Public Document

Sustainability of Plantwise: an assessment after 10 years of the programme

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KNOWLEDGE FOR LIFE

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Acronyms

BPRMS	Beijing Pesticide Reduction Management System
CBF	community-based facilitator
DAO	district agricultural officer
DAS	Diagnostic Advisory Services
DCA	data collection app
DOAE	Department of Agriculture and Extension
FGD	focus group discussion
ICT	information and communications technology
INIA	Instituto Nacional de Innovación Agraria
IPM	integrated pest management
KEPHIS	Kenya Plant Health Inspectorate Service
KII	key information interview
M&E	monitoring and evaluation
MAG	Ministry of Agriculture, Costa Rica
MoA	Ministry of Agriculture
MPCP	monitoring of plant clinic performance
MSSRF	M S Swaminathan Research Foundation
NFASS	National Food and Agricultural Statistics Systems
NCS	National Steering Committee
NDC	National Data Centre
NGO	non-governmental organisation
PIMS	pest management information system
PMDG	pest management decision guide
POMS	Plantwise Online Management System
PPRSD	Plant Protection and Regulatory Services Directorate
RADA	Rural Agricultural Development Authority
SENSA	Servicio Nacional de Sanidad Agraria
UCATSE	Catholic University of the Dry Tropics
UNAN León	Universidad Nacional Autónoma de Nicaragua
VKC	Village Knowledge Centre
VRC	Village Resource Centre

Summary

The global Plantwise programme has been operating since 2011 and is currently implemented in 30 countries, working with more than 200 partner organisations across Africa, Asia and the Americas.

Plantwise has been demonstrated to be a working concept for the effective delivery of plant health information to smallholder farmers. However, it is critically important that CABI interventions contribute to lasting positive change beyond the end of direct Plantwise funding, hence the need to assess the sustainability[1] of activities across the 30 Plantwise countries. At this advanced stage of Plantwise, it was therefore felt that Plantwise sustainability needed to be viewed from a broader and country-specific perspective to gain a deeper understanding of ***what elements of Plantwise are operating within the country, whether these are likely to continue and why or why not*** (beyond the 'who is going to pay' question).

This synthesis report draws on the country reports of the sustainability assessment carried out in 2020, as well as other recent reports and evaluation studies, to present the key findings as to where indications of sustainability or risk/challenges to Plantwise activities have been highlighted. These findings are presented within the overarching five Plantwise themes: 1) stakeholder linkages, 2) plant clinics and complementary activities, 3) data management and use, 4) information exchange and Knowledge Bank, and 5) monitoring and evaluation (M&E).

Findings indicate that for the Plantwise programme to run effectively, the role of stakeholders is critical as different stakeholders play key roles in the various components of the plant health system. The introduction of tablets (e-clinics) and the establishment of social network groups has become a 'game changer' in terms of linking plant doctors to peers, experts and farmers. The use of social media apps to support advice delivery on plant health is likely to remain as an essential activity within the plant health system and e-extension. However, issues with the cost of data, internet connectivity and language challenges remain.

Overall, findings lead to the conclusion that some elements of Plantwise are more sustainable than others:

- Increased levels of linkages between stakeholders will remain, though it is more likely that they will remain on an informal basis.
- Plant clinics are likely to continue to run in most Plantwise countries, though the scale and frequency of the clinics will depend on how the governments are able to fund them.
- Complementary extension methods will also continue with varying methods used in different countries, depending on which method (plant health rally, radio, etc.) fits better with the country's general approach to extension delivery.
- The sustainability of the data management system and use of data is more challenging. While some countries see the value of the data for pest and disease surveillance, there is limited enthusiasm for continued data entry into the Plantwise Online Management System (POMS), or data harmonisation or validation, which is seen as time consuming, and little funding is available for harmonisation or validation work.

[1] Sustainability is one of the six Organisation for Economic Co-operation and Development's Development Assistance Committee criteria used in the evaluation of development interventions: relevance, coherence, effectiveness, efficiency, impact and sustainability.

- The information resources developed within the Plantwise programme are highly valued across all programme countries and will continue to be used. There is strong demand for further resource development, but funding and staff capacity mean it is unclear whether further information resource development will take place.
- M&E has had the lowest uptake of the five Plantwise programme areas, as it was a new concept within the extension arena in many countries. It is possible some basic monitoring will continue, such as plant doctor validation at cluster meetings, but it is unlikely that monitoring of plant clinics, training courses and mass extension campaigns will continue.

Any Plantwise-type approach should be flexible and adaptable to local contexts with local partners able to unpack and choose which elements of the approach are appropriate for the country context. Overall, the flexibility of the Plantwise approach and its adaptability to local contexts were the main contributors to its uptake by countries. Continuous involvement and engagement with country partners are essential for adoption, adaptation, acceptance, integration and, finally, sustainability of any such plant health advisory programme.

Introduction

CABI, in collaboration with national partners, has been implementing the global Plantwise programme since 2011. Now operating in 30 countries and working with more than 200 partner organisations, across 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. This is achieved by establishing networks of plant clinics where farmers can receive practical plant health advice. Plant clinics are run by extension staff trained as plant doctors. The services at plant clinics are reinforced by the Plantwise **Knowledge Bank,** a gateway to online and offline actionable plant health information, including diagnostic resources, pest management advice and basic pest data for effective global pest surveillance.

Table 1: Plantwise countries by year of programme launch

Pre-2009	2009–2011	2012	2013	2014	2015	2020
Bangladesh	India	Afghanistan	Brazil***	Costa Rica	Jamaica	Burundi[#]
Bolivia	Kenya	Barbados	Burkina Faso***	Myanmar		
Democratic Republic of the Congo**	Nepal	Cambodia	Ethiopia			
Nicaragua	Pakistan	China	Malawi			
Sierra Leone**	Peru	Ghana	Mozambique			
Uganda	Rwanda	Grenada	Thailand			
Vietnam	Sri Lanka	Honduras***	Zambia			
	Suriname*	Tanzania**				
		Trinidad & Tobago				

** exited in 2014; ** Limited activities since 2015; ***Minimal activities beginning 2019; [#] Country-specific funding*

After 10 years of operation, Plantwise has been demonstrated to be a working concept for the effective delivery of plant health information to smallholder farmers. Plantwise's value to stakeholders is now supported by a full body of evidence of its impact, generated through a number of studies carried out with varying levels of rigour, in different countries. This includes evidence of its contribution to: increased crop productivity and household incomes, improved country systems for managing threats to plant health through engagements in multi-stakeholder partnerships, establishing systems for detection and providing good plant health management advice based on integrated pest management (IPM) approaches, opportunities for corrective action in the case of inappropriate use of agro-inputs, understanding the usefulness of digital devices in enhancing the efficiency of the delivery of agricultural advisory services to farmers, and supporting the management of agricultural data systems.

The last 10 years have also brought about a lot of learning and insights into the complexities of plant health systems, institutional dynamics and the influences of the diverse country contexts. However, it is critically important that CABI interventions contribute to lasting positive change beyond the end of direct Plantwise funding, hence the need to assess the sustainability of activities across the 30 Plantwise countries.

Sustainability assessment

Sustainability of Plantwise is defined as: “The likelihood that the positive effects of Plantwise will continue, or are likely to continue” (adapted from Kusters *et al*., 2017 and OECD/DAC, 2019). Positive effects may refer to Plantwise’s *impact*, but also to certain *interventions* that are necessary to sustain that impact. Although there is a blurred line between impact and interventions, practical and pragmatic measures are needed to assess sustainability in a way that makes sense to CABI and its Plantwise partners.

One could look at sustaining benefits/positive effects at different levels, e.g. farm, service provider, institutional and/or policy level. However, assessing farm level results is time- and resource-demanding, thus not feasible to do very often, neither for CABI, nor its partners. Instead, looking at the sustainability of the Plantwise model for service delivery (and its adaptations) is a suitable proxy to establish the programme’s contribution to long-term change, or at this point in time, the likelihood that the positive effects will be sustained in the future.

At this advanced stage of Plantwise, it was felt that Plantwise sustainability needed to be viewed from a broader and country-specific perspective to gain a deeper understanding of ***what elements of Plantwise are operating within the country, whether these are likely to continue and why or why not*** (beyond the ‘who is going to pay’ question).

This synthesis report draws on the country reports of the sustainability assessment to present the key findings, as well as recent Plantwise annual reports and evaluation studies where indications of sustainability or risk/challenges to Plantwise activities have been highlighted.

Methodology

The assessment of the sustainability of Plantwise interventions took into consideration the context within which the interventions were implemented in each of the countries. Thus, the key questions in the assessment were: **what elements of Plantwise are operating within the country, and what is the likelihood of continuity beyond donor funding?**

The assessment focused on four main areas:

1. How Plantwise **interventions** are being implemented at present, and why those implementation methods were chosen (including adaptations, innovations, scaling activities, and replications by other institutions).
2. The **value** (or lack thereof) that countries place on these interventions, and why.
3. Which interventions partners see as **desirable to sustain** after the funding/technical support phases out, and the drivers for that sustainability.
4. What the **challenges and risks** are to sustainability, and what could/is already being done to **mitigate** these.

Data collection

The sustainability assessment involved: document review (strategies/action plans, progress reports, evidence of impact etc.), key informant interviews (KIIs), and focus group discussions (FGDs). Initially it was assumed that much of the engagement would be carried out through face-to-face meetings, with some use of remote methods. However, due to COVID-19 restrictions, remote methods, including WhatsApp, Skype and Zoom, had to be deployed. This increased the challenges, with lack of group discussions limiting the opportunities to delve into questions in-depth, and created limitations in terms of the time for discussions. As a result, interviews were either separated into multiple sittings, which often meant losing continuity of discussions, or were shorter and thus able to cover fewer topics. Therefore, some of the assessments were not as comprehensive as they would otherwise have been. Nevertheless, it was still possible to gain a good understanding of the elements of Plantwise that are likely to be sustainable in the implementing countries, as well as those that may be challenging.

One-day validation workshops were also originally proposed to facilitate discussion between those stakeholders that have played a substantial role in implementing Plantwise in each country. However, small country budgets and the social and movement restrictions resulting from the onset of the COVID-19 pandemic prohibited workshops taking place with the exception of Rwanda and Uganda where they did take place.

