PlantwisePlus
Annual Report
2021

KNOWLEDGE FOR LIFE

PlantwisePlus enables countries to confidently face the challenges of plant health threats in a changing climate by empowering smallholder farmers to increase income, food security and food safety by producing more and higher quality food.

Contents

Abbreviations

ACIAR	Australian Centre for International Agricultural Research
ACP	African, Caribbean and Pacific
CAS	Certificate of Advanced Studies
CfS	Candidates for substitutions
COLEACP	Europe-Africa-Caribbean-Pacific Liaison Committee
DGIS	Directorate General for International Cooperation of the Netherlands
ECTS	European Credit Transfer and Accumulation System
EPPO	European and Mediterranean Plant Protection Organization
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FAW	Fall Armyworm
FCDO	UK Foreign, Commonwealth and Development Office
FRI	Farm Radio International
GFRAS	Global Forum for Rural Advisory Services
GRAST	Gender and Rural Advisory Services Assessment Tool
IBMA	International Biocontrol Manufacturers Association
ICM	Integrated Crop Management
INTPA	European Commission Directorate General for International Partnerships
IPM	Integrated Pest Management
KALRO	Kenya Agricultural and Livestock Research Organization
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MARA	Ministry of Agriculture and Rural Affairs
MAS	Masters of Advances Studies
MRL	Maximum Residue Levels
PARC	Pakistan Agricultural Research Council
PPE	Personal Protective Equipment
PRA	Pest Risk Analysis
SDC	Swiss Agency for Development and Cooperation
SEO	Search Engine Optimization
USDA	U.S. Department of Agriculture
ZARI	Zambia Agricultural Information Service

Executive summary

The CABI-led PlantwisePlus programme was officially launched in 2021. CABI and programme partners will enable countries to predict, prevent and prepare for plant health threats through effective and sustainable measures, supporting countries and farmers to produce the required quantity and quality of food in a changing climate. PlantwisePlus enhances the work undertaken in the previous Plantwise and Action on Invasives programmes by addressing gaps and opportunities identified. PlantwisePlus will continue efforts in the Plantwise countries that are actively implementing various elements of the Plantwise approach.

Despite ongoing challenges caused by Covid-19, CABI and its partners have succeeded in making progress on several programme activities. In the proof-of-concept phase, PlantwisePlus implementation includes activities with a global focus as well as activities with a country focus. Kenya, Ghana and Pakistan were the first three focus countries of this programme proof-of-concept. This decision on focus countries was motivated largely by the presence of CABI centres in these countries, ensuring that activities would be able to continue regardless of international travel restrictions. It also took into account the strong collaboration between CABI and national partners in these countries during Plantwise and Action on Invasives. Nonetheless, several additional countries, such as Zambia, Rwanda and Uganda, were engaged through a mixture of face-to-face and virtual means in support of stakeholder surveys, training, research on biological control solutions and information campaigns. Most notable was the ongoing Plantwise backstopping, which CABI provided for 24 countries.

Some key highlights from 2021 include the following:

- National plant protection organization staff and other relevant personnel from 36 countries were trained in using CABI's horizon scanning and pest risk analysis (PRA) tools
- Two biological control agents were approved for release by government authorities in Kenya and Pakistan, with initial releases made and more to follow in 2022
- Progress was made in developing new digital decision support tools, including the further expansion of the CABI BioProtection Portal to include 16 new countries (bringing the total to 28), the design and development of a pesticide dosage calculator (Crop Sprayr) and an online catalogue of crop protection apps and websites (Crop App Index)
- A number of baseline surveys and socioeconomic studies were executed to create an evidence base to inform further programme planning with partners
- A literature review on pesticide residue levels in domestic food systems in Ghana, Kenya and Pakistan gave insights about crops and pesticides where maximum residue levels (MRL) are most likely to be exceeded. This can guide policy and communication strategies to reduce food safety risks
- A survey was conducted in 17 countries across Asia, Africa and the Americas to understand the current regulatory frameworks governing operating environments for agro-input dealers – particularly the current

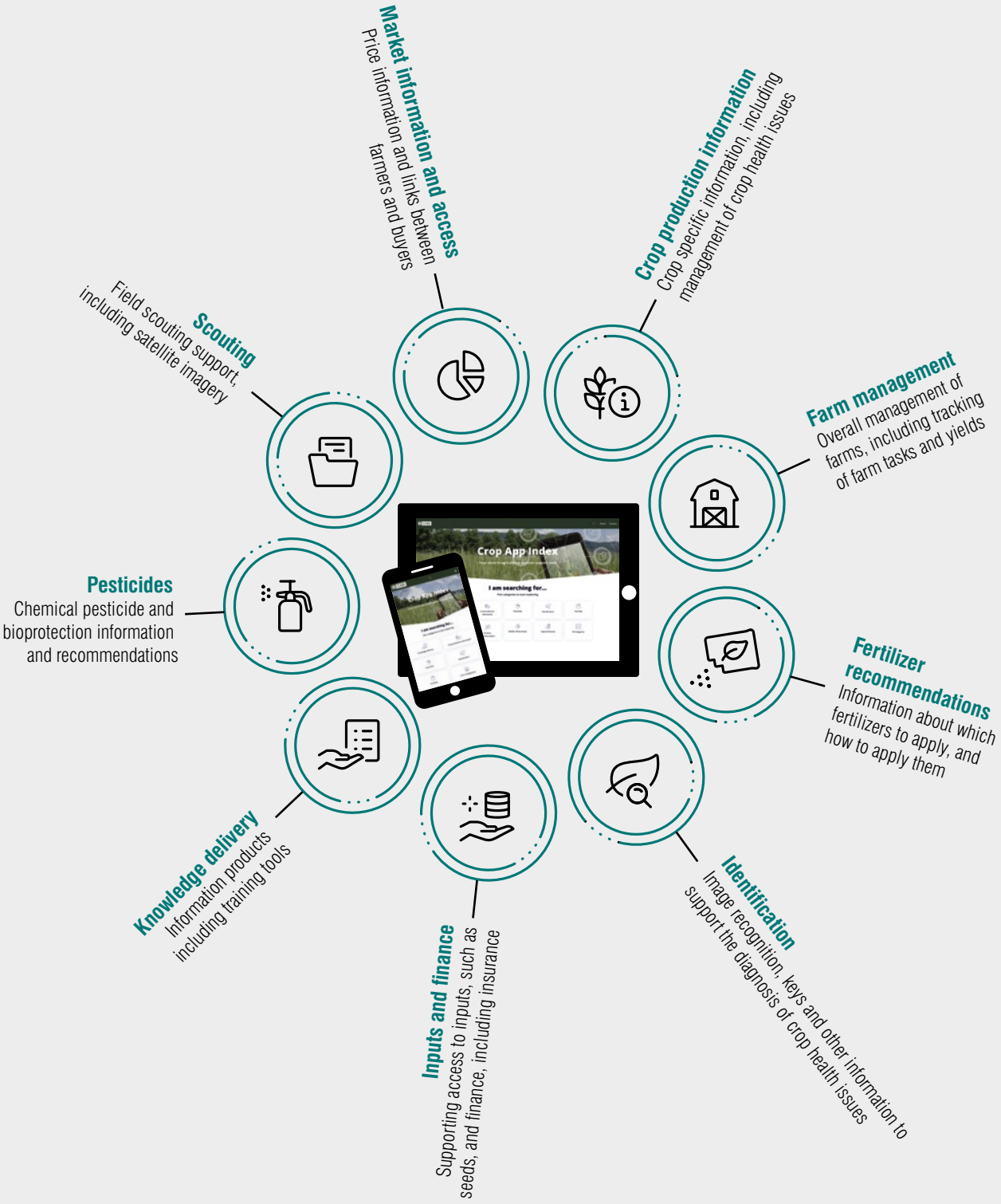
requirements for registration, training and/or certification as a regulatory obligation – and to identify any existing gaps or needs

- A process was developed to analyse the potential impact of withdrawing high-risk plant protection products from the market, considering available alternative pesticides and crop production practices
- Countries continued to demonstrate their commitment to the Plantwise approach with a number of activities implemented in 2021, particularly plant clinics, in spite of significantly reduced support from CABI
- An estimated 636,747 farmers were reached through a combination of plant clinics (264,723), plant health rallies (10,864), mass extension campaigns (95,450), the CABI BioProtection Portal (220,548) and the Plantwise Knowledge Bank (45,162)

The achievements and lessons learned in 2021 will help enable the further roll-out of PlantwisePlus in 2022, with a focus on proving the programme concept in a limited number of countries.

Improving app search efficiency

The **Crop App Index** offers a way to more easily discover digital tools that can support decision making in crop production and plant health.



The Crop App Index (www.cropappindex.org) brings together more than 350 resources (and growing!) from across multiple platforms allowing users to search and browse the full suite of tools availa-

Introduction

PlantwisePlus is a new global programme, led by CABI, that contributes to improving incomes and livelihoods for smallholder farmers through sustainable approaches to crop production, leading to safer and higher quality food in domestic markets. The programme builds on and enhances work done under Plantwise and Action on Invasives, but also introduces new elements to address gaps and opportunities identified through the lessons learned.

To respond to the needs of farmers and the systems that support them, PlantwisePlus will help countries **predict**, **prevent** and **prepare** for plant health threats, thereby reducing crop losses. This will be achieved by addressing three key remaining challenges identified through the Plantwise and Action on Invasives programmes, thus supporting countries and farmers to **produce** the required quantity and quality of food in a changing climate.

The programme will deliver processes and tools that will contribute to the following:

1. **Pest preparedness**: by strengthening **detection and response** to pest outbreaks, the programme will support countries with more consistent and coordinated mechanisms to detect, identify and respond to plant health problems
2. **Farmer advisory**: by delivering digital **advisory tools**, the programme will boost sustainable agriculture and improve the capacity of public and private actors providing support to smallholder farmers to diagnose crop health problems and recommend sustainable solutions
3. **Pesticide risk reduction**: by enhancing the use of **low-risk plant protection** solutions, the programme will help reduce reliance on high-risk farm inputs that have adverse effects on human health and biodiversity, while promoting the demand for safer and locally produced food

The donors contributing to PlantwisePlus in 2021 are the Directorate General for International Cooperation of the Netherlands (DGIS); the Swiss Agency for Development and Cooperation (SDC); the European Commission Directorate General for International Partnerships (INTPA); the UK Foreign, Commonwealth and Development Office (FCDO); and the Australian Centre for International Agricultural Research (ACIAR). In addition, the Ministry of Agriculture and Rural Affairs (MARA) of the People's Republic of China provides financial contributions for programme implementation in China through its contributions to the CABI Development Fund for the operations of the MARA–CABI Joint Laboratory in Beijing.

