Impact Report
2011-2018
Plantwise is a global programme, led by CABI, that aims to increase food security and improve rural livelihoods by reducing crop losses. Working in close partnership with relevant actors, Plantwise strengthens national plant health systems from within, enabling countries to provide farmers with the knowledge they need to lose less and feed more.
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## Acknowledgment

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## Credits

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**Technical review team:** Mary Bundi, Anna Wood, Verona Groverman.
### Abbreviations

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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>BPPS</td>
<td>Beijing Plant Protection Station</td>
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<td>BPRMS</td>
<td>Beijing Pesticide Reduction Management System</td>
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<td>DAS</td>
<td>Diagnostic and Advisory Service</td>
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<td>IPM</td>
<td>Integrated pest management</td>
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<td>KALRO</td>
<td>Kenya Agricultural &amp; Livestock Research Organization</td>
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<td>MSSRF</td>
<td>MS Swaminathan Research Foundation</td>
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<td>NAF</td>
<td>National Agro Foundation</td>
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<td>NPPO</td>
<td>National Plant Protection Organization</td>
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<td>POMS</td>
<td>Plantwise Online Management System</td>
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<td>RCT</td>
<td>Randomized control trial</td>
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<td>SNNP</td>
<td>Southern Nations, Nationalities, and Peoples’ Region</td>
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<td>SOP</td>
<td>Standard operating procedure</td>
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<td>UCATSE</td>
<td>Universidad Católica Agropecuario del Trópico Seco</td>
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<td>UNAN</td>
<td>Universidad Nacional Autónoma de Nicaragua</td>
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Preface

Over the many years that I have been working in the area of crop protection, I find that colleagues rarely talk about extension, or community engagement or encouraging farmers to adopt more effective and sustainable practices to manage plant health. Usually discussions are focused on phytosanitary issues, research, diagnoses and pest control as independent functions. Yet, managing plant health requires a multi-disciplinary and multi-sectoral approach. Unless farmers are able to adopt production practices in response to new threats, realising effective pest management will remain an uphill task.

Extension workers are the link between technology development and farmers and it is necessary to find ways of developing their capacity in plant health management and effective use of a wide range of communication approaches to support farmers in adopting cost-effective and sound crop management practices. The International Plant Protection Convention phytosanitary capacity building strategy envisaged integrated action of individuals, institutions and systems in countries as key to phytosanitary capacity. Focusing support to capacity development only on National Plant Protection Organisations limits the impact of most plant health initiatives. It is against this background that CABI’s Plantwise programme was conceived.

Plantwise does not work directly with farmers, but delivers its interventions through agricultural advisory service providers, training them to be able to conduct visual diagnosis of plant health problems, operate plant clinics and give good advice to farmers. A measure of the improved capacity of extension officers is the change in farmer practices and how these benefit the farmers. Whereas reducing crop losses from pests is important, in Plantwise we are also interested in assessing how the losses are reduced. Some pest control products are highly efficacious against pests, but also pose health risks to farmers and the environment. Plantwise emphasises the use of solutions based on Integrated Pest Management that promote judicious use of pesticides thereby contributing to pesticide risk reduction: fewer highly toxic products being recommended for use by farmers and less negative impacts on human and environmental health. Plantwise also emphasises the importance of stakeholders in national plant health systems working in integrated rather than fragmented ways, with crop protection experts supporting extension to ensure that new pest situations are detected and responded to rapidly.

As an African from a farming family I look at benefits of agricultural development interventions in terms of how they affect what farmers do. I am keen in knowing if there is an impact and also in understanding reasons for the lack of it. Success of Plantwise should ultimately be seen as change in the way farmers manage the health of their crops resulting in reduced crop damage in a cost-effective way.
This report is a compilation of existing evidence of impact of Plantwise, from farmers to systems. Apart from demonstrating what we have achieved, it also enables us to assess where the results of our actions turned out differently from what we expected. Only by understanding the reasons behind the successes as well as the failures will we be able to determine what we need to do differently going forward.

I would like to acknowledge the invaluable contributions and tireless efforts of our partners and Plantwise staff around the world. It is impossible, in this short report, to do full justice to their accomplishments. Undoubtedly, we still remain to see impacts unfolding from the many Plantwise tentacles spread across more than 30 countries on three continents. Learning lessons from every country experience is a key determinant of future actions.

Dr. Washington Otieno

Plantwise Programme Executive
### Country highlights

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<tr>
<th>Country</th>
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<tr>
<td>Afghanistan</td>
<td>Six women-only plant clinics run by the National Horticulture and Livestock Project in five districts of Kabul constitute the only plant health advisory service available to female farmers in the area. In 2018, they delivered plant health advice to 442 female farmers to help them solve their crop problems.</td>
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<tr>
<td>Bangladesh</td>
<td>The Department of Extension has integrated the Plantwise tablet-based digital platform in 310 Farmer’s Information and Advisory Centers across the country, improving farmers’ access to up-to-date quality information on plant health management.</td>
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<tr>
<td>Barbados</td>
<td>Plantwise has strengthened the national pest detection system by providing plant doctor training to all extension officers and researchers, including a group of training-of-trainers from the Ministry of Agriculture, and linking the NPPO to CABI’s diagnostic service.</td>
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<td>Bolivia</td>
<td>Plantwise partner, Centro de Investigación Agrícola Tropical, won the Potosí Department Prize for “Innovative Actions to Fight the Locust Outbreak” in 2017 for their research on the life-cycle of locusts, and for the development of extensions materials and the implementation of plant clinics and plant health rallies to address the pest.</td>
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<tr>
<td>Burkina Faso</td>
<td>Plant health information collected at plant clinics is used by the NPPO in their monthly phytosanitary bulletin which is shared with the regional Liptako–Gourma Authority covering Burkina Faso, Mali and Niger.</td>
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<td>Cambodia</td>
<td>Plantwise plant health advisory services played an important role in addressing farmers’ excessive use of chemicals, leading to a 37% reduction in pesticide applications and a 60% increase in the use of non-chemical practices.</td>
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<td>China</td>
<td>Plant clinic prescription forms (&gt;28,000 in 2018) are being used to support a USD 4.3 million/year governmental subsidy programme in the Beijing area to encourage the use of Green Control (IPM-compatible) products.</td>
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<td>Country</td>
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<td>Costa Rica</td>
<td>Plantwise information materials and tools have been integrated into the compulsory training course that agro-input dealers have to take in order to receive authorization to work as input sellers.</td>
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<tr>
<td>Ethiopia</td>
<td>In 2018 the government invested over USD 100,000 in training of plant doctors, procurement of plant clinic facilities and expanding clinic operations in the Oromia, Amhara, Tigray, SNNP and Benshangul Gumz regions.</td>
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<td>Ghana</td>
<td>Proactive plant doctors came up with an innovative way to share lectures through social media groups (so far on 16 topics to over 185 plant doctors) through the app. This triggered the creation of a programme-wide plant doctor quiz series that both assesses plant doctor’s knowledge and provides training reinforcement.</td>
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<tr>
<td>Grenada</td>
<td>The Ministry of Agriculture has established an active and locally driven process for developing Plantwise Pest Management Decision Guides and farmer-validated factsheets as a means to deliver practical and farmer-friendly advice on sustainable production practices to farmers.</td>
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<tr>
<td>Honduras</td>
<td>Plantwise has improved reach to the Lenca and Misquita ethnic minorities, making possible the access to information about agricultural technology to solve some of the major challenges they face in their crops, such as paratrioza in potato and yellow aphid in sorghum.</td>
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<td>India</td>
<td>While Plantwise activities are forming a key component of the services provided by partners in Tamil Nadu (MSSRF and NAF) and Jammu (Department of Agriculture), linking with other programs and projects targeting food security, climate change and value chain development helps to leverage sustainability and increase outreach to thousands of farmers and farmer groups.</td>
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<td>Jamaica</td>
<td>The Government has institutionalized the Plantwise programme with a strong ownership, taking over training and implementation responsibilities, covering operational costs, and integrating plant clinic activities in the public extension system.</td>
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<td>Kenya</td>
<td>A randomized control trial involving &gt;2,500 households showed a 13% general increase in the value of production per hectare among maize farmers in plant clinic areas.</td>
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<td>Malawi</td>
<td>Plant clinics users in 11 districts, reported 20% higher tomato yields [9.8 tonnes/ha] and 21% improved net income [USD 6,884/ha] compared to non-clinic users.</td>
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<td>Mozambique</td>
<td>The Plantwise national coordination team has become part of the National Phytosanitary Programme that has included the Plantwise method as one means to identify the main plant health problems in different areas and to provide statistics on farmer queries and recommendations to support strategic and operational decisions.</td>
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<td>Myanmar</td>
<td>The Ministry of Agriculture, Livestock and Irrigation, together with CABI, has developed the Myanmar Plant Health System Strategy to pave the way for large-scale adoption of the Plantwise concepts and processes within the country’s national extension system.</td>
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<td>Country</td>
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<td>Nepal</td>
<td>The Government of Nepal has invested an average of USD 38,000 every year since 2013 to build the capacities of government extension officers and staff. About 300 extension officers have now been trained as plant doctors, working in remote locations across the country.</td>
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<td>Nicaragua</td>
<td>In 2012, UCATSE and UNAN León, two local universities, integrated the Plantwise training modules and plant clinic approach into their curriculum for agronomy students. Around 300 students have completed the plant doctor training and gone on to work for extension organizations or private companies, or as farmers.</td>
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<td>Pakistan</td>
<td>With an investment in Plantwise activities of over USD 900,000 between 2016 and 2018, Punjab and Sindh Provinces are now driving their own programme with more than 800 plant clinics and local level data validation for quality assurance.</td>
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<td>Peru</td>
<td>The plant clinic method has been integrated into the national guide on extension methodologies produced by the Agricultural Extension Unit at the National Institute of Agricultural Innovation.</td>
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<td>Rwanda</td>
<td>Seeking plant health advice from plant clinics has been found to be significantly associated with a 5% reduction in the likelihood of a Rwandan household falling below the poverty line of USD 1.25 per day.</td>
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<td>Sri Lanka</td>
<td>The plant doctor Telegram group enabled prompt action when banana skipper, a new pest, was picked up at a plant clinic: Within one day, the pest was identified and management advice sent to over 300 plant doctors. Three weeks later the Department of Agriculture had published and shared awareness raising materials with all extension workers in banana growing areas.</td>
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<td>Thailand</td>
<td>The Department of Agriculture Extension is improving the country’s preparedness to act on pest outbreak by investing in Plantwise training of 33 national trainers and 233 extension officers and applying their skills at the Agriculture Learning Centers at regional (9), provincial (77) and district (882) levels.</td>
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<td>Trinidad &amp; Tobago</td>
<td>The Extension Training and Information Services Division has adapted and integrated the Plantwise methodology and training materials into their training courses which have been delivered to more than 110 persons.</td>
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<td>Uganda</td>
<td>The inclusion of the plant clinic approach in national agricultural policy has enabled resource allocation and expansion of plant clinics to dozens of districts, as well as the inclusion of plant clinic tasks in the formal job descriptions of Ministry and Local Government agricultural officers.</td>
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<td>Vietnam</td>
<td>Plantwise is playing an important role in strengthening the peppercorn supply chain (export worth USD 270 million in 2017) by helping to identify information, knowledge and market gaps and by training Olam International staff in sustainable production of peppercorn and provision of plant health advisory services to farmers.</td>
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<td>Zambia</td>
<td>Plant clinics have become the preferred to-go-to place for advice and information on plant health issues for 86% of sampled clinic visitors in Kapiri Mposhi, Mumbwa, Kabwe, Chibombo, Chilanga, Kafue, Rufunsa and Chongwe districts.</td>
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Executive summary

This review of the Plantwise programme, from its inception in 2011 up to 2018, sets out the programme’s outcomes, impacts and lessons learned. Drawing on an analysis of documents, interviews with Plantwise staff, and an online survey of plant doctors and other Plantwise partners, the review highlights Plantwise achievements, identifies factors that facilitated or hindered achievements, and compiles lessons learned as a basis for improving future interventions.