As the assessment was intended to be country-specific, teams were encouraged to consider aspects of the implementation context, including: the level of decision-making (national/county/district), and what areas of Plantwise the country has focused on and considers critical.

Checklists

Checklists were developed to guide open-ended questioning during KIIs and FGDs, depending on what was suitable and feasible in the particular context, as determined by the country teams. Key to carrying out this assessment was to ask a lot of 'why' and 'how' questions to gain understanding of the reasons that things have happened, and whether things will continue. The guiding questions were designed to explore each of the four focal areas detailed below, and to cover the five over-arching work areas by which Plantwise interventions can be organised.

Key informant interviews (KIIs)

KIIs were carried out with individuals involved in the implementation of Plantwise interventions, the roles and positions of which differed depending on the country. Interviewees included representatives from partner organisations, key individuals in extension departments, universities, farmer associations, and local government authorities. Due to the challenges of COVID and restrictions in various countries, most KIIs were carried out over the phone or WhatsApp, although some face-to-face interviews were also conducted, e.g. Bolivia and Ethiopia.

The number of KIIs varied per country, e.g. Bangladesh (5), Ethiopia (13), Ghana (13), India (40) Nepal (16), Pakistan (25), and Rwanda (24). In the Latin America and Caribbean region, where only KIIs were used, a larger number were conducted with mostly farmers, plant doctors and national coordinators/decision-makers, e.g. Costa Rica (30), Jamaica (35), Nicaragua (25), and Peru (20).

Focus group discussions (FGDs)

In countries where FGDs were able to be organised, these provided information about how well-embedded the Plantwise system is at a local level, provided evidence as to whether plant clinics are useful or not, explained whether the services will be continued to be used in the future, and identified areas for improvement. Groups consisted of farmers as plant clinics users (both men and women), plant doctors, extension staff, agro-dealers, and local government officials. FGDs were carried out in countries including Bangladesh (31), Ghana (16), India (5 held virtually), Nepal (2 held virtually), Pakistan (4), and Rwanda (4).

In some countries, e.g. Pakistan, provincial cluster meetings with plant doctors and extension staff were also used to gain insights into the sustainability, as well as risks/challenges, of Plantwise activities. In Uganda, a meeting of the steering committee and two regional consultation meetings provided the main forum for discussion.

Literature reviews and collection of country team observations

As workshops and FGDs were not always feasible, additional information at country level was gathered (e.g. Ethiopia, India, Nepal and Rwanda) from an extensive review of existing documents and reports including government strategies and plans, Plantwise progress and annual reports, national and regional partners' reports, and previous Plantwise studies.

Some countries made use of country coordinators' understanding and the implementation and evolution of Plantwise through their extensive involvement in the implementation and monitoring of Plantwise activities in their respective countries/regions, e.g. Ethiopia, Ghana.

Data analysis

In most countries, the data collected were analysed by transcribing the interviews and discussions. These were read comprehensively before organising the information within the overarching five Plantwise themes: (1) stakeholder linkages, 2) plant clinics and complementary activities, 3) data management and use, 4) information exchange and Knowledge Bank, and 5) monitoring and evaluation (M&E) in order to address the following subthemes: value placed on the interventions including the benefits from interventions that will be sustained; specific interventions that are likely to be sustained post-2020 (beyond the current funding contract between CABI and various donors); and challenges and risks to sustaining Plantwise interventions post-2020.

Stakeholder linkages

The Plantwise approach and elements are implemented through institutions at country level. In most countries, the key partner for implementing plant clinics, for example, was government extension services and/or national plant protection organisations. However, the programme engaged with many other partners through its focus on linking plant health stakeholders.

At a country level, Plantwise activities are planned, implemented and monitored through a national coordination unit, or National Steering Committee (NSC). This unit is composed of public and private sector stakeholders from extension departments, plant health regulatory institutions and research organisations, among others. However, the way in which Plantwise is adopted and implemented varies from country to country, as the exact function and role of NSCs, which are a key mechanism for fostering stakeholder interactions and facilitating operational and strategic decisions, differs across countries. Meanwhile, in some countries (e.g. Bangladesh, Ghana, Pakistan), plant clinic coordination clusters provide the governance structure for programme implementation at district, county and provincial levels.

In addition, beyond the role of the NSC, Plantwise has sought to ensure that, as programme implementation progressed, national stakeholders have taken on greater ownership of financing and implementation. Examples of strong ownership and an active NSC are found in Rwanda, Malawi and Mozambique, where the Plantwise programme is able to run even without a CABI in-country presence. Other countries with good engagement from national partners include Ghana and Kenya. In countries (e.g. Pakistan) where country- or province-wide plant clinics are operational, there has been stronger integration of the Plantwise approach into national processes and therefore sustainability is more likely.

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. At this point, 28 farmer organisations/co-operatives (most of which were from the Americas), agro-input suppliers (in Bolivia, Kenya, Nicaragua and Uganda) and other market-oriented companies (China, Ghana, Myanmar, Uganda and Vietnam) were active participants in Plantwise activities as plant clinic operators. Recent examples of such efforts suggest that private sector-operated plant clinics may reach different types of farmers compared with government- or non-governmental organisation (NGO)-supported clinics; in some cases by being linked to farmer organisations, and in others by having a commodity focus.

What is likely to be more sustainable?

Good partnerships are essential for institutional anchoring, national ownership and achieving scale, as well as sustainability. However, what this looks like in practice varies by country, and can largely depend on governmental structure. For example, Plantwise strategies in various countries differ greatly in their involvement with the public versus private sectors in terms of the level at which they conduct activities, and which sector provides the most fruitful partnerships.

In countries such as Kenya and Pakistan, which have strong devolved constitutions and provincial/county governments, engagement and incorporation of interventions into the provincial/county systems is paramount. However, in countries that have a more centralised government, e.g. Zambia, it has been necessary to incorporate the Plantwise approach at that

level. It is worth noting that during the 10 years of Plantwise funding, Kenya and Nepal have both changed from a central to a devolved government system, and CABI has thus had to adapt the Plantwise approach. In Kenya, there has been sufficient time since devolution, which occurred in 2013, to engage with county governments. However, in Nepal, a severe earthquake following the adoption of a new constitution in 2015 slowed progress in establishing the devolved government, and thus Plantwise engagement with provincial governments has been more challenging.

In Kenya and Myanmar, the NSCs have served as an entry point for developing national plant health system strategies. In Kenya, members of the NSC developed standard operating procedures to describe how plant clinics should work in the country, with a plan to gazette these as regulations. In the Plantwise Impact Report (2011-2018), Kenyan stakeholder testimonials highlighted that Plantwise was improving multi-institutional coordination in national plant health systems at various governance levels, resulting in the generation of enhanced plant doctor knowledge, and an improvement in the likelihood that pest outbreaks would be detected and responded to. It has also been observed that counties have demonstrated the strongest ownership and support of Plantwise activities where senior government staff appreciate the role of extension staff and/or have an agricultural background.

Myanmar has taken a significant leap towards national ownership and sustainability by developing a national plant health system strategy, based on the Plantwise model. It was also a key driver behind the integration of Plantwise in a recently funded International Fund for Agricultural Development project.

In Sri Lanka, a national level plant health system has also been established, which has helped in linking different stakeholders and establishing a system of permanent crop clinics.

The Ministry of Agriculture (MoA) in Ethiopia included Plantwise and other community-based initiatives into the Plant Protection Roadmap, in the recently drafted five-year agriculture plan, as well as factored it into their annual work plan and budget. Relevant experts in the Plant Protection Directorate of the MoA and some regions (such as Tigray) have included Plantwise activities into their annual work plan and budget.

Public sector collaboration has also proven to be critical in Peru, where partnerships with Servicio Nacional de Sanidad Agraria (SENASA) – the National Plant Protection Organisation – local governments and universities are leading the improvement of plant clinic services and strengthening the national plant health system. Plant clinics are considered one of the key technology transfer methodologies in the country, and as such are being included in Instituto Nacional de Innovación Agraria's (INIA) extension division work plan.

In Ghana, the programme has also worked to gradually transfer responsibilities to national government institutions and their partners. To encourage national ownership and sustainability of funding, as of 2020, the Plantwise programme no longer provides transport and lunch allowances for plant doctors to hold plant clinics, or data bundles for plant doctors to submit their queries in the Plantwise Online Management System (**POMS**).

The approach taken in Pakistan is also very strongly public sector-driven and effective partnerships, national leadership and a conducive policy environment have played an important role in the large-scale expansion of plant clinics in Punjab and Sindh provinces. It is stated that over 1,000 plant clinics have been established countrywide and are run by over

2,000 extension staff. The Plantwise activities in Pakistan are based on partnerships between agriculture extension departments and other organisations, such as the Directorate General of Pest Wing and Quality Control of Pesticides Punjab, Sindh and Baluchistan; and the Department of Plant Protection.

India provides a different model for sustainability, in which Plantwise has been fully integrated into the existing Village Knowledge Centres (VKC) and Village Resource Centres (VRC) run by the M S Swaminathan Research Foundation (MSSRF). The VRC-VKC model is demand driven and community owned and works through a multi-stakeholder-based approach. Plantwise has enabled MSSRF to fill a gap in their extension services by providing field-based plant health information and farmer-centric plant health diagnosis and advisory services. Farmers noted that the individual attention, correct diagnosis and advice provided by Plantwise guided them in the correct use of chemical inputs and inspired them to adopt IPM strategies. This information instilled confidence in many farmers, particularly women, and encouraged them to actively engage and continue in farming. Most importantly, the model has built and sustained linkages with relevant stakeholders for running plant clinics, knowledge management through the Knowledge Bank platform, and M&E.

Partnering with an NGO in Bangladesh has presented an opportunity for scaling out some elements of Plantwise with iDE (formerly International Development Enterprises, an international non-profit organisation that promotes a business approach to increasing income and creating livelihood opportunities for poor rural households) to enhance the capacity of 'farmer business advisors' to diagnose and advise on plant health problems. This NGO also serves as a Plantwise partner in Nepal.

On the contrary, in China, the Beijing Plant Protection Centre and other partners have created strong links to the private sector and adapted the Plantwise concept to business models, not only for plant clinic operations but also for fee-based plant doctor training, data use and other aspects of Plantwise. An annual government budget of ¥100 million for subsidies will include contributions to support plant clinics.