PlantwisePlus is managed by a programme board that facilitates interaction and collaboration with regional/international organizations, as well as with in-country partners. It collects and considers feedback and advice from internal teams, national and international partners and impact studies to steer the programme, such as in deciding when to scale up and scale out activities. It is also guided by inputs from donors who are represented at an annual donor forum meeting.

The PlantwisePlus programme began to take full shape in 2021, with a distinct transition from planning and preparation to partner engagement and delivery of activities. Under this new global programme, CABI continues its efforts in the 24 Plantwise countries that are actively implementing various elements of the Plantwise approach. CABI's strategic contributions complement the investments by in-country partners, supporting plant clinic operations and associated capacity building and outreach.

In the proof-of-concept phase, PlantwisePlus implementation includes activities with a global focus as well as activities with a country focus. In-country implementation has proceeded in spite of Covid-19-related travel restrictions, with most activities taking place in the three focal countries of Kenya, Pakistan and Ghana. CABI's strong presence in these countries enabled activities to be carried out almost according to plan. Further activities, such as stakeholder surveys, training, research on biological control solutions and information campaigns, were carried out in several additional countries through a mixture of face-to-face and virtual means. These additional countries, such as Zambia, Rwanda and Uganda, were chosen according to many criteria, for example whether they had opportunities to build on previous interventions, stakeholder interests in the activity and existing Plantwise partnerships to facilitate smooth collaboration.

This report presents an update on PlantwisePlus implementation between January and December 2021. This global programme consists of more than 50 activities under 13 outputs. To simplify communication, this report gives a narrative on progress made through a selection of key highlights from programme activities, challenges encountered and measures taken during the reporting period, as well as listing some of the next steps to be taken in 2022. The report contains two annexes. Annex I provides a concise update on progress against programme indicators and specific milestones, and Annex II sets out the new programme milestones for 2022. In addition to this annual report, CABI has compiled supporting activity-specific technical reports containing further details on implementation. These are available upon request.

PlantwisePlus highlights

Pest preparedness

Invasive pests continue to spread to new areas, driven in part by changing weather patterns, and existing pests can flare up unpredictably. However, there is often no consistent or coordinated mechanism at a national or regional level for pest surveillance, rapid detection and response or for providing the technical support needed to deliver effective solutions. The highlights below capture how PlantwisePlus has worked to address these capacity gaps in 2021.

Horizon scanning, PRA and response planning for identified threats

During 2021, PlantwisePlus support Ghana, Kenya and Pakistan in developing systematic approaches to identify and prioritize pest threats and to develop national planning capabilities for responding. The three countries were given training on and access to CABI's new horizon scanning and PRA tools, as well as to the CABI Crop Protection Compendium, to undertake PRA for import control and trade. The horizon scanning tool is a decision support aid that helps in identifying and categorizing species that might enter a particular geographic area from another geographic area. The PRA tool, in turn, presents scientific information from the CABI Crop Protection Compendium to aid the selection of appropriate measures for reducing risk and facilitating the movement of plants and plant products associated with a commodity pathway.

PRA reports were completed for three pest species in Ghana, 16 species in Kenya and nine species in Pakistan. These prioritized species included pathogens like banana bunchy top virus and insect pests like the carambola fruit fly (*Bactrocera carambolae*) and southern armyworm (*Spodoptera eridania*), all of which were identified during the horizon scanning because they are considered to be major threats of quarantine importance and pose significant risks to commodity trade of affected crops. Additionally, pest insight reports were produced for the first time for emerging national pest risks to create awareness and preparedness by enabling improved monitoring of changes to risk. Partners in Ghana did not limit themselves to carrying out PRAs and developed a response plan for the celery leafminer (*Liriomyza trifolii*) and the vegetable leafminer (*L. sativae*), two invasive pests identified in Ghana in 2021 as a result of surveillance efforts. The European and Mediterranean Plant Protection Organization (EPPO) has classified these two leafminer species as quarantine pests, meaning that their detection in Ghana could pose a trade risk on leafy vegetables and cut flowers if strict measures are not put in place. Additionally, both species cause both qualitative and quantitative loss of produce (leafy vegetables and ornamentals) and could result in significant economic losses if they became widespread. Four key thematic areas for a response were identified: (i) planning, coordination and resource mobilization; (ii) awareness creation and communication; (iii) surveillance and research; and (iv) management, monitoring and assessment. During 2022, some of this will be supported by PlantwisePlus.

In an effort to support several more countries, including fragile states, online events were jointly organized by CABI and the FAO to introduce the horizon scanning and PRA tools to plant health stakeholders who could not

be reached through face-to-face workshops. CABI extended gratis access to these CABI tools to workshop participants and staff of the national plant protection organizations of all qualifying African, Caribbean and Pacific (ACP) countries. These PlantwisePlus-supported online events reached 140 participants from the national plant protection organizations of 36 countries in western, eastern and southern Africa using a blend of PRA theory alongside training materials newly developed by CABI and the Europe–Africa–Caribbean–Pacific Liaison Committee (COLEACP). At the same time, a key informant survey was conducted in Burkina Faso, Niger and Mali to identify knowledge gaps and PRA-related needs of the respective national plant protection agencies. None of the respondents had seen CABI's horizon scanning and PRA tools previously, and most (70%) said they had never used such knowledge tools before for this purpose. They expressed great interest in being trained on the use of these pest prioritization tools, and CABI is exploring options to deliver training in 2022.

Creating an evidence base for interventions against invasive species

An evidence base is required prior to investing in interventions that support the management of invasive species. In Zambia, a socioeconomic study was conducted to establish the impact of the cassava brown streak disease on farmers' livelihoods. Based on an assessment of 516 households, 98% of farmers had suffered cassava yield loss due to the disease and the severity of the problem is increasing. The majority of farmers obtain cassava cuttings from their own fields or those of a neighbour to propagate new plants, which is a key contributor to the spread of this disease. Another finding was that women play a key role in sourcing and planting cassava, as well as in managing the cassava crop in the field. Therefore, infections can be heavily reduced through training of farmers, particularly women, on the exchange and movement of planting materials. Following these insights, CABI and local partners developed a targeted awareness-raising campaign on management of cassava brown streak disease. A communication campaign, focused on radio and face-to-face approaches (plant health rallies), was launched in late 2021 in collaboration with the National Agricultural Information Service and Zambia Agricultural Information Service (ZARI). Seven 15-minute radio programmes in the relevant local languages are being aired on local stations (Radio Liseli, Radio Kalungwishi, Radio Mufumbwe, ZNBC Radio 1, Radio Kabangabanga and Radio Lubuto) during the cropping season. Through these coordinated outreach activities, which will extend into 2022, it is estimated that more than 100,000 cassava farmers will receive information to help manage the disease (the reach from this campaign will be reported in 2022). Additionally, a range of information materials has been produced, including a video documentary, adverts in local language, trailers, posters and factsheets. A radio briefing is being developed with Farm Radio International (FRI) for sharing with radio stations across the country and the wider region. Although the radio campaign is still ongoing, anecdotal feedback from the districts has been positive, with farmers contacting the radio shows about the programmes and requesting further information and access to clean planting materials. There is currently a centralized system for distributing clean cassava cuttings run by ZARI; however, there could be ways to increase the efficiency and reach of this system, such as by decentralizing the distribution.

In Kenya, a study covering 706 rice farmers sought to understand the socioeconomic impacts of the apple snail (*Pomacea canaliculata*) on livelihoods. This invasive pest was recently identified in Kenya – its first appearance on the African continent – and is causing widespread damage to rice crops, with the potential to spread to new areas and feed on other crops as well. Insights into key challenges around the management of the apple snail were documented, showing that chemical pesticides are not effective and that there is demand for solutions that are environmentally friendly and safe for pesticide applicators. Without any proven, effective biological control options for this invasive pest, cultural practices likely need to be strongly promoted in the first instance. The next steps will be to work with the government stakeholder committee to develop an agreed technical management brief and appropriate communication activities to reduce damage and the spread of the apple snail to other rice-growing regions.

