



Action on Invasives Annual Report

2018



Contents

Acronyms.....	5
Introduction	6
Programme highlights	8
Stakeholder engagement: fostering the right partnerships.....	11
Providing best practice solutions for invasive species	16
Community action: bringing information and action to scale	22
Knowledge and data: creating and using knowledge	26
Monitoring and evaluation	32
Publications.....	34
Annex 1: Associated projects.....	36
Annex 2: 2018 milestones.....	37
Annex 3: 2019 milestones.....	42



Acronyms

ABIM	Annual Biocontrol Industry Meeting
APAARI	Asia-Pacific Association of Agricultural Research Institutions
APPPC	Asia-Pacific Plant Protection Commission
ARC-PPRI	Agricultural Research Council Plant Protection Research Institute (South Africa)
ASHC	Africa Soil Health Consortium
AU	African Union
CAADP	Comprehensive Africa Agriculture Development Programme
CBSD	Cassava brown streak disease
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Centre
COMESA	Common Market for Eastern and Southern Africa
CPC	Crop Protection Compendium
DAI	Development Alternatives, Inc
DEVCO	Directorate-General for International Cooperation and Development (European Commission)
DFID	Department for International Development (UK)
DGIS	Directorate General for International Cooperation (Netherlands)
ECOWAS	Economic Community of West African States
EPN	Entomopathogenic nematode
EU	European Union
FAO	Food and Agricultural Organisation of the United Nations
FAW	Fall armyworm
GAC	Global Affairs Canada
GDP	Gross Domestic Product
GISD	Global Invasive Species Database
GIZ	Gesellschaft für Internationale Zusammenarbeit (Germany)
GRIIS	Global Register of Introduced and Invasive Species
HST	Horizon Scanning Tool
IAPSC	InterAfrican Phytosanitary Council
ICIPE	International Centre for Insect Physiology and Ecology
ICT	Information and Communication Technology
IFAD	International Fund for Agricultural Development
IITA	International Institute of Tropical Agriculture
IPM	Integrated Pest Management
KALRO	Kenya Agricultural and Livestock Research Organization
NARC	National Agricultural Research Centre, Pakistan
NGO	Non Governmental Organisation
NISSAP	National Invasive Species Strategy and Action Plan
NPPO	National Plant Protection Organisation
PAD	Precision Agriculture for Development
PARC	Pakistan Agriculture Research Council
PMDG	Pest Management Decision Guide
PRA	Pest risk analysis
PRISE	Pest Risk Information Service
R4D	Research for Development
RAB	Rwanda Agriculture and Animal Resources Development Board
REC	Regional economic community
RPPO	Regional Plant Protection Organisation
SAARC	South Asian Association for Regional Cooperation
SAC	SAARC Agriculture Centre
SADC	Southern African Development Community
SDC	Swiss Agency for Development and Cooperation
SDG	Sustainable Development Goal
SIDA	Swedish International Development Co-operation
SMS	Short message service
US	United States
USAID	United States Agency for international Development
USD	United States Dollar
USDA	United States Department of Agriculture
ZARI	Zambia Agricultural Research Institute



Introduction

Action on Invasives is CABI's programme to address the growing problem of invasive species. It is not a new problem, but climate change, trade and tourism are all exacerbating the situation and increasing the urgency for a coordinated and effective response at local, national and regional levels. Invasive species disproportionately affect vulnerable, rural communities and undermine sustainable development. So it is appropriate that the Sustainable Development Goals (SDGs) include a goal to "introduce measures to prevent the introduction and significantly reduce the impact of invasive species on land and water ecosystems and control or eradicate the priority species" (SDG 15.8).

The overall technical approach to managing invasive species is internationally agreed to comprise three tiers: prevention (stopping them invading in the first place); early detection and rapid response (eradication and/or containment); and – for species that become permanently established – control and mitigation of the impacts. All too often it is the third tier that is required, despite the fact that prevention is widely recognized as being more cost-effective.

Action on Invasives is designed to enable countries and regions to adopt this approach through four interrelated work packages:

- stakeholder engagement: fostering the right partnerships
- providing best practice solutions for invasive species
- community action: bringing information and action to scale
- knowledge and data: creating and using knowledge

While the aim of Action on Invasives is to strengthen overall capacity to tackle invasive species, many of the activities focus on priority species as case studies. The first focus species are Fall Armyworm (*Spodoptera frugiperda*) (FAW), *Tuta absoluta* and parthenium weed (*Parthenium hysterophorus*). Similarly, part of national capacity involves regional and international collaboration, so Action on Invasives is working through selected countries as foci from which activities can be regionalized. The first countries for implementation are Ghana, Kenya, Pakistan and Zambia.

Late in 2017, programme support was provided by UK's Department for International Development (DFID) and the Netherlands' Directorate-General for International Cooperation (DGIS). Thus, 2018 was the first full year of Action on Invasives activities. The following sections report progress under each of the work packages, including both species- and/or country-specific activities and broader systems strengthening activities.

Monthly highlights

JANUARY



CABI formally launches Action on Invasives programme

MARCH



The invasive species Horizon Scanning Tool is released

AUGUST



Action on Invasives scientists warn of rapid spread of fall armyworm across Asia

SEPTEMBER



Launch of the redesigned ISC / Plenary on invasives convened at the African Green Revolution Forum in Kigali

OCTOBER



Action plan to fight parthenium weed in Pakistan agreed at major stakeholder workshop

NOVEMBER



Fall Armyworm Tech Prize awarded. Shortlisted prototypes field tested by CABI

DECEMBER



Course on classical biological control of weeds delivered in Pakistan



Programme highlights

Stakeholder engagement

- Action on Invasives added to the mandate and agenda of Plantwise steering committees in Ghana, Kenya and Zambia, with additional stakeholders to be included
- Ghana's national FAW action plan was reviewed and revised with stakeholders, covering coordination, research, communication and surveillance. In 2018 the national policy was to promote 'biorational' products for control
- Review by stakeholders of the parthenium action plan in Pakistan resulted in agreement to establish an interdepartmental coordination mechanism to oversee implementation of the revised plan
- Update to the Evidence Note for FAW published in October 2018; over 5,000 reads for the paper summarizing the 2017 Evidence Note. Evidence notes on *Tuta absoluta* and parthenium (Pakistan) completed
- Global environmental suitability models for FAW and *Tuta absoluta* developed. FAW model results published and used to support preparedness in Asia
- CABI/International Institute of Tropical Agriculture (IITA)/International Centre of Insect Physiology and Ecology (icipe) workshop on 'Tackling Invasive Species in Africa' held to guide collective action towards management of invasive species in Africa. Need for a continental invasive species strategy agreed
- Action on Invasives served as testing partner for the FAW Tech Prize, funded by the United States Agency for International Development (USAID)'s Feed the Future initiative, run by Nesta
- Assisted AgBiTech™ to secure a permit for testing a virus product for FAW control in Kenya; and similarly assisted Provivi™ for a FAW mating disruption product
- Workshop held for 14 countries on the polyphagous shot hole borer (a new invader in South Africa) to support risk analysis, prevention and early detection
- Stakeholder meeting convened to plan the response to the invasion of Cassava Brown Streak Disease (CBSD) in Zambia
- Draft National Invasive Species Strategy and Action Plan (NISSAP) for Ghana was completed

Best practice solutions

- Prioritization of threats from over 120 potential invasive plant pests in Kenya with 19 Kenyan scientists. Priorities will guide risk mitigation actions
- Surveillance programme under way to identify presence of *Tuta absoluta* in Pakistan
- Permit for testing a parthenium biological control agent (*Listronotus*) in quarantine granted by the authorities in Pakistan
- First quarantine facility for testing non-indigenous biological control agents built in Pakistan
- Course on weed biological control trained 36 Pakistani scientists (five women). Three Pakistani scientists trained in South Africa on the biological control of parthenium
- Parthenium biological control agent already present in Pakistan (*Zygogramma bicolorata*) redistributed to regions of the country newly invaded by the weed
- Trials testing non-chemical approaches (biopesticides, botanicals and traditional methods) for FAW control initiated in Ghana, Zambia and Kenya
- Natural enemy surveys found at least 12 parasitoids already attack FAW in Africa. Up to 70% of larval parasitism was found. *Telenomus remus*, an egg parasitoid used in the Americas to control FAW, was found for the first time in Africa
- Studies in Latin American smallholder maize farms with no pesticide use showed abundant parasitoids, offering prospects for finding a classical biological control agent
- Collaboration between the Rwanda Agricultural and Animal Resources Board (RAB), Action on Invasives and the University of Neuchâtel (Switzerland) identified several nematodes that attack FAW
- Studies on methods for assessing the economic losses caused by invasives commenced with Wageningen Economic Research

Community action

- From household surveys, farmers estimate a maize yield loss to FAW of 26% in Ghana and 35% in Zambia, equivalent to a national annual loss of USD 177m and USD 159m respectively. This is less than in 2017
- Household surveys in Kenya and Zambia found 98% farmers suffer *Tuta absoluta* attacks on their tomatoes. Ninety-six per cent of farmers apply pesticides, sometimes 10 times or more in a season
- A household survey in Pakistan found parthenium causes varying levels of damage in wheat; hand weeding and chemical sprays are the most common control methods
- FAW communication campaigns launched in Ghana, Kenya, Uganda and Zambia, reaching over half a million farmers (41% female, 43% below the age of 35). Integrated communication channels targeting men, women and youth provided information on identification, monitoring and management
- For four invasive species in five countries of Africa, analysis of Plantwise clinic data found 90% of plant doctors giving recommendations entirely or partly from the pest management decision guides (PMDGs); 64% of recommendations are from the non-chemical section of the PMDGs
- A survey in Kenya found less than 10% farmers use biological products for managing invasives. Awareness of biologicals is low; affordability and availability constrain use
- In the parthenium awareness campaign in Sheikhpura district with Department of Agriculture (Extension), 438 farmer meetings were held, 30,000 leaflets and 15,000 brochures distributed, 'weeding weeks' were held in 24 villages and there were seminars in schools and colleges, whilst an urban campaign took place in Islamabad in public parks.

- Mass media campaigns on parthenium were run on three TV news channels, two radio channels, local cable network, and social media
- A survey of 50 small and medium enterprises producing biological control products in 14 countries of Africa, Asia and Latin America found involvement and linkage with public sector organizations is often critical. Such enterprises need to not only sell the product, but provide support services to ensure appropriate use of the products

Knowledge and data

- Invasive Species Compendium (ISC) upgraded to include over 5,400 new practical information resources and dedicated species portals for priority species such as FAW
- Over 2.1m visits to ISC in 2018 (56% female, 60% under 35 years of age) from 239 countries, which is 41% more than 2017
- Horizon Scanning Tool (HST) fully launched; over 6,600 visits from 160 countries; 59 stakeholders (24% female) from 10 countries trained in the use of the tool
- Regional workshop on new invasive species threats in South Asia held in Nepal
- Pest Risk Analysis (PRA) Tool developed; beta version launched to 24 pest risk analysts (25% female) from 11 African countries
- 30 FAW Pest Management Decision Guides (PMDGs) published, providing country-specific advice for 17 African countries in nine languages
- Open access data portal created for collating and sharing invasive species datasets. First 12 datasets added, including 2018 FAW household survey



Stakeholder engagement: fostering the right partnerships

This work package recognizes that national, regional and international stakeholders in the public and private sector need to work together to achieve sustainable management of invasive species. Through such partnerships, effective policy, plans and practices can be developed and implemented. Action on Invasives is building on and extending linkages established through the Plantwise programme and other partnerships.

