



Action on Invasives Annual Report

2017



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Acronyms

| | |
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| AfDB | African Development Bank |
| AGRA | Alliance for a Green Revolution in Africa |
| BCA | Biological control agent |
| CABI | Centre for Agriculture and Biosciences International |
| CBC | Classical biological control |
| CIMMYT | International Maize and Wheat Improvement Center |
| CPC | Crop Protection Compendium |
| DFID | Department for International Development (UK) |
| DGIS | Directorate General for International Cooperation (Netherlands) |
| FAO | Food and Agriculture Organization |
| HST | Horizon Scanning Tool |
| IAPSC | Inter African Phytosanitary Council |
| ICIPE | International Centre of Insect Physiology and Ecology |
| IFAD | International Fund for Agricultural Development |
| IITA | International Institute of Tropical Agriculture |
| IPM | Integrated pest management |
| ISC | Invasive Species Compendium |
| ODK | Open Data Kit |
| PARC | Pakistan Agricultural Research Council |
| PMDG | Pest Management Decision Guide |
| PPRSD | Plant Protection and Regulatory Services Directorate (Ghana) |
| PRA | Pest risk analysis |
| PRISE | Pest Risk Information Service |
| SDC | Swiss Agency for Development and Cooperation |
| STFC | Science and Technologies Facilities Council |
| USAID | US Agency for International Development |
| ZARI | Zambia Agriculture Research Institute |



Introduction

Action on Invasives, CABI's growing programme to strengthen and co-ordinate the national and regional management of invasive species, will help to reverse a threat that has an estimated annual economic impact of more than US\$1.4 trillion worldwide. Invasive species, such as mesquite, parthenium weed, cassava brown streak virus, fruit fly and the tomato leaf miner have been reported to affect the livelihoods of farmers, the tourism industry, irrigation systems, biodiversity, plant genetic resources and livestock production. Across East Africa, five major invasive species cause annual economic losses in maize, beans and tomatoes of US\$0.9–1.1 billion. These species are predicted to cause annual losses in the next five to 10 years of US\$1.0–1.2 billion for the 22 million households that rely on these crops in Ethiopia, Kenya, Malawi, Rwanda, Tanzania and Uganda. In natural ecosystems, invasive plants threaten pastoralists' livestock and natural resources – and even human health. Parthenium weed (*Parthenium hysterophorus*), for instance, is an invasive plant that, besides causing up to 90% crop losses in agriculture, is poisonous to livestock and can cause severe asthma and dermatitis in people. Lantana (*Lantana camara*) and parthenium weed are currently the most problematic weeds on grazing land in Tanzania and Uganda. An independent study of the economic and environmental impact of invasive species in Southeast Asia reported a cost of at least US\$33 billion annually, or US\$55 per capita per year. Extrapolating these figures across sub-Saharan Africa, South and Southeast Asia together, provides an economic cost estimation of >US\$183 billion per annum.

The lack of collaboration and co-ordination on, and knowledge about, the impacts of and potential solutions for such infestations have been identified as the main barriers to effective invasive species management at national and regional levels. Moreover, the geographic spread and impact of invasive species is increasing due to climate change, trade and tourism. Invasive species disproportionately affect communities in poor rural areas, who depend on natural resources and healthy ecosystems for their livelihoods. This drives food insecurity and undermines ongoing investment in development, including measures for adapting to climate change.

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. The programme's goal is to protect and restore agricultural and natural ecosystems, reduce crop losses, improve health, protect trade and reduce the degradation of natural resources and protected areas. To achieve CABI's overarching aim, we seek an investment of US\$50 million (> £30 million).

CABI is well placed to champion systematic change in invasive species management. CABI's member countries, particularly those in Africa and Asia, have identified invasive species as a real and present danger to their agricultural economies and the environment. The organisation also manages high-quality information and data on issues relating to rural livelihoods and the problems of biological invasions. These are widely used by the global scientific community and in developing countries. CABI's open-access Invasive Species Compendium (ISC) is an up-to-date encyclopaedic resource that brings together a wide range of different types of science-based information to support decision-making in invasive species management worldwide.

Leveraging the CABI-led Plantwise programme, as well as other pest risk forecasting efforts (such as the Pest Risk Information Service (PRISE)), optimises the existing role of stakeholders in established plant health systems and demonstrates increased value for money. CABI promotes a unified and collaborative invasive species management approach that allows for the sharing of knowledge, experiences and capacity. In this way, experts who are specialists in particular fields (for example, horticulture, maize or conservation) can work together across sectors. The programme co-ordinates skills and knowledge to provide practical and authoritative invasive species solutions to those who need it, from farmers to policymakers, to deliver sustainable impact.

This report provides information on the implementation of the programme's activities in 2017, according to work packages deliverables. The report includes the next steps planned for the programme and a summary of the funding required in order to achieve the desired impacts.

“I would like to welcome the newly-formed Action on Invasives team, who will take this programme forward. I have full confidence that this enthusiastic and multitalented team with skills and experience in invasive species management, phytosanitary systems, socioeconomics, knowledge management and gender can build on previous success and utilise CABI's century-long track record on invasive species to deliver this ambitious programme”

– Roger Day, Programme Executive



Programme background and design

Action on Invasives is a regional, cross-sectoral partnership endeavour involving a coalition of stakeholders. It adopts a systems-based approach to managing biological invasions across sectors in three stages:

- prevention – development and implementation of biosecurity action plans, raising awareness of threats at the local level (including through mass media campaigns), and preventing arrival and spread
- early detection and rapid response – development and implementation of surveillance and emergency action plans for detecting and eradicating listed species, and building capacity to implement these plans
- control and restoration – evaluating and scaling up existing invasive species management solutions, and developing and scaling up new solutions to ensure those living in rural communities have in place best practice and locally adapted solutions

To pursue this three-stage approach, the programme is organised into four work packages (outlined below), managed by a co-ordination unit and directed by a programme board. Each work package includes strong elements of gender/youth involvement and monitoring and evaluation (M&E). Work packages are implemented together with relevant partners in the identified countries and regions, as follows:

Stakeholder engagement: fostering the right partnerships

This work package identifies and brings together partners under operational frameworks at various institutional levels, using established linkages through the Plantwise programme and other partnerships. The programme works with relevant local, national, regional and international stakeholders to identify and evaluate implementation successes and problems, monitor compliance with national and international policies/agreements and addresses regulatory issues while monitoring institutional change and collaboration.