Plantwise has had a positive impact on the lives of smallholder farmers in Asia, Africa and the Americas. It has improved farmers’ plant health knowledge, adoption of good agricultural practices, sustainable use of pesticide, crop productivity and income. Seeking plant health advice from plant clinics has been found to be significantly associated with a 5% reduction in the likelihood of a household falling below the poverty line of USD 1.25 per day. At the same time, crop-based productivity and income were found to increase between 12 and 30%.

Plantwise has improved the capacity of extension staff to provide advice on plant health issues to millions of farmers through plant clinics and complementary extension approaches. Since the beginning of the programme, the annual reach of Plantwise has increased 25-fold from an initial direct reach of 70,000 farmers in 2012. In 2017, the programme reached an estimated 1.7 million resource-poor farmers directly with plant health messages: 10% through plant clinics, 4% through plant health rallies and other face-to-face activities and 86% through mass extension campaigns. Globally, women were responsible for 32% of queries at plant clinics in 2012–18, and female attendance of plant clinics is increasing in some countries. The Plantwise Knowledge Bank, which provides free, online and offline technical information on plant health, has been used by over 1.9 million people since 2011 (almost half from Plantwise countries), a high proportion of which were women and youth.

Plantwise has contributed to raising the profile of plant health as a priority for advisory services and research in some countries. The introduction of tablets (e-clinics) by Plantwise and the establishment of social network groups are helping to improve the technical capacity of plant doctors and to transform the inter-connectedness of plant health systems. In fact, social network groups are radically changing countries’ ability to respond to pest outbreaks. Data from plant clinics have been used to map and monitor pest occurrence so that information on the spread of pests is used to design extension materials and actions accordingly. In 2017, Plantwise contributed to detecting eight new pests (insects and pathogens) in six countries, including fall armyworm in three countries.
There are promising signs of Plantwise-supported approaches being institutionalized and scaled up in a number of countries: in 2017 the training of Plantwise plant doctors was mainly conducted by trainers from partner organisations. A number of countries are making strategic plans and investments in plant health systems strengthening, including: the adoption of plant clinics as an extension approach by the governments of Peru, Myanmar and Kenya; the integration of plant doctor training into national universities and agricultural colleges in Nicaragua and Uganda; reforms in plant health policies and regulations in Nepal; development of Standard Operating Procedures in Kenya, and significant financial investments in plant doctor training and plant clinic operations by a growing number of countries. Estimates from Kenya show that the monetary benefits outweigh the costs of implementing the programme, at a ratio of 2.9:1, and that its internal rate of return is 54%.

Lessons from this report will be used to inform the future directions of Plantwise, some of which include: increasing emphasis on building synergies and linkages between different advisory approaches and service providers; prioritizing gender and youth; putting more emphasis on mechanisms for quality assurance of the diagnoses and advice provided by plant doctors; providing regular testing and refresher training to improve the capacity of plant doctors; encouraging the institutionalization of plant doctor training in more countries; and improving how the programme measures reach and impact at farmer and systems levels, and how it captures lessons learned from each country and region for continuing improvement.
Introduction

Every year, 40% of crops grown worldwide are lost to pests. In some areas, losses between the field and the fork can be as high as 70%. Reducing crop losses by just 1% could potentially mean more food being available for the 815 million people around the world who are currently hungry and undernourished. To achieve this change, smallholder farmers in Africa, Asia, Latin America and the Caribbean need timely access to reliable, accurate and appropriate information and advice on plant health. However, rural extension and advisory services in most low-income countries are weak and unable to provide regular and reliable plant health information and advice. At the same time crop-protection services are often under-funded with weak border controls leaving countries exposed to the incursions of new pests.

It is in this context that CABI, in collaboration with national partners, has been implementing the global Plantwise programme since 2011. Now operating in 30 countries in Africa, Asia and the Americas, the Plantwise vision is to ensure increased food security and improved livelihoods by enabling farmers to lose less of what they grow to plant health problems.

Table 1: Plantwise countries by year of programme launch*

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<td>Bolivia</td>
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<td>DR Congo***</td>
<td>Nepal</td>
<td>Cambodia</td>
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<td>Nicaragua</td>
<td>Pakistan</td>
<td>China</td>
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<td>Sierra Leone***</td>
<td>Peru</td>
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<td>Uganda</td>
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<td>Suriname**</td>
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<td>Suriname*</td>
<td>Trinidad &amp; Tobago</td>
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* Prior to 2012 plant clinics were establishing by CABI’s Global Plant Clinic, the Plantwise predecessor
** Exited in 2014
*** Limited activities since 2015
Plantwise takes a systems approach, by strengthening the linkages between various components of national plant health systems to ensure that 1) smallholder farmers have access to the knowledge and practical advice they need to address plant health issues; 2) countries respond rapidly and effectively to new and emerging pests; and 3) organizations are able to effectively meet their mandates for the benefit of farmers. By improving the plant health system’s responsiveness, plant health problems can be detected early, and sound and effective control measures can be put in place before they become devastating. Plant clinics are the programme’s principal entry point for problem detection and delivery of advice and play a key role in driving change as the “front end” of a plant health system, strengthening linkages between organizations and stakeholders.

Plantwise is made up of three components.

- **Plant health systems development**: Supporting plant clinics and other advisory methods that provide plant health advice, and improving information flows and collaboration among national plant health systems stakeholders to enable them to be more effective in improving plant health.

- **The Plantwise Knowledge Bank** includes two parts: a free open-access source of locally relevant, comprehensive plant health information for everyone from farmers to extension agents and scientific researchers (including the Plantwise Factsheets Library app); and a password-protected platform for plant clinic data management and use, as well as information exchange and collaboration within countries and as part of a global vigilance system to help identify emerging pests and other threats to plant health.

- **Monitoring and evaluation**: Carrying out monitoring and evaluation activities, assessing Plantwise impact through internal and external evaluations, and carrying out research to test and improve interventions, thus enabling the programme to capture lessons and share this knowledge with partners to improve programme performance.

This review of Plantwise, from its inception in 2011 up to 2018, covers the programme’s outcomes, impacts and lessons learned. It highlights Plantwise achievements, identifies factors that facilitated or hindered achievements, and compiles lessons learned as a basis for improving future interventions.
1. Reaching our clients

Between 2012 and 2017, the annual direct reach of Plantwise has increased from 70,000 to 1.7 million (25-fold), using innovative extension and advisory approaches to deliver plant health messages to farmers in Africa, Asia, Latin America and the Caribbean.

Plantwise provides practical plant health advice to smallholder farmers through plant clinics, plant health rallies, mass extension campaigns, and other means. In 2017, the programme reached 1.7 million farmers directly with plant health messages (c. 170,000 queries (10%) brought to plant clinics by farmers, 75,000 people (4%) attended plant health rallies and other face-to-face advisories, and 1.45 million (86%) reached through mass extension campaigns). This represents a 25-fold increase since 2012, thanks to an increase in the number of plant clinics and the more focused effort placed on supporting other complementary approaches such as plant health rallies and mass extension campaigns.

Figure 1: 2017 reach broken down by method and direct vs. indirect reach
Plantwise approaches for delivering plant health advice

Plant clinics

Plant clinics are Plantwise’s primary entry point to engaging with farmers. During a plant clinic session, a farmer presents a problem affecting his or her crop and discusses it with a “plant doctor”, a local extension worker/adviser, and receives a written recommendation for managing it. The plant doctor provides a diagnosis of the problem, with written and verbal recommendations for managing it. Plant clinics take place on a regular basis, at least once every two weeks, and are held in easy to access public places. In some countries, mobile clinics rotate among different communities. Plant clinics are usually free of charge for the farmer, but in a few cases, they charge a nominal fee (Nicaragua, India).

By the end of 2018, CABI and partners had established approximately 3,000 plant clinics in total. Plant clinics received approximately 450,000 farmer queries from 2011 to late-2018, averaging 4.7 queries per session.

Plant doctors are what make plant clinics function. By the end of 2018, Plantwise and partners had trained more than 10,000 plant doctors. The vast majority of plant doctors work within government extension services but some are affiliated with NGOs and private sector organizations, such as farmer co-operatives, agro-input dealers and community-based organizations. An increasing proportion of plant doctors are female: 26% of plant doctor trainees in 2018 were female, compared to 15% of extension workers globally [16].

In addition to providing advice, plant clinics capture on-the-ground intelligence about what is happening in a particular region in the form of recorded query data, thus helping national extension and crop protection agencies to make extension materials more relevant and contributing to early warning of new pests.

“These plant clinics help us in the surveillance of pests and diseases. The plant doctors and extension workers are quite thin on the ground – we just can’t be everywhere where we are needed – but with these plant clinics, definitely when a farmer sees something not familiar to him, he’ll bring it to the plant clinics. And that could be an opportunity for us to see whether this is a new disease which has come up, or it’s an old disease that has resurfaced. And we can only do that through these plant clinics.”

District Agricultural Officer, Buikwe, Uganda [31]
Figure 2: Highest percentage crops (and their main pests) presented at plant clinics by sub-region

Source: POMS data from 21 June 2016 to 21 June 2018, approximately 250,000 queries
Plant health rallies
Plant health rallies are organized events that focus on awareness raising and management of specific plant health problems. They are run by local extension workers and target farmers in relevant areas who, in most cases, have been specifically mobilized for the event (through advertisements). Rallies begin with a short explanation of the selected plant health topic, followed by participants asking questions and being given factsheets with validated recommendations on how to manage the plant health problem [5].

Between 2013 and 2017, Plantwise reached nearly 145,000 farmers through plant health rallies and other face-to-face activities (such as field days and agro-fairs), in 21 countries. New threats have featured prominently in rallies held in Kenya, Rwanda (maize-lethal necrosis disease), Uganda and Ethiopia (fall armyworm). Rallies have also been used for rapid surveillance of major diseases, such as cassava brown streak disease in the Democratic Republic of Congo [6].