Funding

An underlying issue for the sustainability of every intervention is funding. This is not unique to Plantwise, but is true of all initiatives undertaken by governments or the private sector. However, indications that funding will be made available for different Plantwise interventions can be seen through: inclusion of aspects of Plantwise in government policy (national or local); budget requests to finance ministries; funding requests to other donors; and incorporation of specific activities within standard operational practices, future planning and capacity building. Specific examples of this can be seen in various Plantwise countries.

For instance, in Pakistan, a project manager has been appointed in each province to manage Plantwise activities, and in Punjab and Sindh all operating costs, training, clinic monitoring and data management are covered by government staff, without any external support. Furthermore, in Sindh, the government has already allocated funding for scaling-up of the programme and in Balochistan the extension department has applied for provincial funding for scale-up activities. Also in Sindh, implementation of plant clinics has been incorporated into staff key performance indicators, and all expenses of running weekly plant clinics are covered by the local implementing organisation.

In Malawi, Plantwise interventions have been included in the National Agriculture Policy and National Agriculture Extension Strategy. To enable implementation of these aspects of the policy, funding for the steering committee and plant clinics has been included in the Agriculture Sector Wide Approach-Support Project II, and in a proposal for additional funding under this project.

In addition, the Government of Jamaica has institutionalised the Plantwise programme and shown strong ownership of its interventions. Plantwise is included in the Plans and Priority Programmes of Rural Agricultural Development Authority (RADA) 2018-2022 Strategic Business Plan; plant clinics and plant doctor services have been mainstreamed within extension services and a minimum target for output of plant doctor prescriptions was established (per month/per plant doctor) and included in RADA's corporate plan 2021/2022.

Risks and challenges

Uncertainty relating to the commitment of human, financial and infrastructure resources by national and local governments, and related future funding from the Plantwise programme, is perceived as a major risk to sustainability.

In recent years, political instability (e.g. Nicaragua and Peru) and administrative restructuring in some countries have impacted on resource allocation for Plantwise activities. In Nepal, for example, administrative restructuring has combined with the aftermath of the 2015 earthquake to affect resource allocation (funding, change in staff mandates, etc.) and, therefore, the implementation of Plantwise activities. Efforts are being made by provincial governments, with the establishment of provincial steering committees to streamline Plantwise activities, but this will take some time and could impact on sustainability despite promising reforms in national plant health policies and regulations in recent years.

In Ethiopia, emerging national priorities (such as the massive outbreak of desert locusts, the wide-scale irrigated wheat production programme, and farm commercial clustering initiatives) have been a major focus for government resources. This has resulted in a reduction in funds allocated by the government to Plantwise activities, as well as absorbing the time and effort of national and regional staff.

In many contexts, Plantwise activities are still viewed as a complementary project partially dependent on donor funding. In Rwanda, for example, despite the seeming success of plant clinics and other activities, Plantwise is yet to be fully integrated into the main extension activities of local governments. It is indicated that the prominent role of Rwanda Agriculture Board inhibits local governments' sense of engagement and accountability to the initiative, relative to their main activities.

In Thailand, there has been good support for the programme since 2017 when efforts were made to build partnerships with other plant health stakeholders to broaden the programme's scope beyond the rice clinics overseen by the Rice Department. The Department of Agriculture and Extension (DOAE), Department of Agriculture and private sector partners are now involved, with DOAE funding some clinics. However, partners state that they do not see the plant clinic model expanding without donor support, as the programme has not been implemented across Thailand at a sufficient scale to encourage its wider acceptability. Partners state that there is a need to increase understanding of the programme at the policy level in Thailand in order to continue the project and lobby for provision of extra budgets to

support the programme’s expansion. Here, lack of budget allocation to cover plant doctors’ staff time and clinic operations, as well as challenges associated with information and communications technology (ICT) infrastructure, are major concerns.

In Honduras, lack of consistent and committed national leadership was cited as an issue to sustainability of activities which have been limited since 2015, although there been interest from stakeholders in using the Plantwise approach to reach indigenous people in remote regions of La Mosquitia. Weak partnerships also resulted in heavy scaling back of Plantwise activities in 2018 in the Democratic Republic of the Congo and Sierra Leone.

Plant clinics and complementary activities

Plantwise does not work directly with farmers, but delivers its interventions through agricultural advisory service providers, training them to be able to conduct visual diagnoses of plant health problems, operate plant clinics and give good advice to farmers. This is achieved by establishing networks of plant clinics through which farmers can receive practical plant health advice. 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 organisations and stakeholders.

Plant clinics run by extension staff trained as plant doctors are a valuable channel for facilitating the face-to-face exchange and two-way flow of knowledge and information between plant doctors and farmers. They respond to the immediate needs of farmers, offering advice on demand. Clinics generally take place on a regular basis, at least once every two weeks, in easy-to-access public places. In some regions, mobile clinics rotate among different communities, such as in the Caribbean. In Nepal and Rwanda, plant doctors are brought to farmer field school sessions and other group-based extension events. Meanwhile in Costa Rica, India and Vietnam, a deliberate strategy to reach secluded tribes and indigenous communities was adopted in which plant clinics are positioned in areas where there is a high concentration of these groups.

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. In 2020, almost 350 new plant clinics were established in nine African and Asian Plantwise countries, bringing the cumulative total to 5,000 plant clinics established since the launch of the programme. Despite the challenges of COVID-19 around 3,700 clinics were estimated to be active during 2020, handling over 275,000 plant health queries through plant clinics (12% of which were from women farmers).

In recent years, private sector-run plant clinics have been piloted in 14 countries. Embedding plant clinics in farmer associations in Latin America has been relatively successful, with sustainability achieved by farmers paying a membership or levy to the association, which in turn provides technical support to the farmers.

In India, Syngenta Foundation's agri-entrepreneur model follows a decentralised approach to empowering young people in rural areas to play an active role in local agricultural development. Agri-entrepreneur mentors have been trained as plant doctors in order to transfer their new skills to the agri-entrepreneur, which increases both the quality of interactions with farmers and farmers' overall satisfaction with the service.

In Nepal, iDE entrepreneurial farmers have become community-based facilitators (CBF), who act as last-mile input supply chain actors, earning a commission on sales of agricultural inputs. The potential of plant doctors' role was recognised as a powerful complement to the CBF model, increasing farmers' trust in these local service providers and thereby increasing sustainability. Currently there are 44 iDE CBFs trained as plant doctors and around half have established and are operating plant clinics in the field through their own initiation and resources. These CBF plant doctors are working with the rural municipality and sustaining their programmes in specific area. This innovative public-private partnership could be a great approach for sustainability.

Plant doctor training

The improved capacity of extension staff to provide advice on plant health issues to farmers through plant clinics and complementary extension approaches has been achieved through the training of plant doctors. In 2020, over 1,400 plant doctors (34% female) were trained across 17 countries. In total, almost 11,500 extension officers have been trained to run plant clinics effectively, with 95% of the trainings being conducted by national trainers in all countries where Plantwise is active. However, it should be noted that while the vast majority of plant doctors work within government extension services, some are affiliated with NGOs and private sector organisations, such as farmer cooperatives, agro-input dealers and community-based organisations. In Cambodia and Mozambique, farmer field school facilitators have also been trained as plant doctors.

Plant doctor training is provided under Modules 1 and 2 ("Field Diagnosis and Plant Clinic Operation" and "Giving Good Advice") of the Plantwise course, which build on plant doctors' existing knowledge and show them how to use their skills to maximum effect when diagnosing problems and giving 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.

In addition to the traditional training of advisory staff as plant doctors (Modules 1 and 2), CABI has worked with numerous partners to integrate the Plantwise course content into existing programmes of institutions of higher education. The aim is to incorporate the plant doctor training as a standard part of the curriculum for future personnel in agricultural support services (see *Institutionalising plant doctor training*). In 2020, training took place in 11 countries; three in Latin America and the Caribbean (Costa Rica, Jamaica and Nicaragua), five in Asia (Bangladesh, India, Myanmar, Nepal and Sri Lanka) and three in Africa (Malawi, Rwanda and Zambia). The training workshops were held virtually instead of face-to-face, due to COVID-19 restrictions. These virtual trainings turned out to be less costly and were easier to organise compared to face-to-face training.

In recent years, plant clinic services have been largely digitalised with the introduction of tablets for plant doctors and almost 4,000 plant doctors have been trained on digital devices in 28 countries, which has considerably improved their efficiency in providing timely advice to farmers, and improved collection of plant clinic data.

In recent years, a specific effort to train women as plant doctors (e.g. Afghanistan and Ethiopia) and to have women-only plant clinics (e.g. Afghanistan, Ghana and Pakistan) has been adopted as an approach to resolve low attendance of women at plant clinics and to adapt to cultural barriers that prevent male plant doctors interacting with female farmers and vice-versa to enable more women to access plant health advice.

Complementary activities

Beyond plant clinics, plant health knowledge and advice is shared more broadly via plant health rallies, field days and mass extension campaigns. Other means of sharing information include social media and magazines, as well as mobile loudspeaker announcements, printed factsheets, and radio and TV broadcasts. In 2020, it was estimated that almost 70,000 farmers (52% of which were women) were reached through plant health rallies and other face-to-face advisory activities, and nearly 1.7 million farmers reached through mass extension campaigns

across Plantwise countries. In Rwanda, for example, the use of plant health rallies and mass extension campaigns are a popular method of disseminating information. The potential of plant health rallies to address new threats (e.g. maize lethal necrosis disease, tomato leaf miner and fall armyworm) has been successfully demonstrated in Rwanda and has attracted the attention of both local and international institutions, which have consequently collaborated with CABI and have invested resources to develop targeted messaging to farmers.

In order to maintain advisory services during the COVID-19 pandemic, a lot of the plant doctors' outreach in 2020 had to be done through remote means due to travel and movement restrictions. In the absence of plant clinics, plant doctors resorted to mass media dissemination methods (such as radio, television and video) to reach out to many more farmers, as well as using phone calls and social media messaging, such as WhatsApp, as an alternative to face-to-face meetings.

The most common adaptation across countries was to increase communication by telephone and, in some cases, partners even established special telephone hotlines. In a few countries, most notably India, plant doctors were able to conduct online consultations with farmers, like virtual plant clinics. In Latin American countries like Bolivia and Peru, radio served as an important medium for communication and CABI saw its partners producing radio broadcasts on diverse plant health topics. In the Caribbean, partners resorted to holding webinars and creating instructional videos that were posted online as a way of disseminating information to farmers. In spite of the reduced plant clinic activities during the pandemic, clinics still reached over 275,308 farmers (12% of which were women).