Progress in 2018

Plans and strategies provide focus and coordination for the various stakeholders involved in tackling individual invasive species or invasives more generally. In 2017, Action on Invasives supported the development of national action plans for FAW in Ghana and parthenium in Pakistan and in 2018 stakeholders reviewed these plans to learn lessons and make appropriate adjustments.

In Pakistan, the review resulted in agreement to form an interdepartmental coordination mechanism to oversee implementation of the revised action plan. Buy-in from national partners was vital: commitment from the Pakistan Agricultural Research Council (PARC) and other stakeholders has reinforced the programme's aim to understand and control the spread of parthenium, as well as to reduce the weed's negative impacts on human, agricultural and environmental health. In the short to medium term, the plan includes evidence collection, mass communication and awareness raising, and the importation and testing of biological control agents; in the longer term, it includes amendments to national policy and legislation and the establishment of a broader biological control programme.

The Ghana FAW action plan focused on four key elements: collaboration, awareness, surveillance and research, and management. A task force was established at the outset and subcommittees were instituted to oversee and coordinate implementation. In 2018, a workshop was held with stakeholders to review implementation and a questionnaire was separately sent to key informants. Many positive aspects as well as challenges were identified. Areas for improvement included: the engagement of input dealers on recommended insecticides; the engagement of the media through training and press briefings/releases; improving two-way communication between national and local stakeholders; and identifying and harmonizing the activities of new collaborators.

The FAW task force was seen to have provided the opportunity to shape policy on how threats from invasive species could be managed more effectively in future. One option would be for the task force to evolve into a standing task force for invasive species issues in general. An invasive species policy was drafted some years ago by the Environmental Protection Agency, but the process stalled. A national consultative meeting was therefore held in 2018, where it was agreed the document should be reformulated as a NISSAP. A small team from agriculture and environment was convened to oversee the reformulation and a draft has been developed, including a proposal for a cross-sectoral oversight/implementation mechanism.

In 2018, CBSD was detected in Zambia, and Action on Invasives assisted with a stakeholder workshop to plan the response. The outcome of the workshop was the establishment of a task force and agreement on internal quarantine measures by the Ministry of Agriculture to prevent the spread of the disease to other parts of the country.

Also during 2018, South Africa announced the detection of the polyphagous shot hole borer (*Euwallacea whitfordiodendrus*), a tiny beetle whose symbiotic fungus (*Fusarium euwallaceae*) has a major impact on many cultivated and wild tree species. Together with the Forestry and Agricultural Biotechnology Institute in South Africa, a training workshop was held for representatives from 14 African countries, who agreed to collaborate in monitoring and reporting the invasion. To assist countries in assessing and managing the risk from the invasive, a risk analysis resource document was prepared.

In February, an international meeting was co-organized with IITA and icipe, bringing together participants drawn from 18 countries in Africa as well as experts from further afield. Many national and regional public and private sector organizations were represented, including the African Union and its Inter-African Phytosanitary Council (IAPSC), regional economic communities (RECs), universities, national research organizations, NGOs and media. The meeting strongly endorsed the need for coordinated action in addressing invasive species, including the development of a continent-wide strategy that would be owned by the African Union. A consultant has been jointly commissioned by the conference organizers to develop a draft strategy.

Providing evidence of the impacts of invasive species informs decision making by policy makers and others. The FAW Evidence Note produced in 2017 was widely read and used, so an updated Evidence Note was produced in 2018. Further detailed household surveys in Ghana and Zambia found that 98% of farmers still see FAW as a major problem. However, the average maize loss reported by farmers was 26% in Ghana and 35% in Zambia, somewhat lower than reported in 2017. This may be natural season-to-season variation, but it may also be due to the build-up of natural enemies (see page 18), improved management and farmers getting better at estimating their losses. Applying pesticides was still the most frequently used control method, but in Ghana there was increased usage of biological based pesticides following the government's decision to recommend and distribute 'biorational' control products for FAW. The summary of the 2017 Evidence Note published in *Outlooks on Pest Management* has now been read over 5,000 times on ResearchGate alone, and the 2018 update has already been read over 700 times.

During the year FAW reached Asia (it was first reported in India in July 2018), so the 2017 Evidence Note and 2018 update have been widely read there too. The 2018 update included environmental suitability maps for Asia as well as Africa, showing wide areas of the continent, including some important maize growing regions, to be highly suitable. FAW has also reached China, where several of the major maize growing regions are not suitable for year-round breeding of FAW, but could be susceptible to seasonal northward migrations of the pest.

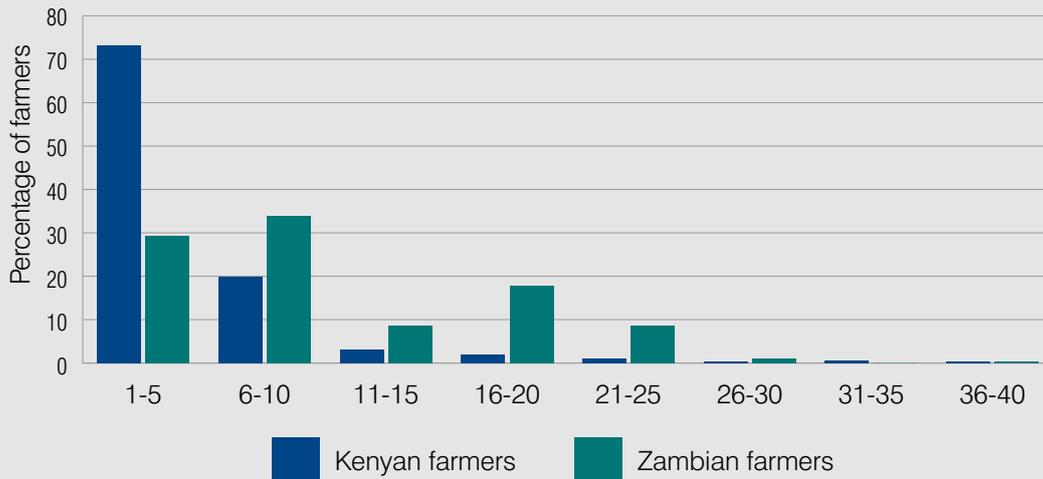
Several countries in Africa have indicated that another invasive moth, *Tuta absoluta*, continues to have economic impact. A *Tuta absoluta* Evidence Note was therefore produced, including the results of a detailed household survey in Kenya and Zambia examining its impacts and farmers' coping strategies (see page 22). The evidence collected of heavy pesticide use strongly supports the need to find alternative biological based approaches that are economical and safer for farmers and consumers, as well as for the environment.

In Pakistan, a parthenium Evidence Note was produced, incorporating results from a household survey, the results of which can be found in the Community Action section on page 22.

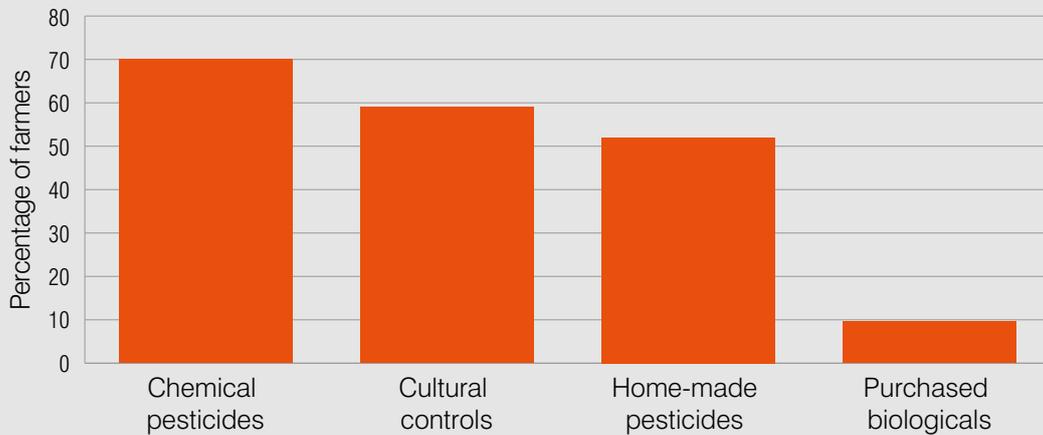
Farmers' use of pesticides and biologicals

The use of pesticides to fight *Tuta absoluta* is very common among farmers in Kenya and Zambia (see first graph below). It would be far safer and better for the environment if they were to use biologicals. Action on Invasives surveys in Kenya found that while the use of biologicals is limited (second graph), farmers have positive perceptions of them (third graph). A major barrier to increasing use is availability, and numbers of registered biopesticides vary widely between countries.

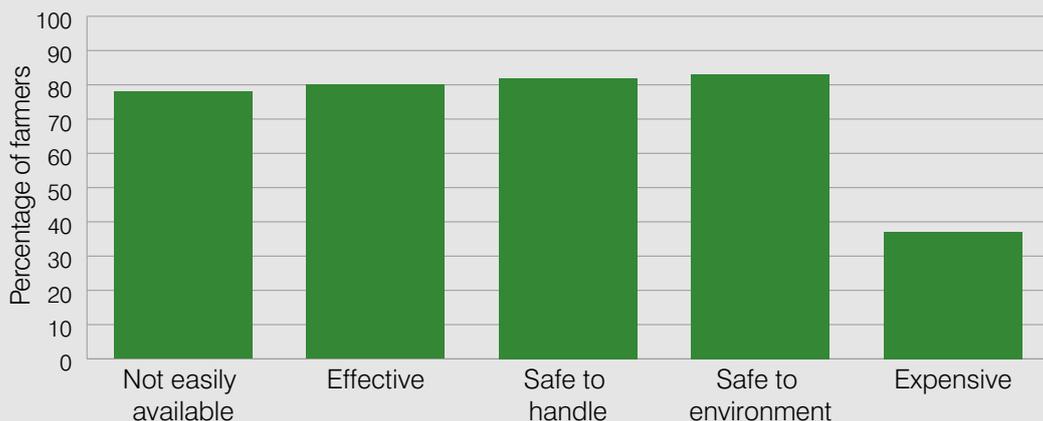
Number of pesticide sprays on *Tuta absoluta*



Use of control methods last season



Perceptions of biologicals



With the arrival of FAW in Asia, the assistance of CABI has been requested by several countries. Together with Plantwise, Action on Invasives has been able to provide information and expertise. In Bangladesh, a meeting was jointly organized with the South Asian Association for Regional Cooperation (SAARC) Agriculture Centre (SAC), to constitute a task force to promote preparedness and response to FAW and other transboundary pests. A similar meeting was held in Myanmar.

Sustainable management of invasives must be based on an ecological approach, and making biological solutions available to farmers requires regulators and input providers to work together. In 2018, a number of private sector manufacturers have been assisted in the regulatory process with the aim of accelerating testing and registration of lower risk FAW control products. Where this leads to field trials in support of registration, this links with the 'Best Practice Solutions' work package (see page 16). In Kenya, the programme facilitated the company AgBiTech to apply for and secure a permit for introducing their product for FAW based on a naturally occurring virus, and registration trials have been established with the Kenya Agricultural and Livestock Research Organisation (KALRO). Also in Kenya, the programme facilitated Provivi (a US company that produces a pheromone for mating disruption of FAW) and a permit for trials was again granted, with registration trials planned for 2019. Discussions have also been held with Koppert Biological Systems (biological control company and global market leader) on facilitating access to biological control agents for *Tuta absoluta*.