Mass extension campaigns
Mass extension campaigns are used to convey a clear message about a simple solution or proven technology to achieve quick, large-scale change in farmer behaviour and practices. Radio is most commonly used due to the high potential for reaching large numbers of farmers, followed by television, printed materials and mobile messaging. Mass extension campaigns reached an estimated 2.8 million farmers globally between 2014 and 2017, more than half in 2017 alone. Examples include a radio campaign in Uganda that created awareness about, and increased farmers’ ability to identify and manage, fall armyworm [17] (Case 1); and the integration of plant doctors and plant health information into existing radio programs in Malawi [18].

Case 1: Using radio in mass extension campaigns to combat fall armyworm in Uganda
Since fall armyworm was first detected in West Africa in 2016, it has spread to more than 40 African countries, causing vast devastation in the maize fields of small-holder farmers. In 2017, CABI and the Ministry of Agriculture, Animal Industry and Fisheries of Uganda piloted a participatory radio campaign in the Kiryandongo and Masindi districts of Western Uganda to create awareness about how to identify, prevent and manage the fall armyworm.

Eight agricultural radio programmes were aired twice weekly by two community radio stations – Radio Kitara and Radio Simba – in November and December. Subject matter experts were hosted for 30 minutes on live agricultural shows, with farmers calling in to ask questions and give feedback.

The radio programmes – which reached an estimated 70,000 users – aired in local languages and were supported by an interactive ICT platform to allow for farmer feedback and insights. Weekly polls were posed to listeners to find out how they were managing the fall armyworm at present and whether they were learning from the programme contents. The polls revealed that, at the time of the programmes, 73% of those who responded had fall armyworm in their farm and that people were not consistent about when and how to act due to a lack of knowledge about the pest. Feedback received from listeners after the mass extension campaign was very positive:

“This worm has disturbed me for a very long time. But I have learned some things through the radio programme on Radio Kitara. Actually, I have learned a lot, which I am going to put into practice so that I achieve more because even my fellow [farmers] were crying because of this worm.” Deo Mutekanyiza, a farmer in Labondo village, Uganda. [17]
Pursuing synergies to boost reach

Creating synergies among extension providers and methods boosts Plantwise’s reach to clients. For example, in Rwanda and Nepal plant doctors are brought to farmer field school sessions and other group-based extension events [25, 37]. In Cambodia and Mozambique farmer field school facilitators have also been trained as plant doctors. In Peru, plant doctors combine different extension methods: clinics, rallies, field demonstrations and field visits. In an effort to address farmers’ demand for advice more broadly, plant doctors in the Chami region have turned the plant clinic into a plant–animal clinic [10]. In Bulambuli district of Uganda, animal health clinics and rallies are being implemented alongside clinics and rallies for crops.

Reaching disadvantaged groups

Reaching indigenous and tribal groups

Indigenous and tribal groups often make up an important part of rural, farming communities but they tend to be ignored by mainstream programmes. These groups have higher poverty rates and lack access to productive and non-productive resources, including land, information, credit and education. They are also often physically isolated. In Honduras, Costa Rica, India and Vietnam Plantwise has adopted a deliberate strategy to reach secluded tribes and indigenous communities by locating plant clinics in areas where there is a high concentration of these groups [20].

Reaching youth

Currently, youth tends to be somewhat underrepresented among plant clinic users, which is likely a reflection of a more general trend of declining involvement of young people in agriculture [27, 32]. However, the high percentage of youth that use the Knowledge Bank website (59% under 35 years) and the Factsheet app suggests that other channels may be more appropriate for reaching youth. In the Americas, there has been a focus on including youth and children in Plantwise activities, such as training young plant doctors (Nicaragua); inviting 11th-grade school children to participate in plant clinics by registering farmers (Jamaica); working with agriculture students to develop extension materials and inviting children in marketplaces to inspect plant samples under the microscope to try and diagnose the problem (Brazil).

“Let’s also work with educating children in agriculture and plant health. Out of 10 children who graduate from school, eight or nine will stay here and work in the agricultural sector.”

Juan Paco Cabanillas Palomino, Director of Secsemayo Educational Institution, Peru [15]
Reaching women farmers
Although Plantwise has recognized women as farmers and clients of rural advisory services since its inception, across almost all countries a larger share of men than women attend plant clinics, even in countries where women provide the bulk of agricultural labour. Globally, women were responsible for 32% of queries presented at plant clinics from 2012 to 2018, with a higher proportion of female queries in Africa (35%) compared to the Americas (21%) and Asia (31% - excluding Pakistan and Afghanistan, where almost no women have been attending plant clinics). Comparing the female clinic attendance rates with the proportion of women employed in agriculture [22] shows that women are under-represented at plant clinics in most Plantwise countries.

Figure 3: Proportion of plant clinic queries presented by women in each country

Plantwise addresses this gender gap through a number of strategies: holding clinics in areas accessible to women, and preferred by them, and at a time that suits their schedules; targeting clinics’ publicity specifically to women; and recruiting more female plant doctors. In Kenya, Sri Lanka and other countries, female plant doctors attract a slightly greater proportion of female farmers than male plant doctors, suggesting that in some cases women farmers may prefer to interact with a female plant doctor. In some cultural contexts, such as in Afghanistan and Pakistan, it may make sense to organize female-only plant clinics (an approach that is being tested in Afghanistan). The results of these strategies so far are mixed, with increased female attendance in some countries, but not in others.
**Plantwise partnerships for extension and rural advisory services**

Plantwise embeds its activities in local institutions. Initially, the key partner for implementing plant clinics was government extension services and/or national plant protection organizations. However, the programme has increasingly broadened its range of partners to ensure greater sustainability, to achieve greater scale and to improve its impact.

In 2017, CABI began developing a private sector strategy, which outlines alternative ways to promote private sector-run plant clinics as a way to sustain their operations. In 2017, 28 farmer organizations/ co-operatives (most from the Americas), agro-input suppliers (Bolivia, Kenya, Nicaragua and Uganda) and other market-oriented companies (China, Ghana, Myanmar, Uganda and Vietnam) were active participants in Plantwise activities. Recent examples of such efforts suggest that private sector-operated plant clinics may reach different types of farmers compared with government- or NGO-supported clinics: in some cases by being linked to farmer organizations, and in others by having a commodity focus. However, private sector-run clinics may be less likely than government-run plant clinics to capture data, distribute factsheets, make field visits or conduct additional extension activities like plant health rallies.

**Reaching clients through the Knowledge Bank**

A key component of the Plantwise strategy for strengthening plant health systems is providing materials and information to clients and stakeholders. The Plantwise Knowledge Bank serves as a free, open-access, online source of locally relevant, expert validated, comprehensive knowledge about diagnosing and managing plant health problems facing farmers. It is a searchable repository containing factsheets (also available off-line through the Plantwise Factsheet app), management advice and other information on problems of plant health affecting common crops worldwide. Over 1.9 million people have used the online Knowledge Bank since its inception in 2011.

In 2017, there were 430,000 visitors, 185,000 of whom were from Plantwise countries. Half of the users were women, and in some countries, such as India and the Philippines (a non-Plantwise country), use by women exceeded that by men, at 58% and 61%, respectively. Youth are also active users of the Knowledge Bank website, with 59% of users being under the age of 35. It is not possible to say who the Knowledge Bank users are but it is fair to assume that they cover different roles across plant health systems, e.g. researchers, extension staff, crop protection/quarantine staff, students and maybe also some farmers. Knowledge Bank pest alerts provide information about new pests anywhere in the world. Over 800 individuals are signed up for this service. Between 2012 and 2018, the Knowledge Bank sent out over 50,000 pest alerts to approximately 1,200 individuals.

Over 13,600 factsheets and photosheets are now available through the online Knowledge Bank, with 3,000 specifically written under the Plantwise programme also available through the Factsheet app. In some cases, factsheets and other extension materials are developed in the local language or translated from English: materials are currently available in 24 different languages. The Knowledge Bank has also contributed to capacity development, as evidenced by the development in-country of more than 2,700 factsheets to date. Views of the Factsheet app reached more than half a million in the second half of 2018, with 95% of the sessions involving users in Plantwise countries. Having doubled between 2015 and 2016, usage of the Factsheet app increased by a further 70% between 2016 and 2017. Notably, 73% of Factsheet app users are below the age of 35.
Figure 4: Knowledge Bank resources and users

Number of resources published

Number of users

Knowledge Bank website
Factsheet App
Lessons learned

- While mass media and ICT can be used to reach many people with simple plant health messages in response to outbreaks or emerging problems, plant clinics are better suited to delivering more complex messages and can play a unique role in early warning of pest outbreaks.

- Creating and strengthening linkages between diverse extension and advisory approaches is critical in order to optimize reach and foster synergies among rural advisory providers.

- Plant clinics operated by private companies may operate differently from those run by government extension or NGOs, by targeting different types of farmers, focusing on specific commodities and being less likely to capture query data.
2. Adoption and impact

Across the countries it operates in, Plantwise has helped to improve farmers’ plant health knowledge, contributing to the adoption of good agricultural practices, safer pesticide use, increased crop productivity and income.

Plantwise assesses programme impact at farmer and farm level in four areas: (i) on farmer knowledge about plant health issues; (ii) on the adoption of practices recommended by plant doctors; (iii) on changes in pesticide use; and (iv) impact at the farm and household level (productivity and income gains).

**Farmers’ knowledge about plant health issues**

Plant clinic users tend to have better and more detailed knowledge about pests and diseases, and are better able to identify symptoms, compared to non-plant clinic users. In a study from 2016, plant clinic users in *Rwanda* and *Ghana* were able to provide more details about the symptoms of pests and diseases in maize and beans compared to non-users [38]. In a study from 2018 in *Malawi* plant clinic users recognized more (11 out of 13) tomato disease symptoms than non-users, and were more likely to recognize the not-so-obvious symptoms [4]. This indicates that plant clinics play an important role in advising farmers about more complex diseases, including pathogen-based symptoms. A knowledge and adoption study carried out in *Vietnam*, *Sri Lanka*, *Malawi* and *Zambia* among a total of 891 farmers documented that clinic users in all countries were better able to identify and address plant health problems than non-users [21].

**Figure 5: New knowledge acquired through plant health rallies in Uganda [29]**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall armyworm</td>
<td>100%</td>
</tr>
<tr>
<td>Banana bacterial wilt</td>
<td>80%</td>
</tr>
<tr>
<td>Safe use of pesticides</td>
<td>60%</td>
</tr>
<tr>
<td>Soil fertility management</td>
<td>40%</td>
</tr>
<tr>
<td>Angular leaf and fruit spot</td>
<td>20%</td>
</tr>
</tbody>
</table>

*Note: n = 556*
Evidence suggests that plant health rallies are also effective in improving farmer knowledge and stimulating adoption of agricultural practices. Among 556 farmers who attended a plant health rally in Uganda the majority acquired new knowledge related to key agricultural issues. However, a significant number of farmers found the knowledge provided by the rallies inadequate to manage banana bacterial wilt, angular leaf and fruit spot [29]. In Honduras, feedback from potato farmers indicates that plant health rallies helped increase farmers’ understanding of the life-cycle of the zebra chip disease. However, it was also found that the highly complex life-cycle and multiple symptoms make it challenging to convey effective control advice in a plant health rally setting [19].

