Fall Armyworm:
Impacts and Implications for Africa

Evidence Note (Summary Version), September 2017

This publication is a digest of an Evidence Note commissioned by the UK Department for International Development (*Fall Armyworm: Impacts and Implications for Africa*) and published by CABI in September 2017. The full report is available at www.invasive-species.org/fawevidencenote

Acknowledgement

The authors gratefully acknowledge the financial support of the Department for International Development (DFID). The views expressed in this document are those of the authors and do not necessarily reflect the views of DFID.

KNOWLEDGE FOR LIFE

Key messages

- Fall Armyworm (FAW) in Africa has the potential to cause maize yield losses in a range from 8.3 to 20.6m tonnes per annum, in the absence of any control methods, in just 12 of Africa's maize-producing countries. This represents a range of 21%-53% of the annual production of maize averaged over a three year period in these countries. The value of these losses is estimated at between US$2,481m and US$6,187m.
- FAW should be expected to spread throughout suitable habitats in mainland sub-Saharan Africa within the next few cropping seasons. Northern Africa and Madagascar are also at risk. At the time of this document's publication, 28 countries in Africa have confirmed the pest on their territory (compared to 12 in April 2017). A further nine countries have conducted or are presently conducting surveys, and either strongly suspect its presence or are awaiting official confirmation. Two countries have stated that FAW is absent. No information on FAW presence or absence could be gathered from the remaining 15 countries.
- Control of FAW requires an integrated pest management (IPM) approach. Immediate recommendations include (i) awareness raising campaigns on FAW symptoms, early detection and control, including beneficial agronomic practices; (ii) national preparation and communication of a list of recommended, regulated pesticides and biopesticides and their appropriate application methods. Work should also start immediately to (i) assess preferred crop varieties for resistance or tolerance to FAW; (ii) introduce classical biological control agents from the Americas. A conducive policy environment should promote lower risk control options through short term subsidies and rapid assessment and registration of biopesticides and biological control products.

Purpose

The purpose of the Evidence Note is to review current evidence of the potential impact of FAW in Africa, with the aim of:

- assessing the likely social/economic impact on affected farmers and value chains
- quantifying the likely economic effect on agricultural sectors in affected countries/regions if left unmanaged
- recommending and prioritising control options which are economically appropriate and practical in the local context, with the aim of mitigating the prospective impact of FAW
- identifying non-beneficial interventions
- recommending next steps for FAW management
- collating evidence of current FAW biology and ecology, and its future distribution

FAW biology

FAW, scientific name *Spodoptera frugiperda*, is a moth that is indigenous throughout the Americas. It is widely agreed to be one of the most damaging crop pests in the Americas, feeding on over 80 different crops, including maize, rice, sorghum and sugarcane, as well as other crops, including cabbage, beet, peanut, soybean, alfalfa, onion, cotton, pasture grasses, millet, tomato, potato and cotton. It has not previously been established outside the Americas but its two strains have now appeared in Africa and are rapidly spreading throughout the tropical and subtropical regions of the continent. Its impact on maize yields in Africa has been, and is likely to continue to be, significant. FAW is capable of migrating long distances on prevailing winds, but it can also breed continuously in areas that are climatically suitable.

FAW distribution

The first confirmed reports of FAW were from West Africa in early 2016. Research to date suggests that both strains of FAW entered Africa, perhaps as stowaways on commercial aircraft, either in cargo containers or airplane holds, before subsequent widespread dispersal by the wind. The probability is high (>90%) that the introduction to Africa was from the characterised Florida strain of FAW, which is restricted to the eastern seaboard of the USA, and the Caribbean islands.