What is sustainable and why?

The high value of the Plantwise concept for stakeholders is confirmed in the continued expansion of plant clinic networks, although there's a higher adoption and integration of plant clinics into provincial or national governments in countries where plant clinics have a wide geographical spread, as there was greater national ownership, and therefore a higher likelihood of sustainability. Significant financial investments in plant doctor training and plant clinic operations has been reported in recent years, most notably in Afghanistan, China, Ethiopia, Malawi, Mozambique, Nepal, Pakistan and Rwanda.

In many countries, the sustainable elements, such as plant clinics and plant doctor trainings, are likely to continue to run after 2020. By the end of 2019, plant clinic operations had been included in government strategy and/or operational documents in nine countries (for example, in Burkina Faso, Ethiopia, Kenya, Malawi, Peru and Uganda).

In Peru, for example, the plant clinics that the eight INIA stations have established are serving as models for the agricultural extension programmes of the agrarian agencies of regional governments and the environmental staff of municipal governments. The joint efforts with the local government and key institutions like SENASA have been critical for the success of the programme at the national level and national partners are confident that plant clinics will be maintained because they have been included as part of the institutional work plan.

The uptake of digital technology by plant doctors and the use of social media (WhatsApp and Telegram) to interact with fellow plant doctors (see *Information exchange and Knowledge Bank*) has resulted in increased motivation and professional development of plant doctors, and has facilitated their work. These improvements have resulted in major changes in the plant doctors' performance across a number of Plantwise countries. However, digitisation has been slow to be adopted in countries such as Ethiopia and Pakistan.

Budgetary support for plant clinics

The potential for sustainability is demonstrated by annual funding commitments by partners to embed some of the concepts, such as plant clinics, into their agricultural strategies, development plans or job descriptions of their staff. As a complement to Plantwise donor funding, in 2020, in-country partners contributed approximately £1.05 million to implementation costs for activities such as training and plant clinic operations. This figure excludes contributions in terms of staff time, such as that of plant doctors, trainers and data managers. In 2019, budgetary allocations by in-country partners to Plantwise activities were very similar and amounted to £1.1 million across 23 countries.

The Government of Santa Cruz in Bolivia, for example, has budgeted resources for plant clinic activities in its Annual Operational Plan, since clinic activities are included in the terms of reference for technicians to be hired. The regional government of Oruro has also renewed an agreement with the municipality of Challapata providing financial resources for plant clinics and included them in their annual operational plan.

Funds amounting to US$230,323 have been allocated to Plantwise activities by the Malawi Government through its Agriculture Sector Wide Approach – Support Project II. This budget is intended for plant doctor trainings, cluster meetings, plant health rallies and for the creation of a permanent plant clinic structure at Penga Penga in Ntcheu.

In Ethiopia, rapid expansion of the plant clinic networks was made possible largely because of the keen interest and support of the MoA and other partners. In view of the vastness of the country, the MoA felt that the pace of Plantwise in introducing plant clinics was not adequate and decided to take measures to accelerate its expansion. Plant clinics are also mentioned in the new (revised) agriculture and rural development policy and strategy of Ethiopia.

In Kenya, two county governments have included plant clinics in their County Integrated Development Plans, and performance contracts of senior staff. This will ensure that plant clinics are eligible for county government funding and not marginalised through competing demands for government funding and there is a better chance of sustainability.

In Nicaragua, the NGO, Humboldt Centre, is becoming a strong partner in the implementation of plant clinics, investing time and resources to facilitate extension activities. It also provides weather information through a WhatsApp diagnostics group, which has been very useful for plant doctors (see *Information exchange and Knowledge Bank*).

Strong collaboration and ownership between SENASA in Peru, the local government and national and local universities is leading to the improvement of the country's plant clinic service. Plant clinics are now considered one of the key technology transfer methodologies, and are being included in the MoA's (INIA) extension division work plan with an interest to expand plant clinics to all INIA's experimental stations, although this will be dependent on available budgets.

In India, strong interest from partners has been demonstrated through the promotion and scaling up of plant clinics using their own resources, both human and financial. Partners have also shown commitment in ensuring that clinic operations are included in other ongoing state or national level programmes (Fairs, Back2Village) and in other projects working to provide farmers with good advice. New plant doctors have also been trained and new plant clinics have been established in new areas.

Although plant clinics in Uganda operate very infrequently, as and when local funds are available, plant clinic management and supervision roles are now specifically included in the job descriptions of ministry extension staff, following revisions in 2018.

In the Caribbean, most of the current plant clinic services are conducted under the mobile plant clinic scheme, which has been incorporated as part of the everyday work of agricultural extension officers, including farmer meetings and field visits. This working scheme has proved to be more sustainable for the organisations involved and backstopping of training through Plantwise Module 1 and 2 has helped to build the technical capacity of participants, including youths, to serve as good plant doctors.

Institutionalising plant doctor training

Integration of plant doctor training takes different forms, sometimes as a stand-alone sub-component of a practical course, or as part of the main curriculum unit. As of the end of 2020, plant doctor training had been integrated into curricula of university/college programmes in four countries, which involves multiple institutions in three of the four countries: Bolivia (3), Nicaragua (2) and Uganda (2). Collectively, these institutions have trained hundreds of undergraduate/graduate students using Plantwise training materials.

In Uganda, Makerere and Uganda Christian Universities have developed curricula based on Plantwise trainings for their undergraduate and in-service courses. Plantwise training content not only enriches the study experience of faculty and students with a very practical and interactive training experience, it also is a community outreach tool that increases the visibility and impact of these institutions in the surrounding communities. The success of plant doctor training for students, coupled with the community satisfaction, has helped ensure institutional funding commitments from the Ministry Agriculture, Animal Industry and Fisheries, local governments and universities to continue plant doctor training as part of the curriculum. It has also become evident that using Plantwise training makes graduates more marketable where the plant doctor function is included in the official job description for government extension workers.

This observation is consistent with experiences from Nicaragua, where universities and colleges have set up plant clinics in local communities to serve farmers while providing practical experience for the students. In Nicaragua, a three-month diploma course for plant doctors is run by the Catholic University of the Dry Tropics (UCATSE), based on the Plantwise

training modules, and is supported by the training team from the Universidad Nacional Autónoma de Nicaragua (UNAN León) and UCATSE. Using the Plantwise modules for training advanced agronomy students has proven to be one of the most sustainable ways of embedding or integrating Plantwise modules for training future generations of protagonists of national plant health; each year between 60 and 80 new students from UNAN León and UCATSE are introduced to the methodology. Other universities, such as the Martin Lutero University, are also requesting training for their students.

Plant doctor training is supported by the University of Costa Rica who collaborate on the training of plant doctors on disease identification and provide support to the clinics through the diagnostics group via WhatsApp: this will continue active, managed by Ministry of Agriculture (MAG) staff.

In Ghana, attempts have been made to integrate the Plantwise Modules 1 and 2 into the curriculum of agricultural colleges across the country. While this process is ongoing, stakeholders insist that it is the way to go if the country wants to ensure that its extension agents are firmly grounded in crop protection issues.

Risks and challenges

Where Plantwise is limited to a small number of plant clinics operating in just one area, such as in Vietnam, or through just one value chain, as in Thailand, there is a low level of adoption and integration into country systems, and therefore low likelihood of sustainability. In Vietnam, lack of an official policy on plant clinic operations and plant doctors' selection has resulted in insufficient support budgets to pay plant doctor salaries and fund activities, including the development of communication materials. Vinh Long, where the local authority is well-established, is the only province that has clinics running on government funding and where sustainability is likely but it was stated this was only likely if technical backstopping was provided.

High turn-over of plant doctors and relevant experts has continued to be a major challenge in several countries, including Ethiopia and Sri Lanka, and the constant restructuring of extension departments/areas resulting in transfer of plant doctors was cited as an issue in Mozambique. Meanwhile in Kenya, a high turn-over or transfer of staff trained as plant doctors is a key challenge, and in some instances, there are not enough officers to replace those that have retired. The same issue exists in Malawi, as retirement of personnel in some districts has resulted in a lack of trained plant doctors. In Ghana, reduction of the transportation and lunch allowance for plant doctors by the programme proved to be demotivating for some plant doctors. Lack of funds to replace faulty equipment and materials can also be an issue.

Motivation, performance and quality of work can also be affected by the high workload and limited time of agriculture extension workers to run plant clinics as plant doctors. Besides organising and running plant clinics, extension officers are also expected to carry out other tasks assigned by district level agriculture personnel.

In countries such as Afghanistan, precarious security conditions in some areas jeopardise plant clinic operations and the feasibility of running plant health rallies. Such safety concerns mean that relocation of clinic sites or the stopping of clinic activities during periods of insecurity is inevitable. Instability and violence in some parts of the Ethiopia has also impacted on the continuation of some Plantwise activities, including monitoring and backstopping to plant clinics. Political instability and changes in government in countries like Bolivia have been cited as a potential risk for the survival of plant clinics.

In Nepal, iDE plant doctors are less keen on the use of e-plant clinics due to issues with poor internet connectivity, typing, accessibility and time to fill prescription sheets.

Reduced or low plant clinic attendance rates by farmers over time has been observed when plant clinics are continually held in the same place, which is a risk to sustainability. In Ghana, it was speculated that this may be due to a certain level of saturation of the plant health issues brought to the plant clinic in a given period and area. In addition, an increased level of independent problem solving, peer-to-peer advice and ‘self-medication’ by farmers after advice has been given is likely. In some countries, this challenge has been overcome by organising plant clinics on a rotational basis (mobile clinics), serving additional communities at a lower frequency and making use of weekly markets and one-stop-shop locations where farmers aggregate to set up plant clinics and reach a wider audience.

Data management and use

An effective plant health system is dependent on strong interactions between plant health stakeholders, and effective data and information exchange to underpin actions. To assist in this regard, Plantwise has implemented a framework (plant clinics, linked to POMS) and methods for standardised data collection, validation, management and analysis. A culture of data-driven advocacy, and decision-making policy development and planning has been encouraged by Plantwise.