The spread of FAW to over 40 countries in Africa has generated a need and an opportunity for engagement with multiple stakeholders. CABI participates in a number of the technical working groups convened by the United Nations Food and Agriculture Organisation (FAO) and leads the group on communication and awareness. A draft communication framework for policy makers has been prepared through the working group, using FAW as an example (see page 24). Together with the International Maize and Wheat Improvement Centre (CIMMYT), IITA, African Union Commission (AUC), FAO, icipe and USAID, a FAW Research for Development consortium meeting was convened in Addis Ababa to bring together over 200 experts from an array of scientific and development organizations worldwide, including Action on Invasives partners from Ghana, Kenya and Zambia. CABI also created awareness about FAW impacts among African policy makers at the 14th Comprehensive Africa Agriculture Development Programme (CAADP) Partnership Platform at Libreville. The CAADP Partnership Platform brought together over 400 leaders from African Governments, including parliamentarians and other stakeholders.

Action on Invasives was invited by Nesta to be the testing partner in a USAID Feed the Future 'FAW Tech Prize', which aimed to promote engagement of the ICT sector in addressing FAW. A large number of digital tools and approaches designed to provide timely, context-specific information were assessed, including testing with farmers in Uganda, as a result of which the prize was awarded to six organizations at an event in South Africa in November 2018.

Lessons learned

The Plantwise collaborative infrastructure has proved useful in engaging with partners in Ghana, Kenya and Zambia. Action on Invasives has been presented at the Plantwise national steering committees, and in all cases it was agreed that the committee could serve a similar role for Action on Invasives as it has for Plantwise. Noting that Action on Invasives has a broader range of stakeholders to engage than Plantwise, it was also agreed that additional stakeholders could be included. In Kenya, the steering committee has already identified priority invasive species that Action on Invasives could work on, including the papaya mealybug. Action on Invasives' plans for 2019 are being annexed to the Plantwise workplans for the three countries. In Pakistan Plantwise partners are also fully engaged with Action on Invasives, meaning that synergies are being realized.

The FAW invasion has drawn much attention to the threat of invasive species, confirming that the approach of using high priority species as an entry point is appropriate. However, the risk of this approach is that Action on Invasives may be seen as only being concerned with managing one or more species that have already invaded, rather than with strengthening the capacity to prevent as well as to respond to invasions.

The severity of FAW has resulted in multiple stakeholders becoming involved, including many organizations seeking to support farmers directly as well as research and development organizations. Action on Invasives has endeavoured to work with and through national FAW task forces, as well as through the international coordination mechanism set up by FAO and the Research for Development (R4D) consortium led by the Consultative Group for International Agricultural Research (CGIAR) (a draft charter has been written by CIMMYT, but has not yet been agreed by partners).

While individual species provide a suitable focus and entry point, opportunities have also been identified for building on previous work, such as the draft invasive species policy in Ghana. An identical set of activities cannot therefore be used in every country; rather, an adaptive and flexible approach is needed, seeking out and taking advantage of opportunities for making progress towards a consistent set of overall objectives.

Even when plans and strategies are in place, challenges will continue to be faced in their implementation due to lack of resources and implementation mechanisms. This needs to be considered when making the plans so that they remain living and useful documents.

Next steps

Steps will be taken to initiate Action on Invasives activities in additional countries. Burkina Faso, Rwanda and Bangladesh have been selected, a primary criterion being the existence of active Plantwise activities in the country. The Plantwise collaboration mechanism will again be used in each country, and engagement will build on other previous or ongoing collaborations.

The draft NISSAP for Ghana will be finalized and steps taken to establish a practical mechanism for its implementation. In other countries, any existing national plans and strategies will be assessed to identify opportunities for mobilizing stakeholders around a NISSAP. Opportunities at a regional level will also be sought with the Southern African Development Community (SADC) and other regional economic communities in Africa and with the South Asian Association for Regional Cooperation (SAARC) Agriculture Centre in Asia (headquartered in Bangladesh). The work on developing an African strategy with the African Union will also continue.

Linked to the development of strategies and plans, additional efforts will be made to engage policy-level stakeholders to strengthen their awareness of invasive species and the need for action. A one-day African policy-level summit will be held in Botswana, following CABI's Member Country Consultation, as well as face-to-face meetings, supported by policy briefs and other evidence.

Facilitation of private sector entities providing appropriate lower risk management products will continue. Linked to this, opportunities will be sought with regulatory agencies for revising or updating product registration processes and permits, with the aim of encouraging the use of safe and efficacious management technologies.



Providing best practice solutions for invasive species

Prevention, early detection and control of invasive species requires a set of technologies and processes that are efficient and effective for risk assessment, diagnostics, surveillance, eradication or suppression and mitigation of impacts. Action on Invasives works with partners to strengthen capacities to develop, test and validate such solutions and practices through specific case studies.

Progress in 2018

Preventing invasive species: prioritizing potential invasive plant pests in Kenya

A project involving 19 Kenyan scientists (nine women) has been undertaken using a new approach to establish a prioritized list of potential invasive plant pests (invertebrates and pathogens) that could be harmful to the country's agriculture, forestry or environment. At the first workshop, the new HST (see the Knowledge and Data work package on page 27) and expert knowledge was used to identify over 120 species not yet present in Kenya. An express risk assessment was then carried out for each pest by at least three individual assessors, covering likelihood of entry, establishment and spread, as well as the expected level of socioeconomic and environmental impact. At the second workshop, a final risk score was obtained through consensus among the assessors, leading to a ranking of species according to their potential threat. The final list contained 73 arthropods, 41 pathogens, nine nematodes and three molluscs, and will be used to prioritize actions that can be taken to mitigate the highest risks. Some of these actions, such as a full pest risk assessment, surveillance or contingency planning, will be initiated in 2019.

Detecting invasive species: surveillance for *Tuta absoluta* in Pakistan

In recent years *Tuta absoluta*, native to South America, has invaded most of Europe and Africa. It is now spreading in Asia. In most invaded regions, it has become the most serious tomato pest. A detection survey was set up to assess its presence in Pakistan as it has already been reported by neighbouring countries. Surveys were carried out in the Federally Administered Tribal Areas bordering Afghanistan and in the region of Peshawar, using sticky delta traps baited with synthetic pheromones. The traps were deployed by agriculture extension and research staff and were monitored every two weeks for up to three months. The authorities intend to review results with a view to develop and implement an action plan should its presence be confirmed.

Controlling invasive species: biological control methods for parthenium in Pakistan

Research and development has focused largely on two biological control approaches; improving the efficacy of the beetle *Zygogramma bicolorata* (already present in Pakistan), and importing another beetle, *Listronotus setosipennis*, from South Africa. Testing and training on other integrated pest management (IPM) compatible technologies are also in progress.

Zygogramma bicolorata is an effective biocontrol agent in some areas (including Australia and South Africa), but in Pakistan the first growth of parthenium has already started to flower and set seed by the time the overwintering beetles emerge from diapause in May and June. The beetle population builds up, and by October causes up to 100% defoliation, although this has little effect on the seedbank due to the early season asynchrony. The possibility for early season releases in priority areas to damage the plants before they flower and set seed is being tested. Currently, over 1,000 beetles are being held in cages in winter diapause, ready for the spring. *Zygogramma bicolorata* is present in the north-east and north-west districts of Punjab but is absent in the southern parts, which seem climatically suitable. Over 1,000 *Zygogramma bicolorata* have been released at two sites to increase its overall range in Pakistan.

Listronotus setosipennis is a small nocturnal stem boring weevil native to Argentina and Brazil that has previously been introduced for controlling parthenium in South Africa, Ethiopia, Uganda and Australia. The Pakistani authorities gave permission to conduct research on its host specificity under quarantine conditions in Pakistan, which has necessitated the construction of a quarantine facility. The facility was designed and the building is nearly complete. A test plant list of 28 plant species and/or varieties covering crops as well as native plant species that may be at risk of non-target attack has been compiled. To avoid delays in waiting for the quarantine facility to be built, the Agricultural Research Council in South Africa (ARC-PPRI) has been contracted to test 10 sunflower cultivars grown in Pakistan.

To strengthen weed biocontrol capacity, a course on invasion biology and classical biological control of weeds was delivered in Pakistan between 3 and 16 November. The aim of the course was to provide a general foundation in invasion biology and weed biological control, and to introduce parthenium weed biological control specifically. There were 28 (five women) national participants, plus eight from CABI. The participants represented all provinces of Pakistan and included PhD students, academic staff, extension officers and senior staff of the National Agricultural Research Council (NARC) and PARC.

In addition, three Pakistani scientists took part in a one-week training course on *Listronotus setosipennis* handling and host range testing at ARC-PPRI in South Africa. The course had practical and classroom training and covered parthenium growing, culturing *Listronotus setosipennis*, the dissection of larvae from attacked plants and host specificity trials. The course also covered procedures for working in a full quarantine facility (such as the one being constructed in Pakistan), including the proper disposal of waste and other material.

Controlling invasive species: IPM methods for FAW in Africa

Cultural control methods and application of biopesticides are expected to be more sustainable for FAW control than the pesticides to which many farmers have turned. A diverse range of technologies were therefore tested to assess their efficacy under the growing conditions experienced by smallholder farmers in Ghana, Kenya and Tanzania.

Field trials were conducted in the three major maize growing regions of Ghana around Wa, Kumasi and Accra during the main cropping season between June and November. Control methods were selected with national partners to avoid duplication and provide locally relevant information, and detailed experimental designs and protocols were developed. From preliminary analyses, two neem based products and maltodextrin showed some promise, and their cost-effectiveness is being assessed. Traditional insect control treatments with soap, ash and soil do not appear to provide adequate control.

In Zambia, a virus based product was field-tested with the Zambia Agriculture Research Institute (ZARI) during the off-season (June–October), showing partially successful results. Towards the end of 2018, field trials were initiated for the main cropping season in all three ecological zones, testing locally produced neem preparations and intercropping. Rearing of FAW was established at ZARI to allow tests under more controlled conditions, and a greenhouse experiment was set up to assess the potential mode of action of ash and soil against FAW in more detail. For all trials, the design and protocols were developed and agreed with implementing partners.

In Kenya, field trials with a commercial virus based product were started in collaboration with KALRO, as well as preliminary testing of a novel lure-and-kill method. The trials will conclude in 2019.

Controlling invasive species: biological control methods for FAW

Biological control is seen as an essential component of IPM against invasive pests, using three strategies (see infographic on page 19). All require a good knowledge of the natural enemy complex of the target species in its invasive range. Therefore, studies of parasitoids and predators of FAW are being carried out in Ghana and Zambia and advice and diagnostic assistance is being provided to similar work elsewhere in Africa. In Ghana, comprehensive surveys found larval (eight) and egg (one) parasitoids. Larval parasitism rates were locally very high in the rainy season (up to 70%) but much lower in the dry seasons. Predatory bugs were also found preying on FAW larvae and eggs. These results suggest that the conservation and enhancement of natural enemies could be an important part of IPM for FAW.