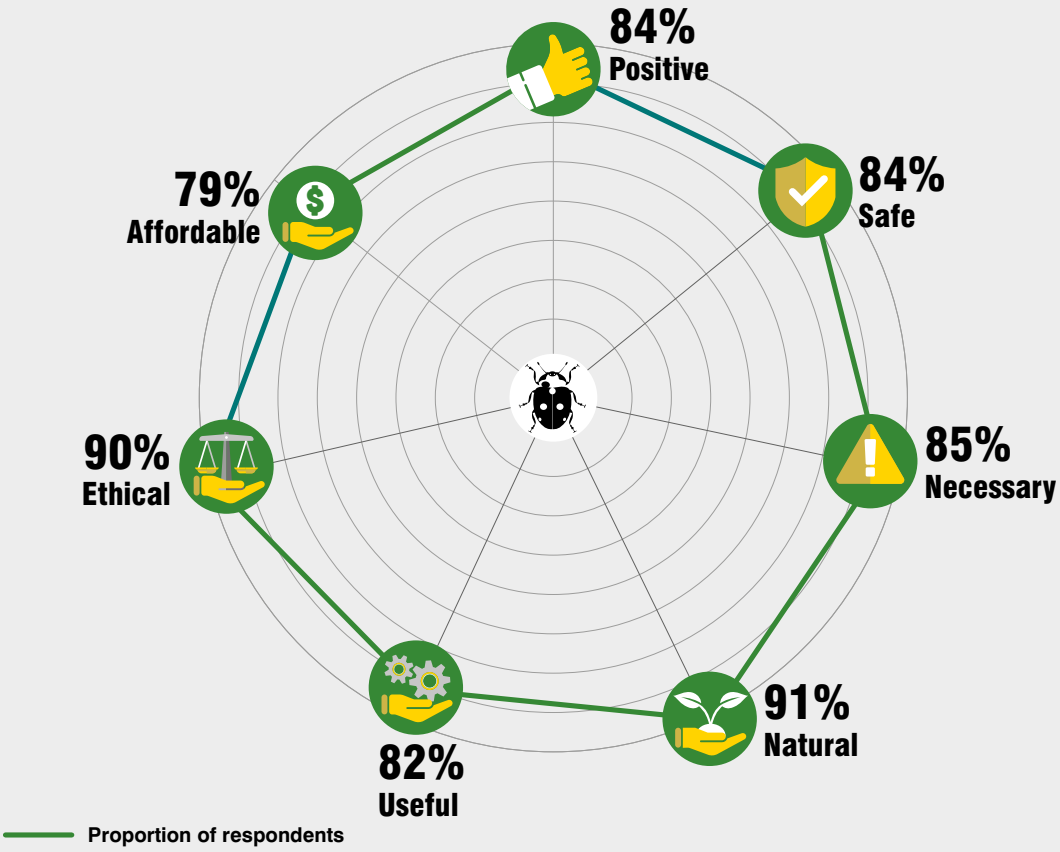
Biological control of invasive species

Excellent progress was made in 2021 towards the biological control of two key invasive species in Africa and Asia, with official government approval for the release of two biocontrol agents, one in Kenya and one in Pakistan.

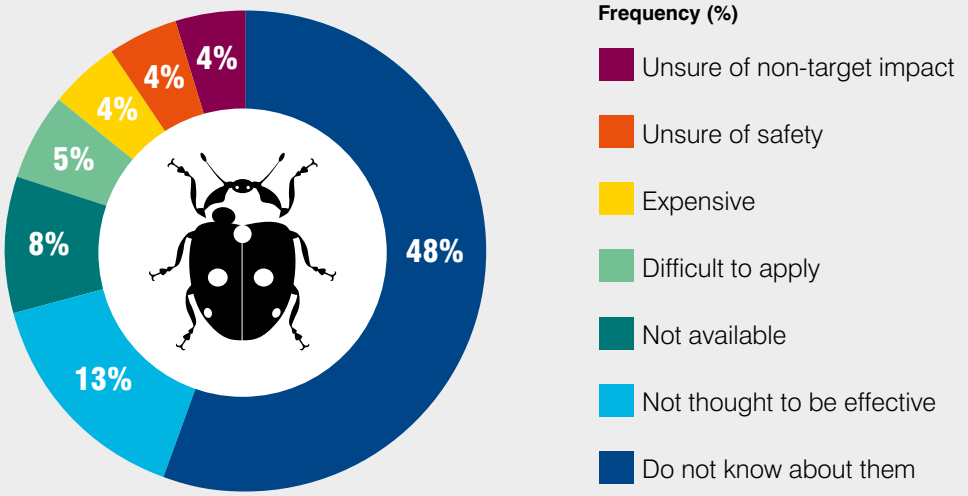
The papaya mealybug (*Paracoccus marginatus*) is an invasive species in several African countries affecting fruits, vegetables and ornamental plants. This sucking insect causes yield losses of 57% per year and reduces household incomes by £2,224/ha. A study was undertaken to assess Kenyan farmers' knowledge, attitudes and practices towards biological control for the management of the invasive papaya mealybug. A majority of the 383 farmers interviewed reacted positively to the idea of releasing a natural enemy against the papaya mealybug.

Perceptions of biological control

Kenyan smallholder farmers' perceptions of biological control against papaya mealybug were generally positive.



Among the smallholder farmers interviewed, fewer than 25% claimed to have used biological control previously in their production. For those who had not, the main reasons are indicated below. This information provides a framework for targeted communication on and awareness of the benefits of this approach.



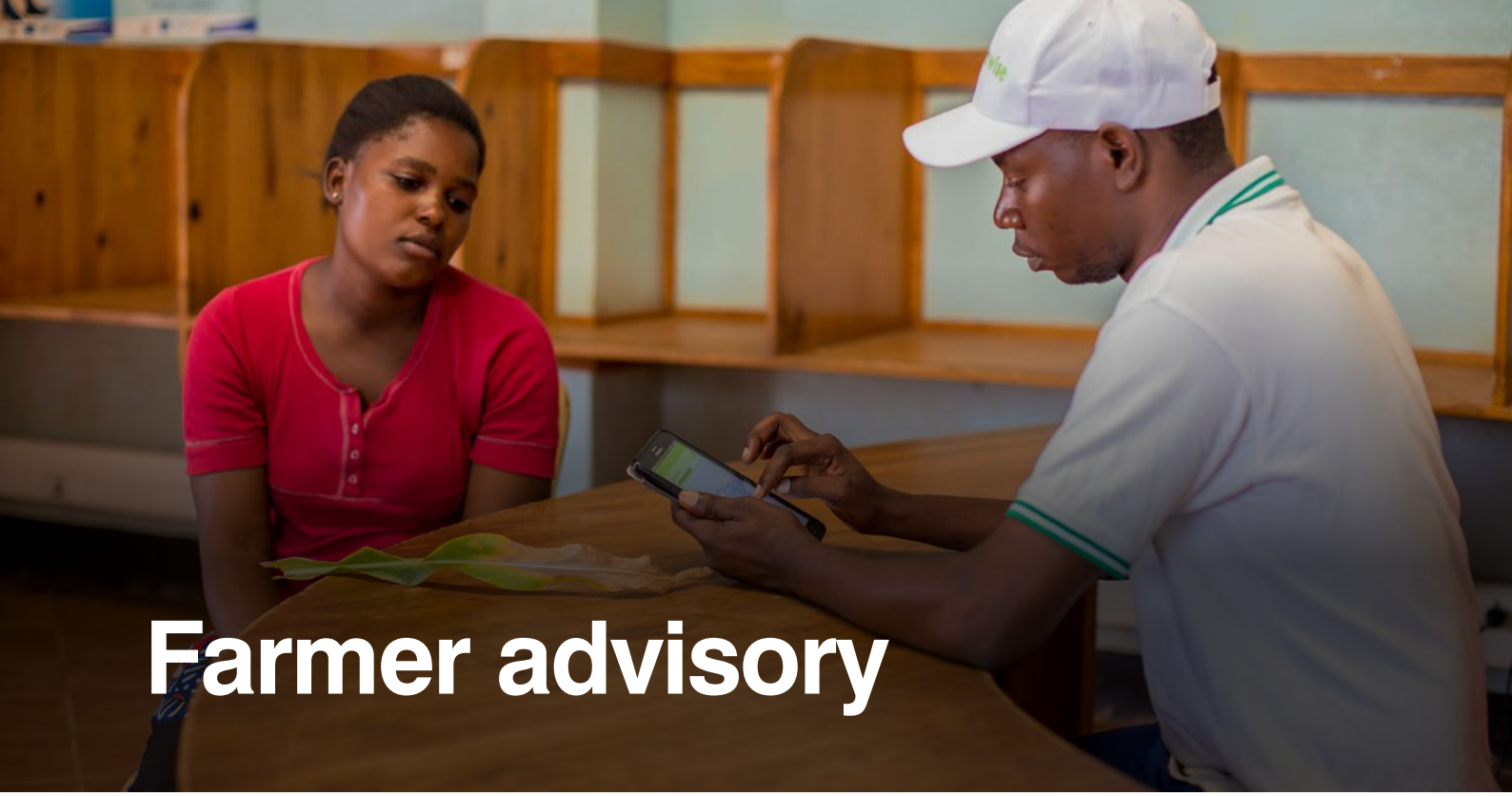
They indicated they would support the biological control initiative, for example through adopting practices to support natural enemy establishment, by reducing their chemical pesticide use to conserve the natural enemies and by monitoring populations of the pest and biological control agent on their farms.

The biological control agent *Acerophagus papayae* is a parasitic wasp and a well-known natural enemy of the papaya mealybug in its area of origin, but it is not present in East Africa. This biological control agent was transferred from Ghana to a quarantine facility in Kenya, following access and benefit sharing protocols, to assess its capacity in controlling the papaya mealybug and suitability for release in Kenya. CABI and the Kenya Agricultural and Livestock Research Organization (KALRO) demonstrated that the biological control agent could significantly reduce pest populations while posing very little risk to non-target species in the environment. Consequently, a formal request to approve the agent release was submitted to Kenyan authorities. Following official approval, the first field releases were made in the coastal region of Kenya. As one of the next steps in this intervention to control papaya mealybug, the dissemination of the biological control agent will be further supported by PlantwisePlus activity to facilitate local production of biocontrol agents. Locally based mass production facilities will be established to increase the availability and affordability of this low-risk alternative to pesticides.

Parthenium weed (*Parthenium hysterophorus*) is a highly invasive plant that has spread throughout many parts of the world. It is a major weed in field crops and impacts negatively on biodiversity, and has toxic effects on livestock through grazing. Humans can be severely affected through contact with the plant or exposure to its allergenic pollen, which causes respiratory issues. The Parthenium stem boring weevil (*Listronotus setosipennis*) is native to South America and is considered a potential biocontrol agent of the weed, given its previous success in reducing Parthenium weed populations in Australia, South Africa and Ethiopia. A phytosanitary certificate was obtained to transfer the biocontrol agent from South Africa to Pakistan for assessment in CABI's quarantine facility. Following very positive results, the Pakistan Agricultural Research Council established a panel of experts who reviewed and approved the release request in late 2021.

Based on the approval of these two biological control agents, CABI and national partners will scale up both biological pest management approaches. Mass production and area-wide releases of these two biological control agents will be a key activity in 2022. For example, CABI and KALRO are aiming to boost production capacity of *A. papayae* from 12,000 parasitic wasps per week to 50,000 per week to enable larger releases in more locations in Kenya. These agent releases will be accompanied by post-release monitoring to evaluate the suppression of papaya mealybug populations in Kenya and of Parthenium in Pakistan.