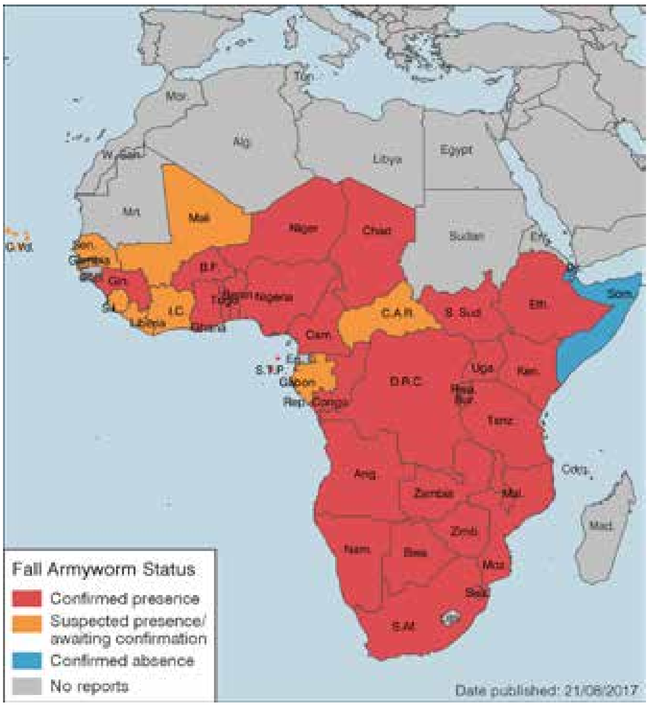
Information was collated from all 54 countries in Africa through literature searches, personal communications and internet mining. 28 countries have confirmed the presence of FAW, while a further nine countries suspect its presence, or are awaiting official confirmation of the pest in the country (Map 1). Two countries (Somalia and Djibouti) have conducted surveys and not found any FAW.

Using distribution data collected from South America and in Ghana and Zambia, models have been used to investigate the environmental (climatic) factors affecting the distribution of FAW. Results from 560 models have been combined to produce an environmental suitability index for FAW across Africa.

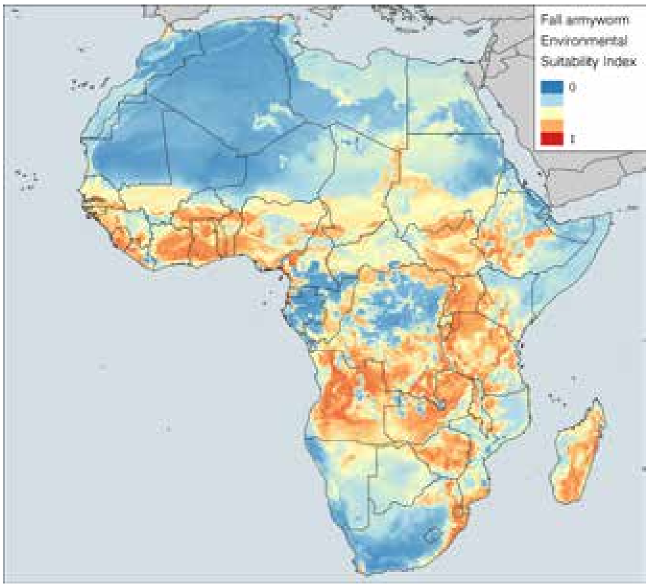
Map 2 shows possible hotspots, as well as areas where climatic conditions are not considered favourable. Dark blue shading denotes an unsuitable environment for FAW, yellow shading represents a moderate suitability, while orange and red signify the environment is suitable or very suitable for FAW.

By comparing the current reported FAW presence with maize growing areas and environmental suitability in Africa (Maps 3 and 4), it is possible to make some predictions about FAW distribution.

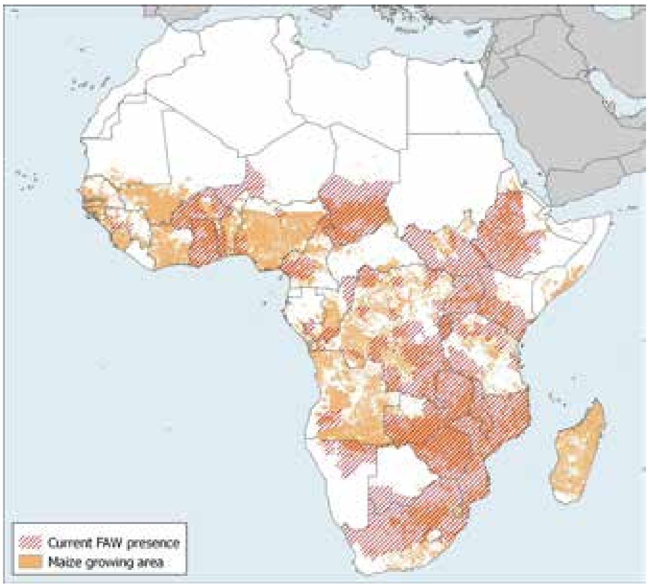
Map 1: Current FAW distribution in Africa (August 2017)