In Zambia, surveys are being carried out in collaboration with ZARI and students from the University of Zambia. At least nine parasitoids have been found in Zambia, and studies are continuing to assess their potential as biological control agents in conservation and augmentative biological control.

The egg parasitoid *Telenomus remus* has been found in at least five countries by CABI and other organizations. This discovery is highly significant as the species has not previously been recorded in Africa, although its use has been reported in Latin America to control FAW through mass releases. Possibilities for mass production and use of this egg parasitoid in rural communities in Africa will be assessed.

Studies on the natural enemies of FAW are also being conducted in Latin America through collaboration with Plantwise partners in Bolivia, Brazil, Colombia, Ecuador and Nicaragua. These studies aim to assess the natural enemy complex and natural control of FAW in smallholder and organic farms as compared to chemically based production systems. Based on the findings, important parasitoids will be shipped to Africa for studies of their potential as classical biological control agents. This will be done in collaboration with IITA and icipe, with whom a review paper on the potential for classical biological control of FAW using parasitoids from the Americas is being written. In some regions of Latin America, it has been found that maize can be grown in smallholder systems without insecticides; parasitism can be high, suggesting good prospects for their use in Africa.

Controlling invasive species: a nematode based control for FAW in Rwanda

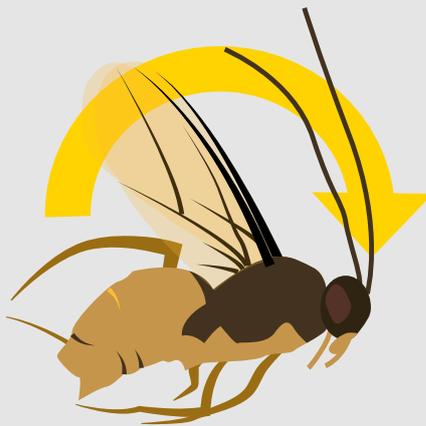
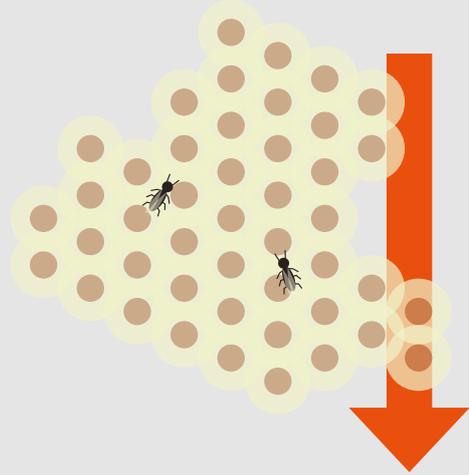
A collaboration between RAB, the University of Neuchâtel (Switzerland) and CABI started in April 2018, with the aim of developing a biocontrol solution for FAW based on entomopathogenic nematodes (EPN). The research is being carried out by a student registered at the University of Neuchâtel. A field survey of 208 soil samples resulted in the isolation of two novel EPNs, identified via DNA analysis as *Heterorhabditis bacteriophora*. The EPN isolates have been returned to RAB and nematode strains held by RAB from a previous project were also incorporated into the research. Seven extensive bioassays were conducted on 29 Mexican, five Rwandan and six internationally commercial EPN species and strains. All EPNs appear capable of killing FAW caterpillars; the best results were obtained with the commercially available *Steinernema carpocapsae* 'All' strain and *S. abassi*. In addition, the Rwandan *Heterorhabditis bacteriophora* strains also showed great promise. A preliminary trial was conducted to assess the potential

Biocontrol strategies against FAW

Biological control (or biocontrol) is the use of natural enemies to control pests. Three categories of biological control strategies are recognised. Action on Invasives is considering all three approaches to control FAW in Africa, based on several natural enemies including parasitoids, predators, nematodes and viruses.

Augmentation

Regular releases of natural enemies for direct control. A product based on entomopathogenic nematodes is presently being developed in Rwanda and Switzerland in the framework of Action on Invasives. Virus-based products are also being tested in Zambia and Ghana. In addition, during surveys by Action on Invasives scientists and collaborators, an egg parasitoid, *Telenomus remus*, has been found in six countries. This parasitoid is already mass-produced and released in Latin America to control FAW and a similar approach is being considered for Africa.

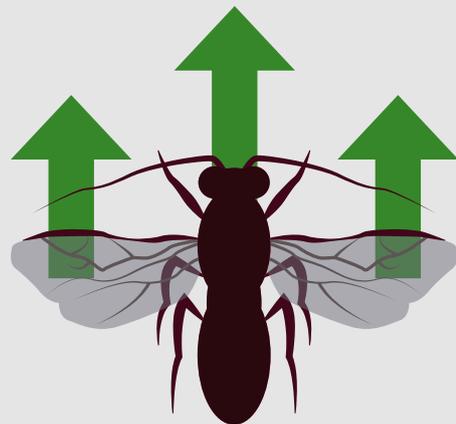


Introduction

The introduction of a natural enemy of exotic origin to control a pest, usually also exotic, aiming at a permanent control of the pest. Under Action on Invasives, scientists are studying the natural enemies of FAW in five Latin American countries, with the aim of importing and releasing the most suitable species in Africa. This work is done in collaboration with the International Institute of Tropical Agriculture (IITA).

Conservation

Includes all cultural methods favouring the efficiency of natural enemies already present in the system. Action on Invasives is studying the natural enemies of FAW in Ghana and Zambia, where 12 parasitoid species and several predators have already been found. In Ghana, parasitism rates up to 70% have been observed at some sites and Action on Invasives scientists are now going to test cultural practices that favour or hamper the action of these local natural enemies.



of EPNs against FAW when applied to maize plants in alginate beads, alginate gel or in sand. Preliminary results suggest that EPN can successfully control FAW on plants in laboratory conditions. As part of the work, five RAB staff (one male, four female) have been trained on FAW rearing and techniques for studying and formulating EPNs.

Controlling invasive species: biological control methods for *Tuta absoluta*

Surveys for potential biological control agents of *Tuta absoluta* have been initiated in Zambia, and one parasitoid and several predators were found. The objective is to find natural enemies that can be used in an augmentative biological control programme similar to those successfully implemented for the pest in Europe and North Africa. The project will be intensified in 2019, including work conducted by a Masters student at the University of Zambia.

Lessons learned

The invasion of FAW in Africa has shown that sometimes local natural enemies can adapt quickly to the arrival of a new host or prey. Any biocontrol/IPM programme for an invasive species should therefore include determining the natural enemies of the pest in the region of introduction. However, such studies often stop at that point and do not proceed to determine how the natural enemy action can be increased by conservation and encouraging natural populations, or through augmentation by mass rearing and release.

The progress and success of classical biological control through the importation of natural enemies relies heavily on reliable collaborators in the region of exportation of natural enemies. It is fortunate that CABI already has networks of suitable collaborators; the benefits and costs of such collaborations should not be underestimated.

The capacity of national collaborators to design and conduct field trials is variable; some are able to work independently, while others need continuous backstopping. As Action on Invasives is concerned with capacity development, it is important to work with the appropriate partners in a country and to provide the level of support and assistance necessary for delivering good results. Field trials, especially those designed by biological scientists, tend to focus on technical effectiveness. However, overall cost-effectiveness also needs to be considered, although assessing the costs of local or indigenous control methods is not always easy.

Next steps

The list of the potential invaders that has been produced through the horizon scanning activity in Kenya will be used to prioritize and organize mitigation actions such as pest risk analyses, surveillance programmes and contingency plans for high risk species such as the polyphagous shot hole borer. A similar activity will be organized in Ghana in 2019. The results from Kenya will be shared regionally through the Common Market for Eastern and Southern Africa (COMESA) and other regional partners.

If *Tuta absoluta* is confirmed as present in Pakistan, an action plan will be developed with stakeholders, including surveillance and impact assessment.

The biocontrol project against parthenium weed will continue with *Zygogramma bicolorata* diapause experiments and mass rearing for redistribution to areas of Pakistan without *Zygogramma bicolorata*. The weevil *Listronotus setosipennis* will be imported from South Africa, and host range tests will be conducted in the completed quarantine facility.

Based on the natural enemy complex of FAW observed in Ghana and Zambia, further studies will be conducted to develop recommendations for conserving and enhancing the action of these natural enemies in smallholder maize cropping systems. The potential for developing an augmentative approach using the parasitoid *Telenomus remus* will be assessed.

The ongoing FAW control trials in Zambia and Kenya will be completed and the results from all trials conducted in Ghana, Zambia and Kenya will be analysed and published. The studies in Latin America on potential classical biological control agents of FAW will continue and promising species will be imported to Africa. Based on this work, the trial results and other available information, a sustainable IPM system will be outlined to control FAW in sub-Saharan Africa.

Potted plant trials using EPNs against FAW are planned at RAB Rubona. More extensive laboratory trials will be conducted to assess the potential of EPNs against FAW when applied to maize plants in alginate beads, alginate gel or in sand. Feeding stimulants will be identified and tested to improve baits.

Further surveys for natural enemies of *Tuta absoluta* will be carried out in Zambia and Ghana to assess the potential for biological control. In Zambia, the study will be carried out by an MSc student from the University of Zambia. The development of biological control methods using predatory bugs and/or egg parasitoids applicable to African farming systems will be initiated.

A biological control project against the papaya mealybug will be initiated in Kenya, using parasitoids from West Africa.



Community action: bringing information and action to scale

This work package aims to achieve large-scale implementation of best practice solutions, adapted to community contexts and needs. The programme works in partnership with rural communities and local actors to understand the socioeconomic context, strengthen extension and advisory activities, facilitate the widespread uptake and adoption of appropriate control practices and document the costs of invasive species, as well as the benefits to communities of managing them.

Progress in 2018

Understanding farmer contexts

Socioeconomic surveys were conducted in Ghana, Kenya, Zambia and Zimbabwe to understand farmers' perceptions and management of FAW and *Tuta absoluta*, as well as the agricultural knowledge and information systems within which they work. The findings have various uses, such as informing communication campaign message design and the selection of appropriate information dissemination pathways for reaching different types of farmers.

For FAW, household surveys were conducted in Ghana, Zambia and Zimbabwe. A majority of farmers could correctly identify FAW and reported it as the most important maize pest during the 2016/17 cropping season. Control measures were dominated by pesticide use, along with other cultural approaches such as hand picking and crushing egg masses and the application of ash/sand in the funnel. Use of cultural practices and biologicals/biorationals increased in 2018 compared to 2017, particularly in Ghana, where the government promoted biorationals in 2018 (for example through free distribution). The average maize loss due to FAW was reported by farmers as 26% and 35% in Ghana and Zambia respectively. This was considerably lower than reported for the 2016/17 cropping season, probably due to a range of factors including the build-up of natural enemies and improved perception by the farmers of actual losses.

For *Tuta absoluta*, the study was conducted in Kenya and Zambia. Over 97% of farmers in both countries reported *Tuta absoluta* as a serious problem and over 96% of farmers relied heavily on the use of pesticides, although many were unsatisfied with the control they provide. Pesticide application is heavy; 20% of farmers in Kenya and 34% of farmers in Zambia used six to 10 sprays per season. Of further concern is that 6.4% of farmers used highly hazardous pesticides (Class 1b according to the World Health Organization classification), including monocrotophos, beta-cyfluthrin, methamidophos and methomyl, and a number of farmers reported symptoms of poisoning.