Knowledge and data: creating and using knowledge

This work package aims to map existing content against need and to identify knowledge gaps that should be filled for comprehensiveness. The programme is developing processes to exchange, create and use online/offline content, information and data at 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 end users' needs.

Providing best practice solutions for invasive species

This work package develops and strengthens cross-sectoral risk assessment procedures, prevention protocols and contingency plans with partners in line with international guidelines, using innovative approaches to support diagnosis and surveillance for priority species. To support large-scale delivery of best practice packages, the programme aims to train relevant border/port staff to improve the rate of interception success and develop training curricula, business plans and protocols, paying particular attention to the use of biological control methods. For longer term implementation activities, the programme works with partners, strengthening their capacities to identify and test invasive species control options, validating existing methods and testing new ones to help deliver sustainable solutions.

Community action: bringing information and action to scale

This work package develops large-scale implementation plans based on identified best practice solutions, and validates and amends these according to community needs. The programme works in partnership with rural communities and local actors to collect and analyse information and data on the negative impact of invasives on livelihoods, to strengthen additional extension approaches, and to understand the costs and beneficial impacts of managing invasives. In the longer term, where possible, local production of biological control methods will be facilitated, encouraging business plans that contribute to local employment opportunities.

The programme works with relevant local, national, regional and international stakeholders to identify and evaluate implementation successes and problems, monitor compliance with national and international policies/agreements and addresses regulatory issues while monitoring institutional change and collaboration