Furthermore, assessments of potential biological control options for the management of fall armyworm (FAW) (*Spodoptera frugiperda*) have continued to show promising results. In Rwanda, entomopathogenic nematodes incorporated into a gel formulation were as effective in killing FAW caterpillars as cypermethrin, a chemical pesticide commonly used against this pest. In Zambia, a promising entomopathogenic fungus, *Metarhizium rileyi*, was found to kill up to 70% of FAW larvae. This fungus belongs to the same group of organisms used in the biopesticide Green Muscle product to control locusts and will therefore be investigated further in 2022.



Farmer advisory

Access to reliable information about best practice in agriculture, such as preventing and managing threats to crops, is still limited or non-existent for many smallholder farmers. Although public extension plays a significant role in supporting smallholder agriculture, the numbers of professionally trained advisors are insufficient to ensure consistent support. Farmers therefore often turn to agro-input dealers and others in their communities for plant health advice. Acknowledging that there are limitations on the number of agricultural service providers that can be given formal training on best practice, PlantwisePlus aims to increase access to intuitive decision support tools and to information that can enable advisors and farmers to make more informed decisions in their crop management. The highlights below illustrate the progress made in 2021.

Continuation of Plantwise approach

The conclusions of the Plantwise sustainability assessment conducted in 2020 were further corroborated in 2021, with 24 countries actively implementing various elements of the Plantwise approach: Afghanistan, Bangladesh, Barbados, Bolivia, China, Costa Rica, Ethiopia, Ghana, Grenada, India, Jamaica, Kenya, Malawi, Nepal, Nicaragua, Pakistan, Peru, Rwanda, Sri Lanka, Thailand, Trinidad & Tobago, Uganda, Vietnam and Zambia. The sustainability of these activities was clearly the result of countries having incorporated the programme concept into daily operations by linking it with agricultural development strategies, budgets, job descriptions, training programmes, etc. In total, an estimated £430,000 was committed by Plantwise partners to support activities in 2021 (this amount does not include the staff time of the plant doctors and other personnel involved). These investments by partners helped sustain and, in some countries, even expand operations in 2021, despite challenges caused by Covid-19. Although receiving little or no direct support from CABI, more than 1,700 additional advisory staff (28% female) were trained as plant doctors and 265 new plant clinics were established.

Across all countries in 2021, Plantwise records show that 367,267 farmers were reached through Plantwise activities. Of these, 106,103 were reached through physical plant clinics, 158,620 through online plant clinic approaches, 7094 through plant health rallies and 95,450 through mass extension campaigns. In 2019, before Covid-19, plant clinics reached 268,610 farmers. The 2021 reach through plant clinics is thus remarkable, given the disruptions caused by Covid-19.

Over 46,000 new plant clinic queries were recorded on the Plantwise Online Management System, for a cumulative total of over 780,000 queries in the system since its creation. Chinese partners, who use a data storage system of their own, captured 72,827 new plant clinic queries in 2021, for a cumulative total of over 310,000 in their system. Partners' use of plant clinic data was reported in 13 countries, mainly for deciding on topics for extension campaigns on specific pests and research, as well as for monitoring plant doctor performance.

CABI provided a backstopping role in support of ongoing Plantwise activities for all 24 countries in 2021. Although travel to certain countries was seriously hampered by Covid-19, CABI managed to maintain adequate communication with key partners. This light support included troubleshooting issues with data collection processes, monitoring progress and planning next steps. In addition, a segment of PlantwisePlus funding was reserved to support specific Plantwise activities. This funding was released to countries through a competitive process whereby CABI teams and local partners submitted proposals for strategic activities to help strengthen or expand the Plantwise operations. This mechanism further supported 21 countries with modest sums to conduct activities such as stakeholder meetings, integration of Plantwise training into education institutions, training of trainers, translation of training materials, finalization of new Pest Management Decision Guides and conducting evaluative case studies.

As a strong testament to the success of Plantwise, there is still clear demand for the Plantwise approach to be introduced to new countries and new partners. For instance, in Uganda, CABI and Biovision Foundation began piloting a "one health" approach through joint crop–livestock advisory services for smallholder farmers. In addition, the Plantwise concept was newly introduced to Burundi with funding support from the Embassy of the Kingdom of the Netherlands based in Bujumbura and from Nuffic (the Dutch organization for internationalization in education).

Landscape analysis of existing digital decision support tools

Within Google and Apple's online app stores, hundreds of digital support tools (apps or web-based applications) are available that are designed to assist in crop production. However, finding the most relevant tool can be a challenge because they address a wide range of different agricultural aspects and may be tailored to specific countries, crops or production systems. PlantwisePlus is therefore building a toolkit of digital decision support tools that can effectively serve the needs of public and private-sector agricultural advisors on whom farmers rely for information and guidance.

As a first step, CABI has been conducting a landscape analysis of existing digital decision support tools. This review has involved assessing criteria for each app or web-based tool (crop/country focus; language; online/offline capabilities; user rating; etc) to assess its applicability for smallholder agriculture and its potential for integration with the PlantwisePlus Toolkit. By the end of 2021, a total of 399 apps had been characterized covering 10 broad subject matter categories, the most common being on knowledge delivery (16%), market information access (15%), farm management (14%), pest identification (13%) and pesticides (10%). Most of the digital tools (80%) are freely available to users. Additionally, 193 websites equipped with agricultural decision support tools were investigated. As a second step, the most promising tools were tested more comprehensively to identify those that could be considered for the PlantwisePlus Toolkit. This process resulted in a list of nearly 50 digital tools that were deemed adequate and relevant. Next steps in 2022 will include decision-making on which tools to begin linking to the PlantwisePlus Toolkit.

The landscape analysis of digital decision support tools highlighted the difficulties encountered when searching for such tools, in particular in narrowing search results. Both Google and Apple have filters to narrow results; however, these filters are generic, such as "education" or "business", and are not related to crop production. It is possible to search by keyword and each of the app stores has their own bespoke algorithms to filter results, but a key limitation of this is that any individual search is restricted to 250 results chosen by the algorithm. Furthermore, the results from app store searches often include irrelevant options. To streamline this search process for agricultural service providers and farmers, CABI developed the Crop App Index website. This novel tool aligns very well with CABI's expertise in linking users to the information they need through improved search mechanisms. The Crop App Index automatically pulls in apps and their associated information from the Apple and Google stores based on defined keyword searches. The data from the app stores are complemented by additional information captured by CABI, including target countries, crops, available languages and subject matter categories. In addition to mobile apps, the Crop App Index also includes information on web-based decision support tools that are also of relevance to agronomists. Together, these valuable data enable users of this search tool to discover mobile apps and web-based tools that fulfil their requirements more easily. The Crop App Index is being populated with the characterized apps and websites in Q1 of 2022, with an official launch in February.

Enhancement of the open-access Plantwise Knowledge Bank

In 2021, improvements were made to the Plantwise Knowledge Bank interface, including the addition of a new "Show All" button for users to browse all content, as well as better signposting on the country resources page

to the website search and the Plantwise content. This was in response to user feedback that suggested some confusion involved in navigating content under "country resources". There continued to be new additions of advisory materials to this massive repository: 93 new factsheets were uploaded, including 14 Plantwise Factsheets for Farmers and six Pest Management Decision Guides. This brings the cumulative total of available factsheets on the Knowledge Bank to over 11,100, a proportion of which is available through the Plantwise Factsheet Library app. Overall, there was a 34% increase in visits to the Knowledge Bank compared to 2020, drawing users from both Plantwise and non-Plantwise countries.

A survey was conducted on the use and benefits of the Plantwise Knowledge Bank. This showed that the main use of the Plantwise Knowledge Bank was for research, identifying plant pests and diseases and for training/teaching. Examples of use show that the site has real-life applicability and helps users create solutions to crop health problems. Most survey respondents felt that the site provides them with quick access to relevant information. In addition, users reported that the website saves the need to search many different websites and that it increases the quality of their work. The data analytics and the survey have shown that, going forward, it is essential to continue site optimization for mobile users to ensure increased access by target users. There is also a need to prioritize the most searched sections on the home page, making it easier for users to find what they are looking for.

Expansion of the open-access CABI BioProtection Portal to reach more users

One of the first digital decision support tools to be developed with backing by PlantwisePlus was the CABI BioProtection Portal. This free, web-based tool enables growers and advisors to identify, source and apply registered biocontrol and biopesticide products against agricultural pests in their country. The products listed on the portal are permitted for use by the relevant national authority in each country, and the information is presented in the local language and in English to cater for a broad audience. A number of upgrades to the portal were made in 2021. The scope was expanded to cover 16 new countries, nine of which belong to the Sahel region of Africa, bringing the total number of countries covered to 28. A new, custom-built data management system for the portal was also launched, bringing with it significant benefits and efficiency gains for launching in new countries and maintaining/enhancing existing product information. The portal's content was expanded to include general information on biological control in the form of blogs and a dedicated resources area to support users who wish to enhance their understanding and implementation of biological control approaches. In addition, several "look and feel" redesigns to the portal website were implemented to improve user experience and make the portal more engaging.

Between 1 January and 31 December 2021, the CABI BioProtection Portal received a total of 432,449 users generating 550,896 visits. The main user groups were farmers (51%), advisors (15%), researchers (13%) and agro-input suppliers (7%). An analysis of the devices used to access the portal showed that the vast majority (91%) were using a mobile phone to access the site, with 7% using desktop computers and 2% using tablets. Users visited from a total of 196 countries, with Bangladesh, Kenya, Ghana and Jordan being four of the top 10 user locations. The top crops searched for across the whole portal in 2021 were coffee, tomato and mango.

Engagement with biocontrol manufacturers and potential private-sector sponsors was a primary focus throughout 2021 to diversify revenue streams towards financial sustainability. In total in 2021, agreements with nine new partners, three sponsors and five associate members were signed. The signing of partner and sponsor agreements is key to the future sustainability of the portal. To reduce reliance on donor funding, private-sector revenue needs to increase. The portal currently has 14 partners and four sponsors, and these numbers must be increased in 2022 with support from the widely connected international industry umbrella organizations, including BioProtection Global and the International Biocontrol Manufacturers Association (IBMA), both currently associates of the portal.