In Pakistan, a survey was carried out to understand farmers' perceptions and practices in relation to parthenium, as well as to provide a baseline. Ninety-eight per cent of farmers recognized the

negative impacts of parthenium on crops, human health, animals and the environment. For the farmers reporting the impact of parthenium on wheat production, 57% estimated that the weed reduced yield by 5% to 15%, and 9% estimated it reduced yield by 16% to 30%. Sixty-nine per cent of farmers reported that parthenium had increased in the last five years, suggesting that the invasion is still in progress. Hand weeding and chemical sprays were the most popular choice for managing parthenium.

Reaching farmers through communication campaigns

For a new pest such as FAW, large numbers of farmers need to acquire new knowledge quickly. Working with various partners, mass extension campaigns were designed and implemented in Ghana, Kenya, Uganda and Zambia to deliver messages on FAW identification and management. The key steps of a campaign are formative research, development of technical briefs, message design and delivery, and evaluation.

Formative research used evidence from socioeconomic surveys and focus group discussions to understand farmers' access to information sources and their preferences. In Africa, this informed the selection of channels and timing of delivery to ensure wide reach of the target audiences, including radio, mobile (SMS), community video screening and printed materials. In Pakistan, information from the formative research was analysed and reviewed at a consultative workshop with communication and scientific experts tasked with developing the scaled-up communication campaign planned for 2019.

Across all countries and invasives in Africa and Pakistan, and despite the constraints experienced by extension systems, extension workers remain the dominant and most valued and trusted source of information. Radio programmes and community information exchange were also important information sources. However, in Pakistan mobile phones are a preferred channel for reporting problems.

Technical brief development is a multi-stakeholder process involving national agricultural research institutes, ministries of agriculture and national FAW task forces. A technical brief contains all the key information on FAW identification and management, sourced from available materials (such as the FAO and USAID/CIMMYT manuals in the case of FAW) and informed by local research information (such as the results of trials). The aim of a technical brief is to promote consistency of messaging and to avoid providing contradictory advice to farmers. The technical briefs thus form the basis of a set of messages communicated using various materials and through various channels.

For a full FAW communication campaign, weekly messages are designed for a period of 18 weeks, synchronized with the cropping calendar to ensure that farmers get relevant information. Early messages therefore cover land preparation and planting and (once germination has occurred) how to undertake pest scouting, identification of FAW and decision making on FAW interventions. Later messages cover harvest and post-harvest handling. Different communication channels are used to maximise the reach to men, women and young people. The delivery also ensured appropriate timing to coincide with times when household members are less engaged in farm work or household chores.

Delivery of FAW campaign messages in Africa leveraged existing project efforts and partnerships to ensure wide reach. For example, in Ghana, the video screenings were done alongside CABI's African Soil Health Consortium (ASHC) project, while in Kenya the messages were delivered through a partnership with Precision Agriculture for Development (PAD). In Zambia, the National Agricultural Information Service took the lead in delivery of messages, partnering with regional radio stations, while in Uganda the work was done through contracts with Farm Radio International, Radio Kitara FM, Peripheral Vision International and Hamwe.

In Pakistan, a parthenium communication campaign was conducted in Sheikhpura district in collaboration with the Agriculture Extension Department and CABI's Plantwise programme. The campaign used video documentaries and public service messages transmitted on local and national TV channels, giving a total viewership of more than one million people for all channels over the campaign period. Thousands of posters were also printed and disseminated at key locations in the pilot district. Awareness activities were also targeted at youth in schools and colleges in the district with a 'Root it out' message, including practice in the school grounds. The children were also provided with literature (flyers and booklets) for further sharing of information with friends and family.

Evaluation of communication campaigns is undertaken in various ways, including calculating the size of the target audience reached (see Monitoring and evaluation below on page 32). For the campaign in Zambia, a full evaluation (including household surveys) will be conducted after the season ends in 2019.

Broad issues around communication for FAW management were discussed at a meeting held in Lusaka, Zambia entitled 'Fighting FAW through strategic communication and cross-sectoral knowledge management'. Participants from nine countries critically reviewed the role of communication to date and identified lessons learned and ongoing priorities. A draft framework for strategic communication was developed to support government communications in response to major invasions such as FAW.

Facilitating access to best practice solutions

Identifying, validating and communicating best practice solutions is necessary but not sufficient for them to be widely used. They also need to be available, affordable and selected by farmers. Action on Invasives has conducted several studies working towards the objective of getting lower risk control products widely used.

In collaboration with a German Corporation for International Cooperation (GIZ)-funded study, biological pesticides potentially suitable for FAW control were assessed for 19 countries in Africa. Based on a literature search, 50 active ingredients registered for FAW in Africa or elsewhere were assessed for their efficacy, health and environmental hazards, agronomic sustainability and practicality for smallholders. Twenty-three active ingredients were recommended for follow-up, but 12 were identified for immediate action. Many of these are only registered in a few countries in Africa, so are not available even if farmers want to use them. A paper has been published on this study (Bateman *et al.*, 2018; see list of publications below on page 36).

In Kenya, over 300 households were surveyed to establish knowledge, attitudes and practice in relation to biological pest control products and other control methods. Focus groups and key informant interviews including extensionists and input providers were used to triangulate the findings. Over 70% of farmers use pesticides, but less than 10% use any form of biopesticide or biological based control product. The most widely known products are azadirachtin/neem (29% of farmers) and *Bacillus thuringiensis* (16%), so awareness is low. A major disadvantage of biologicals reported by farmers (78%) is that they are not easily available. However, farmers would be willing to pay nearly 10% more for the reduced risk provided by biological products. Extension workers have good awareness of biological products, but only 33% have received training in this area. Of the agro-input dealers interviewed, 58% stocked biological products but reported a low demand due to farmers' lack of awareness, affordability and accessibility.

A study was conducted examining the experiences of 50 small-scale or local businesses producing biological control products in 14 countries of Asia, Africa and Latin America. The aim was to understand what factors contribute to success and to learn lessons for promoting such businesses as a route to providing locally available, affordable, low-risk products for managing invasives. A number of key issues and recommendations were identified. Businesses established with project/public funding need to prioritize their commercial objectives from the outset to ensure sustainability. Government plays a critical role for most companies, providing them with funding, supplies, research and technical support. Companies established through project funding often struggle to make the transition to fully commercial operations and require ongoing support from government to survive. Businesses should therefore seek to establish strong relationships with government agencies, research institutions and extension providers. As well as the products themselves, businesses need to offer support and advisory services to their smallholder customers on how to use the products. Important customer feedback is also obtained through such services. Enterprises also reported that product registration regulations can be a significant burden due to the time, complexity and cost involved.

Lessons learned

A cost-effective approach to reaching large numbers of farmers with information and advice is to work with other programmes and partners communicating with farmers, including other CABI programmes. In Kenya, partnership with PAD offered opportunities to deliver messages to over 130,000 farmers during 2018. CABI contributed resources for development of the technical brief and messages, while PAD used its mobile platforms to push messages to farming households. Similarly, in Ghana, the programme delivered FAW messages in northern Ghana alongside CABI's African Soil Health Consortium videos on soybean, which reached over 40,000 farmers. This highlights the benefits of engaging and working with likeminded organizations for delivering invasive management messages to scale.

Even though the large majority of stakeholders in Pakistan agreed that parthenium is harmful, the fact that they also cited various uses for the weed re-emphasizes that it cannot be assumed everyone will be in favour of control, even for major invasive species. Different stakeholders therefore need to be involved in planning and implementing a management strategy, and if there are likely to be 'losers', in seeking possible ways of minimizing or mitigating their loss.

There are various reasons why smallholders do not use biological products for managing invasives. These include non-availability (products are either not registered in the country, or are registered but not distributed or on sale locally), and the cost compared to pesticides. Work is needed to address each of these constraints and to set up a virtuous circle of greater availability, lower price and higher demand and use. Local, small-scale businesses offer one option for this, even though in many cases they rely at least to some extent on public sector assistance.

Next steps

In Africa, country communication plans will be facilitated and multisectoral invasive management training conducted aimed at supporting the institutionalization of invasive response and communication. The FAW communication campaign in Zambia will be completed and evaluated as part of a survey to reassess the household-level impacts of the species and farmers' coping strategies. The framework for strategic communication in response to new invasives will be completed.

In Pakistan at least 1m rural households will be targeted with new knowledge on parthenium management. This will be achieved by employing targeted communication channels (TV/radio channels, mass/social media campaigns) and by working with the extension staff of public and private organizations, including rural support programmes. As well as assessing the reach of the communication campaign, changes in recipient behaviour will also be evaluated. The programme will capitalize on links with the Plantwise programme, as well as on external partnerships with coordination and research bodies (such as the National Agricultural Research Centre and universities).

Community-level management plans will be initiated in selected areas for management of invasive species, using validated best practices (e.g. *Tuta absoluta* in Kenya). The aim will be to facilitate concerted action to benefit all community members and avoid the negative impacts of different methods being used on different farms (for example, if one farmer is encouraging natural enemies, success may be limited if the neighbour is spraying pesticides). Lessons learned from community management will be used to scale up such initiatives in other areas by Action on Invasives and other partners.



Knowledge and data: creating and using knowledge

This work package is developing processes to create, exchange and use online/offline content, information and data at the regional, national and local levels. Novel information tools are being developed to support diagnosis, risk analysis and regulation using globally relevant information resources and complementing Plantwise processes. New tools are fully integrated into CABI's existing information infrastructure to allow for the most efficient delivery to meet the needs of end users.

Progress in 2018

Launching the invasive species knowledge platform

The Action on Invasives programme design envisaged a knowledge platform for invasive species information, and the ISC (www.cabi.org/isc) provided the appropriate basis for this. Several major enhancements to the ISC have therefore been made to make it suitable for a range of end users. It has been given a fresh new look and made mobile responsive.

The scope of ISC content has been broadened to include practical information materials aimed at extension workers, protected area managers, quarantine officers and risk assessors. These include identification guides, posters, leaflets, manuals, reports, videos, factsheets and decision guides. Over 5,400 new materials were added from a wide range of contributors, adding to the 10,000 datasheets and 221,000 research abstracts. One hundred and twenty-nine new invasive species datasheets were added, 52 datasheets were fully revised and habitat data was updated for approximately 7,000 species based on new data from the Global Register of Introduced and Invasive Species (GRIIS) and the Global Invasive Species database (GISD). New functionality includes the addition of a 'toolbox' containing horizon scanning, mobile apps and pest alerts, to which further tools will be added. ISC usage increased substantially in 2018, reaching over 2m visits from 239 countries (56% female, 60% under 35 years of age).

Another major addition was species information portals providing easy access to information for high priority species, including distribution maps, news items, images and a directory of organizations working on the species. So far portals have been created for FAW, *Tuta absoluta* and parthenium, and new portals can be added as the need arises. The FAW portal (www.cabi.org/isc/fallarmyworm) has been very popular, ranking high in Google searches and receiving over 4600 visits in 2018 since its launch on 11 September. Sixty-five per cent of FAW portal visits came from countries where FAW is known to be present; of those, 81% were from countries in Africa and Asia (particularly India, Kenya, Sri Lanka, Uganda, Nigeria, Zimbabwe, Tanzania and Ghana).