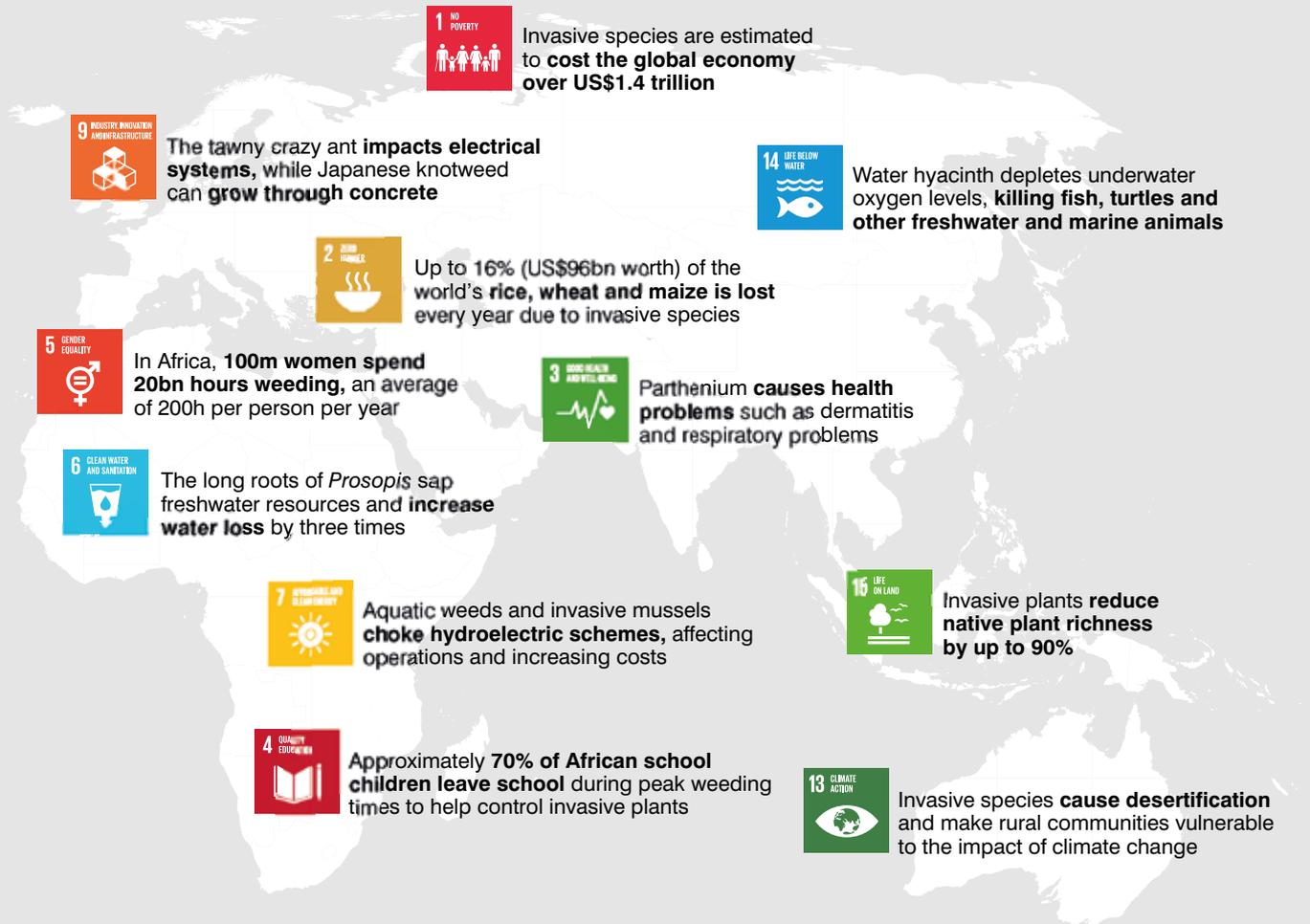


Programme highlights

- Ghana national planning workshop on fall armyworm management conducted, resulting in the formation of a taskforce to co-ordinate and oversee implementation of the agreed plan
- Research and development workshop organised on parthenium in Pakistan: stakeholders actively involved in the inception of a parthenium control campaign in Punjab Province
- Comprehensive fall armyworm evidence note produced to document the spread, and initial and potential impact, as well as potential management solutions
- CABI assigned key responsibilities in the continental Food and Agriculture Organization (FAO) fall armyworm framework, influencing the design and implementation of fall armyworm activities in Africa
- First weed biological control agent (BCA) accepted for research in Pakistan on parthenium
- Beta version of invasive species Horizon Scanning Tool (HST) developed, with launch anticipated in 2018
- Invasive species mapping functionality enhanced in CABI's ISC
- Eight papers published, including two on links between invasive weeds and malaria
- Methodology developed and baseline review conducted on specific pest impacts at the community, national and continental levels to help guide further Action on Invasives impact evaluations, and furthering the call to action on invasive species management on a global scale

A threat to sustainable development

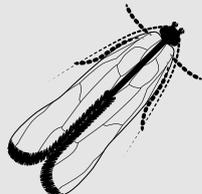
A global crisis



Focus on Africa



Fall armyworm could cause maize losses costing 12 African countries up to **US\$6.1 billion** per annum



Across East Africa, five major invasive species cause annual economic losses in maize, beans and tomatoes of **US\$0.9–1.1 billion** per annum



Parthenium causes over 90% crop losses and is **poisonous to pastoralists' livestock**

A photograph of four people (three men and one woman) standing in a lush green field, likely a farm or agricultural setting. They are all smiling and looking towards the camera. The man on the far left is wearing a light-colored shirt. The man next to him is wearing a light blue button-down shirt. The man in the center is wearing a red shirt. The woman on the far right is wearing a dark top with a colorful patterned vest. They are all holding a large, healthy green plant with broad leaves. The background shows more greenery and a clear blue sky.

Fostering the right partnerships

Effective partnerships are essential for successful management of invasive species. In 2017, CABI conducted reviews and convened workshops with particular focuses and follow-up actions, to bring together national, regional and international stakeholders on specific invasive species, and to further the agenda on invasive species management.

Partnerships to combat fall armyworm

Partnerships at the national level

In order to discuss solutions to fall armyworm, evidence was presented at a stakeholder workshop CABI co-organised with the Plant Protection and Regulatory Services Directorate (PPRSD) in Ghana. A comprehensive action plan comprising short-, medium- and long-term strategies was drafted with concerned public and private sector stakeholders, as well as key donors investing in tackling Africa's fall armyworm problem. This workshop was instrumental in developing a national action plan and in the formation of a national taskforce charged with advising the Minister and co-ordinating the response to fall armyworm. CABI is a member of the taskforce, so the programme is well placed to work with partners on specific activities that fit within, and add value to, the overall national plan.

Partnerships at the continental level

At the continental level the programme has been heavily involved in efforts to develop and implement a continental framework for addressing fall armyworm. CABI presented the preliminary evidence note at an international meeting in Nairobi in April 2017, co-hosted by the International Maize and Wheat Improvement Center (CIMMYT), Alliance for a Green Revolution in Africa (AGRA) and FAO, at which it was agreed FAO should take on a co-ordinating role. The meeting also developed a draft framework identifying roles for different organisations, including CABI. Subsequently, with inputs from many stakeholders, FAO finalised the framework and established a set of 12 thematic working groups co-ordinating different areas of work. CABI leads one of the groups, and is involved in eight others.

In September 2017 CABI and AGRA co-hosted a high-level panel on fall armyworm at the African Green Revolution Forum in Abidjan (see Visibility section below). Dialogue has been maintained with the International Institute of Tropical Agriculture (IITA), the International Centre of Insect Physiology and Ecology (icipe), CIMMYT and FAO in relation to activities prioritised in the overall framework.

Partnership for research

As a result of discussions between CABI and the UK Department for International Development (DFID), an evidence note was developed to provide information on the current extent of the fall armyworm invasion in Africa, known prevention, detection and control measures, short-term and long-term impacts of fall armyworm in Africa (at the household, national and continental level), and the invasion's potential impact on trade. The approach included carrying out farmer perception surveys of fall armyworm impacts on maize, modelling the environmental suitability of Africa for fall armyworm, and carrying out national and continental economic analyses. CABI worked with PPRSD in Ghana and the Zambia Agriculture Research Institute (ZARI) to undertake farmer surveys, as well as undertaking key informant interviews and literature reviews in the Americas, fall armyworm's region of origin. A summary version of the fall armyworm evidence note was published in an academic journal.

Fall armyworm biology and impact

In 2016, fall armyworm, a major pest in the Americas, was found in Africa for the first time. Since then, fall armyworm has spread rapidly across much of sub-Saharan Africa – the problem is frequently raised at Plantwise plant clinics. The caterpillar feeds on more than 80 different plants, but its preferred host is maize, a staple for half the continent. Based on farmer interviews, the DFID-supported evidence note found that fall armyworm has the potential to cause maize yield losses ranging from 8.3 million to 20.6 million tonnes per annum in the absence of any control methods in just 12 maize-producing African countries. The value of these losses is estimated at US\$2.48–US\$6.19 million.

Partnerships seeking to reduce impacts of parthenium weed

In Pakistan, the programme organised a knowledge and data workshop on parthenium weed, inviting stakeholders from the public, private and non-government sectors to understand current knowledge gaps and to contribute to a national management plan involving short-term, medium-term and long-term activities. Buy-in from national partners was vital: commitment from the National Plant Protection Organisation (Department of Plant Protection) and the Pakistan Agricultural Research Council (PARC) 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.