Adoption of recommended practices

Studies show that Plantwise plant clinic users have a higher adoption rate for most recommended practices investigated, compared to non-users. In Rwanda, panel data from 637 smallholder maize farmers show that plant clinics significantly increase the adoption of pest management practices to control devastating maize pests, such as fall armyworm and maize stalk borer [39, 44]. In Malawi, 59% of plant clinic users surveyed, compared with 41% of non-users, adopted recommendations for early and late blight outbreaks in tomato, with users adopting a higher number of recommendations than non-users [4]. In Ghana, clinic users adopted a higher number of disease and pest control options, mostly based on advice from plant doctors [38]. Natural insecticide, early weeding, seed selection, use of certified seed, timely planting, correct spacing, and row planting were some of the recommended practices adopted exclusively by clinic users surveyed. Farmers in plant clinic catchment areas in Kenya were 4 percentage points more likely to use different agronomic practices than those in areas with no plant clinic [1].

Clinic users and non-users tend to differ in their knowledge and attitude. Studies in Rwanda [39, 44] found that clinic users were on average better informed about where to get agricultural inputs, as well as proper usage, and were directed towards purchasing the correct pesticides. Users of plant clinics in Malawi, Zambia and China reported using a larger number of information sources on plant health than non-users, suggesting that farmers attending plant clinics are generally more active in seeking information [4, 32].

Changes in pesticide use

The use of chemical pesticides is deep-rooted in many farmers’ minds, making the practice difficult to change. Nonetheless, there is promising evidence that plant clinics influence farmers’ adoption of more sustainable pesticide practices. A study in Kenya found that farmers in plant clinic catchment areas were 6 percentage points less likely to prefer chemical pest control compared to the control group, and 7 percentage points more likely to avoid chemical drift when spraying, and they showed a decrease in pesticide use on perennial crops [1]. Other studies show the same tendency. For example, a survey of 91 farmers who attended plant clinics in Cambodia, Myanmar, Thailand and Vietnam [46] found a drop in the frequency of pesticide applications and use of the most toxic chemicals, and an increase in the use of safer alternatives. A reduction in the amount and frequency of pesticide application is not always observed though. There are other measures of positive change. In some cases, farmers report a change to more efficient products and applications methods, but not a reduction per se. In Uganda, for example, farmers admitted to using pesticides that work after plant clinic visits unlike before where they used cocktails of random pesticides [31], a common phenomenon in many countries. Studies from Malawi and Rwanda also show that clinic users are more likely to combine chemical control with various agronomic practices, including pest monitoring [4, 38].
“It is my third time I visit this plant clinic because it is important to me. Here we get advice on our plant health problems. Most of the farmers who don’t attend this plant clinic go directly to buy pesticides which sometimes are not recommended for the pest and disease. But here, we become sure about the treatments that we are using.”

Female farmer, Rwanda [30]

A 2017 study in Kenya [33] found a positive and statistically significant relationship between the wearing of protective clothing and visits to plant clinics among both men and women farmers. As such, farmers who attend plant clinics are less likely to suffer pesticide related health risks than those who do not.

Figure 6: Increased awareness after plant clinic visit, Kenya [33]
In China, the plant clinic data is used to implement a public incentive scheme to stimulate the transition from synthetic pesticides to IPM-compatible products (Case 2) [11].

**Case 2: Using clinic prescription forms to incentivize use of non-toxic products**

There are 93 plant clinics running in three provinces of China. Since late 2017, plant clinic prescription forms are being used to support a 30 million Chinese yuan (Renminbi) (nearly USD 4.5 million) governmental subsidy programme in the Beijing area that encourages the use of IPM-compatible products (known as Green Control products in China), such as biocontrol products, biopesticides, and low-toxicity chemicals. In previous years the government purchased promoted products and distributed them free of charge to big farmers and demonstration plots, but after five years of Plantwise implementation, the Beijing Plant Protection Station (BPPS) decided to use the plant clinic network to facilitate the subsidy programme. The plant clinic prescription form was embedded into a data management system called “Beijing Pesticide Reduction Management System” (BPRMS) and used to underpin the subsidy programme. Farmers in Beijing can only buy subsidized IPM-compatible products from defined agro-input dealers if their plant health problem is diagnosed by a plant doctor who recommends the appropriate subsidized products in the prescription form. The agro-input suppliers claim the subsidy back from BPPS based on the sale records and supportive plant clinic prescription records in the BPRMS. The role of trained plant doctors in this market-oriented subsidy approach ensures that the subsidized products are used where and when they are really needed [11].

### Productivity and income gains

The adoption of recommended practices by plant clinic users often contributes to productivity and income gains. In Kenya, a three-year randomised control trial documented a 13% increase in the value of production per hectare among maize farmers in clinic areas, i.e. both users and non-users—an effect driven mostly by an increase in the quantity of maize produced. This is highly relevant, given that maize is the most commonly produced crop in Kenya for both food and cash [1].

**Table 2: Impact of plant clinics on maize production, Kenya [1]**

<table>
<thead>
<tr>
<th>Impact difference</th>
<th>Control median</th>
<th>Treatment median</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Production</strong></td>
<td>12%*</td>
<td>2,669 kg/ha</td>
</tr>
<tr>
<td><strong>Value of production</strong></td>
<td>13%*</td>
<td>800 USD/ha</td>
</tr>
<tr>
<td><strong>Costs of production</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seed</td>
<td>4%</td>
<td>73 USD/ha</td>
</tr>
<tr>
<td>Inorganic fertilizer</td>
<td>-11%</td>
<td>114 USD/ha</td>
</tr>
<tr>
<td>Pesticide</td>
<td>-18%</td>
<td>30.9 USD/ha</td>
</tr>
<tr>
<td>Labour</td>
<td>-3%</td>
<td>79.7 USD/ha</td>
</tr>
</tbody>
</table>

Significance level: * p<.10

In Rwanda, panel data from 637 smallholder maize farmers show that participation in plant clinics resulted in significant yield and net income gains of 24% and 30%, respectively. Seeking plant health advice from plant clinics was also significantly associated with a 5% reduction in the likelihood of a household falling below the poverty line of USD 1.25 per day [39, 44].

Table 3: Impact of plant clinic participation on farm-level outcomes, Rwanda [44]

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Difference btw clinic users and non-users (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adoption of pest control practices</td>
<td>8***</td>
</tr>
<tr>
<td>Maize yield</td>
<td>24***</td>
</tr>
<tr>
<td>Net maize income</td>
<td>30***</td>
</tr>
<tr>
<td>Extreme poverty likelihood</td>
<td>-5**</td>
</tr>
</tbody>
</table>

Significance level: ** p<.05 *** p<.01

Similar results were observed in Malawi, where a survey with 738 households found tomato yields to be significantly higher among clinic users, leading to a 21% higher average income for plant clinic users compared to non-users. However, visiting a plant clinic does not always lead to an increase in yield: in Ghana, whilst clinic users were found by one study to have higher yields for maize, there was no difference in the net value of groundnut and cowpea between users and non-users [38].

Overall, we observe positive impact of plant clinics in terms of yield and net income for most of the studied crops. The evidence from Kenya also shows that the impact can reach beyond the plant clinics: both farmers visiting clinics and farmers in the vicinity saw improved yields.

Lessons learned

- Plant clinic users tend to have better and more detailed knowledge about pests and diseases, and are better able to identify symptoms. They are also better informed about agriculture generally, and about where to get information and inputs and how to use pesticides correctly.
- The adoption of recommended practices by clinic users tends to contribute to productivity and income gains as well as safer pesticide use in most cases.
- Farm-level impact generated from the interaction between farmers and plant doctors at plant clinics appears to be reinforced by the actions of other actors in the plant health system, and/or plant doctors’ actions outside plant clinics.
3. Strengthening the capacity of individual advisers

Most plant doctors acknowledge that the Plantwise training has helped improve their plant health knowledge and their confidence regarding being able to provide good advice to farmers.

Extension staff are the frontline workers in bringing new information, knowledge and technologies to farmers. Improving their capacities, both technical and functional, to engage with farmers and provide them with appropriate advice is a critical part of strengthening plant health systems. Plantwise seeks to do this by providing specialized training and supporting tools to extension staff to become plant doctors and training on using other extension methods to disseminate targeted plant health information.

Improving plant doctors’ capacity in plant health

Plant doctors are given two two- to three-day training courses covering field diagnosis, and how to run plant clinics and provide good recommendations. The Plantwise training for plant doctors is unique in that it focuses on field diagnosis and uses live plant samples in the learning process, which encourages the trainees to use their knowledge more effectively and apply it in the field.

“Before training I was not quite sure myself, but after the training I upgraded my knowledge. Also, the other plant doctors and experts are quite different from previous. It is a complete change. In regard to competency, we may not be 100% competent, there are still some gaps, but it is better.”

Ethiopian plant doctor [34]
Evidence suggests that plant doctors’ capacity to provide good recommendations improves with the training they receive from Plantwise. An assessment of Kenyan plant doctors before and after Plantwise training, and a comparison of their knowledge with extension agents of the same level but who did not receive Plantwise training, showed that plant doctors scored consistently higher than extension agents who did not train as plant doctors (scale of 100 points) [1].

Figure 7: Plant health test scores among extension workers with and without plant doctor training, Kenya [1]

Note: Scale up to 100. Scores are scaled to adjust for annual differences in exam difficulty [1].

This is backed up by evidence from plant doctors themselves: for example, plant doctors in Ethiopia note that they adopt a more participatory approach to advising farmers based on the approach used during the Plantwise training, while Zambian plant doctors report being able to conduct proper diagnoses of plant health problems – whereas, before their training, they just inspected crops for plant health issues, paying little attention to details.

“Those who received the CABI training adopt the [teaching] material but also the learning process. Previously it was just a lecture; it was not participatory. Now we make two-way communication: the trainer gains knowledge from the participants, and the other way around. There is more practical, more exercises, more pictures.”

Male entomologist, Head of Crop Protection Department, Ethiopia [34]
Improving the quality of plant doctors’ diagnoses and advice

Plant doctors deal with multiple crops and problems and need to provide recommendations that will both address the immediate problem and prevent the problem from re-occurring. The wrong advice from a plant doctor can result in the loss of a crop or wasted resources, as well as a loss of trust in the plant clinic service. The accuracy of plant doctors’ diagnoses and quality of recommendations, is therefore paramount.

While assessing the quality of plant doctors’ diagnoses and recommendations is difficult without being present at the plant clinic, an analysis of Plantwise Online Management System (POMS) data, which holds data about farmers’ visits, indicates that plant doctor performance in Ghana improves with experience, especially during the first year after receiving plant doctor training. A recent analysis of POMS data also shows that plant doctors are largely providing the right kind of advice: from nearly 460 individual records examined from 15 countries, 48% of plant doctors gave advice fully aligned to the Plantwise Pest Management Decision Guide for the management of selected invasive pests, while only 10% gave advice with no Guide content. The remaining 42% of plant doctors gave advice which contained recommendations from Guides, with roughly two-thirds of their specific recommendations coming from Guides [13].