A third of users accessed the portal via a mobile phone or tablet. The portal includes content from participants in the FAO-led Framework for Partnership for Sustainable Management of FAW in Africa and the FAW R4D International Consortium, and users are invited to provide feedback and share their content via the portal.

Developing decision support tools

The invasion risk Horizon Scanning Tool (HST), built in 2017, was fully launched in 2018 and has received over 6,600 visits from users in more than 160 countries. Further improvements were made following beta testing to add additional country filters based on trade data, to enhance sharing of horizon scans and to improve the output and integration of habitat data. Fifty-nine stakeholders (24% female) from 10 countries were trained on the use of the tool as part of workshops in Kenya, Nepal and Afghanistan. An extended horizon scanning activity was carried out with 19 Kenyan scientists (nine of them female) between June and December 2018 using the HST (see Best Practice Solutions on page 16).

A new pest risk analysis (PRA) tool was developed, in line with international standards, to support users assessing the risk of commodity and other imports introducing new invasive species. Feedback from national plant protection organisations (NPPOs), quarantine and research institutions from 14 African countries, as well as regional plant protection organisations (RPPO) and other international experts who attended a user needs assessment meeting in Nairobi, indicated the new tool should be based on the PRA tool previously available in the pre-2007 Crop Protection Compendium (CPC) on CD-ROM. The new PRA tool is available online so uses the latest CPC distribution data, and a beta version was launched to 24 pest risk analysts (25% female) from 11 African countries at a workshop in Nairobi in December 2018. The workshop also provided an opportunity to discuss PRA information and report sharing between countries, including through the International Advisory Group on Pest Risk Analysis. A framework for enhancing the PRA component on assessment of economic and social consequences was presented by Wageningen Economic Research and discussed by participants.

Development continued on a biopesticides portal to facilitate the identification, sourcing and application of macrobial and microbial products for particular crop/invasive problems. Comparing data collected automatically from the internet (scraped) with data from several manufacturers showed that scraped data is not sufficiently accurate, so direct participation from the manufacturers will be required to keep the data current. The portal was promoted through a stand at the Annual Biocontrol Industry Meeting (ABIM) in Basel, Switzerland, generating much positive feedback and interest in partnership. Initial user testing was conducted in Kenya and IT development work has commenced. This will include an app version of the portal for users who wish to use it offline.

Documenting and delivering management advice

In partnership with USAID, CIMMYT and NPPOs, 30 FAW PMDGs were published on the ISC, Plantwise Knowledge Bank, Plantwise Factsheet app and the USAID Feed the Future Agrilinks website. The PMDGs (format developed under Plantwise) provide country-specific advice for prevention, monitoring and control of FAW on maize in 17 African countries in nine languages, and general advice for FAW on wheat, sorghum, rice and millet that can be used globally. A further 53 PMDGs were drafted during the year and are in the final stages of verification with partners; they are due for publication in 2019. The content of the PMDGs was verified by experts in USAID, Oregon State University, CIMMYT and local NPPOs where possible, to provide recommendations that are effective, safe, available, affordable and practical in the local context. Some of the changes requested by local partners included the addition of named varieties, changes to chemical recommendations based on availability and the addition of information about relevant local contacts.

In addition to the FAW PMDGs, a further 11 globally relevant PMDGs were published for other invasive species, such as the southern armyworm, which was reported in Africa during 2018.

Gathering, using and sharing data

A data needs assessment exercise was initiated in 2018 to find out what datasets are needed by invasive species researchers, modellers and government staff. Interviews were carried out with individuals in Pakistan during a data ecosystem mapping workshop, jointly organized with Plantwise, as well as during field visits with extension staff. Individuals were asked about their data needs and about local datasets available to them that might be suitable for sharing more widely. An invasive species dataset inventory was simultaneously carried out within CABI.

A data portal (<https://ckan.cabi.org/data/organization/action-on-invasives>) was created on the open source CKAN platform, for collating invasive species datasets, adding metadata to facilitate searching and sharing these either openly or with restricted access on a dataset-by-dataset basis. So far in 2018, 12 invasive species datasets have been added to the data portal to trial the site, including data from the household surveys. Further datasets identified in the data inventory will be added in 2019, at which point the portal will be promoted more widely (including links from the ISC and other sites as appropriate), allowing invasive species researchers and modellers to access the datasets they require more easily.

Underlying the ISC, CPC, PRA and HST is distribution data, and Action on Invasives has supported a significant upgrade to the database. Once completed, the new database will allow for rapid importing, editing and repurposing of distribution data, enabling more up-to-date and accurate data to be made available through the various products and tools. The new structure also allows for future development of real time data visualization, predicted/potential distributions and data categorized by source type, with the aim of providing a holistic picture of the spread of invasive species.

Lessons learned

The seriousness and urgency of FAW has resulted in many stakeholders creating and disseminating content and advice through multiple channels. Their different objectives, experience and knowledge results in differing views on what constitutes valid and accurate information and advice. This has presented a challenge in creating advisory materials. In collating content for the FAW portal, users want a 'one-stop shop' where they can find all the information they need. At the same time, CABI needs to maintain robust standards, even in the rapidly changing research and communication environment created by a major new invasion such as FAW.

Producing and disseminating timely advice on newly arrived invasives is also a challenge when, for various reasons, governments are cautious about officially confirming that a species is present. This may delay appropriate responses, but building systems to enable more rapid response is part of Action on Invasives' strategy. Nevertheless, ISC usage analytics show that FAW information is being accessed by large numbers of users in countries where the species has not yet been officially recognized as present, confirming the value of a globally compiled and accessible resource.

While the HST has significant potential for time-saving in generating lists of species that present threats in well defined situations, user feedback on the beta version indicated that the lists are still impractically long for full risk analysis of all the species. Users of both the HST and PRA tools have requested an output that provides at least a preliminary prioritization. Such a function should be designed to support expert analysis rather than to replace it.

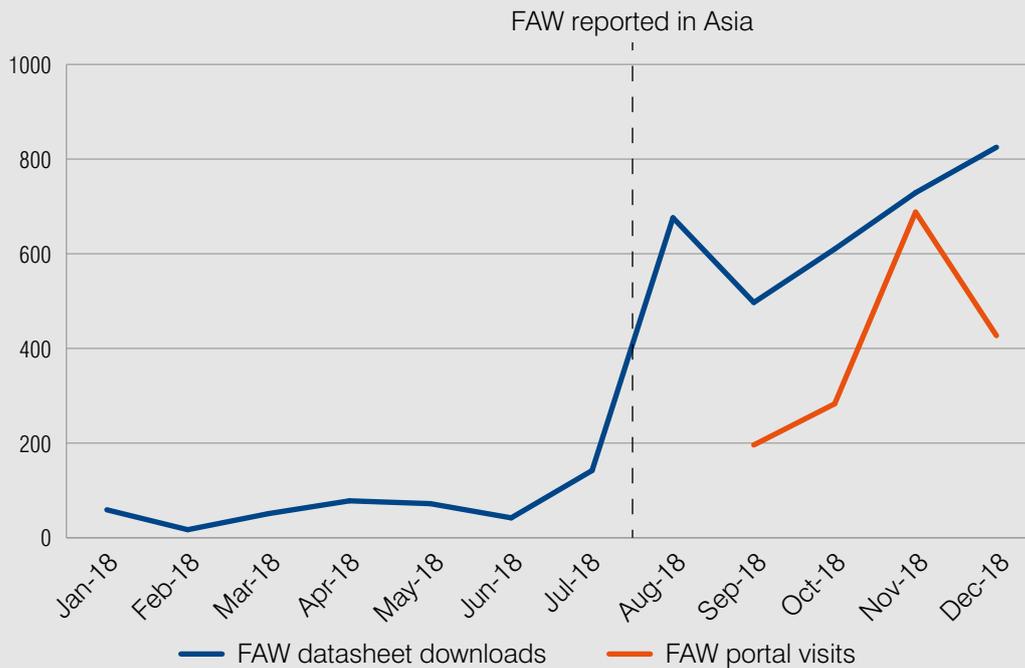
Building the new PRA tool within the online CPC allows use of the most recent information, which is a prerequisite for PRA. However, it also means internet access is required, as well as (under the current business model) a subscription to the CPC. To ensure use by those countries most in need of the tool, a new business model was defined, providing access free of charge to NPPOs in low-income countries. It will be important to monitor the use of the tool, to ensure this approach is effective in maximizing impact.

Sourcing data for the biopesticides portal was not as straightforward as initially expected. Data scraping technology proved insufficiently accurate in retrieving lists of registered pest control products from regulators' websites, so this must be carried out manually for the time being. Not all countries list information on target pest(s) and target crop(s) in the same way, so a different data collection procedure is needed for each country. In addition, some manufacturers do not hold central records of their products registered in each country, further complicating data collation.

ISC use and improvements

Web analytics illustrate a correlation between the confirmation of FAW in India in August 2018, and an increase in downloads of the FAW datasheet and visits to the FAW portal (launched in September) from Asian countries. The enhancements to the ISC and the launch of the Horizon Scanning Tool and Species Portals have not only increased the amount of available information but also increased visitor numbers to the ISC.

ISC use in Asian countries



5,186

new identification and management resources added to the ISC



41%

increase in visits to the ISC to over 2 million in 2018



12,539

completed scans on the Horizon Scanning Tool



65%

of FAW portal visits came from countries where fall armyworm is present

Next steps

Further species portals will be added to the ISC in response to any major new invasive species outbreaks. The upgraded ISC has been developed in a way that enables new portals to be added relatively quickly so that information can be made available for emergency responses. Links from the ISC to the invasive species data portal, PRA tool and biopesticides portal will also be added. Further PMDGs will be published and distributed for FAW affecting maize and sorghum – not just in Africa but also in Asia, in response to recent spread to that region. We will continue to seek opportunities for sourcing content from other organizations to reinforce the vision for a central repository of information from a range of sources. New datasheets will continue to be added to the ISC.

Beta testing of the PRA tool will continue, with a focus on supporting users through training guides, on-the-ground support and the collection of detailed feedback on its use to provide a basis for further improvements. All existing CPC subscribers will be invited to opt in to the beta trial, and 92 NPPOs in low-income countries will be provided with free access to the CPC and PRA tool. Work will commence on a species-initiated PRA component. Beyond 2019, further improvements will include integration of a species prioritisation model into the PRA tool and HST as requested by users, options for offline access and sharing of PRA reports among collaborators and between countries. In preparation for this, users are already given the option to grant CABI permission to share their final PRA reports under a Creative Commons licence.

The next steps for the biopesticide portal will be to launch a prototype with data for Spain, Brazil and Kenya. A consortium of biological control manufacturers is being formed to fund and steer a subsequent three-year development phase. The consortium will select new countries to include in the portal, identify required features and functionalities, and agree what market intelligence should be gathered through user analytics.

Further work will be undertaken on CABI's distribution database, enabling more streamlined updating and consistent reporting on current distributions of invasive species across CABI's data-driven products, including the ISC, PRA tool and HST. The database will also facilitate further integration of granular distribution datasets into the ISC in future.

The data needs assessment and data inventory work will continue, building a user community around the data portals, and developing it iteratively responding to their needs. An open data strategy will be developed for Action on Invasives, defining the target audience/users and their needs and other relevant data sources. The strategy will make Action on Invasives data assets increasingly FAIR – findable, accessible, interoperable and reusable – through the open access data portal. Standardized metadata, vocabularies, schemas and ontologies will be used to promote interoperability, and clear licencing such as under Creative Commons will be used. Feedback mechanisms will be implemented to enable NPPOs and others to comment on and contribute to newly acquired information and data.