Parthenium

Parthenium weed is invasive in many countries around the world, including South Asia, where an eco-climatic model suggests that many uninvaded areas are a good climatic match for this noxious weed. The weed disrupts the ecology of grasslands and invades woodlands through aggressive competition and allelopathy, inhibiting the growth of other plants. It also poses serious health hazards to livestock and can cause severe allergenic reactions in people who regularly come into contact with it. It also reduces crop yield: for example, in one experiment in Ethiopia sorghum yields were reduced by as much as 97%, while in India, parthenium infestations have resulted in yield losses of up to 40% in several crops. In terms of pasture production, this noxious weed has been found to reduce livestock carrying capacities by as much as 90%.

Having conducted an initial literature review on the weed's known impacts and management methods, as well as surveying the rural and urban public to understand their knowledge of the weed, CABI, convened a knowledge-sharing workshop to work towards short-term and long-term solutions. The workshop noted the lack of co-ordination between research groups in regard to investigating environmental, agricultural, human health and socioeconomic impacts. This translates into a lack of collaboration and a duplication of effort, wasting valuable resources. There is also no clear communication strategy to raise awareness, as a result of which parthenium's significant impacts largely go unnoticed. After the workshop, the importance of parthenium's impacts on agriculture and the environment was highlighted by the PARC, a federal body, which appointed its Chairman as focal person for parthenium research and development in Pakistan.

The workshop resulted in an action plan, composed of short-term goals focusing exclusively on gathering evidence to generate awareness among key stakeholders, and to provide comprehensive integrated pest management- (IPM-) related activities to prevent, detect and control parthenium. Medium-term goals include in-depth communication activities, such as the use of mobile apps in mass extension campaigns, activities to import host-specific and effective BCAs, and the registration of appropriate chemical herbicides for parthenium control. Long-term goals will focus on the development of appropriate national amendments to existing legislation and the development of a long-term biological control programme.

Lessons learnt

The fall armyworm evidence note answered some key initial questions for the development community on the importance of fall armyworm and the appropriate short-term, medium-term and long-term responses. The document has been widely quoted and referred to, emphasising the value of the approach, which will be replicated for other invasives.

One identified area that could be refined involves providing more comprehensive evidence of fall armyworm's impacts, both in terms of actual yield loss and possible effects on food security. Although farmer surveys remain an extremely useful technique for understanding farmers' perceptions of a problem and how they respond to it, for a new pest such as fall armyworm their estimates of loss may not be as accurate as for other pests for which farmers have prior experience, such as stem borers. More sophisticated surveys taking into account biophysical aspects (such as density, abundance and crop-related impacts across a season) would add to the overall picture, although these would be more time-consuming and resource-intensive.

In Ghana, the fall armyworm stakeholder workshop kickstarted many activities, including support for the formation of the national taskforce. It also forged new links between stakeholders and other initiatives.

Next steps: 2018

The fall armyworm evidence note will be updated by conducting further field and farmer surveys in Ghana and Zambia, contributing to continental and national agendas on research and development in relation to fall armyworm. There are several control measures, including pesticides and biopesticides, that have been deployed across Africa and the follow-up survey will be useful to determine the related costs of control and to better determine impacts in Ghana and Zambia. The programme will capitalise on links with the Plantwise and PRISE programmes, as well as on external partnerships with co-ordination and research bodies (such as FAO, icipe, IITA, Desert Locust Control Organisation for East Africa, and CIMMYT). Linkages that have been established with the Inter African Phytosanitary Council (IAPSC) and the African Development Bank (AfDB) will also be strengthened

Further evidence notes will be prepared on key invasive species, such as parthenium weed and the tomato leaf miner (*Tuta absoluta*), which are both spreading across Asia and Africa.

For parthenium weed, the programme will extend engagement with existing national and international research efforts for biological control, as well as with human health institutions (including the National Institute of Health in Islamabad), regarding Pakistan's need to understand parthenium's effects on human health through allergies and skin diseases, such as dermatitis. Action on Invasives will establish linkages with projects focusing on biological control in neighbouring countries, with the aim of beginning to build regional impact.





Creating and using knowledge

Creating knowledge

In 2017, a variety of activities were carried out to develop purpose-built tools and to update and refine the ISC platform. The beta version of the HST was built to provide risk assessors, plant protection officers, quarantine officers, protected area managers and researchers with a quick and user-friendly means of accessing a large volume of relevant data for categorising and prioritising potential invasive species for a more focused/better adoption of preventative measures.

To present geographical distribution of invasive species in a more granular manner, the ISC was enhanced with zoomable maps and improved presentation of point data. Using this enhanced capacity, observational data from invasive plant surveys in East Africa was included for 220 species. Preliminary evaluations of the Crop Protection Compendium (CPC) and ISC, and their value in carrying out risk and impact assessments, were made for the purpose of prioritising content enhancements and in preparation for the development of online decision support functionality. This will be followed-through in 2018 when an online pest risk analysis (PRA) decision support tool will be developed and launched.

A knowledge and data workshop was held, bringing experts together from different areas within CABI. The workshop focused on creating a basis following 'FAIR' principles (that data should be findable, accessible, interoperable and reusable), for the management of data used and created by the Action on Invasives programme. The resulting report sets out recommendations for next steps and references best practice standards for data management, with special reference to invasive species.

A Biopesticides Portal prototype has been developed to increase the awareness, and uptake, of biological control products by extension workers and farmers. A baseline study was carried out as part of the Plantwise programme, which revealed that extension workers lack knowledge about existing, low toxicity pest management solutions. Currently, the information that farmers and extension workers are able to obtain about microbial and macrobial biocontrol products, and where to source them, is limited and comes from scattered sources. The Biopesticides Portal aims to overcome this by facilitating the identification, sourcing and application of macrobial and microbial products for particular crop/pest problems across a range of countries.

Using knowledge

The programme has supported in-country research activities by developing digital processes for data collection in the field. Open Data Kit (ODK) apps were developed for use in Ghana, Zambia and Pakistan, generating socioeconomic data on farmers' knowledge, access to information and perceptions of pest impacts. The activities in 2017 mainly focused on the collection of baseline data. This data will be vital for understanding the current impacts of invasive pests present in the field. In addition, it helps in understanding how digital data collection can be most effective in collecting high-quality data.