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. 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. This information is used to help national extension and crop protection agencies to make extension materials more relevant and contribute to early warning of new pests.

The data are part of the 'glue' that can connect stakeholders in different ways and stimulate action to strengthen plant health systems. However, although the benefits of the data gathered through the plant clinic networks is now well recognised, there has been a lack of recognition that data are only available if entered into POMS. Value is placed on the plant health data but not necessarily on the data management system.

Initially, data was collected in the form of paper-based prescription forms across all plant clinics, but the introduction of tablets from 2014 onwards, and the development of a data collection app (DCA), has enabled plant doctors to record data digitally. These developments were undertaken side-by-side with training plant doctors in the use of ICT tools and applications. In total, 3,953 plant doctors have been trained on the use of tablet computers at plant clinics in 28 countries, with 911 e-plant clinics running in 25 countries during 2020.

Data collected via the DCA is instantly uploaded to POMS, which provides data management support across the Plantwise programme and allows partners and Plantwise coordinators to store and manage information on Plantwise activities in their countries, including for monitoring plant doctor performance.

In 2019, the DCA account administration tool was re-designed to improve security and to allow country partners to create and self-manage accounts, and to streamline the account management system for all users. Globally, the number of accounts required is anticipated to continue increasing beyond the scope of current funding, therefore release of the data collection app ensures sustainability of the data collection process. The POMS site has also been re-designed to be mobile-responsive and therefore easier to use by plant doctors in the field. The net effect of these efforts has been increased data flow and an increase in the number of plant clinic records in POMS to 650,000 by 2020 (with an additional 80,000 records in the China system).

In addition, a PowerBI dashboard was also incorporated into POMS to increase the accessibility of clinic data analytics to a wide range of users, and to allow users to drill down on metrics such as the most common pest problems and recommendations given to farmers by plant doctors.

What is sustainable and why?

Data collection for plant pests and diseases via POMS, which did not exist before the Plantwise programme, have been established in all Plantwise countries. The benefits of the data gathered through the plant clinic networks are now well recognised, especially their use for mapping and monitoring pest outbreaks and the current challenges facing farmers, as well as designing appropriate extension materials. However, clear differences exist between countries in terms of their interest in collecting and using plant clinic data, with only a small number of countries (e.g. China, Kenya, Pakistan and Zambia) showing a strong commitment in both areas. Of these, Pakistan and China are so far the only countries that have taken on full ownership of their data management systems that have been operating with minimal Plantwise support.

A CABI study in Kenya (Chege, *et al.* 2020: p.11) highlights that before the Plantwise programme, it was difficult to get a 'general picture' of the plant health issues that farmers were dealing with in a specific location, and there was no systematic way of collecting and analysing data. The POMS and Knowledge Bank have helped to solve this problem. Furthermore, in a Plantwise evaluation study conducted in Kenya, Ghana and Pakistan, the main innovations mentioned by key informants typically referred to data collection within plant clinic activities as the first and most complete effort ever conducted for plant health data in their respective countries. Ministries, departments of agriculture and researchers in all three countries reported that the access to real-time information informed their decision-making.

Digitalisation of data collection

ICT tools have considerably increased the efficiency of data collection and resulted in significant improvements in data management, with plant clinic records and photographs increasingly being submitted through tablet computers. This has made clinic data collection nearly '*real time'*, making it more available for prompt action by end-users in relation to emerging plant health issues.

The migration to tablet-based data collection and services, in combination with development of social media platforms, has also accelerated data and information sharing and allows for peer-to-peer support and problem solving, while only the most difficult problems are referred to subject matter specialists and researchers. In Myanmar, the establishment of e-plant clinics and use of tablets has improved the data management process and supported more data uploads to POMS.

For example, in the Caribbean, the desktop and mobile versions of the DCA were acknowledged to have streamlined the data collection process, leading to increased data flow and data use by national stakeholders. This improvement was demonstrated by the fact that 84% of plant clinic data collected in 2018 came from mobile devices. Nevertheless, in Jamaica, while data collection and use is ranked as very important by the Rural Agricultural Development Authority's (RADA) Principal Director, 75% of plant doctors interviewed are still using the Plantwise paper form for collecting data, and only some information is reported through RADA's digital app. RADA's primary focus is to gather sufficient POMS data in order to see the trends in crop/pest dynamics; there are also efforts on sharing information and identifying ways to use data for interventions and decision-making. Access to POMS was stated as a need to continue with the plant clinic programme.

Encouragingly, in Costa Rica, plant doctors are now using their own smartphones and computers for uploading plant clinic data, demonstrating acceptance of the DCA. The introduction of the app together with the encouragement of the MAG regional directors resulted in a significant increase in plant clinic data uploaded to POMS; it is now necessary to continue demonstrating the value of plant clinic data at higher ranks of MAG to ensure that pest data collection becomes a priority in their pest management strategy.

Data usage

Overall, the amount of clinic data stored in POMS varies by country, with Pakistan, Kenya and Ghana accounting for more than 70% of all clinic data in 2019. 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 2020, the use of plant clinic data by partners was reported from 22 countries, which is the highest count of countries using this unique resource since this assessment started in 2017. As in previous years, the most common data uses were for pest reporting (eight countries), monitoring plant doctor performance (seven countries), identifying topics for research (six countries), identifying topics for resource materials (six countries) and administrative reporting (six countries). Based on country annual reports, the most intensive use of clinic data appeared to be in Bolivia, China, Malawi, Pakistan and Peru. There were eight countries that used the data for more than one purpose and countries demonstrating more than one type of use tend to have more than one organisation using the data.

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). Major highlights in 2019 included the use of plant clinic data in Kenya to support the work of an 'early warning team' established to deal with pest threats, and Pakistan's use of plant clinic data as a routine practice in cotton production systems. In Thailand, plant clinic data is used by the Rice Department to generate reports for sharing with other stakeholders and to decide topics for mass extension campaigns. Other uses of POMS include assessing the quality of diagnoses 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. In 2020, of the 27 countries that accessed POMS, activity was highest in Sri Lanka and India, representing 34% of all log-in cases. Of 110 partners who accessed POMS, the highest numbers were seen from Kenya and Ghana. Downloads of clinic data by partners continued in 2020, particularly in Bangladesh, Kenya and Malawi.

In Kenya, most counties during 2020 reported using POMS data to report internally on top pests and diseases seen at clinics, as well as sharing information with various stakeholders including agro-dealers, Kenya Agricultural and Livestock Research Organisation, Kenya Plant Health Inspectorate Service (KEPHIS), and county government officials. This usage indicates that data may continue being used post-2020, given that its use was not pushed by either CABI or the MoA. During the September 2020 NSC meeting, KEPHIS also stated that it was developing a pest management information system (PIMS) database to compliment information in POMS, and that stakeholders would be invited to review the PIMS in the near future and to discuss whether there was an opportunity for POMS data to be integrated or used to supplement PIMS.

In China, the Beijing Plant Protection Station has been using plant clinic data since 2017 to help manage 'Green Control' subsidies for agro-input dealers that sell less toxic plant protection products to farmers. This partnership was attainable due to policy developed by the national government, where linking the plant clinic concept to input supply enabled a large number of small-scale farmers to be reached. Plant clinic prescription forms are also used as a monitoring tool for agro-input dealer operations in Sichuan province. However, the heavy workload of clinic data validation and data harmonisation is a challenge in sustainability.

National data management systems

So far, the only countries that have assumed full ownership of their data management systems, as in operating with minimal CABI support, are China and Pakistan.

In Pakistan, it was cited that the proposed establishment of a National Data Centre (NDC) at the Department of Plant Protection would help the department in compiling vital information nationwide regarding major pests, and would also help in devising a national policy by analysing the data coming from plant clinics. In addition, a project manager has been appointed in each province to manage Plantwise activities going forward, and in Punjab and Sindh all operating costs, training, clinic monitoring and data management are carried out by government staff, without any external support. It was acknowledged that the use of data in Pakistan has been weak, which will be strengthened with the establishment of the NDC.

In China, the plant clinic prescription form has been embedded into a data management system called the Beijing Pesticide Reduction Management System (BPRMS), and is used to underpin their subsidy programme. In this programme, farmers in Beijing are able to buy subsidised IPM-compatible products from defined agro-input dealers if their plant health problem is diagnosed by a plant doctor who recommends the appropriate subsidised products in the prescription form. The agro-input suppliers claim the subsidy back from Beijing Plant Protection Station 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 subsidised products are used where and when they are really needed.

In Uganda, the Department of Crop Protection and CABI successfully lobbied the National Food and Agricultural Statistics Systems (NFASS) committee to link the Plantwise Knowledge Bank to the national database, with the ultimate aim of linking NFASS to POMS so as to manage, harmonise and ensure access to data for government decision-making in agriculture. Discussions are currently underway as to how best to integrate POMS clinic data to NFASS and provide a system that will enable data access by plant clinic supervisors who will be placed in positions to harmonise and validate the data.

As a country, Ghana places a lot of value on plant clinic data as it is the main database on pests and diseases at the National Plant Protection Organization, and much emphasis has been placed on the validation of plant clinic data to ensure accuracy before decision-making and sharing. To date, over 85% of the 54,743 plant clinic records have been validated. To sustain this effort, the programme had to move away from the data validation workshop approach to a system where records were sent to subject matter specialists within Plant Protection and Regulatory Services Directorate (PPRSD) and experienced plant doctors to be validated. So far, this has proved to be successful and sustainable. With the willingness and interest in using these tools, data collection is likely to continue beyond the Plantwise

programme if existing challenges (see *Risks and challenges* below) are resolved. However, it is also acknowledged that data sharing and use have been weak and the data is rarely utilised beyond the programme and PPRSD. For some of the regional/cluster coordinators interviewed, this is because the data is not representative of the whole of their operational areas which makes it difficult to use for concrete decision-making.

Risks and challenges

So far, no country has yet made full use of the potential of the data it currently collects from plant clinics and it has taken longer than expected to create partner interest and buy-in of clinic data management and use. This is, however, expected to take time as this type of multi-use data is a relatively novel concept for many Plantwise country partners.

Nevertheless, keeping the country data management system going is challenging, especially when value is placed on the plant health data, but not necessarily the management system. Establishing efficient procedures for managing, sharing and using clinic data is a major organisational challenge that requires technical, knowledge and management issues to be addressed. Some plant doctors feel that collecting data is a task that goes beyond their role, while staff managing plant clinic data may not be able to cope with the additional workload, especially in the absence of incentives and, in some cases, they may lack the technical capacity.