A photograph of two men standing in a lush green field, possibly a farm or agricultural site. The man on the left is wearing a striped polo shirt and is gesturing with his hands as if speaking. The man on the right is wearing a light-colored short-sleeved shirt and a white cap with a red brim, and is listening attentively. The background is filled with green foliage.

Monitoring and evaluation

The Action on Invasives logical framework and theory of change have been reviewed and updated and together provide the basis for the monitoring and evaluation framework. Output indicators have been defined for each of the four programme components, and progress against these has been reported in the preceding sections. Progress towards evaluating outcomes and impacts is presented here.

The goal of Action on Invasives is to protect and improve the livelihoods of over 50m poor rural households impacted by invasive species. As different invasive species impact rural livelihoods in different ways, livelihood indicators need to be evaluated in relation to individual species. However, four key indicators have been selected, so that there will be scope for comparison in evaluations between and aggregation across different invasives. The indicators are net farm income, productivity, biodiversity (restored or maintained, in managed or natural ecosystems) and human health. In each case the specific measurement will be selected according to the context. Human health, for example, could relate to reduced use of pesticides for agricultural pests or it could be reduced levels of allergic response to allergenic invasives, such as parthenium.

For parthenium in Pakistan, FAW in Ghana and Zambia and *Tuta absoluta* in Kenya and Zambia, household surveys were undertaken in 2017 and 2018. Some aspects of these surveys have been reported in evidence notes and published papers, but the information will also be compiled as baselines, against which impacts can be assessed at a later date. During 2019 more detailed plans for impact evaluation will be developed.

The Action on Invasives programme purpose is to strengthen system capacity to prevent, eradicate, control and manage priority invasive species at the local, national and regional level. Three outcome indicators have been identified:

1. the number of men, women and youth utilizing and/or benefiting from best practice solutions
2. the number of countries using invasive species knowledge and data to inform operations for invasive species management
3. the number of countries/regions that are more responsive to invasive species threats and the need to implement control measures

Specific evaluation studies will be commenced in 2019, but the following analyses and observations are reported as preliminary evidence of change.

The **number of men, women, youth utilizing and/or benefiting from best practice solutions** depends, in part, on the number of people who receive the relevant information. The communications campaigns reported above in six countries (Kenya, Uganda, Ghana, Zimbabwe, Zambia and Pakistan) reached an estimated **2,837,370** people. While it is not possible to disaggregate public service message and radio viewership/listenership by gender and age, it is estimated that 40% of the population reached were women and that 43% were under 35 years of age.

Extension method	Farmer reached			
	Total	Male	Female	<35
Mobile phone contact/SMS in Uganda and Kenya	163,350	106,670	56,680	92,675
Video screenings in Ghana and Uganda	45,507	28,847	16,660	14,911
Print in Pakistan, Ghana, Zambia and Zimbabwe	50,890	N/A	N/A	N/A
“Crowd pullerz” (video sharing through retail outlets) in Uganda	36,344	14,262	22,082	10,903
Training workshops in Pakistan	8565	8565	0	3544
Weeding week in Pakistan	1369	1369	0	277
Awareness stalls in Pakistan	2537	N/A	N/A	N/A
Youth seminars in Pakistan	418	218	200	418
Radio campaigns in Uganda and Pakistan	329,890	191,336	138,554	131,956
Television campaigns in Pakistan	2,198,500	N/A	N/A	N/A
Total	2,837,370			

A field study in Uganda of 607 randomly selected households in campaign locations showed that 75% of the respondents received information on FAW during the campaign season. Radio and community video screening were the most commonly mentioned sources of information on FAW. At least 43% of recipients fully implemented FAW management practices learned, while 50% only implemented them partially. A phone survey of 1,182 farmers subscribing to the PAD SMS platform in Kenya showed that 79% of information recipients learned new things, particularly information on pesticides (47%), cultural practices (24%) and how to determine the extent of infestation (8%).

The communication campaign in Zambia will be evaluated in 2019 to assess the extent to which farmers have used and benefited from the advice that was disseminated.

The **number of countries using invasive species knowledge and data to inform operations for invasive species management** requires evidence that management is being informed by relevant knowledge and data. The PMDGs encourage farmers to use cultural practices and biological approaches, with less hazardous chemicals as the last line of action. An analysis was made of recommendations given by plant doctors (using the Plantwise Online Management System, or POMS) in relation to 23 PMDGs for 16 invasive pests in 15 countries, including FAW and *Tuta absoluta*. It was found that 48% of plant doctors included only recommendations from PMDGs in their advice to farmers; a further 42% gave advice which include PMDG and other recommendations. Sixty-four per cent of all recommendations given by plant doctors come from the green (non-chemical) sections of PMDGs.

The heavy usage of the ISC implies that it is perceived to be useful. Visits were received from 239 countries, and in Asia analytics show the FAW portal has been used by countries where FAW was expected to arrive and/or soon after its arrival but before any official announcement was made. The HST has received visits from over 160 countries. The PRA tool has been introduced to NPPOs in Africa; one user commented: “The tool will help increase our speed, accuracy when undertaking PRAs. It is interactive and will increase our efficiency in PRA.” As part of gathering user feedback, the outcomes of tool use will also be evaluated.

To evaluate the **number of countries/regions that are more responsive to invasive species threats and the need to implement control measures** requires a way of measuring ‘responsiveness’, or the capacity to respond. A consultant was to have been contracted to develop and test such a methodology, but none of the proposals received was suitable. The work will therefore be done in-house during 2019, drawing from experience in Plantwise, as well as from other approaches to capacity and responsiveness assessment in related areas (including human health).



Publications

Bateman ML, Day RK, Luke B, Edgington S, Kuhlmann U and Cock MJ (2018) Assessment of potential biopesticide options for managing fall armyworm (*Spodoptera frugiperda*) in Africa. *Journal of Applied Entomology* 142(9), 805–819.

Early R, González-Moreno P, Murphy ST and Day R (2018) Forecasting the global extent of invasion of the cereal pest *Spodoptera frugiperda*, the fall armyworm. *NeoBiota* 40, 25–50.

Guo J, Zhao J, He K, Zhang F and Wang Z (2018) Potential invasion of the crop-devastating insect pest fall armyworm *Spodoptera frugiperda* to China. *Plant Protection* 44(6), 1–10.
DOI: 10.16688/j.zwbh.2018452 [In Chinese with English abstract]

Mansour R, Brévault T, Chailleux A, Cherif A, Grissa-Lebdi K, Haddi K, Mohamed SA, Nofemela RS, Oke A, Sylla S and Tonnang HE (2018) Occurrence, biology, natural enemies and management of *Tuta absoluta* in Africa. *Entomologia Generalis* 38(2), 83–112.

Stone CM, Witt AB, Walsh GC, Foster WA and Murphy ST (2018) Would the control of invasive alien plants reduce malaria transmission? A review. *Parasites and Vectors* 11(1), 76.

Witt A, Beale T and van Wilgen BW (2018) An assessment of the distribution and potential ecological impacts of invasive alien plant species in eastern Africa. *Transactions of the Royal Society of South Africa* 73(3), 217–236.

Accepted

Toepfer S, Kuhlmann U, Kansiime M, Onyango DO, Davis T, Cameron K and Day R (2018) Communication, information sharing and advisory services to raise awareness for fall armyworm detection and area-wide management by farmers. *Journal of Plant Diseases and Protection*
DOI: 10.1007/s41348-018-0202-4

Witt AB, Shackleton RT, Beale T, Nunda W and van Wilgen BW (2019) Distribution of invasive alien *Tithonia* (Asteraceae) species in eastern and southern Africa and the socioecological impacts of *T. diversifolia* in Zambia. *Bothalia-African Biodiversity and Conservation* 49(1), 1–11.



Annex 1: Associated projects

Pest Risk Information Service (PRISE)

CABI's PRISE project seeks to provide information to extensionists and farmers on the population development and build-up of specific pests, including some invasive species. Action on Invasives therefore maintains close contact with the project. One of the pests PRISE is working on is *Tuta absoluta* on tomatoes. Fieldwork is being conducted in collaboration with the same partners in Ghana and Zambia as Action on Invasives is working with. The purpose of the current fieldwork is to collect observational data on the presence and abundance of pests at all points in their lifecycle and to compare this to the predicted life stage in the PRISE models. This links to the environmental suitability modelling conducted under Action on Invasives. PRISE does not yet have a pest model for FAW, but laboratory and fieldwork is being conducted in Ghana and Kenya to develop and test/validate the models, as for *Tuta absoluta*.

PRISE sends alerts to plant doctors and other extension workers via an automated bot on Telegram, a platform already widely used by plant doctors, who can then communicate the alert to farmers and provide associated diagnostic and management advice. PRISE thus provides an additional channel through which advice on individual invasive species can reach farmers. The PRISE monitoring and evaluation framework includes assessment of impact, outcome and output indicators and baseline surveys have been carried out in Ghana, Kenya and Zambia. This information also links to and complements the household surveys undertaken under Action on Invasives.

Utilizing remote sensing technology to identify parthenium in Pakistan

In partnership with the University of Manchester and funded by the Science and Technology Facilities Council, this project aims to develop methods for mapping and monitoring the distribution of parthenium; to strengthen capacity to utilize remote sensing technologies and satellite data; and to create and make available distribution data for policy makers' decision making in agriculture, livestock and human health. The project thus links closely with Action on Invasives and will provide a tool for monitoring changes to parthenium infestation in the country.

Imperial/Reading Tiger Team

Part of doctoral training at Imperial College and Reading University involves 'tiger teams', or groups of doctoral students who work with an outside organization on a particular topic not directly related to their doctoral work. A group of three PhD students with agriculture and ecology backgrounds has been working since April 2018 on improving the potential distribution maps for parthenium in Pakistan. The aim is to create a hierarchical distribution model that will incorporate the global climatic niche of the species with the regional and landscape distribution patterns of the species. The exercise thus links closely to Action on Invasives and the remote sensing work and will lead to a full database of parthenium occurrences that will be available via the Action on Invasives data repository.