A 2021 study funded by the African Development Bank found that 50% of agricultural advisors, 8% of agro-dealers and 12% of farmers interviewed were already using the portal. The use of biological products among farmers remained low; however, 99% of them claimed they would be willing to use them in future seasons. The CABI BioProtection Portal and its use by farmers and intermediaries represents a strong link between the programme objective of improved farmer advisory and the objective on pesticide risk reduction. In addition to aiding farm-level decisions on plant protection practices, the portal helps stimulate discussion between national pesticide regulators and biocontrol manufacturers on the subject of registering lower-risk plant protection products.

Developing opportunities in digital learning

In 2021, CABI worked with AlphaPlus, an education service business, to assess opportunities for PlantwisePlus in digital learning. The findings of this, plus the knowledge CABI already had about the potential users of digital learning products, were used to develop a digital learning strategy document, a business case and a plan for the approach that should be taken in CABI's digital learning offerings to serve agricultural service providers. One of the first steps taken once a strategy was outlined was to develop a skills framework. This was carried out with input from organizations including Gatsby Africa, Digital Green, Croplife Latin America and Cultivating New Frontiers in Agriculture, as well as with agricultural service provider representatives in Zambia and Pakistan. The skills framework describes more than 200 skills relevant to the work of agricultural service providers. The skills are categorized by role (including extension worker and agri-input dealers), topic and level. The levels employed are Foundation, Practitioner and Advanced. Foundation level applies to someone at an early stage of their career who works under supervision, and the exams for this level test simple recall of information. Practitioner level applies to someone working without supervision; exams for this level therefore require demonstration of applying the course information. Advanced level applies to those in a leadership role, and the assessment for this level requires individuals to submit a portfolio of work reflecting on their practice in light of the information they have learned. The skills framework gives a solid foundation on which to build training programmes, certifications, training needs analysis, job descriptions and career plans for agricultural service providers. A beta version of the skills framework has been published and is available at agricultureskills.org. A "Skills For Agriculture" working group was initiated, with monthly online activities designed to refine the framework. It also served to garner buy-in from individuals and organizations across the world who might consider adopting the framework and applying it to their career development and business.

CABI's first two digital learning courses, Crop Pest Diagnosis and Crop Pest Management, were developed prior to 2021 and are based on Plantwise face-to-face training courses. In 2021, Foundation level exams and certifications were developed for both courses to test attendees' recall of information provided in the courses. Following this, the Crop Pest Management course was piloted with Plantwise partners: participants were given a three-month window to complete the 15-hour, self-study course. A total of 805 users enrolled from 28 countries (53% from Asia, 37% from Africa and 10% from the Americas). Of these, 249 completed the course. This completion rate of 31% is significantly higher than the median for online courses, which is below 10%. Feedback from users showed that 81% completed the course during their private time, while the other 19% completed it during work time. More than half of those who responded said this was the first online course they had taken, and 60% strongly agreed and 31% agreed on the need for a course certificate to demonstrate their capabilities.

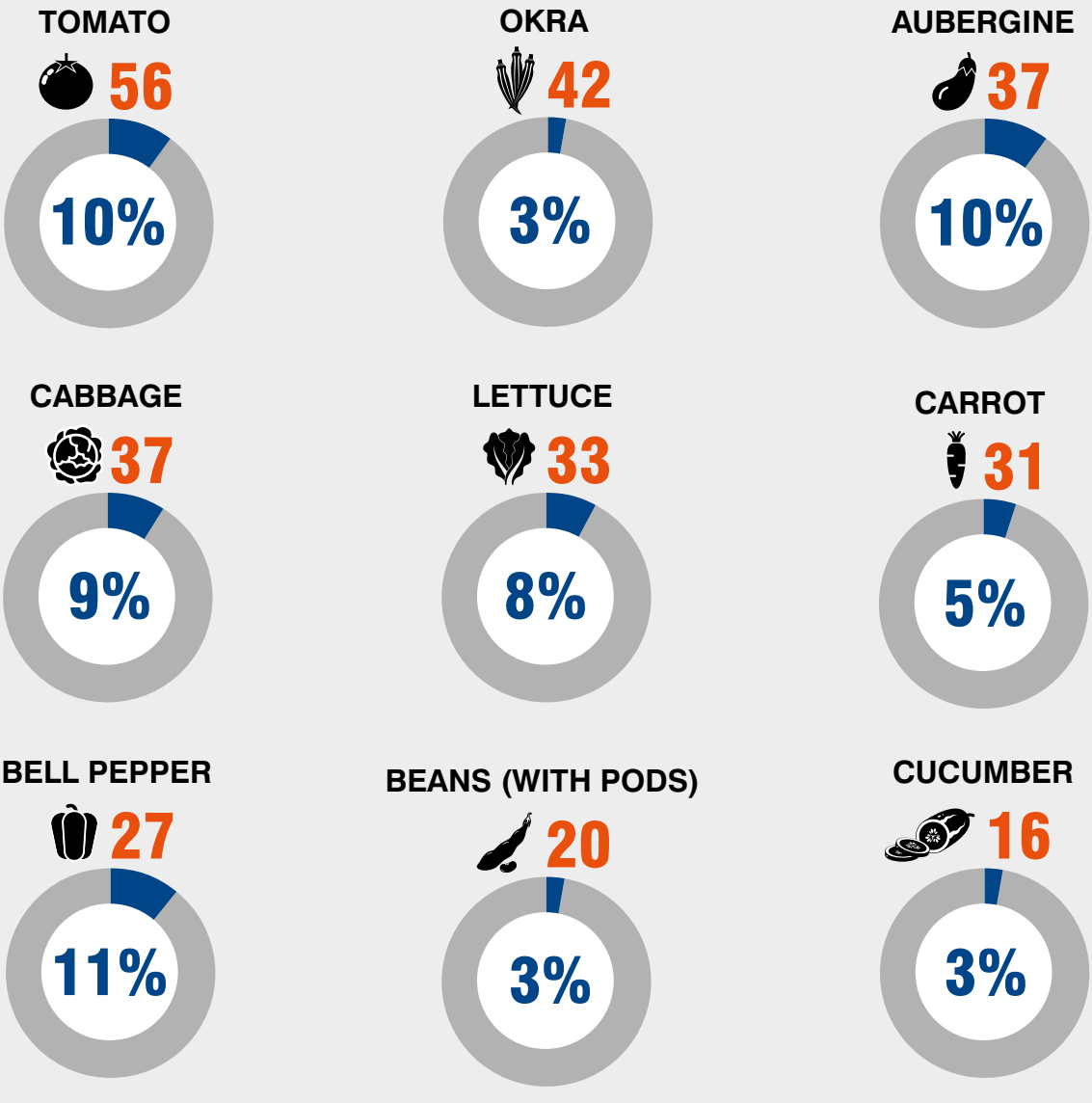
This feedback from the first pilot led to a second experiment to assess the willingness of course users to purchase a certificate after completing the Crop Pest Management course. This is an important question in identifying options for sustainability of digital learning courses. This experiment ran for three months, from 1 October to 31 December, and was open to anyone in the world who wanted to enrol. Once the course was completed, users were given the option to purchase a certificate for £18. This fee was based on research by the Global Forum for Rural Advisory Services (GFRAS), which showed that people would pay US$ 25 for a certificate. A total of 110 users from 31 countries participated in the experiment. Approximately 90% of those users were based in low- and middle-income countries. Only 15 users completed the roughly 15-hour course and, of those, four paid for and downloaded the certificate. Certificates were purchased by users in Nigeria (1), the Philippines (1), Costa Rica (1) and Bolivia (1). PayPal was not available in India, so one user who wanted the certificate was not able to pay. These results, which were captured at the very end of 2021, will feed into discussions on sustainability models for this type of online learning. While the certificate fee may have been an important deterrent, particularly for users from low- and lower-middle-income countries, the credit card-based payment approach was also expected to pose challenges.

In late 2021, the Crop Pest Diagnosis and Crop Pest Management courses, which had been piloted under the Plantwise programme, were reformatted for the CABI Academy, an online platform for a range of CABI products and services. On their previous platform, these two courses had been well received, in particular by plant doctors; however, user feedback made it clear that they would be easier to use and would reach more people if they were reformatted. The content is now searchable, so course participants looking for information can now jump straight to the relevant sections, and the courses are now mobile-friendly, which is very important for the target user groups, most of whom will be accessing the courses from mobile devices. In addition to these improvements, which were requested by the users, the course is now more easily translatable through automated processes and therefore has the potential to reach many more people than in its original format. These improvements are crucial for the wide uptake and longevity of these two courses. In addition, to help with sustainability, a more efficient system was implemented for granting access to users based on their location, reducing the time required by course administrators during roll-out.

Pesticide residues in produce

A review of over 70 different data sources, including academic papers, reports, and databases, examined the status of pesticide residues on food in local markets in 8 countries in Africa and Asia.

In some cases, there were residues of pesticides in both domestic and export crops that exceed the **EU maximum residue levels** (MRL).



Crops displayed here had the largest sample size across all countries examined in the study

NUMBER OF SAMPLES MEASURED	NUMBER OF CROPS	NUMBER OF PESTICIDES (AND METABOLITES) MONITORED	NUMBER OF PESTICIDES EXCEEDING MRL
12,000+	69	989	124

In separate digital development activities in 2021, CABI worked with partners to develop new, high-quality digital learning content. In one instance, CABI collaborated with COLEACP to create online PRA training, making use of relevant CABI tools, including the Crop Protection Compendium, the horizon scanning tool and the PRA tool (see the related description under "Horizon scanning, PRA and response planning for identified threats").