In countries with more pluralistic plant clinic operators, it has been difficult to create a shared interest in the data; farmer cooperatives, 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 analyse and use the data has also been reported as a demotivating factor for those engaged in the data chain, particularly as there is often a lack of recognition that data are only available if entered into POMS.

The data management process, which has improved where tablets are used to enter the prescription form data, is still very challenging, particularly where paper forms are being used. In Bolivia, for example, challenges in obtaining prescription forms from plant doctors was hindering the establishment of data management system. However, even where tablets are used, technical difficulties in handling the digital data have led to late submission and even data loss, as reported in Malawi and Sri Lanka. Similarly, challenges with the DCA and POMS in recent years were also reported to have resulted in the loss of significant amounts of data in Ghana and India.

In Ethiopia, the process of distributing tablets to plant doctors has been slow, leading to delays in the digitisation of clinic data collection and transfer, and data collection has remained largely paper-based with few records uploaded to POMS. As such, data management, sharing and use has been reported as very weak. Language (in recording data) has presented an additional challenge.

Poor internet connectivity, coupled with power shortages and cost of data, has also created delays in transmitting data to POMS in Afghanistan. Thus, plant clinic data sharing and use via POMS is not yet fully adopted in Afghanistan, nor appreciated by national stakeholders. A lack of data bundles to upload data to POMS was also cited as a challenge in Mozambique, amongst other countries.

Data validation, harmonisation and data sharing

Regular validation and harmonisation of large amounts of data collected from clinics remains a challenge for many countries, which also impacts its use by partners. This was cited as a particular issue in several countries including Bangladesh, where the data manager alone is responsible for harmonising the large data sets.

Based on the effective system of district-level validation in Pakistan, the data validation process has been decentralised to spread the workload in some countries. Unfortunately, this solution is not necessarily transferable to all other countries, as the in-country experts with the relevant data validation skills are often too senior and thus too busy to invest any significant amount of time in this work. Skills capacity, particularly for data validation, is therefore a significant challenge for many countries, and there is a need for technical backstopping.

Findings from studies conducted in Kenya and Myanmar in 2017 confirmed these challenges. At the time, little data validation was being carried out in Kenya due to technical problems (procedures deemed to be tedious, use of outdated datasheets), financial challenges (costly procedures, dependency on CABI funds) and questions about organisational roles. Myanmar, on the other hand, faced budgetary constraints, a lack of investment in ICT equipment and insufficient staff with the required qualifications.

In Ghana, a lot of data is collected and validated but data analysis and sharing has been minimal. Despite steps being taken by the national team to analyse plant clinic data from the previous year and share with regional coordinators for onward sharing with plant doctors and district directors, changes in staff and a lack of coordination with regional staff has hindered efforts.

One of the main barriers to data sharing was identified to be a lack of trust in the potential impact of the data and its intended use. It is evident that significant amounts of effort and time will need to be invested to build trust and engagement among in-country stakeholders in order to enhance sharing of data. For example, challenges with data use by partners necessitated conducting a workshop in Bangladesh that identified some of the barriers, even in a country that that had signed an open data sharing agreement. As a result, a memorandum of understanding was developed to enable sharing of data between the Department of Agricultural Extension in the MoA and the Department of Environment in the Ministry of Environment and Forests.

Information exchange and Knowledge Bank

The Plantwise Knowledge Bank is a free, open-access source of online and offline plant health information available for everyone from farmers to extension agents and scientific researchers. The site brings together plant health information from across the world and includes diagnostic resources, pest management advice, and basic pest data for effective global pest surveillance.

Locally-relevant information pest management advice is provided in the Knowledge Bank in the form of an extensive range of pest management decision guides (PMDGs), one-page, concise factsheets for farmers, and diagnostic photosheets. A total of 11,000 factsheets are now available through the online Knowledge Bank, with 3,740 specifically developed within Plantwise and available through the Factsheets Library app. In some cases, factsheets and other extension materials are developed in the local language or translated from English. However, it should be noted that while materials are available in 24 different languages, the majority of these materials are still only in English.

Recent ICT developments under the Knowledge Bank component of Plantwise include the release of an improved version of the DCA and the re-design of mobile-responsive Knowledge Bank and POMS sites. These developments were undertaken alongside training plant doctors in the use of ICT tools and applications. This digitisation approach enables these plant doctors to facilitate their work through tablets and, in particular, allows for easy data entry, access to the Knowledge Bank and peer-to-peer support through social media platforms (WhatsApp, Telegram).

Plant doctors have reported that accessing the Plantwise Factsheets Library app allows them to have clear, accurate, comprehensive, and detailed information at their fingertips, wherever they go, without needing to carry lots of heavy books. They also report that the ability to click on a pest image in the app and see it full size helps them to identify pests more accurately, and is also useful for showing the image to farmers during explanations.

Plant doctors reported that they were satisfied with the quality of information provided by Plantwise through the Knowledge Bank, as well as through Plantwise training, and subject matter specialists. The information provided by the Knowledge Bank and experts was used specifically to respond to queries and give recommendations, for reference, and to increase plant doctors' general knowledge.

The net effect of these ICT developments and the transition to digitisation has been increased access to online information in the Knowledge Bank. In 2020, 288,964 visits were recorded to the online Knowledge Bank, bringing the cumulative total to almost 2.4 million to date, with over 878,000 sessions recorded in the Factsheets Library app.

Augmentation of the Knowledge Bank content library continued in 2020 with sustained use of the PMDG model for content creation and the formation of new collaborations with content partners. In addition, partners were encouraged to update existing content, some of which had been written in 2013-14. A number of factors were in play in 2020, culminating in an increase in visitor numbers to the Knowledge Bank, including a substantial increase in new visitors (86%). For example, the COVID-19 pandemic restrictions across the globe meant that online resources, such as the Knowledge Bank, became the only sources of plant health management advice. The Knowledge Bank was also used to develop resources for remote training, which became necessary following the introduction of social and travel restrictions.

Social media

As well as the Knowledge Bank itself, CABI has helped to establish one central social media group (generally through WhatsApp or Telegram) in most of the countries of operation during the course of the Plantwise programme as a means of providing technical support and information sharing. By the end of 2018, 27 Plantwise countries were confirmed to have at least one peer support group for plant doctors facilitated by messaging apps, with WhatsApp being the most commonly used platform, followed by Telegram, Facebook, WeChat (China only), Line (Thailand only) and Zalo (Vietnam only). These groups can become quite large, such as has been seen in Kenya (355 members), Pakistan (528 members) and Bangladesh (1,036 members).

These groups were initially formed to enable plant doctors to interact with one another but, in many cases, the networks quickly expanded to include diagnostic experts and subject matter specialists, such as department of agriculture staff and researchers, for increased technical support, peer-to-peer troubleshooting, capacity building, and even virtual training. An additional development is that plant doctors tend to also create more localised groups, and membership in multiple groups enables further sharing of information. Many of these platforms have flourished and are used across multiple countries, and feedback to plant doctors from research partners has accelerated and response rates have increased.

What is sustainable and why?

Across Plantwise countries, the online Knowledge Bank is seen as a valuable resource by stakeholders for accessing appropriate, timely and locally-relevant information. In Ghana, for example, it was noted that a number of agricultural extension officers who were not plant doctors had downloaded and were using the Plantwise Factsheets Library and this was reflected across other countries. However, whilst the open access Knowledge Bank is seen as a valuable resource of plant health information by stakeholders, and the use of PMDGs, factsheets and photosheets is likely to continue over many years, resources will need to be developed to ensure these materials remain up-to-date and validated.

In Ethiopia, for example, PMDGs, the Factsheet Library app, field diagnostic guides and other Plantwise resources were cited by key informants (plant doctors and experts), as important components that have been widely used and are likely to continue being used in the future. Experts interviewed were generally of the opinion that various resources in the Knowledge Bank are very useful and indicated a desire and intent to continue accessing and using them. The former Plant Protection Director noted that Plantwise materials and resources gave direction and guidance in pest management.

In Ghana, a 2019 survey showed that more that 90% of the 80 respondents who were plant doctors indicated that they had used all the ICT tools within the Plantwise programme on a regular basis in the past two years, including the DCA, Knowledge Bank website, Factsheets Library, as well as Telegram and WhatsApp platforms. The POMS, however, had a lower utilisation rate of 72% (CABI, 2020 unpublished). This shows the interest and willingness of extension officers to utilise available new tools.

In Afghanistan, where most plant doctors do not have computers or smart phones to access the Plantwise Knowledge Bank content, the provision of offline tools such as USB sticks and printed PMDGs and factsheets are an important means of accessing technical information.

Digitalisation

Examples of social media use and evidence as to its effectiveness for providing plant health advisory services are extensive. A Masters of Advanced Studies in Integrated Crop Management thesis focusing on social networks in Uganda, for example, showed that many plant doctors use Instagram, Twitter and Snapchat to communicate and access plant health information. These networks have been shown to enable timely and accurate diagnosis of plant health problems.

In Ghana, plant doctors using their own initiative started a WhatsApp group for information sharing among themselves as early as 2015. This was later formalised using the Telegram platform to address only plant health issues involving a combination of plant doctors, subject matter specialists and programme coordinators at various levels. The platform became a major hub for diagnosis support and advice, including lectures on various plant health issues where special guest experts were invited to the Telegram group to present to the plant doctors and answer their questions. This led to the innovation of plant doctor quizzes which, in 2018, triggered the launch of Plantwise programme-wide plant doctor quizzes to assess plant doctors' knowledge and provide training reinforcement.

In Nicaragua, plant doctors and collaborators reported active use of ICT and social media to improve diagnostics and information sharing. Here, although coordinating the implementation of Plantwise with a high number of local implementing organisations has proved complicated, ICTs like WhatsApp have helped to improve communication and networking among participants. Furthermore, in Honduras, WhatsApp groups for diagnostic support have been found to be important tools, especially for plant doctors in remote areas such as the Misquitos.

In some cases, such as in China and Costa Rica, plant doctors have established digital networks with farmers for effective, targeted communications. In China, for example, WeChat was used to facilitate a series of mass extension campaigns to reach over 8,000 farmers with messages on plant and soil health. In 2018, the social media group in China, also received more than 4,280 queries from the public, 60% of which were about pest control on vegetables and fruit trees. In Costa Rica, the University of Costa Rica also provides support via WhatsApp to plant doctors through a diagnostics group, which will continue to be supported and managed by MAG staff.