Annex 2: 2018 milestones

Milestones: Stakeholder engagement	Date due	Status	Comments
Study of FAW's economic impact at micro (household) and macro (agricultural GDP) levels published, based on detailed evidence from 2+ countries	Q3	●	FAW Evidence Note completed and published. So far it has been read 551 times on ResearchGate and cited in two journal publications; 2017 Evidence Note read over 5000 times
Regulatory approval of 1+ FAW biopesticide/biocontrol product in one to two countries, attributable to CABI invasives policy/evidence support	Q4	●	Permits secured in Kenya for field testing a virus based product and a mating disruption product
Evidence notes for two additional invasive species (e.g. parthenium, <i>Tuta absoluta</i>) causing food insecurity developed for sub-Saharan Africa and Asia	Q4	■	Evidence note for <i>Tuta absoluta</i> and Parthenium hysterophorus written; published in Q1 2019
Engagement with existing mechanisms for regular regional discussions of invasive species management in two regions (one in Asia and one in Africa)	Q4	●	Engagement with FAW FAO continental framework and CG-led international FAW R4D consortium. Interactions with and participation in regional plant protection organizations in Africa (IAPSC) and in Asia (Asia and Pacific Plant Protection Commission, APPPC); and with regional bodies (COMESA, IGAD, SADC, ECOWAS in Africa; SAC, APAARI in Asia)
Discuss business models with stakeholders to enable future production of biocontrol agents	Q4	●	Assessment with 50 SMEs conducted in Asia, Latin America and Africa. Farmers' knowledge, attitudes and practices regarding biological control products assessed in Kenya
Programme initiated in four countries	Q4	●	Programme fully initiated in Pakistan, Kenya, Zambia and Ghana building on Plantwise collaborative infrastructure
Co-organize CABI–icjipe–ITA invasive species management in Africa workshop – Kenya	Q1	●	Workshop held in February 2018; participants from 26 nations. Need for continental invasive species strategy agreed
Initiate organization of policy makers conference on invasive species impacts and actions needed	Q2	●	Summit for key government officials and other policy makers organized for Gaborone in February 2019 in association with CABI Member Country consultation

Milestones: Best practice solutions	Date due	Status	Comments
Review of different control options, as put into use (subject to legislative approval) and compared for effectiveness (impact and cost–benefit analysis), undertaken in at least one country/one invasive (FAW)	Q4	●	Different control options in use in Ghana and Zambia surveyed and assessed in Evidence Note update. 2017 data analysed and draft paper written for publication in 2019. Biopesticide options for FAW approved in Africa compared for effectiveness, safety, affordability and sustainability and published
Initiate and undertake research study of management control effectiveness/cost efficiency, comparing different approaches on one invasive in one country	Q4	●	Studies on management methods for FAW initiated in Ghana, Zambia and Kenya and for parthenium weed in Pakistan
FAW bioprospecting survey completed in one country and initiated in two others	Q4	●	Surveys for natural enemies of FAW have been undertaken in Ghana and are ongoing in Zambia and Rwanda
Biocontrol strategies and protocols for FAW developed and published (jointly with IITA/icipe)	Q3	■	Surveys for FAW classical biological control agents initiated in Latin America, with plans to ship parasitoids to IITA in 2019; paper on <i>Telenomus remus</i> submitted
IPM packages to reduce FAW populations in maize and rotation crops developed and tested in at least one country	Q4	●	Tests of non-chemical IPM methods against FAW have been conducted in Ghana and Zambia
At least 10 master trainers trained in use and application of invasive species content, tools and best practice solutions	Q4	●	19 Kenyan scientists trained on horizon scanning 24 pest risk analysts from 11 African countries trained on the new PRA tool 36 Pakistani scientists trained in invasion biology and weed biological control

Milestones: Community action	Date due	Status	Comments
Indicative evidence of responsible use of (bio)pesticides for control of invasive pests, as indicated by the number of countries adopting PMDG advice	Q4	●	Analysis of Plantwise plant doctor recommendations from five African countries for four invasive pests showed plant doctors are using PMDG advice in 90% of cases; 64% of all recommendations come from the 'green' sections of PMDGs
Management plan implemented and monitored for one invasive species in one target country/region	Q4	●	National FAW management plan implemented and monitored in Ghana. National parthenium action plan reviewed and lessons learned with key country stakeholders in Pakistan
At least six posters/pamphlets and brochures developed as part of awareness campaign	Q4	●	Four FAW technical briefs covering key messages Four FAW photo guides and a FAW lifecycle poster Two videos on FAW for Ghana and Uganda. Pamphlets on parthenium in Pakistan for weeding week; farmer training workshops; awareness stalls and seminars; Islamabad Agricultural Expo
FAW information resources used in 14 countries to inform policy and in-field actions; three of the countries are non-Plantwise countries. All countries provided with evidence on biocontrol/chemical control options	Q4	●	ISC FAW datasheet visited over 13,000 times from over 130 countries. FAW portal visited over 4000 times from over 120 countries. FAW PMDGs in nine languages published for 17 countries (seven non-Plantwise) containing biological and chemical control options
1m rural households reached with new knowledge on invasive species management; over 200,000 receiving and acting on CABI info on FAW and control options	Q4	●	Estimated 2,837,370 individuals reached with information on invasive species impacts and management, including over 240,000 directly receiving information on FAW control options

Milestones: Knowledge and data	Date due	Status	Comments
Vision for knowledge resource finalized; invasive species knowledge platform fully launched	Q2/Q4	●	Action on Invasives knowledge resource based on upgraded ISC launched in September 2018. Contains numerous new materials and three species portals (FAW, <i>Tuta absoluta</i> and parthenium weed). Significant increase in ISC use following launch
Data capturing spread and efficacy of different FAW control methods analysed and stored in knowledge platform; shared with partners and stakeholders; data disaggregated between at least one Plantwise and one non-Plantwise country	Q2/Q4	●	Data on spread and efficacy of FAW control methods from 2017 and 2018 household surveys in Ghana and Zambia analysed and stored in the Action on Invasives public data repository. Additional data from Zimbabwe (non-Plantwise country). 2018 data analysed and shared in FAW Evidence Note update published in October and openly available via FAW portal/ISC
Action on Invasives PRA tool launched and used by quarantine/plant protection staff in five countries (cumulative)	Q4	●	Beta version of PRA tool launched at workshop for PRA analysts from 11 countries. Users from seven of the countries have used the tool since the workshop
New biopesticides portal launched, providing users with online/offline access to geo-relevant and approved biopesticides in three countries	Q4	■	Biopesticides portal designed and presented at the ABIM in Basel. Portal to be launched in early 2019
Horizon scanning/risk analysis and monitoring tools for FAW and 2 + additional invasive species developed and in use in two countries; evidence of prevention protocols being implemented	Q4	●	HST launched and accessed online from over 160 countries. Extended horizon scanning activity in Kenya between June and December 2018 evaluated risk from over 120 invasives. Regional workshop in Nepal assessed risk from FAW and prevention/rapid response protocols identified
Multiple sources of field data used to test and update predictive models	Q4	●	Global predictive models of suitability for FAW completed and published in Early <i>et al.</i> (2018). Models for <i>Tuta absoluta</i> developed and presented in <i>Tuta absoluta</i> Evidence Note
Delivery of 21 FAW PMDGS to Plantwise Knowledge Bank	Q3	●	30 FAW PMDGS developed for 17 African countries in nine languages
ISC maintained and updated	Q4	●	129 new datasheets published, 52 datasheets revised and habitat data updated for 7000 species. Over 5000 new information resources added
One impact study published on the economic impact of invasive species	Q4	●	FAW Evidence Note report published and disseminated: www.invasive-species.org/fawevidencenote2018 . Papers from 2017 and 2018 data drafted
Four papers published	Q4	●	Six papers published in 2018; two further papers accepted for publication

Milestones: Fundraising and market development	Date due	Status	Comments
New Action on Invasives funding of £5m secured from existing and new donors for 2018–2020 (e.g. EU, SIDA, GAC)	Q4	▲	No additional programme funding received in 2018
Awareness raising conducted with donor country desks in Africa and Asia to ensure ownership and linkages to other relevant initiatives, as well as providing local support to Action on Invasives collaborators	Q4	●	Engagement visits with national partners to donor desks in Burundi, Ethiopia, Nepal and Bangladesh
Action on Invasives annual report submitted to donors; annual Donor Forum linked to Plantwise Donor Forum organized 2017	Q1/ Q2	●	2017 annual report finalized and disseminated. Action on Invasives programme update included in 2017 Donor Forum
Strategy and logframe reviewed and updated; 2019 milestones and country activity plans developed	Q3/Q4	●	Strategy document and logical framework both reviewed and updated. 2019 milestones and country activity plans have been discussed and finalized in line with the 2019 activities

Annex 3: 2019 milestones

Stakeholder engagement	Timing
Programme initiated in seven countries (cumulative) and 2020 country action plans developed	Q4
Policy/decision makers informed of options for reducing invasive impact species using lower risk control methods and products	Q4
High-level summit conducted with member countries on invasive species impacts and actions needed	Q1
Surveillance initiated for at least one priority invasive species in two countries	Q3
National response plans developed for two prioritized invasive species	Q3
NISSAP finalized and implementation initiated in one country; development of NISSAP commenced in one other country	Q2
Development and implementation of two regional invasive species strategies facilitated	Q4
Opportunities identified for streamlining regulations for testing, validation and registration of lower risk pest control products in two countries	Q3
Producers of at least four lower risk prioritized control products facilitated in registration procedures	Q4
Methodology for assessing invasives response capacity developed and tested in one country	Q4
Best practice solutions	
Invasive risk assessments and risk prioritization implemented in at least two countries	Q3
Risk management (prevention and rapid response) procedures researched and developed in at least two countries for priority invasive species	Q4
IPM compatible technologies researched, developed and validated for at least three invasive species to support delivery at scale in four countries in Asia and Africa	Q4
Invasive species management research capacity increased in at least three countries	Q4
Community action	
Household study on FAW impact updated to assess revised scale of household economic impacts and scale of farmer adoption of advice	Q3
Best practices for management of invasive species promoted for uptake by communities; 3m (cumulative) rural households reached, over 500,000 receiving and acting on CABI info on FAW and control options	Q4
Baseline and impacts documented for at least one additional invasive species	Q4
Two country communication strategies for a priority invasive species developed in Africa and one in Asia	Q4
Two technology briefs on managing a prioritized invasive updated and popularized (Africa)	Q3

Multisectoral invasive species management training conducted in at least three countries	Q4
Pilot community area-wide invasive pest management plans developed (four in Africa, two in Asia)	Q4
Knowledge and data	
Twenty factsheets/PMDGs developed for key invasive species and published on the ISC and Plantwise Knowledge Bank	Q4
Forecasting/distribution models for one invasive species refined	Q4
ISC maintained and updated; at least one new species portal added	Q4
PRA tool launched and used by quarantine/plant protection staff in eight countries (cumulative)	Q4
Additional data from other work packages, CABl projects and external sources integrated into information management system	Q4
Action on Invasives open data strategy developed and implemented including feedback process of newly acquired information	Q4
Biopesticides portal available as a website and downloadable app with information for 15 countries; partnership agreements with at least 10 biocontrol manufacturers	Q4
Upgraded Distribution Database released, feeding the ISC	Q4
Seven papers published	Q4
Model for financial sustainability of knowledge and data resources developed	Q4
Fundraising and market development	
Plantwise and Action on Invasives programme funding of £15m for 2019–2021 secured from existing and new donors	Q4
Awareness raising conducted with donor country desks in Africa and Asia to ensure ownership and linkages to relevant initiatives and support to Plantwise/ Action on Invasives collaborators	Q4
Action on Invasives annual report submitted to donors and presented at annual Plantwise/Action on Invasives Donor Forum	Q2

CABI's **Action on Invasives**

programme aims to protect and improve the livelihoods of 50 million poor rural families impacted by invasive species through an environmentally sustainable, regional approach to comprehensive biological invasion management.

Action on Invasives is supported by:



Ministry of Foreign Affairs of the Netherlands

Contact

To find out more and discuss how you can get involved in this exciting new initiative, contact either of the following:

Roger Day, Action on Invasives Programme Executive

T: +44 (0)1491 829395

E: r.day@cabi.org

Janny Vos, Strategic Partnerships Director

T: +31 (0)33 4321031

E: j.vos@cabi.org

www.invasive-species.org

 [@CABI_Invasives](https://twitter.com/CABI_Invasives)