Elsewhere, the highly successful Masters of Advanced Studies (MAS) in Integrated Crop Management (ICM) (worth 60 credit points in the European Credit Transfer and Accumulation System (ECTS)) began a transition from a face-to-face course to a set of online courses. The MAS-ICM programme was run annually in Switzerland from 2015 to 2020 by CABI in collaboration with the University of Neuchâtel, with financial support from the SDC and the Canton of Jura. During this period, 71 students from 22 countries across Africa, Asia and the Americas took part in the nine-month programme. Ongoing monitoring of former course participants shows high levels of satisfaction and positive impacts on careers and farming communities. The decision to adapt the course to an online format came as a result of increasing demands for digital learning due to Covid-19, plus the desire to reach more participants around the world with a reduced cost per student. With support from the SDC, the Canton of Jura in Switzerland and PlantwisePlus, CABI and its collaborators began creating content for three virtual, university-certified courses, each of which would result in a Certificate of Advanced Studies (CAS) in ICM (CAS-ICM) (worth a minimum of 10 ECTS credit points, or approximately 300 hours of learning). Roughly 10% of the student hours are live sessions with tutors and fellow participants to significantly enrich the learning experience. Although the course length and intensity is substantial, they are designed to be accessible to people who are already employed and willing to dedicate about 10 hours of study time per week over a period of seven or eight months. The first CAS-ICM course is being launched in January 2022, ending in August, with a cohort of at least 20 participants from low- and lower-middle-income countries. For this initial pilot, the course fees (£3160 per participant) are covered by scholarships, partly financed by PlantwisePlus during the proof-of-concept phase. Marketing efforts will be made to ensure that scholarships are being covered by foundations or other funding sources (including the private sector) to make these CAS-ISM courses sustainable for participants with limited means to pay the fees themselves. However, due to the commitment required from all participants to see the course through to its end, CABI has required the participants to make a relatively small contribution to the fees (£80 for low-income countries and £160 for lower-middle-income countries). In addition to securing buy-in from participants, this allows an assessment of willingness and ability to pay, as well as a feasibility check on different options for financial transactions.

Pesticide risk reduction

In many agricultural production systems, the indiscriminate use of highly toxic plant protection products is affecting product efficacy as well as human, livestock and environmental health. This in turn decreases the resilience of agricultural and other land use systems to shocks, such as new pest invasions. High-risk (ie high toxicity) plant protection products are still registered and recommended to farmers in several countries, particularly when those countries have few low-risk registered products available as alternatives. Awareness of pesticide risks (acute and chronic) and use of mitigation measures (e.g. personal protective equipment; pre-harvest intervals; low-risk alternatives) are still low among smallholder farmers, agricultural service providers and consumers. The highlights below describe some of the ways PlantwisePlus is contributing towards pesticide risk reduction by increasing demand for and the availability of low-risk plant protection products.

Review of data on pesticide residues in domestic food markets

To better understand the context and issues surrounding food safety, literature reviews were conducted for 12 countries involved in the Plantwise programme (Bangladesh, Burkina Faso, Ethiopia, Ghana, Kenya, Malawi, Nepal, Pakistan, Rwanda, Uganda, Vietnam and Zambia) to determine what evidence there is, if any, of pesticides exceeding MRL in domestic markets. In total, this review found over 70 different data sources that contained measurements of residues of 989 pesticides (active ingredients and metabolites) on over 12,000 samples of 69 crops in eight countries. Data came from over 70 different data sources (academic papers, reports, databases, etc). The five crops tested most often, according to these data sources, are tomato, bean, aubergine, okra and lettuce. The five crops that most frequently exceed MRL (15%–20% of samples analysed) are spinach, squash, passion fruit, pineapple and cauliflower.

Based on the initial findings, three focal countries – Ghana, Kenya and Pakistan – were selected for more in-depth analyses. This included an expanded set of data for the three countries, including academic journals and grey literature sources such as theses, reports, databases and the media. Key informant interviews with stakeholders along the value chain were also carried out in an effort to identify less accessible data on pesticide residues. This provided useful insight into residue monitoring in the three countries. In general, there was evidence of residues of pesticides that are not registered for use in the countries, as well as of pesticide residues exceeding the EU MRL in both domestic and export crops. Certain studies and key informant interviews highlighted frequent exceedance of pesticides that are registered in the countries, such as acephate, chlorpyrifos and imidacloprid. Detections of highly hazardous pesticides (such as persistent organic pollutants) that were observed by several studies in one country are particularly concerning. Awareness campaigns and policy briefs may help influence decision-makers to implement systems that enhance monitoring of plant protection products in the market. Such options are being considered for follow-up steps.

Licensing requirements for agro-input dealers

There are vast differences in the regulatory frameworks that govern operating environments for agro-input dealers across **17 countries** in Africa, Asia, and the Americas.

YES NO NO DATA

17 REQUIRE LICENCE TO SELL AGROCHEMICALS

13 REQUIRE AGRO-INPUT DEALERS TO PAY A LICENCE FEE

8 REQUIRE MANDATORY TRAINING TO OBTAIN LICENCE

4 REQUIRE A TRAINED TECHNICAL ADVISOR ON SHOP PREMISES

Pesticide training – topic covered by mandatory training schemes

NON-TARGET EFFECTS

PERSONAL PROTECTIVE EQUIPMENT USE AND MAINTENANCE

SAFE STORAGE

SAFE HANDLING AND DISPOSAL

Consumer perceptions of pesticide risks

Consumer demand is a key driver for change in agricultural practices. A pesticide situation analysis was conducted in Kenya, Ghana and Pakistan to understand the stakeholders involved in food safety and to evaluate the major food safety concerns and causal factors contributing to these issues. The situation across the three countries varies, as expected; however, commonalities were identified. Although consumers were concerned about the risks of residues from pesticides, there was very limited traceability across value chains, often due to the informal routes through which most food is sold in these countries. Therefore, consumers have few – or no – formal, reliable indicators of food quality in the marketplace.

A more in-depth survey was also conducted in Kenya in 2021 to assess consumer perceptions of food safety. Consumers named a number of food safety concerns, such as pesticide residues and food poisoning due to biological contamination both at home and when eating out. Pesticide residues was the most frequently given response (61% of respondents). Despite this awareness of food safety risks and the stages of the value chain where such risks arise, consumers often felt they had limited or no options. They reported making purchasing decisions based mainly on price and convenience. These collective analyses have identified a range of additional opportunities for influencing behaviours around safe pesticide usage, including engagement of food business operators and policy dialogue, which will be pursued in the next steps.

Registration of lower-risk plant protection products

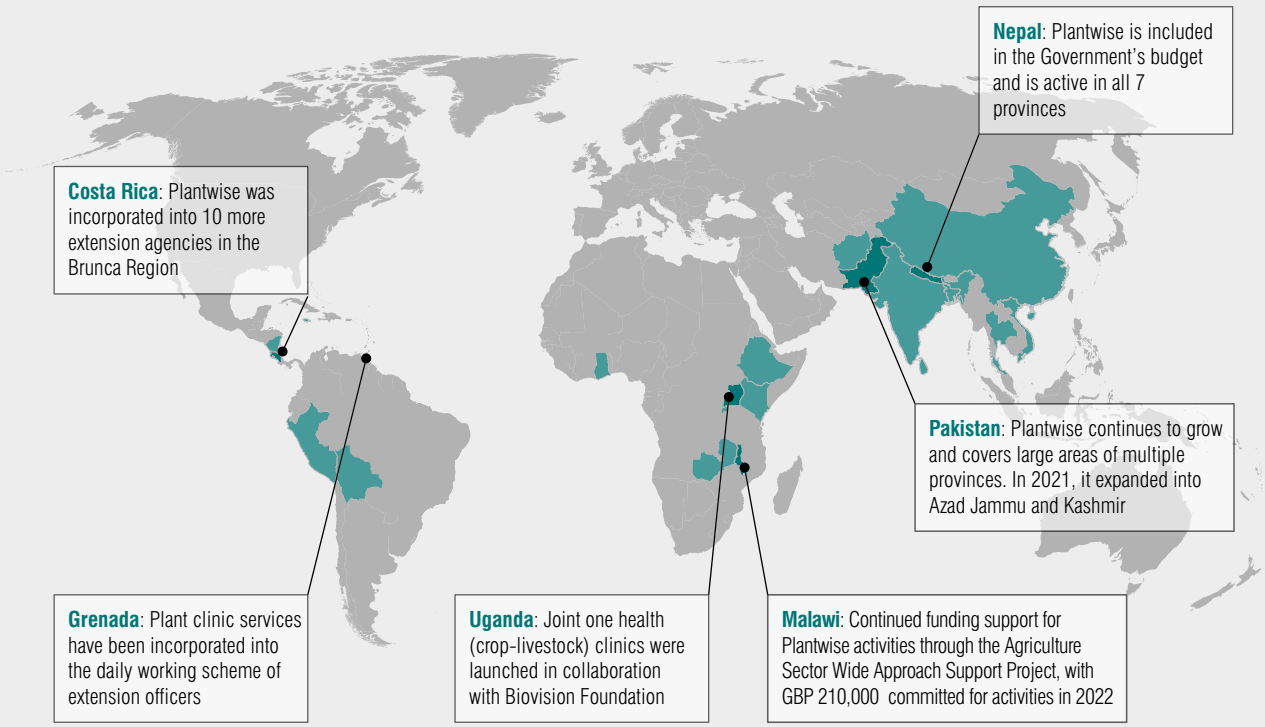
Policy regimes surrounding plant protection products are under review to identify gaps in the enabling environment that constrain the registration and more widespread use of low-risk plant protection products. CABI engages with national and international partners to explore opportunities for establishing more appropriate registration of low-risk plant protection products in their existing legislation/regulations. Pakistan is the first country where PlantwisePlus has engaged partners with this policy-level intervention. This builds on successes made in a U.S. Department of Agriculture (USDA) funded aflatoxin biocontrol project, as a result of which, a policy brief on revised regulations for low-risk plant protection products was prepared and submitted to the Government of Pakistan. Through PlantwisePlus, CABI organized a “biopesticides roadshow”, involving public and private-sector stakeholders to promote discussion on the possibility of increasing the availability of biologically based plant protection products in the country. This event was attended in person by members of the Pakistan Agricultural Research Council (PARC), the Department of Plant Protection and CropLife Pakistan, and included virtual participation by biocontrol manufacturers from outside Pakistan. Presentations by Pakistani authorities revealed that there are currently only six registered biopesticide products and they are struggling to phase out highly toxic pesticides that are currently registered and used. The process for registering microbial and biochemical products in Pakistan is being reviewed and the Agricultural Pesticides Technical Advisory Committee, which is responsible for reviewing and approving the applications/cases related to pesticides registration in Pakistan, has given its approval to the newly developed forms. CropLife Pakistan and the Pakistan Crop Protection Association, official private-sector members of the committees, have also formally agreed to these forms. This provides a basis for governmental approval (foreseen for Q4 2022), which will make a fast-track registration system for bioprotection products available.