Assessments of the success of such social media use have been generally positive. For example, a 2019 evaluation of Plantwise's ICT-enabled extension approach in Uganda showed that the use of digital devices and associated social media networks improved efficiency in the delivery of advice to farmers. In addition, throughout 2019, the CABI Diagnostic Advisory Services (DAS) team monitored the activity of 29 Telegram and WhatsApp groups from 19 countries in Africa, Asia and the Americas and recorded a total of 159 requests for diagnostic support. In most cases, a response was provided by one or more of the local group members: the DAS team only stepped in when a query was unanswered for more than a week.

Work carried out in Kenya, Rwanda and Uganda has shown that the use of Telegram or WhatsApp groups by plant doctors, in particular, has enabled horizontal communication and support, to facilitate assistance in diagnosis and pest management. In addition, these groups have allowed plant doctors to communicate vertically with researchers to report new pest situations and request diagnostic support. The social media groups in Kenya and Rwanda also helped plant health staff to understand how fall armyworm was spreading through the

countries. In Uganda, the use of image-based recognition on maize lethal necrosis disease reduced the time taken to get information to the farmer from six weeks to three days. The study demonstrated that not only did the use of ICTs and social media reduce the time taken for information to flow through the plant health system, but also enabled quick access to expert support and prompt feedback, as well as a reduced timescale for farmers to receive pest management advice. Such fast feedback and rapid system response can help farmers to avoid major crop loss.

However, although social media is a useful way to reach greater numbers of individuals and provide information quickly and remotely, this platform has a set of challenges of its own. A study exploring the extent to which social media was being used to share images and diagnose crop problems found that about 10% of diagnosed cases were unlikely to be accurate. This is primarily because the ability to provide a diagnosis with confidence through social media was limited by the poor quality of shared images. The quality of the pictures on the Knowledge Bank information materials was also acknowledged to be an issue in Kenya.

In addition, Telegram, the messaging app preferred for use in Plantwise due to the high numbers of users per group and the ability to add ‘bots’ to extract the conversation narrative for analysis, has a higher cost of participation given the large numbers of photos posted. This makes it unpopular with plant doctors in some countries, such as Uganda.

It should also be noted that while social media and applications such as blogs, wikis, and WhatsApp and Facebook groups, offer a range of opportunities for participatory knowledge exchange, the information is rarely moderated or validated, for technical accuracy. The information may also not be available for access in the same way as information in, for example, the Knowledge Bank, which is structured, easy to navigate, and available to access by anyone.

Risks and challenges

The Knowledge Bank is seen as a valuable resource of plant health information by stakeholders, and the use of PMDGs, factsheets and photosheets is likely to continue over many years and will be further enhanced under PlantwisePlus (a new global programme launched by CABI). However, there is a risk that new plant doctors may not be trained in all aspects of the Knowledge Bank and existing plant doctors have expressed that there is a need for regular updates from the Knowledge Bank on emerging and new pests, as well as to have refresher trainings. Training can also be very general and plant doctors have expressed a need for more specific examples of pests and diseases, particularly area-specific information. In addition, some plant doctors expressed a need for printed material with guidelines and pictures that are helpful in disease diagnoses, control and treatment (e.g. Pakistan).

However, whilst countries generally acknowledge the usefulness of the online Knowledge Bank, Factsheets Library app and printed resources, development of PMDGs, factsheets for farmers and diagnostic photosheets require expert knowledge. Social media groups for horizontal and vertical communication on diagnostic and advisory issues will be maintained because partners have become reliant on this medium for interaction. However, development of PMDGs, factsheets for farmers, and diagnostic photosheets will not be sustained, mostly due to lack of funding.

Increasing use of the Knowledge Bank content also results in increasing expectations for extension materials. However, writing and quality-checking materials is a time-consuming job for partners who are busy with many other tasks. Balancing the time and resources involved against the ultimate payoff of delivering good advice to farmers is a constant consideration for local partners when committing resources to produce these materials on a regular basis. India, for example, is one such country where PMDGs are highly appreciated by partner organisations, leading to high demand, but the length of the external review process results in few publications.

In addition, with plant doctors and others able to access PMDGs and factsheets more easily via the Factsheets Library app, there is an expectation that all pest and disease issues brought into clinics will have a relevant factsheet or PMDG, presenting extra demand on local content development teams. Photosheets also need to be produced more efficiently in order to support diagnosis of a wider range of pests on a variety of crops. Translation into the many different languages used by extension workers and farmers is also an issue in need of resolution in each country individually, so that they can be used effectively by extension workers and farmers. Afghanistan and Ethiopia, for example, both have a reported need for translation of more technical material (plant doctor manual, PMDGs, photosheets and factsheets) to local languages to improve accessibility and use.

Whilst the provision of offline tools, such as USB sticks and printed PMDGs and factsheets, is an important means for plant doctors to access technical information, particularly where electricity and internet connectivity is poor, continuous updates of the USB and printed materials are required if plant doctors are to have up-to-date and relevant information.

In Ghana, lack of updated content was also mentioned as a possible risk to sustainability and it was suggested that this be made part of someone’s official duty at the PPRSD to draft and send updated content to relevant experts for validation. In contrast in Nepal, it was acknowledged that, despite strong expertise and trained manpower, the government does not have a structured system in place to produce content.

Monitoring and evaluation

Monitoring, evaluation and data-driven learning and decision-making are key to the Plantwise programme and, as such, the Plantwise M&E protocols are well-established and mainstreamed throughout the entire programme.

Cluster meetings, monitoring visits and feedback from validation of queries allow for the plant doctors to be monitored. This approach also helps to improve plant doctor services and supports them to stay engaged in the programme and data collection. Cluster exchange meetings, for example, complement and re-enforce clinic implementation and monitoring processes. They also provide an opportunity for plant doctors to share experiences, lessons and information on innovative practices.

In 2018, a series of monthly plant doctor quizzes, designed to test and quantify the knowledge of plant doctors, was launched with five issues released between August and December to assess whether it could become a reliable performance assessment tool. The quizzes were intended to provide engaging, cost-effective, continuous professional development on the topic of plant health for Plantwise-trained plant doctors, while also providing a mechanism to monitor knowledge on specific topics. As of January 2021, there were 30 plant doctor quizzes, with more than 730 plant doctors attempting at least one quiz with participation from the 26 active Plantwise countries.

What is sustainable and why?

The M&E practices introduced by Plantwise constitute a new concept in many countries and, as such, uptake has generally been low. However, there is recognition that M&E is needed and can provide valuable information to monitor performance and demonstrate the benefits of plant clinics to farmers. In particular, the use of plant clinic data to assess plant doctors' diagnostic and advisory performance remains a highly valued benefit to many partners. The information generated can also be used to support in-country budget requests. However, as also seen in the following section on risks and challenges, countries often struggle with insufficient resources to adequately carry out these M&E activities.

In Kenya, counties have reported their clinic operations to CABI and the MoA on a half yearly basis since 2019, which has provided a good monitoring system on how they were carrying out clinic operations with minimum support from CABI and also provided some indication as to how they intended to continue with clinic operations after the end of Plantwise. Through this reporting channel, two counties (Elgeyo Marakwet, Homabay) reported having funded the launch of clinics and day-to-day operations amounting to KSh235,400 (£1,623); while Nakuru County spend KSh830,000 (£5,724) to train 20 new plant doctors in 2020.

The use of plant clinic data for monitoring the provision and quality of extension services by MSRFF for discussion at cluster meetings was reported in India, as well as using data for content creation in the writing of publications such as papers and blogs. While this effort is mainly made by certain individuals, it was stated that plant doctors have also been trained to undertake self-critical assessment on the performance of their own plant clinics. This kind of experiential and discovery-based learning helped the plant doctors to understand gaps and improve their performance.

Implementation of a monitoring strategy at district level in Pakistan was stated to be helping to improve local level monitoring and, overall, the contribution of M&E to the Plantwise programme's improvement, strategy and its ability to provide lessons for policy and implementation in the field in Pakistan has been stated by respondents to be substantive although it could be improved. Cluster meetings, monitoring visits and feedback from peer (i.e. other plant doctors) validation of queries allow for plant doctors to be monitored, their services improved and for them to stay engaged in the programme and data collection. Overall, M&E of plant clinics was considered good and the plant doctors' capacity, level of the diagnosis, material available, and quality of the recommendations were viewed as particularly adequate. However, it was acknowledged that there is a need for a robust M&E mechanism for e-plant clinics and there is a need to set up clear mechanisms for national level reporting and use of M&E results in decision-making.

In Uganda, it is currently part of the district agricultural officers' (DAO) duties to monitor and supervise plant clinic operations. However it is recognised that although a few DAOs have been trained in monitoring plant clinic performance and training using Plantwise Modules 1 and 2 ("Field Diagnosis and Plant Clinic Operation" and "Giving Good Advice"), this is an area that needs further strengthening for proper supervision.

In Sri Lanka, provincial directors of agriculture are monitoring staff activities and performance through the digitisation of the monitoring of plant clinic performance (MPCP) tools (e.g. Google form), particularly using data from e-plant clinics. However, whilst the tools are in place and do not require much investment, routine follow-ups are often not carried out which presents a problem, as technical support is required to sustain a good quality of work.

In Malawi, the evidence for MPCP sustainability was that the extension department, as for other programmes running in the districts, will include plant clinics in the supervision check list although it was stated that this may not take the full MPCP approach.

The Plantwise quality assessment tool has been used by data managers and coordinators in Jamaica for identifying weaknesses in plant doctor's recommendations to define the focus of future trainings and ways to improve the plant clinic service. In Barbados, the Plantwise local coordinator used Plantwise tools and materials to involve students from the community college in diagnostic activities to reinforce plant clinic actions.

With regard to the plant doctor quizzes implemented by Plantwise, quiz users were recorded from all 26 active Plantwise countries, although the numbers and extent of participation vary considerably. Uganda and Kenya represented the most significant amount of users and also showed the highest fidelity to the quizzes. Most other countries had a high 'churn' rate, meaning that there was very poor consistency in use, as discussed in the following section.