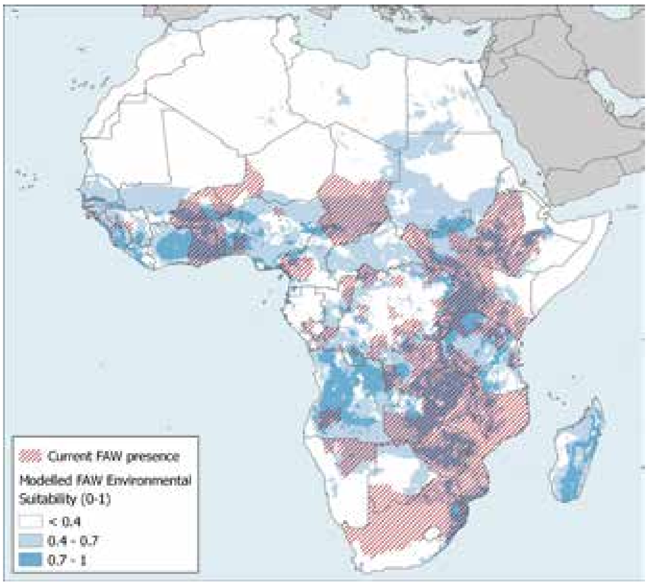
Map 2: Environmental suitability for FAW in Africa



Map 3: Overlay of known FAW presence and maize growing regions of Africa



Map 4: Current and predicted distribution (by environmental suitability indices) of FAW



Due to their suitable climate, reports of FAW presence and impact are expected to be confirmed in further West African countries including Sierra Leone, Mali, Senegal, Liberia and Côte d'Ivoire, and in the Central African Republic and Sudan. In Angola and Nigeria more widespread outbreaks can be expected than has been reported so far, given their environmental suitability and distribution of maize.

FAW has not yet been recorded in Madagascar, although the climatic conditions and maize production areas are suitable for FAW establishment. Given Madagascar's reliance on agriculture for its gross domestic product (24%, World Bank data), this is an important area of concern. It is strongly recommended that rigorous prevention and monitoring activities are initiated in this country as soon as possible.

There is high environmental suitability for FAW on the Mediterranean coast in Morocco, Algeria, Tunisia and Libya, increasing the risk of a possible spread of this insect to Europe. The high suitability areas in Ethiopia, for example, could enable the pest to progress towards the Middle East and Asia.

Impact in Africa

Maize is the most important staple cereal crop grown by smallholders in sub-Saharan Africa and is also one of the dominant cereals grown in most other African countries. It is grown across diverse agro-ecological zones (AEZs) where over 200 million people depend on the crop for food security. Maize accounts for almost half of the calories and protein consumed in eastern and southern Africa, and one-fifth in West Africa.

CABI conducted a household socio-economic survey in Ghana and Zambia in July 2017. Survey questions examined farmers' perception of losses specifically due to FAW over the last full growing season. Based on the survey results, the estimated national mean loss of maize in Ghana was 45% (range 22-67%), and in Zambia 40% (range 25-50%).

Using the data from Ghana and Zambia, CABI estimated the potential impacts on national yield and revenue in 10 other major maize-producing countries that are likely to occur in the maize-producing seasons, assuming that the FAW will spread throughout all areas where it is predicted to survive (Table 1). Kenya and South Africa were not included as there was insufficient data on agro-ecological zones, maize production and economic value for these countries to include in the models.

Table 1: Estimated lower and upper yield and economic losses in the 12 maize-producing countries included in the study (lower and upper losses based on lower and upper quartile of significance in yield loss values for each agro-ecological zone)