The programme has also been involved in the development of IPM content on parthenium and fall armyworm in Asia and Africa, respectively. Utilising Plantwise's tried and tested Pest Management Decision Guide (PMDG) process, the programme has written IPM guides on parthenium in Pakistan and on fall armyworm in 12 countries in Africa. A further 40 green lists (featuring non-chemical IPM techniques) have been developed on invasive weeds. These guides are disseminated to all plant doctors in Africa and Asia through the Plantwise Knowledge Bank and the Plantwise factsheet app.

Lessons learnt

The HST accesses and filters data held in factsheets on over 17,000 species. This provides significant time-saving in generating lists of species that present threats in well-defined situations. However, it is inevitable that when screening such a large dataset there will be some 'data gaps'. Solving problems as to how to present the possible effects of data gaps on query results in ways that are transparent and useful to the user has so far proved to be challenging. Lessons were learnt regarding user assumptions and attitudes to the presentation of information on missing data. Users accept the inevitability of missing data, but the effects of this on scan results need to be communicated clearly and unambiguously. Improvements to the design of the HST were made as a result. Work planned for 2018 will focus on addressing data gaps through content enhancements, to reduce the magnitude of the issue. User assessments and feedback collection will continue in 2018 to identify and implement further improvements to the HST.

Next steps: 2018

A knowledge platform will be launched, collating and disseminating information and data from several existing resources to best serve programme partners and the end users who will benefit from the programme's objectives. The knowledge platform will provide easy access to existing digital resources, but will also include new content, particularly on priority species, as well as decision support tools, including PMDGs, compendium datasheets, a selection of CAB Abstracts articles, videos, the Invasives blog, and links to relevant reports and resources developed by partner organisations. The knowledge platform will incorporate a fall armyworm portal, which will bring together all of the latest knowledge about this species.

In 2018, the HST and the PRA tool will be launched: they will be utilised for prevention and control activities during various country workshops in East Africa and Central West Asia. These workshops will be conducted to gather continuous feedback on the use of these tools, build capacity on their use for future invasive species, and gather important information on the programme's next steps in terms of invasive species prevention and management in those countries.

Anticipating a viable business model for sustainable use, the programme will contribute to a prototype Biopesticides Portal, which will provide users with online access to geo-relevant and registered biopesticides. A pilot phase will be undertaken, in partnership with two to three biological control manufacturers, for quality assurance and user-testing purposes.

Comprehensive data collection tools will be designed based on experiences during 2017, knowledge development and data creation capacity. These tools and the data collected will help maintain and upgrade available predictive models on key pests' distribution, notably fall armyworm, and CABI will partner with other organisations to share this data and work collaboratively. Action on Invasives will develop additional predictive models for parthenium and tomato leaf miner. These findings will be used in the in-country workshops on prevention activities referred to above.

A Biopesticides Portal app will be created to allow users to look up which biopesticides can be used in their country for particular crop/pest problems and to filter these products by hazard, post-harvest intervals, voluntary market standards, etc. Profiles of the registered biopesticides will display information on appropriate use, including maximum number of applications, re-entry interval, application interval, compatibility issues, personal protective equipment requirements, etc. Potential other customer groups who will likely have a strong interest in the portal include governmental regulators (pesticide registrars), private sector decision-makers (e.g. out-grower schemes, cooperatives, organisations operating voluntary certification schemes), and biocontrol manufacturers.

The production of high-quality content for end users will continue: in total, 21 further national fall armyworm PMDGs will be finalised and will be made available through the Plantwise Knowledge Bank and the Plantwise factsheet app, as well as through the invasive species knowledge platform.

The ISC will continue to be enhanced through the addition of 40 new invasive species data sheets, 25 reviews and specific initiatives to fill known content gaps, to improve utilisation of the HST.

The knowledge platform will provide easy access to existing digital resources, but also include new content particularly on priority species as well as decision support tools





Providing best practice solutions

Action on Invasives will apply new knowledge on best practice solutions for specific invasive species.

Classical biological control

Classical biological control (CBC) refers to the introduction of a natural enemy of exotic origin to control a pest, with the aim of achieving permanent control. The technique has been applied against weeds and arthropod pests for well over a century and it has a long global history, with many examples of spectacular successes, such as the complete control of the cassava mealybug across many African countries using a parasitoid, or the control of rubber vine infestations across 40,000 km² of Australia using a rust fungus from Madagascar. Such major impacts can only be delivered responsibly after detailed safety testing has been carried out. Risk assessment protocols for biocontrol agents are well established and need to be balanced against the potential benefit:cost ratio of successful biocontrol, which can be in the 100s:1 range.

Fall armyworm-related best practice solutions

In 2017, the process of natural enemy surveying was initiated in Ghana and Zambia, in regard to fall armyworm. These surveys will provide data in support of biological control efforts, in partnership with other international and national organisations (icipe, IITA, CIMMYT).

Scientific rigour was applied in the development of high-quality fall armyworm materials for large-scale dissemination, alongside Plantwise and the FAO. The outputs include a general PMDG, an identification guide, and a simple management guide.

Parthenium weed-related best practice solutions

In Pakistan, initial activities on best practice solutions for parthenium were undertaken in conjunction with students from the University of Arid Agriculture, Rawalpindi. These activities focused on investigating the spread and impact of parthenium on maize crops, as well as the ecology of a leaf-feeding beetle (*Zygogramma bicolorata*), a proven BCA for parthenium in Nepal, India, Australia and parts of Africa, and its impacts on parthenium in the Islamabad area's agro-climatic zone.

A parthenium weed PMDG was developed in collaboration with in-country experts and the Plantwise Knowledge Bank. Two factsheets were written, one on the appropriate and safe use of pre- and post-emergence chemicals for parthenium, the other on a parthenium yearly management calendar.