Risks and challenges

Timely analysis of plant clinic data, as well as sharing during cluster meetings to improve use and ensure continued capacity building of coordinators and plant doctors, has proved a challenge for many countries. In addition, inadequate resources for effective implementation of monitoring activities and limited follow-up make it difficult to determine the effectiveness of M&E in many Plantwise countries. Overall, lack of human resources and time are considered as key risks in the sustainability of Plantwise M&E activities.

In Ethiopia, rapid expansion and increase in the number of plant clinics has made monitoring and backstopping activities difficult. Instability and violence in some parts of the country has also delayed implementation of activities, as well as affected monitoring and backstopping to plant clinics. There is a need to build the capacity of local partners to engage in monitoring, backstopping and quality assurance to offset these challenges to implementation.

M&E of different trainings, plant clinics, and plant doctors in Nepal was felt to be an important exercise for maintaining the quality standard of Plantwise operations. However, it was acknowledged that allocation of human and financial resources may need a lot of coordination and support and that although the digitalisation of the MPCP is in place, it needs to be communicated to provincial governments who are now in the lead in delivering plant clinics. It was also stated that structured advocacy is required at provincial level to make plant doctors aware of MPCP tools.

According to plant doctors in Rwanda and Uganda possible reasons for lack of uptake of the quizzes included: (i) lack of awareness of the quizzes, (ii) challenges with internet access and stability, and (iii) lack of time. Due to the inconsistent participation by individual users over time, the entry of new users into the quiz scheme at a late stage, and the relatively small sample size, it was not possible to detect changes in performance (i.e. learning) over time.

Lessons learned

Enhancing stakeholder engagement

Over the last 10 years, the role of stakeholders has proved to be critical in the effective running of the Plantwise programme, as different stakeholders in the areas of research and development, outreach and extension play key roles in the various components of the plant health system. Plantwise has encouraged the focus on improving plant health among stakeholders, leading to new synergies and improved linkages between actors in the system through joint actions and enhanced information sharing. However, without Plantwise interventions, plant health systems will need enhanced, coordinated actions of these various stakeholders for better delivery of plant health advisory services to farmers.

Countries such as Pakistan have recommended that structures be put in place to formalise the mandate for action and build ownership and commitment to the plant heath agenda among all individuals/organisations. In addition, clear roles and responsibilities of partners need to be defined, and structures agreed, including an impact framework, for mutual accountability. To this point, Vietnam highlighted a need for a formal cooperation agreement between implementing agencies for the long-term continuity of plant health activities.

Digitalisation of plant health advisory services

In challenging contexts (COVID-19, insecurity, and difficult-to-reach communities), the transition to digital and tablet based e-extension services holds great promise for increasing reach and enabling implementation of plant health activities. In the Plantwise programme, the introduction of tablets (e-clinics) and the establishment of social network groups has become a ‘game changer’ in terms of linking plant doctors to peers, experts and farmers. In addition, the migration from paper-based to tablet-based data collection with specialised apps has circumvented the slow and tedious process of collecting and entering paper queries into a database. Consequently, the use of ICTs has helped to improve the technical capacity of plant doctors, transform the inter-connectedness of plant health systems and radically change countries’ ability to respond to pest outbreaks.

The use of social media apps to support advice delivery on plant health is likely to remain an essential activity within the plant health system and e-extension. However, issues with the cost of data, internet connectivity and language challenges remain. Quality assurance in terms of checking the quality of plant doctors’ diagnoses and advice also need to be kept in mind.

As a result of the COVID-19 pandemic and government-imposed restrictions, the number and/or frequency of documented plant clinics held in the beginning of 2020 was reduced significantly in comparison to the previous year. While lifting of restrictions has varied between countries, there have been several suggestions to overcome the restrictions by adapting plant clinics to the ‘new-normal’, taking into account protective measures and relying more on virtual/digital tools for diagnosis and advice. In addition, local resource personnel, who may not have all the skills of a plant doctor, but who have access to a connected smartphone and are ‘tech-savvy’, could also play an important role in facilitating interactions between farmers and plant doctors.

With regard to training, the use of digital tools and social media as facilitation tools should be further encouraged for training of staff, peer-to-peer support between plant doctors, and troubleshooting diagnoses and recommendations with subject matter specialists and researchers. However, it should be noted that while virtual training was a necessity in 2020 due to COVID restrictions and provided some advantages in terms of reduced cost etc., the format also allowed less hand-holding and lacked group support. As such, this virtual approach did not allow the same level of interaction, which made it difficult to gauge the level of trainee understanding on how to use, for example, the DCA and the Factsheets Library app. Several respondents stated that the lack of personal contact with trainers also meant they were less likely to seek support after the training, as there was a lower level of comfort and familiarity with the trainer. Another challenge with virtual training was reliability of internet connections, as some of the trainees' bandwidth was too low to allow full participation in the training.

Nevertheless, expanding the institutionalisation of plant doctor training in whatever format, whether digital or non-digital, will require concerted effort based on national strategies and institutional mandates.

Gender

Gender assessments and studies carried out in 2020 have demonstrated that women farmers benefit from tailored advice by plant doctors at plant clinics. In addition, preliminary results indicate that using plant clinic services is starting to empower women through an increased knowledge base, and increased ability to seek out information and make on-farm decisions. All this has been achieved by ensuring that clinic timings and locations are decided through consultation with women farmers, running women-only plant clinics, and women plant doctors conducting special plant clinics targeting women farmers. These are not difficult issues to consider, but they do require an active focus on women, and ensuring that women extension officers are chosen to be trained as plant doctors.

For example, women-only clinics in Pakistan provide women farmers with plant health advice, and serve to empower them in agricultural decision-making, including over the use of productive resources, time, and income. They are tailored to fit the needs of women farmers and the plant doctors are able to focus on providing information on good agricultural practices related to those activities carried out by women, including vegetable cultivation for kitchen gardens, cotton picking, weed management, and crop harvesting.

In Malawi, the participation of women in the plant clinics increased when plant doctors conducted mobile clinics at the village savings and loans groups, where women meet to discuss agripreneurial issues.

These gender-sensitive changes have been brought about by small but significant modifications in the way that Plantwise has been implemented. The key step is to think about women, as well as men, farmers when making decisions about how to implement Plantwise and other advisory services. It is essential to recognise that women and men farmers have different levels of control over different crops. In addition, it should be recognised that women and men have different levels of access to information itself, as well as information about advisory services, and that, combined with social norms and women's unpaid care work responsibilities, reduces women's access to plant clinics.

Conclusion

Overall, findings from the country sustainability reports, and other reviewed Plantwise documents lead to the conclusion that some elements of Plantwise are more sustainable that others.

The current, increased levels of linkages between stakeholders will remain, though it is more likely that they will remain on an informal basis, rather than through formal committees such as the NSC. Given that many of the plant health stakeholders now know each other, and know each other's mandates, informal communication and consultation will continue through phone calls, social media messages and emails.

Plant clinics are very likely to continue to run in most Plantwise countries, though the scale and frequency of the clinics will depend on how the countries' respective governments are able to fund the running of the clinics. In countries where plant clinic operations have already been put into budgets, the likelihood of regular clinics running is higher than in countries where governments are still supporting plant clinics through other donor-funded projects and programmes. Complementary extension approaches will also continue, with varying methods used in different countries depending on which channel (plant health rally, radio, etc.) fits better with the country's general approach to extension delivery.

The sustainability of the data management system and use of data is more challenging. While some countries see the value of the data for pest and disease surveillance, there is limited enthusiasm for continued data entry into POMS, data harmonisation or validation. All of these processes are seen as time consuming, and little funding is available for harmonisation or validation work. There is still a disconnect between data entry/management and the benefits that can be obtained from using the data. If this key challenge can be overcome, then there is a stronger chance for sustainability of the data management system.

The information resources developed within the Plantwise programme are highly valued across all programme countries, and they will continue to be used. There is strong demand for further resource development, especially in local languages, but countries acknowledge that funding and staff capacity will be issues that need to be addressed. It is unclear whether further information resource development will take place, though it is likely in some countries, such as Kenya and Nepal. Other countries may continue to rely on existing information that, in the long term, may become outdated.

M&E has had the lowest uptake of the five Plantwise programme areas, mainly because it was a new concept within the extension arena in many countries. It is possible some basic monitoring will continue, such as plant doctor validation at cluster meetings, but it is unlikely that monitoring of plant clinics, training courses, and mass extension campaigns, etc. will continue. This is due to lack of funding, and also a continued low understanding of the need to carry out these activities. At a higher level, while many countries recognise the value of impact studies to assess whether the Plantwise approach is making a difference for farmers, it is unlikely that any country will have the funding to carry out such studies.

In general, sound understanding of the political, institutional and cultural context in each country is required for the development of strong and lasting linkages among plant health system stakeholders. To ensure that the Plantwise approach can fit with and be adopted and adapted into local structures, it is essential to understand and engage with the local structures in place already. Creation of new, separate structures will not enable sustainability.

A further factor in ensuring sustainability is the ability of Plantwise to address current national and local priorities, as proven by the easy acceptance and adoption of the Plantwise approach in locations where the programme provided a solution to a current issue that the country was facing (e.g. fall armyworm, Banana skipper and tomato leafminer). The scale of uptake also influences sustainability: where there is wider coverage of plant clinics, more stakeholders and institutions/organisations within the country are aware and involved in running Plantwise, therefore building a higher level of awareness and ownership. This in turn increases the likelihood of funding allocations and commitment to the approach, and therefore sustainability.

To increase engagement and ownership of the Plantwise approach, a broader diversity of advisory service providers should be invited to national multi-stakeholder platforms and further engaged, including private sector partners, NGOs and farmer organisations. Nevertheless, despite private companies from different sectors having shown some interest in Plantwise, feedback from certain private sector organisations revealed that the programme was too rigid in its design to address their needs. This was particularly the case with the Plantwise training content, which was not sufficiently tailored for their business needs, such as focusing on specific commodities.

It is critical that any Plantwise type approach is flexible and adaptable to local contexts and local partners are able to unpack and choose which elements of the approach are appropriate for the country context. Overall, flexibility of the Plantwise approach and its adaptability to local contexts were the main contributors to its uptake by countries. Continuous involvement and engagement with country partners are therefore essential for adoption, adaptation, acceptance, integration and, finally, sustainability of any such plant health advisory programme.

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