Country	Maize production (three-year mean) (thousand tonnes)	Value of maize (three-year average FAO stats) US$ million	Yield loss (lower) (thousand tonnes)	Yield loss (upper) (thousand tonnes)	Mean yield loss (thousand tonnes)	Economic loss (lower) (US$ million)	Economic loss (upper) (US$ million)
Benin	1,285.3	376.5	295.6	735.8	530.4	86.6	215.6
Cameroon	1,665.7	697.8	319.2	794.4	687.4	133.7	332.8
Democratic Republic of Congo	1,173.4	343.7	254.5	633.4	484.2	74.5	185.5
Ethiopia	6,628.3	1,580.2	1,227.2	3,054.7	2,735.2	292.6	728.3
Ghana	1,825.5	629.8	401.6	1,213.9	824.3	138.5	418.8
Malawi	3,344.9	979.7	769.3	1,915.0	1,380,3	225.3	561.0
Mozambique	1,247.2	365.3	99.7	239.2	514.7	35.0	84.1
Nigeria	9,302.7	3,271.8	2,129.1	5,299.7	3,838.9	748.7	1,863.6
Uganda	2,748.3	805.0	558.9	1,391.1	1,134.1	163.7	407.5
Tanzania	5,732.6	1,679.1	1,301.3	3,239.0	2,365.6	381.2	948.8
Zambia	2,913.0	500.9	728.1	1,456.1	1,154.0	125.2	250.4
Zimbabwe	1,104.1	360.7	234.8	584.4	455.6	76.7	190.9
Total	**38,971**	**11,590.5**	**8,319.3**	**20,556.7**	**16,104.7**	**2,481.7**	**6,187.3**

It is also important to consider the individual household-level impacts. FAW will have an impact on many different aspects of household livelihoods. As seen through the prism of the DFID livelihood framework, the pest is likely to directly affect natural capital, through yield losses and the ability of agricultural lands to respond to shocks; and financial capital, through increasing the cost of production, and its effect on income. It will also indirectly affect households' social and physical capital (the household's assets).

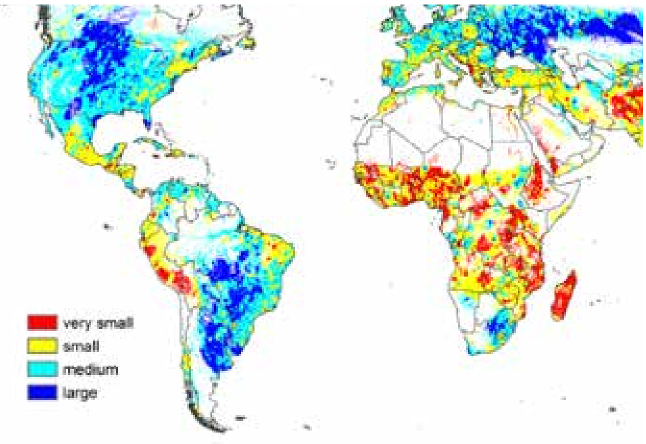
Internatonal trade will also be impacted by FAW. Trade carries the risk of introducing pests to countries where they are not yet present – consignments of food and agricultural products being a particular risk. Thus countries in North Africa, Asia and Europe will wish to manage this risk, by placing additional production or handling requirements and conditions on exports from FAW-affected countries, with cost implications for the exporters. In June 2017 the first shipment (of roses) from Africa contaminated with FAW was intercepted in Europe.

However, National Plant Protection Organisations (NPPOs) in Africa with significant exports to Europe are aware of this situation, and are taking the appropriate measures to reduce the risk of FAW-contaminated consignments being shipped. Well-organised NPPOs supporting major export sectors should be able to cope with this situation, but it could be problematic for countries where export certification is weaker and the agri-food export sector is less developed.

Controlling FAW

There is a large volume of literature on FAW control in the Americas, but the agricultural systems there are often very different from those in Africa. Few areas in the Americas have the small farm and field sizes that predominate in Africa (Map 5).

Map 5: Field size (from Fritz et al., 2015)



Yields are much higher in the Americas, averaging over eight tonnes per hectare for maize, compared with around two tonnes per hectare in Africa. Genetically modified (GM) crops are also widespread in the Americas but are used in only a few countries in Africa.

FAW causes damage by feeding on both vegetative and reproductive structures. Damage to the leaves of maize does not necessarily cause a loss of yield because the plant is able to compensate for at least some loss of leaf area. This may lead to inaccurate perceptions of loss, and economically unnecessary interventions.

Young FAW larvae hide in the maize funnel during the day but emerge at night to feed on the leaves. Spray applications are therefore more likely to be effective if undertaken around dawn or dusk. Older larvae (which cause more damage) tend to stay inside the maize funnel and so are protected from spray application to the foliage. Pesticide applications should therefore be timed to coincide with the presence of the younger larvae. On small farms the cost of pesticide application can be reduced by only spraying affected plants. In Latin America, farms where planting takes place later tended to show a more uniform distribution of the larvae (and higher levels of damage).