Related to this ongoing policy-level activity in Pakistan, the PlantwisePlus programme is also developing an approach to analyse the potential impact of withdrawing high-risk plant protection products from the market. Very importantly, this includes the identification of available alternative pesticides and crop production practices. In 2021, this analysis focused on three widely used pesticides (imidacloprid, mancozeb and metalaxyl) selected from the European Commission’s list of active ingredients classified as “candidates for substitution” (CfS). A list of crops and target pests for which these three pesticides are registered, recommended and applied was compiled for Ghana, Kenya and Pakistan. This creation of crop and pest lists was based on an analysis of the lists of registered pesticides, recommendations by plant doctors in plant clinics and extension materials used in the focal countries. These references, and also the lists of pesticides authorized for use in the EU and in the US, were consulted to identify potential alternatives to imidacloprid, mancozeb and metalaxyl for the same crop–pest combinations, including alternatives that were already registered and alternatives that are not yet registered in each of the three focal countries.

Imidacloprid is recommended and used in Ghana, Kenya and Pakistan for the management of insect pests, including sucking insects, boring insects, leaf miners, leaf feeding insects, termites and other soil pests affecting 30 different crops, including agroforestry nurseries, fruit and vegetables, cotton, tobacco, wheat and flowers. Many of these crops are exported to the EU. Mancozeb, on its own and in formulations with metalaxyl and/or

Ongoing Plantwise approach

Plantwise activities in **24 countries** around the world demonstrate the sustainability and continued importance of the concept to countries and smallholder farmers.



In 2021

2,553
ACTIVE PLANT CLINICS

1,712
PLANT DOCTORS TRAINED

other active substances, is used on approximately 75 crops to manage a variety of diseases, such as early and late blight, downy and powdery mildew and different types of leaf spot on crops both for export and domestic consumption. Many of the other pesticides that are registered in Ghana, Kenya and Pakistan for the same crop and pest combinations are either not authorized for use in the EU or are listed as CfS. However, other active substances currently registered in the three countries for these crop–pest combinations are also permitted in the EU and not listed as CfS. The available information suggests that these options, in combination with other practices as part of an integrated pest management (IPM) programme, could potentially be used as alternatives to imidacloprid, mancozeb and metalaxyl. Data from plant clinics, however, reveal that these alternatives are not recommended as often as imidacloprid, mancozeb and metalaxyl. A next step in 2022 will be to review the efficacy, affordability, practicality and availability of these lower-risk alternatives. This will help countries identify how to prepare for the eventual phasing out of higher-risk products that are currently still in use.

Enhancing capacity of agro-input dealers in IPM and pesticide risk reduction

PlantwisePlus aims to build the capacity of government-licensed agro-input dealers through blended learning approaches and improved decision support tools to increase the provision of IPM-based advice. To help ensure that this enhanced capacity is applied while delivering services to smallholder farmers, the programme is investigating ways in which the performance of agro-input dealers could be monitored. For instance, compliance criteria linked to agreed service standards could be established through either mandatory or voluntary certification schemes.

A multi-country baseline survey was conducted to understand the current regulatory frameworks governing operating environments for agro-input dealers in 17 countries: Bangladesh, China, Costa Rica, Ghana, India, Jamaica, Kenya, Malawi, Myanmar, Nepal, Pakistan, Peru, Sri Lanka, Thailand, Uganda, Vietnam and Zambia. Specifically, this study targeted key stakeholders to examine the current requirements for licensing, training and/or certification as a regulatory obligation, as well as any existing gaps or needs. All countries surveyed have regulations in place regarding the sale of agro-inputs; however, there is enormous variance, for example relating to the required minimum education level, the different training requirements (ranging from none to extensive) and the licensing of agro-input shops versus personnel. The topics covered by the various training schemes ranged from basic business skills to detailed technical training on chemical pesticides. There were, nonetheless, some notable training gaps which could be addressed through future training activities, including IPM and aspects of bioprotection.

In addition to mandatory licensing systems, the survey sought information on existing voluntary schemes for certifying agro-input dealers. Such schemes appear to be very rare in the countries surveyed. Most voluntary training was provided on an ad hoc basis by industry or as part of NGO projects. None were linked to long-term monitoring of use of knowledge attained. There were some exceptions, such as a voluntary certification scheme in China, which uses compliance criteria to assess the status of an agro-input shop (e.g. the availability of trained staff) but does not provide training itself.

As a second step, a large-scale needs assessment was carried out in Uganda to determine the level of interest in a voluntary certification scheme for agro-input dealers and to clearly identify the expectations and needs of the agro-input dealers and key stakeholders of any potential scheme. This survey was developed in collaboration with members of the Department of Crop Inspection and Certification, of the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and of the Uganda National Agro-input Dealers Association to elicit and analyse agro-input dealers' preferences for different attributes of a voluntary certification scheme. More than 550 individual agro-input dealers from 50 districts within the 10 subregions of Uganda were interviewed in November and December 2021. During the same period, a wider global study of agro-input dealers in 13 countries (Bangladesh, China, Costa Rica, Ghana, India, Jamaica, Malawi, Nepal, Pakistan, Peru, Sri Lanka, Uganda, and Zambia) was also implemented using a modified version of the Uganda questionnaire. The data from these surveys will be analysed in 2022 to inform CABI and partners about the need to develop voluntary certification schemes and associated business models. The results should also provide some insights into the type and extent of training of interest to the agro-input dealers.

Annex 1: PlantwisePlus progress against 2021 milestones

Programme outputs	Logframe indicators	2021 milestones	Focus countries	Status	Progress update
Specific Objective 1: Farmer advisory					
Output 1.1 Digitally supported PlantwisePlus Toolkit developed to facilitate implementation of sustainable and safer plant health practices	Toolkit of tools developed and accessible for key users in each country	1 tool of PlantwisePlus Toolkit available for use in 8 countries	Global, but individual tools may have a country focus – e.g. the CABI BioProtection Portal now holds data from 28 countries (16 new in 2021, including Burkina Faso, Chad, Mali and Senegal)	Q4 (on track)	A new version of the CABI BioProtection Portal website was released that allows partners access to analytical dashboards. The Plantwise Knowledge Bank and factsheet app continue to be supported through the programme as they provide information of global relevance and are important elements of Plantwise backstopping. Financial support was provided to the Invasive Species Compendium as part of agreed path to sustainability. User needs workshops, to identify areas for new tool development, were conducted in Zambia and Pakistan, with different user types and genders represented. This was complemented by additional surveys conducted remotely in 14 countries. Landscaping analysis of existing tools (over 400 apps and websites) was completed, with 40 "preferred" apps identified; however, of these only a few were of interest for the toolkit. Design and development of an online catalogue of crop protection apps (Crop App Index) and a pesticide dosage calculator (Crop Sprayr) were undertaken.
Output 1.2 Effective data collection systems developed and tested for quality assurance and market intelligence through the PlantwisePlus Toolkit	Proposed mechanisms for quality assurance of Toolkit use and advice based on it	Enhanced data management system concept developed for capture of data from PlantwisePlus toolkit	Global	Q1 (on track)	An internal survey was undertaken to define which types of data should be collected through the toolkit and how these data would be used. A report of the survey results was compiled, with assessment of data collected through existing CABI tools and interfaces with existing systems/tools. Special consideration was given to the existing Plantwise Online Management System and opportunities that the new CABI platform could offer, but the decision was made to design a bespoke data collection system to ensure flexibility. A simple proof-of-concept data system was developed using data from one tool.

Programme outputs	Logframe indicators	2021 milestones	Focus countries	Status	Progress update
Output 1.3 Training and digital learning products created to support capacity building of agricultural service providers	Existing digital learning and other training products ready for roll-out in local languages to agricultural service providers	3 learning and training products rolled out in English, one of which also in Spanish	Global	**Q4 (on track)**	User feedback from the Crop Pest Diagnosis course was analysed and improvements made in response to the comments received. Workshops were conducted to sort about 200 skills by level (Foundation, Practitioner, Advanced) and by role (for target user groups). A skills framework (beta) was published online and feedback from external organizations was incorporated. Thirteen modules from the Crop Pest Diagnosis and Crop Pest Management courses were reformatted to enable them to be searchable, mobile responsive and more easily translated. The Crop Pest Diagnosis course is available in both English and Spanish, whereas the Crop Pest Management course is currently only available in English. In collaboration with COLEACP, an online PRA course was developed (in English).
	Feasibility for digital learning and training approach appraised	Feasibility report on digital learning approach	Global	**Q3 (on track)**	Work was undertaken with the consultant (AlphaPlus) to assess opportunities for PlantwisePlus in digital learning. The findings were used to develop a feasibility assessment that included a strategy, business case and detailed plan for 2022.
	New digital learning products developed on the basis of existing course materials (e.g. use of natural enemies in sustainable agriculture)	Digital learning content developed for 4 courses	Global	**Q4 (minor delay)**	Two CAS courses on ICM were developed as online courses, with an accredited certificate from the University of Neuchâtel. Ten online course modules were created, covering a range of related aspects. A third CAS course will be completed in early 2022. In collaboration with COLEACP, an online PRA course was developed. The training included PRA theory and made use of relevant CABI tools, such as the Crop Protection Compendium, the horizon scanning tool and the PRA tool. Access to the PRA tool was granted to qualifying plant protection and quarantine staff in the ACP region. In addition, 13 modules from the Crop Pest Diagnosis and Crop Pest Management online courses were updated. A certification framework is under development that includes certificates for completion of courses and badges for modules. New courses are under development based on the curriculum needs identified from the skills framework.
	Financing models assessed for digital learning products	Report on financing models for digital learning products	Global	**Q4 (on track)**	A business model report was developed, including estimates of the potential amounts and sources of revenue based on several assumptions. An experiment to assess the willingness to pay for certificates was conducted to inform the digital learning financial models.