**Figure 8: Plant doctor performance over time in Ghana**

Note: Plant doctor performance assessed as a fraction of rejected diagnoses. The lines represent individual plant doctors [24].

Based on POMS data, CABI has also developed a tool to monitor plant doctors’ recommendations of highly toxic pesticides. Reducing the overall use of Red List chemicals\(^1\) is an important goal for Plantwise, and it is encouraging to see that the percentage of plant doctor recommendations that include Red List chemicals is generally low, between 0% and 2% for most countries (though a few countries show higher proportions). The tool allows CABI and country partners to specifically target the source of the problems. For example, in one country, it was found that three plant doctors were responsible for 89% of the Red List recommendations [35]. Efforts are being made to put in place suitable measures where the problems persist.

\(^1\) The Plantwise Pesticide Red List identifies chemicals categorized as Classes Ia (extremely hazardous) and Ib (highly hazardous) by the WHO Recommended Classification of Pesticides by Hazard (2009), as well as pesticides banned or restricted by international agreements.
The role of ICT and social networking in capacity development

Two recent developments – the introduction of tablets and the establishment of social network groups – are helping to improve the technical capacity of plant doctors, and to transform the interconnectedness of plant health systems (see also Section 4).

Evidence from Ghana, Uganda and Kenya shows that the use of tablets by plant doctors to send pictures of disease symptoms to data validators helps with diagnosis, as well as quality assurance [36]. In terms of the latter, images allow validators to assess what the plant doctor is actually looking at.

Social network groups for plant doctors using messaging services, such as Telegram and WhatsApp, are also proving very effective. At least 25 Plantwise countries have one or more digital support groups set up by plant doctors. Plant doctors use these apps to consult each other, to connect with technical experts, and to share information on diagnostics and pest management, as well as to share updates on Plantwise training, monitoring and forecasting and various other extension services. Over 6,000 photos have been shared to date through this channel.

In Kenya plant doctors alerted each other about fall armyworm using the Telegram messaging service and received management advice from the Kenya Agricultural and Livestock Research Organization (KALRO). In Uganda, exchanges between plant doctors via Telegram reportedly helped reduce Red List chemical recommendations, and experts also use Telegram to validate each other’s diagnoses on various plant health issues, improving their robustness [7]. In Nepal management techniques for tomato leaf miner (Tuta absoluta) were communicated through Telegram. In Costa Rica, in addition to using a WhatsApp group to consult each other on plant health issues, plant doctors use it to invite farmers to participate in plant clinic sessions and other extension activities [3].

An analysis of six messaging app networks (Ghana, Kenya, Malawi, Nepal, Sri Lanka and Uganda) was conducted in 2017 to understand how they are working. A total of 230 requests for diagnostic support, with a photo attached, were recorded during the sample period. Not all queries posted received suggested solutions from peers in the network, with the highest number of answers received in Kenya (88% of diagnostic queries answered) and the lowest in Nepal (32% answered). CABI’s diagnostic experts agreed with virtually all the diagnoses that had been suggested by network peers [14].

“Having tablets and ready access to information has revolutionized how frontline extension staff work. It has expanded their world and inspired many officers to pursue information and knowledge, and in some cases, higher academic credentials.”

From study by Chege et al. on Plantwise Integration into County Agriculture Systems in Kenya [8]

Social network groups can be effective in triggering system-wide responses, as happened in relation to Banana Skipper (Erionota sp) in Sri Lanka, where a plant doctor posted photos of an unidentified pest that a farmer had brought to his clinic on a plant doctor Telegram chat group, requesting diagnostic support. A diagnostic expert, responding the same day, identified the pest as Banana Skipper. General advice for managing this new pest was shared with plant doctors through the chat group and national pest reporting protocols were activated 20 days later. An awareness-raising factsheet, including specific management advice, was then shared with plant doctors by the Department of Agriculture via the group [45].
Social media also enable feedback on outbreaks to be gathered quickly. During the fall armyworm outbreak in East Africa, Telegram was used for mapping the spread of the pest in various locations in **Uganda** and **Kenya**, and subsequently for disseminating management options to relevant stakeholders [7] (see also Section 4).

The use of social network platforms has also been instrumental in supporting continuing capacity development in different ways. In **Ghana**, tutorials on key cocoa pests have been sent to plant doctors via Telegram after identifying training needs through the clinic data (Case 3).

**Case 3: Using Telegram to deliver tutorials on key cocoa pests in Ghana**

In Ghana, plant doctors have found innovative ways of using their digital devices to improve their knowledge base in pest and disease identification and management. In January 2017, the Plantwise Ghana National Data Manager initiated the Plant Doctors Lecturers Series as a way of addressing some of the challenges with pest and diseases diagnosis and management that had been observed in the plant clinic data. This was welcomed and supported by all those who are active on the plant doctors' Telegram platform. To date, lectures have been given by 15 plant doctors experts. A total of 16 topics have been treated by the plant doctors and almost 190 plant doctors have benefited from the lectures. These lectures allow for interactive studies, which include using lots of images both from the internet and those taken by the plant doctors who deliver the lectures. Apart from learning from what others present, the presenters also improve their own knowledge through the research and preparation process. Experts also get involved, giving clarification and additional information when it is required. For example, the Cocoa Research Institute delivered a session on insect pests of cocoa.

**Lessons learned**

- Most plant doctors acknowledge an improvement in their knowledge of plant health and confidence in being able to diagnose problems and advise farmers due to the Plantwise training, information tools and participation in social network groups.

- There is evidence that plant doctor skills and diagnoses are improving due to Plantwise training; however, challenges in the quality of diagnosis and advice remain and further investment is needed to address this.

- The use of ICT, including tablets and social network groups, has become a ‘game changer’ in terms of linking plant doctors to peers, experts and farmers for mutual consultation and information exchange, and in terms of building capacity for system-wide response to pest risks.
4. Strengthening plant health systems

An effective plant health system is dependent on strong interactions between the plant health stakeholders, and effective data and information exchange to underpin actions. Plantwise seeks to stimulate plant health system change and improve plant health stakeholder engagement and delivery of plant health services.

Improving stakeholder linkages

The Plantwise National Steering Committees are a key mechanism for bringing together plant health stakeholders to foster stakeholder interactions and operational and strategic decisions. Reflecting the adaptive approach of Plantwise, the function and role of steering committees differs across Plantwise countries. In Kenya and Myanmar, they have served as an entry point for developing national plant health system strategies; in other countries, they are primarily a programme co-ordination unit. In Jamaica, the committee has been a crucial platform for ensuring the integration of plant clinics and rallies in the existing agricultural advisory and crop protection system.

There is growing evidence of positive effect of Plantwise on stakeholder linkages. In Kenya stakeholder testimonials show that Plantwise is improving multi-institutional co-ordination in national plant health systems at the various governance levels, generating more knowledge, and improving the likelihood that pest outbreaks will be detected and responded to [1, 42]. In Pakistan, effective partnerships have played an important role in the large-scale expansion of plant clinics in Punjab and Sindh Provinces: by the end of 2018, some 1,800 plant doctors had been trained, over 800 plant clinics established, and more than 150,000 farmer queries recorded in POMS. The Plantwise activities in Pakistan are based on partnerships between agriculture extension departments and other organizations, such as the Directorate General of Pest Wing and Quality Control of Pesticides Punjab, Sindh and Baluchistan; and the Department of Plant Protection. Lessons from Pakistan on how to establish and maintain effective partnerships include:

- Engage influential champions across stakeholder groups, including government, private sector, civil society and farmers’ organizations.
- Develop a shared partnership agenda, including high-level goals and top priorities, through multi-stakeholder collaboration.
• Put in place structures to formalize the partnership’s mandate for action and build ownership and commitment to the agenda among all individuals/organizations.
• Define clear roles and responsibilities of partners, and agree on structures, including an impact framework, for mutual accountability.

Using plant clinic data to strengthen plant health systems

Plant clinic data are a unique source of continuous and almost real-time pest and disease intelligence from the field that no other extension method currently offers. Another feature that makes these data unique is that they include a written version of the advice given to farmers by the plant doctors. The data are part of the ‘glue’ that can connect stakeholders in different ways and stimulate action to strengthen plant health systems. The volume of clinic data flowing into the POMS has increased steadily over the years, reaching more than 450,000 query entries by the end of 2018. The amount of clinic data stored in POMS varies by country, with Pakistan, Kenya and Ghana accounting for more than 60% of all clinic data. Greater use of POMS by a given country is associated with the scale of clinic operations, as well as a country’s capacity to handle large amounts of data and its interest in using the clinic data to underpin extension services or support new initiatives.

In 2017, partners in at least 15 Plantwise countries were using data from POMS. Some countries, such as Kenya, Malawi and Zambia, have used POMS data to monitor the distribution and spread of invasive species (e.g. fall armyworm). Other uses include assessing the quality of diagnosis and advice provided by plant doctors; identifying training needs; making decisions on extension and research priorities; making decisions on farmer subsidies related to agro-inputs; and basic monitoring and reporting. So far, no country has yet made use of the full potential of the data it currently collects from plant clinics. This is, however, expected to take time because this type of multi-use data is a relatively novel concept for many Plantwise country partners.

Early warning and joint action

The original design of Plantwise envisaged that plant clinic data would serve as an early warning system for pests, but this has not happened because the data recorded by plant doctors are often not detailed enough to identify new or emerging pests and because the job of regularly screening data for the presence of new pests does not always fit with existing roles. Nevertheless, the data help map and monitor pest occurrence; this information about pest spread is then used to design extension materials and responsive actions. In Kenya, the clinic data informed relevant bodies about the spread of fall armyworm in Trans-Nzoia county, providing a solid evidence base that helped them lobby for funds to support the management of the pest. This activity reportedly enabled the county to avoid large crop losses. Such local initiatives, including the actions of plant doctors outside their clinic sessions, may explain the general farmer benefits observed in the clinic catchments areas, not only by farmers attending plant clinics [1]. In 2017 Plantwise also supported national and regional taskforces to identify the pest, design information packages for its management, and disseminate these to end users in Ethiopia, Ghana, Mozambique, Kenya and Uganda.