Numerous synthetic pesticides are able to kill FAW, and many are registered and recommended in Latin America. These include pesticides from several different modes of action spanning the various WHO hazard categories, including some classified as highly hazardous (WHO Class 1b). A key issue around pesticide use in Africa is the risk to human health. Pesticides are frequently applied without sufficient safety precautions being taken, and there is growing evidence of pesticide poisoning – although so far not as a result of FAW control. Resource-poor farmers are often unwilling or unable to buy the appropriate safety equipment. Highly hazardous pesticide should therefore never be recommended in Africa, and Class 2 pesticides avoided as far as possible.

Many of the cheapest and most widely used pesticides in Africa fall into the mode-of-action classes to which resistance has developed in the Americas. It is not known whether the FAW populations in Africa were already resistant on arrival, but strategies should be devised and implemented to reduce the likelihood of pesticide resistance developing. Pests develop resistance to pesticides through repeated exposure of successive generations to chemicals with the same mode of action. The following strategies should be implemented:

- A combination of control methods should be used, rather than relying only on pesticides
- Treating successive generations using products with the same mode of action must be avoided
- Pesticide application should be based on monitoring and thresholds, rather than being used as a prophylactic or preventative measure
- The manufacturer's recommended dose and concentration should be followed
- Pesticides should be purchased from registered dealers

The preferred approach to FAW control is Integrated Pest Management (IPM), utilising a combination of control methods. In Latin America IPM is seen most commonly in smallholder systems that are more similar to African farming systems than the large monocultures where Bt crops and/or calendar spraying are used. An important element of IPM is conserving the natural enemies of the pest. In Latin America, large numbers of parasitoids, predators and pathogens of FAW have been reported. Studies on what natural enemies are attacking FAW in Africa, what level of mortality they can exact, and how they can be encouraged, are required urgently.

Given the dangers of chemical pesticides, the development of lower-risk approaches using biological pesticides for FAW is high on the list of near-term priority activities. CABI is conducting an analysis of biopesticides registered in 30 countries including for FAW control, which will be published by German Gesellschaft für Internationale Zusammerarbeit (GIZ). The report will make recommendations on regulatory issues affecting the availability and use of biological pesticides, priority biological pesticides for testing against FAW, and the support needed to test and register the products.

Creating an enabling framework

The successful management of FAW in Africa requires coordinated action from multiple stakeholders, operating within an enabling framework set by national governments and regional or international institutions. Some principal considerations include the following:

Advisory services. Governments may not be able to provide advice to all farmers, but they should ensure consistent advice is disseminated through multiple channels and advisory services, and that advice is updated as new information is collected. A combination of communication methods (in both the public and private sectors) is required, taking into account the information to be communicated and the control methods being promoted. Again, there is an important role for government in monitoring whether farmers are receiving the advice they need, and finding ways of addressing gaps. Communication methods, such as radio phone-ins and plant clinics can provide useful feedback in this context.

Policy and regulatory environment. Policy affects the way in which pests are controlled. While IPM Is the preferred approach, often policy intentionally or unintentionally promotes pesticides. In response to the appearance of FAW, several governments are providing or subsidising low cost moderately hazardous pesticides. However, this may encourage pesticide use that in the long run is not sustainable. The perceived short-term benefits must therefore be weighed carefully against the potential long-term costs such as human health hazards, development of pesticide resistance and destruction of beneficial natural control agents. Governments and development partners should consider subsidising lower risk pesticides and biological pesticides.

An important part of pesticide policy is the pesticide registration regime: registration is a legal requirement for a pesticide to be imported, sold, stored, distributed, advertised, packaged or used. To register a pesticide, data must be submitted, including the product's identity, formulation, biological properties, toxicology, and environmental impact. Data from field trials of efficiency may also be required, but the more data that is required, the higher the cost, and often, the longer the process. Products that are lower risk but are for smaller or niche markets may therefore be effectively excluded from registration. A registration system designed to reduce risk may thus end up promoting the use of broad-spectrum mass-market products, and prevent lower-risk products from entering the market. One way to improve pesticide registration is therefore to use harmonised procedures across a number of countries. The Comité Sahélien des Pesticides (CSP) has succeeded in formalising such cooperation.

