterprises (iDE), National Agricultural Research Council (NARC)-Nepal, International Rice Research Institute (IRRI)-Cambodia, and Ispahani-Bangladesh. Thus far, IPM IL has conducted FAW awareness and management workshops in Ethiopia, Nepal, Vietnam, Cambodia, Kenya, Tanzania, and through virtual webinars for participants in dozens of countries, instigating South-South and cross-continental technology transfer. IPM IL and icipe have also developed a FAW biocontrol manual for widespread use.

Among the egg parasitoids IPM IL and collaborators have surveyed in Ethiopia, Kenya, and Tanzania, Trichogramma mwanzai parasitizes >75% of FAW eggs, while parasitism by Telenomus remus ranges from 78% to 100%. Among the larval parasitoids, Cotesia icipe is the most prevalent FAW parasitoid in Ethiopia, Kenya, and Tanzania, with parasitism ranging from 33.8% to 45.3%. Trichogramma species can be successfully reared on an alternative host, the rice meal moth Corcyra cephalonica, which significantly reduces mass-production costs. For sustainable scaling of production and marketing of biocontrol products to farmers, IPM IL develops linkages with local companies such as Agricare in Nepal and Real IPM in Kenya, sugar factories, farmer organizations/cooperatives, and others in Asia and Africa. These stakeholders are expected to participate in the project to accelerate local mass-production of egg and larval parasitoids and to ensure consistent supply to farmer beneficiaries. Currently, however, the COVID-19 pandemic is delaying progress. In the meantime, IPM IL is supplying farmers with FAW management tips through radio, text messages, Community Business Facilitators (CBF), and other communication methods.

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### Additional IPM-based FAW Management Recommendations

- Select high-yielding, locally acceptable, hybrid, and FAW-resistant (if available) crop varieties.
- Treat seeds with Trichoderma to induce defense against soil-borne fungal diseases.
- Treat seeds with PERSUAP-approved chemical pesticides to protect early stages of the crop.
- Set up pheromone traps after sowing seeds for early monitoring of pest entry.
- Release egg parasitoids Trichogramma spp. and Telenomus remus when egg masses are first observed in the field and follow-up with release of larval parasitoid Habrobracon hebetor (B. brevicornis).
- Spray the crop with Metarhizium anisopliae, Beauveria bassiana, Bacillus thuringiensis, nuclear polyhedrosis virus (NPV), neem, or safe PERSUAP-approved chemical pesticides when FAW egg masses and/or damage by early instar caterpillars of FAW is observed.
- Drench whorls with one of the above mentioned pesticides when later instar caterpillar damage is observed in the whorls.