“… a strange/weird caterpillar invading maize fields... reported in all 15 wards who operate clinics... distribution made possible through the Plantwise Online Management System (POMS)”

Trans Nzoia County’s Minister for Agriculture, Kenya,
Cabinet memo on fall armyworm
Plant health systems’ ability to respond to farmers’ needs

Anecdotal information, observations from country partners and CABI field staff, and recent studies in Nepal and Ethiopia show that plant health system performance and responsiveness are improving [34, 40]. In Nepal, the speed and effectiveness of diagnoses have improved due to improved knowledge and skills (plant doctor training) and faster communication tools (e-clinics, mobile phones, Telegram, Internet), resulting in better overall co-ordination between diagnostic and advisory services. In addition, inspired by Plantwise, the Nepal Agricultural Research Council has become more responsive to farmers’ needs for more environmentally friendly control measures, focusing more on developing agronomic and biological control options for pests (e.g. establishing ‘farmer laboratories’ to produce bio-control agents). Plant doctors are now also engaging with local agro-dealers to discuss the supply of certified and effective agro-chemical inputs, as well as biological products – and as a result, agro-dealers now supply a variety of bio-pesticides and pheromone traps. Finally, Plantwise has contributed to policy reforms in Nepal: plant health policies and structures are being revised to improve phytosanitary regulation and control.

Figure 9: Relative changes in plant health system functions in Nepal (2011–2017) and Ethiopia (2014–2017) [34, 40]

“Farmers now have a stronger voice in the plant health systems in Jammu and Tamil Nadu than previously, and while more work could be done, it was felt that there are more robust links between farmers and research. Additionally, the role of ICTs has been crucial in the delivery of advice and collecting feedback from farmers.”

Plant health stakeholder workshop 2018, India [28]
Case 4: Developing a stronger local-level plant health system in Ethiopia

Plantwise has contributed to strengthening the plant health system in Ethiopia at different levels. Plantwise training and reference materials have improved the quality and accuracy of the diagnostic services provided by individual plant doctors and diagnostic labs, making them less dependent on the knowledge of the crop protection experts at *woreda* (district) and zone levels. This greater independence enables crop protection experts and extension officers to focus more on prevention measures. Plantwise has also strengthened working relations between the extension system at the local level and researchers working on crop protection and plant health at the regional and national levels: researchers are now regularly invited to training-of-trainers events and workshops to develop plant health information materials and crop manuals. Other ways in which Plantwise has improved the Ethiopian plant health system’s ability to respond to farmers is by supporting the compiling of information about plant health practices and technologies developed by regional and national research centres into extension materials for use at the national level. By advising agro-dealers on what agro-chemicals to stock, based on the prevalence of specific pests and diseases, and referring farmers to purchase inputs from certified agro-dealers, plant doctors are improving the availability and accessibility of quality agro-chemicals to farmers. As noted by a plant doctor: “The data obtained at plant clinics can be used by plant doctors for planning at grassroots level. They can see the pests identified this year for each crop, so next year they can plan for inputs and extension activities. They know the major pests in the kebele and what inputs are needed.” [34]

Global backstop support

CABI’s UK-based Diagnostic and Advisory Service (DAS), which has links to plant doctor social media networks in 15 Plantwise countries, provides support in cases where the local experts are unable to help. The involvement of the DAS in social network groups has led to an increase in demand for its services: the number of diagnostic queries received by the DAS via WhatsApp and Telegram increased from an average of 52 in 2015 and 2016 to 195 symptom images in 2017 [14]. These digital queries are in addition to the 200+ physical samples sent to the DAS from 16 countries (of which 12 Plantwise countries). Through this process, in 2017 the DAS supported national plant protection organizations to identify eight new pests in a total of six countries (of which five are Plantwise countries), including confirming the presence of fall armyworm in Zambia, Malawi and Rwanda.

Lessons learned

- The exact nature, needs and priorities of plant health systems vary hugely from country to country. Plantwise has adapted its intervention and ways of working with partners to match each particular country context.
- Plantwise has facilitated a focus on plant health among stakeholders, leading to new synergies and improved linkages between actors in the system through joint actions and enhanced information sharing.
- There is a wealth of anecdotes and observations from country partners and CABI field staff about improved collaboration taking place between partners, and farmers’ increased satisfaction with the services they receive. However, much of this information has not been captured systematically.
- Rather than using clinic data to identify new pests or pest outbreaks *per se*, the clinic data have demonstrated their value as a means to map pest occurrence so that information about spread is used to design extension materials and actions accordingly.
5. Scaling up and sustainability

There is growing evidence that countries are institutionalizing Plantwise elements, such as plant doctor training, plant clinic operations and the use of ICT platforms, and taking the approach to scale.

To ensure sustainability (i.e. that positive changes continue beyond the lifetime of the programme and are independent of direct support from CABI), Plantwise adopts different approaches.

Promoting ownership

Plantwise promotes national ownership of the programme activities. One way of doing this is through the national co-ordination unit (steering committee), composed of public and private sector stakeholders from extension, plant health regulatory institutions and research organizations, among others. The steering committee plans and monitors Plantwise activities at country level.

Beyond the role of the steering committee, Plantwise seeks to ensure that, as programme implementation progresses, national stakeholders take on greater ownership of financing and implementation. Overall, the process of reaching sustainability is taking longer than originally anticipated. Setbacks experienced by countries range from civil strife (Nicaragua and Democratic Republic of Congo), natural disasters (Nepal) and health crises (Ebola in Sierra Leone), to policy reforms, decentralization and institutional instability (Uganda, Kenya, Bolivia and Nepal) [12]. Key factors identified by CABI Country Co-ordinators as contributing to Plantwise progress towards sustainability include the perceived value of plant clinics in providing plant health advice to farmers, alignment of programmatic elements with national policies, and institutional commitment. On the other hand, the main factors that impede progress towards sustainability include excessive government bureaucracy, low funding for agricultural extension services, staff shortages and low staff motivation.
Figure 10: CABI County Co-ordinators’ rating of positive (green) and negative (red) factors influencing Plantwise progress towards sustainability

Plant clinic implementation

- Alignment with institutional mandates and structures
- Alignment with national policies
- Staff incentives, motivation
- Commitment, leadership
- Perceived clinic value
- Staff scarcity
- Government bureaucracy
- Funding scarcity
- Staff availability

Data management

- Staff availability
- Government bureaucracy
- Staff scarcity
- Staff incentives, motivation
- Perceived value of data
- Workload
- Supportive managers
- Insufficient technical, IT capacity
- Commitment, leadership
- Collaboration between institutions

Institutionalization

- Collaboration
- Insufficient institutional capacity
- Alignment with national policies
- Funding scarcity
- Perceived clinic value
- Institutional commitment, leadership
- Government bureaucracy
- Alignment with LIO mandate and structure
- Lack of commitment, leadership
- Other extension programs
Developing national sustainability plans

To ensure sustainability, CABI is devoting more time to supporting countries to develop sustainability plans based on the assumption that partners will increasingly support basic operations while Plantwise core donor funds will be focussed more on programme and donor priority areas. Experience suggests that it is more effective to develop medium-term, as opposed to short-term, in-country plans with partners. Myanmar has taken a significant leap towards national ownership and sustainability through developing a national Plant Health System Strategy, based on the Plantwise model.

Institutionalizing plant doctor training

Training of ca. 2,700 plant doctors in 2017 was mainly conducted by partners. In Nicaragua, one of the first countries where plant clinics were introduced, plant doctor training was taken up by a local university as early as 2012 [9] (see Case 5), while in Uganda, two universities, Makerere University and Uganda Christian University, are using Plantwise training content to complement their agricultural curricula. Plantwise training content has been integrated into the compulsory training course that agro-input dealers in Costa Rica have to take annually in order to receive authorization to work as input sellers, with the aim of increasing their skills on giving recommendations to farmers. The Kenya Plant Health Inspectorate Services is considering incorporating the plant doctor training as part of the mandatory training for all plant inspectors. Expanding the institutionalization of plant doctor training in more countries requires concerted effort based on embedding elements of Plantwise in national plant health strategies and work plans.

Case 5: Training a new generation of farmer-oriented plant health specialists in Nicaragua

In 2006, well before the start of Plantwise, Universidad Católica Agropecuario del Trópico Seco (UCATSE), a private university in Nicaragua, opened a plant clinic, operated by university lecturers trained as plant doctors by CABI and supported by the university’s laboratory. When Plantwise started in 2012, the university integrated the Plantwise training modules and plant clinic approach into its curriculum for agronomy students. Students study general entomology and plant pathology during their first two years of study. Third-year students are prepared for fieldwork and research in a course on rural development, which incorporates plant doctor training modules 1 and 2 (“Field Diagnosis and Plant Clinic Operation” and “Giving Good Advice”). Students then undergo a four-month practical training course in the field during the busiest agricultural season. Each student is assigned to a farmer and is expected to visit farmers’ fields once a week between 6:30 and 12:00. During the visit, students make diagnoses and recommendations, recording all of the information in plant clinic prescription forms. The professor checks their work to ensure the quality of diagnosis and recommendations and identifies issues for further discussion in the classroom. By 2016, more than 160 students had completed the plant doctor training and gone on to work for extension organizations or private companies, or as farmers. Professors report that students are motivated and inspired by the plant clinic training modules and approach. After leaving the university, some continue to contact their professors for diagnostic support in their consultations with farmers, while other alumni have tried to integrate the plant clinic approach into their professional work. [9]
Scaling and institutionalization of plant clinics

There is growing evidence that countries are institutionalizing plant clinics and taking the approach to scale. Several countries have incorporated plant clinics into national agricultural strategies. **Uganda** was the first country to do so, in its 2010/11 Development Strategy and Investment Plan, which laid the foundation for the subsequent expansion of clinics to dozens of districts [12]. In **Peru**, the National Institute for Agricultural Innovation has included plant clinics as one of the key methodologies in its technology transfer guide, and is seeking funds from the World Bank to scale up the plant clinic concept to all 17 regions of the country [23]. As highlighted earlier, **Pakistan** has benefitted from effective partnerships, national leadership and a conducive policy environment in relation to taking plant clinics to scale in the Punjab and Sindh Provinces.

**Kenya** has embarked on standardizing Plantwise operations through the development of standard operating procedures (SOPs) under the leadership of Ministry of Agriculture Livestock Fisheries and Irrigation, with the aim of making sure plant doctors are equipped with relevant plant health skills, knowledge, networks, equipment, and appropriate reference materials for improved plant health service delivery to farmers. The SOPs will help harmonize plant clinic operations across the country’s 47 counties and embed good practice and consistency in the use of Plantwise products and services to manage plant health. The SOPs are meant to support a longer-term process by which plant doctors, plant doctor trainers and their organizations develop the capacity and infrastructure needed to do their jobs competently, or to a greater capacity.

Plantwise recognizes that several factors, including operational costs, will determine the scalability of extension and advisory approaches. Regarding cost, plant clinics compare favourably with farmer field days and village-based intermediaries [26]. Data from **Kenya** also suggest that the estimated monetary benefits of implementing Plantwise outweigh its costs, at a ratio of 2.9:1 and an internal rate of return of 54% [1] – higher than the 37% median internal rate of return for similar research and extension programmes [2]. The data also demonstrate that the benefits are not exclusively realized by clinic users; non-users within the catchment areas also benefit from the presence of plant clinics (see also Section 2).