Recommendations

In the **immediate term**, it is suggested that national authorities undertake the steps set out below, preferably through a national task force and response plan. Many countries are already taking at least some of these steps.

- Promote awareness of FAW, its identification, damage and control, in particular IPM, to farmers, extension agents, plant health inspectors and other stakeholders
  - Particular attention on prevention and early detection is required in 'at risk' countries where FAW has yet to be reported (eg Madagascar)
- In consultation with extension agents and agronomists, promote awareness of potentially benefical agronomic practices, to develop tailored guidelines for farmers
- In consultation with agro-input suppliers, prepare and communicate a list of recommended, regulated pesticides and biopesticides. They should be available, and preferably already registered for the crop in which they are to be used, and/or for use on other caterpillars. Pesticides/biopesticides registered/recommended for FAW control in the Americas could be selected, but highly hazardous pesticides should never be recommended
- Arrange for laboratory efficacy tests of recommended pesticides to be conducted by authorised national laboratories
- Provide emergency/temporary registration for the recommended pesticides (including microbial pesticides such as Bt and botanicals such as neem). Regulators should admit supporting data from elsewhere for temporary registration

Other steps for governments in the short-medium term include:

- Regularly review recommendations and publicise changes promptly and widely
- Implement a pesticide resistance management plan
- Assess preferred crop varieties for resistance or tolerance to FAW
- Consider short-term subsidies for small-scale farmers – for example to reduce prices for lower-risk plant protection products
- Document the species and impact of local natural enemies
- Test agronomic and cultural practices for reducing FAW damage including through conservation and encouragement of natural enemies
- Test alternative approaches to pesticide deployment such as seed treatments or dry formulations for manual application into the whorl

Communications to farmers should include the following guidance:

- Maintain plant diversity on the farm – for example by intercropping – since this should encourage natural enemies. Monitor susceptible crops at least weekly, with the aim of detecting egg masses and/or small larvae (<0.5 cm). Large-scale farms could consider using pheromone traps[1] for monitoring twice weekly but visual inspection is also advised
- On detecting FAW or early symptoms (windowing of leaves) consider treatment when suggested action thresholds are reached (eg 20% of whorls damaged in plants <40 days on small-scale farms; 10% on plants 40–60 days post-planting – noting that other threshold levels have been suggested):
  - small farms, depending on resource availability: hand-picking; placing sand/soil mixed with ash/lime into the whorl; pesticide application at dawn/dusk directly into the funnel
  - large farms: pesticide application in affected fields at dawn/dusk
  - pesticides: use WHO Class 3 or U if possible (though lower-risk products tend to be more expensive), from a nationally recommended list. Use personal protective equipment and follow manufacturer's instructions
- After treatment, continue monitoring and consider further treatment if more young larvae appear

CABI has prepared guides to assist with diagnosis and management which are being disseminated through national programmes via the **Plantwise knowledge bank**. For a summarised description of farmers' agronomic practice control options, and national-level control options in maize, refer to the main evidence report, tables 19 and 26 respectively.

1. Chemical lures, used to monitor moth populations

FAO will be publishing the final version of an international FAW action framework in September 2017, which will provide a guide for development of international support projects and programmes by various stakeholders in the areas of their mandates. In addition to the above, the following important elements are also in the framework, to be undertaken in collaboration with other countries and regional/ international partners:

- Establish pest monitoring and early warning systems
- Monitor impact of the pest
- Assess and test additional biological pesticide options such as inundative release and microbial pesticides
- Initiate classical biological control through import and testing of candidate agents from the Americas
- Consider other subsidy schemes for biologically-based biopesticides and/or biocontrol-rearing factories (eg temporary tax breaks) to reduce cost of market development and entry
- Strengthen policy frameworks to promote IPM-led approaches (which minimise unsustainable purchase and use of chemical pesticides)
- Adopt regionally harmonised pesticide and biopesticide registration procedures to reduce repeat costs for manufacturers in introducing new and effective, specific-use or lower-risk narrow spectrum products

To find out more contact either of the following:

Dennis Rangi, Director General, Development
T: +254 (0)20 2271022
E: d.rangi@cabi.org

Janny Vos, Strategic Partnerships Director
T: +31 (0)33 4321031
E: j.vos@cabi.org

www.cabi.org

KNOWLEDGE FOR LIFE