In addition to the BCA already present in Pakistan (*Zygogramma bicolorata*), the programme identified another two potential BCAs that might contribute to long-term control of parthenium. A desk-based risk assessment was conducted and submitted to the Department of Crop Protection for the introduction of a stem boring weevil (*Listronotus setosipennis*). Not only does this progress the case for biological control of parthenium in Pakistan, the templates created for this application can also be used for the development of future applications and for improving the capacity of the Department of Plant Protection in assessing biocontrol applications.

Lessons learnt

The introduction of BCAs for insect pests is already an advanced and well-regulated activity in some countries, but many countries still do not have clear procedures, particularly for the introduction of agents for weed control. Future activities will need to strengthen the regulatory systems for biological control, in line with the appropriate international standard of the International Plant Protection Convention (ISPM 3).

While many BCAs have been introduced to control insect pests in Pakistan, none have yet been introduced to control weeds. The Action on Invasives programme aims both to enable this to happen, and also to create greater capacity in the country's regulatory process to meet the needs and provide the research required for future agents to be introduced.

Next steps: 2018

In Pakistan, the regulatory process for introducing a new BCA will be followed, including testing to demonstrate the suitability and confirm safety of the agent for release. Subject to the results of those tests, an application will be made for trial releases. Consideration will also be given to introducing an additional agent, as experience elsewhere suggests that several agents are required for effective suppression of parthenium populations. Biological control of parthenium activities will be conducted in partnership with national plant protection organisations, such as the National Agricultural Research Council.

The programme will link its results to other projects, including the BCA research and development in Tanzania funded by the US Agency for International Development (USAID) in the past, and a new project investigating the possibility of identifying parthenium through satellite imagery (remote sensing). The latter example is particularly interesting, as it offers the possibility of creating new linkages with physical sciences institutions, utilising satellite data to understand the spread and impact of invasive weeds. We will also link with organisations examining the feasibility of using remote sensing to detect fall armyworm-damaged fields.

In African countries, natural enemy surveys will be concluded for fall armyworm, to provide the information necessary for recommending cultural control methods and for investigating the options for augmentative and classical biological control. These activities will be conducted in conjunction with other international and national research organisations. Studies on the use of native natural enemies in augmentative and conservation biological control will also be carried out through two PhDs, which will be partly funded by the University of Wageningen (on the use of parasitoids and predators of fall armyworm) and the University of Neuchâtel (on the use of entomopathogenic nematodes). Various components of IPM strategies will also be tested, such as the use of biopesticides and botanicals, pheromones and cultural practices.

CABI will also facilitate the registration of novel and low-risk fall armyworm control products in the target countries, adding to the arsenal of tools available to farmers. This will be backed up by development of a fall armyworm master trainers manual that will be made widely available for African extension personnel.

Other invasive insect pests, such as tomato leaf miner, will be the targets of specific studies on related control methods. Prevention will also be an important part of activities in 2018: we will use risk analysis methods and tools to guide the setting up of risk management/prevention practices for both generic approaches and specific pests (an activity many countries rarely undertake at the moment).



Bringing information and action to scale

The adoption of new knowledge or technologies at scale requires a set of activities that extend beyond demonstrating technical effectiveness. Ensuring uptake requires an understanding of stakeholder knowledge and behaviour, and of the factors that will promote or constrain adoption.

Understanding the current situation: the importance of initiating baselines

A survey of farmers' perceptions of, and responses to, fall armyworm attack was carried out, which shows that 72% of farming households in Ghana and 60% of farming households in Zambia use chemical control as a first resort. Importantly, these chemical control measures are costly, estimated at US\$15 to US\$17 per hectare for commonly used pyrethroid insecticides, although in both Ghana and Zambia, the government has also given out pesticides to farmers. The success rate of these measures is a vital influencer of a farmer's predisposition to use them continually over time: while 90% of farmers using one pyrethroid deem the chemical successful in reducing fall armyworm impacts, no farmers in Zambia believe another pyrethroid is successful, even though both pesticides would be expected to be effective. Various factors may have contributed to this result, including inappropriate or mistimed application, or the use of fake or adulterated products. There is no indication yet of any resistance to pesticides in fall armyworm populations in Africa.

A survey of 120 Ghanaian citizens (50% of whom were female) in various parts of the country was conducted to understand the level of access rural populations had to information through mobile phones and the internet, and their willingness to take part in citizen science or crowdsourcing initiatives. Overall, 60% mentioned the extension agent as their most important source of information, with neighbours and the radio also being useful sources. Face-to-face contact was deemed to be the most trustworthy manner of receiving information, although mobile phones were the preferred option for participants to report a problem to the authorities. There were no significant differences according to gender. This is valuable information to take forward when designing large-scale messaging activities in 2018.

In Pakistan, surveys were conducted to assess knowledge and perceptions of parthenium in rural and in urban environments. The questions touched on public opinion on biological control, people's information needs and how they receive it. The results identified several issues that are relevant for the programme's integrated communication plan for 2018. First, many participants did not know about the weed itself, and over half were not aware of its skin disease and allergenic properties. Second, of the rural participants who were aware of the weed, many did not view it negatively, using it as fodder, or even eating it to combat diabetes. There were no significant differences according to gender.

The information gathered was analysed and reviewed at a consultative workshop with communication and scientific experts tasked with focusing on the key messages to disseminate on a large scale at the beginning of 2018. The workshop concluded that a range of different communication tools (for example, radio campaigns, TV messages, extension agents trainings and public awareness campaigns), should take place in the Punjab to reach a large number of residents in the province.

Communication at scale

In 2017, a major outreach activity targeting a large number of rural farmers focused on simple messages developed from the fall armyworm evidence note. In collaboration with CABI's Plantwise programme, a fall armyworm media campaign was implemented in Ghana and other countries in Africa. A video was produced in Ghana on fall armyworm in maize, linked with the Plant Protection and Regulatory Services Directorate and the Department of Extension Services. In total, five television shows were translated into Twi and transmitted on Adom TV and TV3 channels in December 2017. These television channels cover the central region of Ghana, and the cumulative viewership for both channels over the time period was over 3 million people. 40,000 posters were also printed and disseminated at key locations in Ghana.