To encourage scaling up and financial sustainability, Plantwise has adopted a flexible approach to operating plant clinics. For example, in some countries plant clinics are held in the offices of extension organizations, rather than in public places, to cut costs, while in others adaptations include mobile clinics, provision of soil and livestock advice, and linking clinics with farmer field schools, field visits or field demonstrations. Local commitment, political will and leadership, plus strategic national support and alignment with national policies, are key to institutionalizing plant clinics and complementary extension approaches. By contrast, challenges to institutionalization include staffing and funding shortfalls and inadequate institutional capacity.

Data management and use

As mentioned in Section 4, there are clear differences between countries in terms of interest in collecting and using plant clinic data, with a small number of countries showing a strong commitment in both areas. **Pakistan** and **China** are so far the only countries that have taken on full ownership of their data management systems, i.e. operating with minimal CABI support.

Keeping the country data management system going is challenging. Some plant doctors feel that collecting data is a task that goes beyond their role and staff managing plant clinic data may not be able to cope with the additional workload, especially in the absence of incentives. In some cases, they may lack the technical capacity for managing data. In countries with more pluralistic plant clinic operators, it has been difficult to create a shared interest in the data. Farmer co-operatives, NGOs, and public and private extension agencies work in different ways and do not all necessarily see the value of spending time collecting and processing clinic data. Insufficient feedback from those who analyze and use the data has also been reported as a demotivating factor for those engaged in the data chain. Ministry officials in some countries have even expressed concerns that sharing plant clinic data may harm cross-border trade.
Findings from studies conducted in **Kenya** and **Myanmar** confirm these challenges. In Kenya, little data validation is being carried out due to technical problems (procedures are deemed to be tedious, use of outdated datasheets), financial challenges (costly procedures, dependency on CABI funds) and questions about organizational roles [42]. Myanmar, on the other hand, has faced budgetary constraints, a lack of investment in ICT equipment and insufficient staff with the required qualifications [41].

Despite these challenges, requests for data management training, and more recently, requests by some countries for assistance to establish a national plant clinic database suggest growing interest in, and commitment to, using plant clinic data to support actions and decisions in plant health (see also Section 6).

**Lessons learned**

- For many countries, the process of moving from the pilot phase to the sustainability phase of the Plantwise sustainability roadmap is not necessarily a smooth one and is taking longer than was originally anticipated.
- Expanding the institutionalization of plant doctor training in more countries will require concerted effort, based on national strategies and institutional mandates.
- There are clear differences between countries in terms of their interest in collecting and using plant clinic data, with a small number of countries showing a strong commitment in both areas.
- Institutionalization of Plantwise approaches is generally challenged by the inherent funding, staffing and capacity shortfalls that many countries face. This calls for greater efforts to adapt the intervention step-by-step, at a pace and with objectives that are realistic for each country context.
6. Partners’ views of Plantwise

CABI carried out an online survey of partners in July–August 2018, to find out what they think about the programme. Of the over 600 respondents, 30% were female; 61% were from Asia (11 countries), 24% were from Africa (eight countries), and 15% were from the Americas (nine countries). Plant doctors and government extension staff were the most frequent respondents and respondents were mostly from government extension/rural advisory services, government plant health/crop protection departments or NGOs/farmer organizations/the private sector.

Views on Plantwise impact

More than 90% of the respondents feel Plantwise is meeting its objective of providing farmers with information to reduce crop losses caused by pests and diseases very well, with the improved capacity of extension staff and institutions, and the quality of advice offered to farmers on plant health, seen as main achievements (Figure 11). More than two thirds of respondents consider the programme’s efforts to link plant doctors through social media and to increase farmer reach as excellent or good, while the ability to reach women is considered slightly less successful. Around 75% deem the value of plant clinic data as excellent or good. Improvement in support from diagnostic labs was rated lowest, yet around half of the respondents still considered the achievements to be “excellent” or “good”.

“The issues of fall armyworm and *Tuta absoluta* have been managed and this has increased hopes of farmers as the effects on yield loses were high. The yields have picked up”

Malawian extension worker

The surveyed partners perceive Plantwise as having a moderate to excellent impact on strengthening the plant health system in their country, in particular through improvements in countries’ responsiveness to new and emerging pests and stakeholder linkages, and influence over national policies (Figure 12).

**Figure 11: Partners’ perceptions of Plantwise impact**

- **Reduced crop losses**
- **Impoved capacity of extensionists**
- **Social media linkages**
- **Improved quality of advice**
- **Increased farmer reach**
- **Women outreach**
- **Outreach to poor farmers**
- **Youth outreach**
- **Value of data**
- **Increased diagnostic lab support**

![Bar chart showing partners' perceptions of Plantwise impact](chart)

**Figure 12: Partners’ perceptions of Plantwise impact in plant health systems**

- **Responsiveness to new and emerging pests**
- **Stakeholder linkages and collaboration**
- **National policies or strategies**

![Bar chart showing partners' perceptions of Plantwise impact in plant health systems](chart)

“The quick summary of data makes it easy to see unexpected pests on common crops. The number of farmers affected by a certain problem and the associated time and location clearly identify when a ‘pest flare up’ has occurred and action is needed.”

Female researcher and plant doctor, Jamaica
Views on the usefulness of the Knowledge Bank

A little over half of the respondents find the Knowledge Bank extension materials very useful; ~40% find them moderately useful (Figure 13). The numbers are slightly lower for the diagnostic support tools, while a third find the POMS very useful and 41% find it moderately useful. The higher proportion of “not useful” and “can’t tell” responses to this question may reflect challenges in establishing new data work flows and IT procedures.

Figure 13: Partners’ views on the usefulness of the Plantwise Knowledge Bank resources

Views on sustainability

The question about the success of Plantwise in ensuring sustainability of its approaches is the only one that shows a clear difference in response between plant doctors and other partners, with plant doctors being much more positive about progress (Figure 14). Other partners, such as national co-ordinators, data managers and plant doctor supervisors, are more likely to be exposed to the wider organizational, policy and budget challenges that affect institutionalization and sustainability.

Figure 14: Partners’ views on Plantwise success in ensuring the sustainability and institutionalization of its approaches

Regarding respondents’ suggestions for how to ensure the sustainability of plant clinics, 40% suggest that plant clinics should be covered by government budgets (Figure 15). Engaging with civil society organizations and the private sector is preferred by about half of respondents, and less than 10% suggest charging farmers a fee for attending clinics.
More than three-quarters of the respondents state that they would prefer to establish either nationally managed clinic data repositories or a combination of national and global CABI-led repositories (Figure 16).

Figure 16: Respondents’ preferences regarding the future of plant clinic data repositories

Obstacles and areas for improvement

Asked about obstacles to Plantwise implementation and impact, respondents largely concurred with the CABI Country Co-ordinators that staff scarcity, workload, plant doctor qualifications, low awareness of plant clinics and Plantwise, and budget constraints are the key limitations (Figure 17). Around 12% of respondents mentioned that the plant clinic model is not considered optimal in the given context and several responses refer to the challenges of getting farmers to attend clinics. Apart from staff and budget scarcity, the most frequently mentioned organizational limitations include lack of commitment and government support, as well as gaps in co-ordination and communication.

“Need to take the local conditions into account. It is not a one-size-fits-all.”

Male plant doctor, Barbados
Respondents made suggestions for improving staffing (numbers, skills, incentives), clinic operations (infrastructure, logistics, location, timing, publicity), institutional co-ordination, management and ownership, and for better meeting farmers' needs (understand farmer demands, provision of inputs at the clinics) (Figure 18). Some respondents suggested ways to formally embed the plant clinic model into existing extension systems (institutionalization, and combine with field visits and demonstrations).

**Figure 17: The 20 obstacles most frequently mentioned by respondents**
Overall, partners who participated in the survey were broadly positive about Plantwise’s achievements and modes of operation, and identified key areas that need attention in the years to come. The lessons learned from implementing the programme provide a solid base for further developments.
7. Conclusions

Plantwise has had a positive impact on the lives of smallholder farmers in Asia, Africa and the Americas, by contributing to improved plant health management, leading to increased yields and income. The programme has achieved this by strengthening the capacity of extension staff to deliver quality plant health advice through plant clinics and complementary extension approaches, and by strengthening the linkages between plant health system stakeholders, leading to better targeting and coordination of farmer support. Plantwise has also contributed to the detection of at least eight new pests, such as the fall armyworm and tomato leaf miner, in several countries around the world. In addition, Plantwise Knowledge Bank resources are highly valued by thousands of individuals.

Regarding sustainability, there are promising signs of the institutionalization and scaling up of Plantwise-supported approaches in a number of countries, by both public and private sector agencies. Examples of national investments in plant health systems strengthening include the official adoption of plant clinics as an extension approach by the governments of Peru, Myanmar and Kenya; the integration of plant doctor training into national universities in Nicaragua and Uganda; reforms in plant health policies and regulations in Nepal; and significant financial investments in plant doctor training and plant clinic operations in a growing number of countries, most notably, Afghanistan, China, Ethiopia, Malawi, Mozambique, Nepal, Pakistan and Rwanda.

Going forward, what can Plantwise do better?

Like any programme of this magnitude and complexity, Plantwise has faced challenges in meeting its objectives and goals. Some of these were flagged by partners in the online survey, while others have been identified and addressed by programme monitoring and evaluation over the years. Such lessons learned are vital to determine what needs to be done differently.

The development of strong and lasting linkages among plant health system stakeholders, and with CABI, requires sound understanding of the political, institutional and cultural context. Advocacy efforts need to be increased at national and local levels to ensure greater commitment to, and sustained support and ownership of, the Plantwise approach at the country level.
CABI has learned that in order to maximize efficiency and effectiveness, the programme will have to put more emphasis on building synergies and linkages between different advisory approaches used by other service providers, such as farmer field schools, existing radio programs etc. To ensure equitable access and to reach higher numbers of women farmers and youth, gender and youth need to be given higher priority at all levels of the programme, and with partners (in relation to policy, staff recruitment, content of technical advice etc.). Sensitizing CABI staff and partners on gender and further addressing gender and social inclusion in the training curriculum for plant doctors are some measures that deserve attention.

A key lesson is that building capacity of plant doctors is an ongoing process and that plant doctor performance needs to be strengthened through regular training and testing, to which end the institutionalization of plant doctor training must take place in more countries. While digital networks can greatly enhance communication, there is still a need for quality assurance. New ideas and ways of checking the quality of plant doctors’ diagnoses and advice are needed (and are currently being tested).

It has taken longer than expected to create partner interest and buy-in of clinic data management and use. Establishing efficient procedures for managing, sharing and using clinic data is a major organizational challenge that requires technical, knowledge and management issues to be addressed. Promoting national ownership of plant clinic data is also an area where CABI will need to do more work, taking into account national interests and structures to avoid parallel systems and tedious procedures that may undermine motivation and ownership. CABI and partners also need to engage more directly in policy dialogues to support creating an enabling institutional environment with clear communication and management structures, and to advocate for high-level commitment to allocate budgets for Plantwise activities, including data management and use.

There is room for improvement in how Plantwise measures reach and impact at farmer and systems levels. Developing more detailed guidelines together with partners and agreeing on a set of basic impact indicators, as well as how to measure these, would help streamline and better co-ordinate reach and impact assessment efforts for cross-country comparison. Collating and analysing existing, yet undocumented evidence of impact will most likely provide new valuable insights. At the same time, lessons learned from each country and region must be effectively captured and used to adapt and adjust the intervention as needed.

**Looking ahead, what will Plantwise be doing going forward?**

Over the past seven years, CABI has gained a solid foundation for shaping the future directions of the programme, based on local realities and opportunities. Plantwise will continue to work with stakeholders from public and private sector organisations to mitigate agricultural risks at scale, thereby making farming more cost-efficient for millions of farmers. ICT has radically changed how plant doctors access peer and expert support to deal with “any crop, any problem”, yet there is more to gain. Plantwise will respond to the needs of stakeholders through further development and use of digital technology and data driven innovations that enhance responsiveness to emerging risks. In this way, Plantwise will contribute to development of trade enabling systems needed to facilitate access to markets, such as by linking to specific value chains. Plantwise will also continue to work with new stakeholders and rural communities to pilot alternative sustainability models for agricultural advisory services as a way of employment creation, thereby reducing poverty at household levels. Finally, Plantwise will explore ways to support smallholder farmers adopt climate resilient and ecologically sustainable cropping practices.
Sources


### Annex 1: Plantwise country partners

<table>
<thead>
<tr>
<th>Country</th>
<th>Partners/Institutions</th>
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<tbody>
<tr>
<td><strong>Afghanistan</strong></td>
<td>Ministry of Agriculture, Irrigation and Livestock; Plant Protection and Quarantine Directorate; National Horticulture and Livestock Project; Department of Agriculture, Irrigation and Livestock; the Danish Committee for Aid to Afghan Refugees; Agha Khan Foundation – Afghanistan.</td>
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<tr>
<td><strong>Bangladesh</strong></td>
<td>Ministry of Agriculture; Department of Agriculture Extension; Plant Protection Wing; Bangladesh Agricultural Research Council.</td>
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<td><strong>Bolivia</strong></td>
<td>Gobierno Autónomo Departamental de Santa Cruz - Secretaría de Desarrollo Productivo; Servicio Departamental Agropecuario y de Sanidad e Inocuidad Agropecuaria de Santa Cruz; Centro de Investigación Agrícola Tropical; Universidad Autónoma “Gabriel René Moreno”; Facultad Integral Noreste, FINA; Fundación Valles; Fundación PROINPA; Fundación Swisscontact; Instituto Tecnológico Agropecuario de Tarata; Gobierno Autónomo Departamental de Oruro; Gobiernos Autónomos Municipales de Cercado-Tarija, Capinota y Sipe Sipe; Agripac Boliviana; Private agro-input dealers.</td>
</tr>
<tr>
<td><strong>Brazil</strong></td>
<td>Brazilian Research Corporation, Embrapa Agrosilvipastoril Mato Grosso; Ministério de Agricultura Pecuária e Abastecimento; Empresa Mato-grossense de Pesquisa; Assistência e Extensão Rural; Universidade Estadual do Mato Grosso; Instituto Federal de Educação; Ciência e Tecnologia de Mato Grosso, Sorriso; Universidade Estadual do Mato Grosso, Alta Floresta; Luiz de Queiroz College of Agriculture and Universidade Estadual Paulista; São Carlos Federal University; local government, municipalities.</td>
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<tr>
<td><strong>Burkina Faso</strong></td>
<td>Direction de la Protection des Vegetaux et Conditionnement with Regional and Provincial Extension Directorates; Direction de la Vulgarisation et de la Recherche-Développement; Self-Help Africa; Welthungerhilfe.</td>
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<tr>
<td><strong>Cambodia</strong></td>
<td>Department of Plant Protection Sanitary and Phytosanitary, General Directorate of Agriculture, Ministry of Agriculture, Forestry and Fisheries; three provincial departments of agriculture; Royal University of Agriculture; Cambodian Agricultural Research and Development Institute.</td>
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<td><strong>Caribbean</strong></td>
<td>Jamaica: Ministry of Industry Commerce, Agriculture and Fisheries Rural Agricultural Development Authority; Research and Development Division; Plant Quarantine and Produce Inspection Division; Trinidad and Tobago: Ministry of Agriculture, Lands and Fisheries Extension Training and Information Services Division; National Agricultural Marketing and Development Corporation; Barbados: Ministry of Agriculture, Food Fisheries and Water Resources Management Grenada: Ministry of Agriculture, Forestry, Fisheries and the Environment.</td>
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<tr>
<td><strong>China</strong></td>
<td>Ministry of Agriculture and Rural Affairs; Institute of Plant Protection, Chinese Academy of Agricultural Sciences; Beijing Plant Protection Station; Sichuan Plant Protection Station; Xing’an Plant Protection Station, Guangxi Province; Agricultural Information Institution, Chinese Academy of Agricultural Sciences; Information Institute, Anhui Academy of Agricultural Sciences; China Wisdom City Working Committee; School of Agricultural and Food Science, Zhejiang Agricultural and Forestry University.</td>
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<td><strong>Costa Rica</strong></td>
<td>Extension Department and Plant Health Department, Ministry of Agriculture; Ministry of Agriculture Gender and Youth Division (4S clubs); APACOOP RL (farmer cooperative), Iglesia Adventista.</td>
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<td><strong>Ethiopia</strong></td>
<td>Ministry of Agriculture (Plant Health Regulatory Directorate); Oromia Region Bureau of Agriculture; Amhara Region Bureau of Agriculture; Tigray Region Bureau of Agriculture; SNNP Region Bureau of Agriculture; Self-Help Africa.</td>
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<td><strong>Ghana</strong></td>
<td>Plant Protection and Regulatory Services Directorate of the Ministry of Food and Agriculture; GIZ, Market-Oriented Agricultural Programme; USAID/ADVANCE Project; International Development Enterprise; Cocoa Rehabilitation and Intensification Programme.</td>
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<td>Servicio Nacional de Sanidad e Inocuidad Agroalimentaria; Instituto Obdulio Lezama; Instituto Técnico Polivalente Laman; Centro Empresarial de Negocios, Ocotepeque; Aldea Global; Fundación Jicatuyo; Asociación de Productores del Altiplano de Celaque; Fundación Ayuda en Acción.</td>
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<td>M.S. Swaminathan Research Foundation; Department of Agriculture, Jammu; National Agro Foundation; DESEE Force.</td>
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<td>Kenya</td>
<td>Ministry of Agriculture, Livestock, Fisheries and Irrigation; KALRO; Kenya Plant Health Inspectorate Service; Pest Control Products Board; Agrochemical Association of Kenya; University of Nairobi; Katoloni Mission Community-Based Organization.</td>
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<td>Malawi</td>
<td>Department of Agricultural Extension Services, Ministry of Agriculture, Irrigation and Water Development; Self-Help Africa; Department of Agricultural Research Services; Department of Crop Development; United Purpose, Lilongwe University of Agriculture and Natural Resources, Pesticide Control Board</td>
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<td>Mozambique</td>
<td>Ministry of Agriculture and Food Security; Departamento de Sanidade Vegetal.</td>
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<td>Myanmar</td>
<td>Plant Protection Division, Department of Agriculture, Ministry of Agriculture, Livestock and Irrigation; Yezin Agricultural University; Department of Agricultural Research; EWS (private sector customer).</td>
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<td>Nepal</td>
<td>Plant Quarantine &amp; Pesticide Management Centre; Regional Plant Protection Laboratories; District Agriculture Development Offices; Farmer IPM associations (farmer field schools); iDE Nepal.</td>
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<tr>
<td>Nicaragua</td>
<td>Universidad Nacional Autónoma de Nicaragua, León, Universidad Nacional Agraria Managua, UCATSE and Centro Universitario Regional Jinotega; Instituto de Promoción Humana, Foro Miraflor, Norwalk Nagarote, Humboldt Centre (NGOs); Cooperativa de Servicios Múltiples Campesinos Activos de Jalapa; Cooperativa Juan Francisco Paz Silva, Cooperativa Multisectorial Sociedad de Productores y Comercializadores, Central de Cooperativas de Pueblo Nuevo, 20 de Abril, Santiago (co-operatives); Abonatura (agro-input supplier); American-Nicaraguan Foundation, Paisaje Urbano (technical support enterprise).</td>
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<tr>
<td>Pakistan</td>
<td>Ministry of National Food Security &amp; Research; Directorate General of Agriculture Extension and Adaptive Research, Punjab; Directorate General of Pest Warning and Quality Control of Pesticides, Punjab; Department of Agriculture Extension, Sindh and Balochistan.</td>
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<tr>
<td>Peru</td>
<td>Instituto Nacional de Innovación Agraria; Servicio Nacional de Sanidad Agropecuaria; Oficinas Agrarias Regionales (Puno, Cusco, Ayacucho, San Martín); Asociación de Productores de Café y Cacao en departamento de San Martín; Universidad Nacional Agraria La Molina; Sociedad de Entomología del Perú; International Potato Centre; local governments/municipalities.</td>
</tr>
<tr>
<td>Rwanda</td>
<td>Rwanda Agriculture Board; various districts and ministries of local government; Directorate of Agriculture and Livestock Inspection and Certification Services; National Agricultural Export Development Board; College of Agriculture, University of Rwanda.</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>Seed Certification and Plant Protection Centre, Department of Agriculture, Ministry of Agriculture.</td>
</tr>
<tr>
<td>Thailand</td>
<td>Rice Department, Ministry of Agriculture and Co-operatives; Department of Agriculture Extension, Ministry of Agriculture and Co-operatives.</td>
</tr>
<tr>
<td>Uganda</td>
<td>Department of Crop Protection and Directorate of Agricultural Extension Services of the Ministry of Agriculture, Animal Industry and Fisheries; Uganda National Farmers Federation; Uganda National Agro-Input Dealers Association; National Agriculture Research and Development Organization; Uganda Christian University; Makerere University; Rwenzori Information Centres Network; Self-Help Africa; Soroti Catholic Diocese Integrated Development Organization; 96 district local governments; Kibimba Limited (rice producing and processing company); Bugisu Cooperative Union Limited (coffee farmers’ cooperative).</td>
</tr>
<tr>
<td>Vietnam</td>
<td>Vietnam Academy of Agricultural Sciences, Ministry of Agriculture and Rural Development; Plant Quarantine Diagnostic Centre; Plant Protection Department; Plant Protection Research Institute; Southern Horticultural Research Institute; Western Highlands Agriculture and Forestry Science Institute; AgriMedia Vietnam.</td>
</tr>
<tr>
<td>Zambia</td>
<td>Ministry of Agriculture; Department of Advisory Services of Ministry of Agriculture; Self-Help Africa; Zambia Agriculture Research Institute; University of Zambia; Nature Resource Development College; Zambia National Farmer Union; Conservation Farming Unit; SNV Netherlands Development Organization.</td>
</tr>
</tbody>
</table>
Plantwise is a global programme, led by **CABI**, to increase food security and improve rural livelihoods by reducing crop losses.