Lessons learnt

Field and socioeconomic surveys are challenging assumptions about invasive species knowledge amongst stakeholders. While parthenium has been identified in the research and development community as a key problem, surveys in the Punjab show that only half of the population surveyed are aware of this weed. Some surveys even reveal that some people have the perception that parthenium is a beneficial weed. This highlights the need to involve different stakeholders in planning and implementing a management strategy. A first step in this is building awareness of the various impacts of the weed. Awareness and understanding of biological control as an economically and environmentally viable solution also needs to be developed.

Next steps: 2018

In 2018, the programme will reach a minimum of 1 million rural households with new knowledge on invasive species management, including 200,000 households to be targeted regarding fall armyworm prevention detection and control techniques. This will be achieved, first, by reviewing and facilitating knowledge exchange mechanisms and pathways, and, second, by employing targeted communication channels. In Pakistan, the programme will use various social knowledge transfer techniques, such as a "Week of Weeding" festival and village cinemas, providing simple and effective messages for communities affected by parthenium. Large-scale capacity-building training for extension workers on preventing, detecting and controlling parthenium, as well as high-quality extension content and mass/social media campaigns, will also consolidate the programme's outreach agenda.

In Ghana and Uganda, four more televised campaigns and two radio programmes, respectively, are planned in the early part of 2018 on fall armyworm, while a co-ordinated strategy with Plantwise and external partners (including FAO) will generate information and knowledge in large parts of sub-Saharan Africa. In Kenya and Zambia, pilot campaigns on fall armyworm will be initiated using a combination of SMS messages and posters. The campaign design will be informed by a formative appraisal that will be undertaken during the first half of the year. Besides the individual recipient farmers, extension workers (private, public and NGO) and farmers' group/co-operative leaders will be targeted, given their wide coverage and presence in farming communities.

In our communication and awareness activities we aim not only to deliver information to a given audience, but also to provide them with the basis for a change in behaviour. We will thus aim to assess the extent to which this is achieved.



Outcomes and impacts

2017

The nature of the programme's anticipated impact pathways means that we do not expect to see significant outcomes or impacts at this early stage. However, as described above, a number of baseline assessments have been conducted against which future evaluations will be made.

2018

In 2018, M&E efforts will measure programme reach. Studies will be initiated to collect evidence of outcomes or impact. We will review the multiple pathways through which management of invasive species can achieve impact, and identify and focus on the major ones.

Information resources in use

Tools will be designed and launched that are dedicated to increasing the knowledge of various end users, and increasing their application of that knowledge in the field (such as the HST, PRA, the Biopesticides Portal, etc.), and to improving the amount of knowledge presented through existing platforms (such as through PMDGs on the Plantwise Knowledge Bank). We will assess progress by monitoring the use of these tools and resources as part of prevention, detection and control of priority invasives.

Cross-sectoral collaboration delivering biological invasion actions

We will monitor the number of national and institutional shifts in collaboration and regulations to create a more enabling environment for the prevention, detection and control of invasive species. The programme will collect policy- and decision-makers' feedback on evidence notes on fall armyworm, parthenium and tomato leaf miner.

Delivery of sustainable and scalable biological invasion solutions

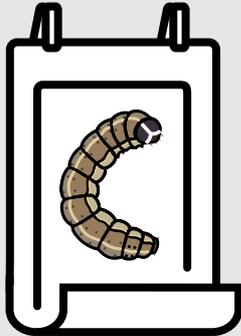
In 2018, the programme will start training in-country partners on invasive species prevention, detection and control techniques. The programme will also collaborate with international partners for long-term biological control research initiatives and test existing solutions for their economic and environmental efficacy. This research will be monitored according to success of application, cost effectiveness and uptake by national partners.

Rural communities adopt and implement solutions at scale

This outcome will be measured by reference to the new practices adopted by local communities to deal with invasive species prevention, detection and control. In 2018, the programme will start comparing its 2017 baseline activities on fall armyworm through repeated surveys in similar locations. An analysis of the short- and long-term advice being given to farmers through developed PMDGs will also evaluate any change in best practice advice given to farmers. The programme will also monitor the implementation of the parthenium management plan drawn up with Pakistani partners.

Raising awareness of fall armyworm

In 2017, CABI's Action on Invasives and Plantwise programmes leveraged the potential of mass communication channels for a number of projects by fall armyworm. Radio programmes, posters, fact sheets and social media messages have been supporting farmers with information on preventing, monitoring for and managing this new pest.



40,000

Posters printed and displayed at local focal points



1.3m

Radio listeners to radio campaigns and call-in shows

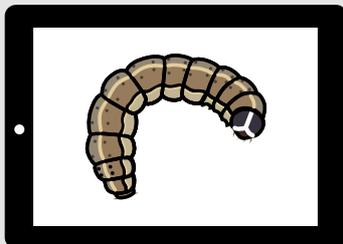
2,455

Visitors to fall armyworm hub on CABI website



9,308

Fall armyworm content views on the Factsheet Library App

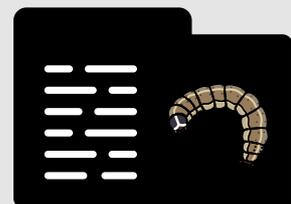


122,000

Impressions / engagements with fall armyworm social media campaign

10,687

Fall armyworm factsheets downloaded from Knowledge Bank





Publications

Day, R.; Abrahams, P.; Bateman, M.; Beale, T.; Clottey, V.; Cock, M.; Colmenarez, Y.; Corniani, N.; Early, R.; Godwin, J.; Gomez, J.; Gonzalez Moreno, P.; Murphy, S.T.; Oppong-Mensah, B.; Phiri, N.; Pratt, C.; Silvestri, S. and Witt, A. (2017) Fall Armyworm: Impacts and Implications for Africa. *Outlooks on Pest Management*. 2017 Oct 1;28(5):196-201.

Muller, G. C.; Junnila, A.; Traore, M. M.; Traore, S. F.; Doumbia, S.; Sissoko, F.; Dembele, S. M.; Schlein, Y.; Arheart, K. L.; Revay, E. E.; Kravchenko, V. D.; Witt, A.; and Beier, J. C. (2017) The invasive shrub *Prosopis juliflora* enhances the malaria parasite transmission capacity of *Anopheles* mosquitoes: a habitat manipulation experiment. *Malaria Journal*, 16(1), 237.

Pratt, C. F.; Constantine, K. L.; and Murphy, S. T. (2017) Economic impacts of invasive alien species on African smallholder livelihoods. *Global Food Security*, 14, 31-37.

Shackleton, R. T.; Witt, A. B.; Aool, W.; and Pratt, C. F. (2017) Distribution of the invasive alien weed, *Lantana camara*, and its ecological and livelihood impacts in eastern Africa. *African Journal of Range & Forage Science*, 34(1), 1-11.

Shackleton, R. T.; Witt, A. B.; Piroris, F. M.; and van Wilgen, B. W. (2017) Distribution and socio-ecological impacts of the invasive alien cactus *Opuntia stricta* in eastern Africa. *Biological Invasions*, 19(8), 2427-2441.

Stone, C. M.; Witt, A. B.; Walsh, G. C.; Foster, W. A.; and Murphy, S. T. (2018) Would the control of invasive alien plants reduce malaria transmission? A review. *Parasites & Vectors*, 11(1), 76.

Witt, A. B.; Kiambi, S.; Beale, T.; and Van Wilgen, B. W. (2017) A preliminary assessment of the extent and potential impacts of alien plant invasions in the Serengeti-Mara ecosystem, East Africa. *Koedoe: African Protected Area Conservation and Science*, 59(1), 1-16.

Witt, A. B. (2017) Use of non-native species for poverty alleviation in developing economies. In *Impact of Biological Invasions on Ecosystem Services* (pp. 295-310). Springer, Cham.



Annex 1: 2018 milestones

| Stakeholder engagement | Date due |
|---|----------|
| Study of fall armyworm's economic impact at micro (household) and macro (agricultural GDP) levels published, based on detailed evidence from 2+ countries | Q3 |
| Regulatory approval of 1+ fall armyworm biopesticide/biocontrol product in 1–2 countries, attributable to CABI invasives policy/evidence support | Q4 |
| Evidence notes for two additional invasive species (e.g. parthenium, tomato leaf miner) causing food insecurity developed for sub-Saharan Africa and Asia | Q4 |
| Engagement with existing mechanisms for regular regional discussions of invasive species management in two regions (one in Asia and one in Africa) | Q4 |
| Discuss business models with stakeholders to enable future production of biocontrol agents | Q4 |
| Programme initiated in four countries | Q4 |
| Co-organise CABI-icipe-IITA 'Invasive species management in Africa workshop', in Kenya | Q1 |
| Initiate organisation of policymakers conference on invasive species impacts and actions needed | Q2 |
| Knowledge and data | Date due |
| Vision for knowledge resource finalised; invasive species knowledge platform fully launched | Q2/Q4 |
| Data capturing spread and efficacy of different fall armyworm 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 |
| Action on Invasives PRA tool launched and used by quarantine/plant protection staff in five countries (cumulative) | Q4 |
| New Biopesticides Portal launched, providing users with online/offline access to geo-relevant and approved biopesticides in three countries | Q4 |
| Horizon-scanning/risk analysis and monitoring tools for fall armyworm and 2+ additional invasive species developed and in use in two countries; evidence of prevention protocols being implemented | Q4 |
| Multiple sources of field data used to test and update predictive models | Q4 |
| Delivery of 21 fall armyworm PMDGs to Plantwise Knowledge Bank | Q3 |
| ISC maintained and updated | Q4 |
| One impact study published on the economic impact of invasive species | Q4 |
| Four papers published | Q4 |

| Best practice solutions | Date due |
|--|-----------------|
| 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 (fall armyworm) | Q4 |
| Research study of management control effectiveness/cost-efficiency initiated and undertaken, comparing different approaches on one invasive in one country | Q4 |
| Fall armyworm bioprospecting survey completed in one country and initiated in two others | Q4 |
| Biocontrol strategies and protocols for fall armyworm developed and published (jointly with IITA/icipe) | Q3 |
| IPM packages to reduce fall armyworm populations in maize and rotation crops developed and tested in at least one country | Q4 |
| At least 10 master trainers trained in use and application of invasive species content, tools and best practice solutions | Q4 |
| Community action | Date due |
| Indicative evidence of responsible use of (bio)pesticides for control of invasive pests, as indicated by the number of countries adopting PMDG advice | Q4 |
| Management plan implemented and monitored for one invasive species in one target country/region | Q4 |
| At least six posters/pamphlets, brochures developed as part of awareness campaign | Q4 |
| Fall armyworm 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 |
| 1 million rural households reached with new knowledge on invasive species management; >200,000 receiving and acting on CABI info on fall armyworm and control options | Q4 |
| Fundraising and market development | Date due |
| New Action on Invasives funding of £5 million secured from existing and new donors for 2018–2020 (e.g. EU, SIDA, GAC) | Q4 |
| 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 |
| Action on Invasives annual report submitted to donors; annual donor forum linked to Plantwise donor forum organised 2017 | Q1/ Q2 |
| Strategy and logframe reviewed and updated; 2019 milestones and country activity plans developed | Q3/Q4 |

Annex 2: The Action on Invasives team

Presenting the Action on Invasives team



Front row: Dr Roger Day, Dr Dennis Rangi, Julien Godwin

Back row: Abdul Rehman, Katherine Cameron, Dr Monica Kansiime, Dr Ivan Rwomushana, Dr Marc Kenis



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:

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