Programme outputs	Logframe indicators	2021 milestones	Focus countries	Status	Progress update
Output 1.4 Agricultural service providers equipped with new digital learning products and decision-making tools	Number of male and female agricultural service providers using PlantwisePlus Toolkit and digital learning products online and offline, per pilot country	12,000 men and women service providers using toolkit, digital learning tools in 37 low and lower-middle income countries	Global	**Q4 (on track)**	Some improvements were made to the existing tools – the Plantwise Knowledge Bank, crop simulator apps and the Fertilizer Optimizer Tool. In total, 96,043 agricultural service providers (advisors and agri-input suppliers) were recorded using the tools (58,034 men and 37,104 women). The largest proportion of users came from the CABI BioProtection Portal (95,138); the remainder came from the Crop Pest Management course (767) and the COLEACP PRA course (138). The Crop Pest Management course was made available through pilot releases, with 915 users registering from at least 31 countries. The CABI BioProtection Portal was launched in 16 new countries and promoted to target users. Feedback on the Crop Sprayr dosage calculator concept, and later prototype, were gathered from target user groups.
	Number of farmers supported with information about climate smart agricultural techniques	475,000 women and men farmers receiving information/advice through direct use of tools or receipt of advice from agricultural service providers	Global	**Q4 (on track)**	An estimated 636,747 farmers were reached through the PlantwisePlus programme in 2021. Plant clinics (both face-to-face and online) accounted for 264,723 interactions between farmers and advisors in 22 countries. Plant health rallies implemented in eight countries reached a further 10,864 farmers. Mass extension campaigns were conducted in a few countries (Nicaragua, Zambia, Uganda and Nepal), reaching an estimated 95,450 farmers. Another major mass extension campaign was launched in Zambia in late 2021 but will carry over to 2022 and will therefore only be considered in the next round of reporting. The CABI BioProtection Portal reported 220,548 users, and the Plantwise Knowledge Bank had 45,162 users in 2021. The enhanced analytics implemented on other digital tools will allow for additional valuable data to be captured on usage (e.g. the Fertilizer Optimizer Tool).

Programme outputs	Logframe indicators	2021 milestones	Focus countries	Status	Progress update
	Number of women farmers accessing extension advice	100,000 women farmers reached through service providers	Global	**Q4 (minor delay)**	In Ghana, a GRAST assessment was completed. The final report with recommendations was shared with partners. Planning and material development for a stakeholder validation workshop and advocacy event was undertaken, but the event was delayed and will now take place in early 2022 due to availability of critical personnel. Gender-disaggregated usage data collected through the digital tools revealed that 112,481 women were reached through service providers associated with the Plantwise programme. The largest proportion of women reached was through the Plantwise Knowledge Bank (86,014), with smaller numbers reached through plant clinics (21,678), plant health rallies (1867) and the CABI BioProtection Portal (2922).
Specific Objective 2: Pesticide risk reduction through safer and locally produced food					
Output 2.1 Domestic demand for safer produce increased	Proportion of stakeholders, including domestic consumers aware of risks of pesticide residues in food (disaggregated by gender, age, etc)	1 literature review conducted on pesticide residues in 5 countries	Bangladesh, Burkina Faso, Ethiopia, Ghana, Kenya, Malawi, Nepal, Pakistan, Rwanda, Uganda, Vietnam and Zambia	**Q3 (on track)**	A literature review was conducted for 12 countries to determine evidence of pesticides exceeding MRL. An in-depth analysis of an expanded set of data, including grey literature and key informant interviews with stakeholders along the value chain, provided further insights into residue monitoring in three countries: Ghana, Kenya and Pakistan. A pesticide situation analysis in these three countries and a consumer survey (Kenya) provided further information on the required policy and communication strategies to reduce food safety risks.
Output 2.2 Farmers working to a voluntary crop production standard to deliver safer, environmentally friendly produce to higher value markets	Number of production standards identified, adapted and adopted for pilot agricultural value chains	2 market assessments conducted in 2 countries to identify focal value chains for implementation of production standards	Kenya, Ghana, Vietnam and China	**Q4 (on track)**	Literature reviews were conducted at a global level and at a national level in four countries: China, Vietnam, Kenya and Ghana. These studies firstly provided insights to determine the relevance and types of existing food safety production standards and demand for standards to safeguard food safety, and secondly helped identify the best-bet supply chains and markets to investigate further.

Programme outputs	Logframe indicators	2021 milestones	Focus countries	Status	Progress update
Output 2.3 Job opportunities for young men and women in rural communities to provide agricultural services to local producers	Number of men and women (by age group) trained to become agricultural service providers, providing high quality and appropriate climate smart agricultural techniques	New partnership developed with 1 agribusiness initiative and 2 training modules adapted according to knowledge gaps identified	Kenya	**Q4 (minor delay)**	A desk-based assessment of existing initiatives that support women and youth engagement in agricultural service provision was conducted. Subsequently, an in-depth skills gap analysis was completed for farmer organizations in Kenya and to identify potential target groups to focus on. The assessment was undertaken through an LoA with the Kenya National Farmers Federation. Decisions on target groups and interventions will be made in early 2022 (pending the results of the assessments), followed by the preparation of training modules. This delay has been caused by discussions with collaborators taking longer than anticipated.
Specific Objective 3: Pest preparedness					
Output 3.1 Decision support system established for national authorities to prioritize pests for monitoring and management	In-country decision support system designed, refined and updated regularly	New or existing decision support tools and processes used to prioritize invasive species for monitoring and management in 2 countries	Thirty-six countries in western, eastern and southern Africa	**Q4 (on track)**	The first pest insight reports were produced for three countries (Ghana, Kenya and Zambia). PRA training sessions were completed in Kenya, Ghana and Pakistan. Horizon scanning tools were used to prioritize nine species in Pakistan, 16 species in Kenya, and three species in Ghana, and full PRAs were completed using CABI's PRA tool. A survey was conducted with key informants of fragile states in West Africa to identify knowledge gaps and needs relating to PRA for a proposed intervention in 2022. Biological control and other management research is ongoing for FAW under four separate research streams: (1) Eiphosoma laphygmae has been imported into Kenya for host specificity testing against different Spodoptera species prior to release against FAW, and similar host range testing was completed on six host lepidoptera species in Pakistan; (2) an assessment of the parasitoid Telenomus remus has been carried out in Ghana; (3) an investigation of intercropping and time of planting has been carried out in Zambia; and (4) testing of entomopathogenic nematodes has been carried out in Rwanda.

Programme outputs	Logframe indicators	2021 milestones	Focus countries	Status	Progress update
Output 3.2 Coordinated pest preparedness, prevention and management through use of newly established decision support system	Number of pests prioritized by national systems	Evidence of impacts for 1 invasive pest generated and its management systems prioritized in one country	Kenya, Pakistan, Rwanda Zambia	**Q4 (on track)**	Three pests have been prioritized by national systems for management (papaya mealybug; FAW; Parthenium). Biocontrol agents have been identified for each of these target species, including Acerophagus papayae for papaya mealybug in Kenya; Listronotus setosipennis for Parthenium weed in Pakistan; and Eiphosoma laphygmae for FAW in Pakistan (and Kenya). In addition, research on an entopathogenic nematode for FAW control is being undertaken in Rwanda. Data have also been collected on the knowledge gaps and impacts of a further three invasive species. (1) A study was carried out on cassava brown streak disease for generating evidence of its economic impacts conducted in Zambia (516 farmers, six focus group discussions (FGDs)). (2) In Kenya, a study was conducted on the economic costs of management practices of the golden apple snail (706 farmers, eight FGDs, seven agricultural extension service providers and eight agro-dealers). (3) In Kenya, a study was completed on knowledge, attitudes and practices relating to biological control approaches against the papaya mealybug to inform field release strategies (383 farmers, eight FGDs, nine extension service providers and 36 agro-dealers). Results will be published in 2022.
	Number of pest prevention and management plans for high priority pests using decision support systems agreed, implemented and regularly updated based on lessons learned	Response plan developed for an established invasive species with national partners in 2 countries	Ghana	**Q4 (minor delay)**	A response plan was developed to mitigate against two Liriomyza pest species in Ghana. A response plan had been planned for golden apple snail in Kenya; however, this has been delayed to 2022 due to prioritization of other related activities, such as an evidence note for the species and the mass extension campaign.

Programme outputs	Logframe indicators	2021 milestones	Focus countries	Status	Progress update
Specific Objective 4: Pesticide risk reduction through promotion of low-risk pest control approaches					
Output 4.1 Enhanced capacity among agro-input dealers following voluntary standard on integrated pest management and pesticide risk reduction	Business models for a voluntary standard for agro-input dealers developed and rolled out	Business concept developed for a voluntary certification scheme for agro-input dealers	Bangladesh, China, Costa Rica, Ghana, India, Jamaica, Kenya, Malawi, Myanmar, Nepal, Pakistan, Peru, Sri Lanka, Thailand, Uganda, Vietnam and Zambia	**Q4 (on track)**	A needs assessment was undertaken through questionnaires sent to 17 countries on the requirements to become an agro-input dealer. Further questions were sent out to 12 of the countries to assess the need/desire for a voluntary scheme on promoting the use of safer plant protection products. Following Covid-19-related travel delays, one large-scale needs assessment was implemented in Uganda in November 2021 (data to be analysed early 2022). Business models will be explored in 2022, taking into consideration the results from the needs assessment.
Output 4.2 Regulators engaged towards registration of low-risk plant protection products and use with a focus on specific crops	Recommendations on fast tracked registration of low-risk plant protection products (for pilot agricultural value chains)	Regulations for registration of low-risk plant protection products updated in 1 country	Pakistan	**Q4 (minor delay)**	A questionnaire on what the current pesticide regulations are for Pakistan was sent out. After sending a policy brief (see below), newly drafted recommendations for biopesticide regulations are currently with the government for consideration. This is a new policy area for this government in Pakistan, and it is difficult to predict how long the review process will take. However, recent discussions indicate the government is committed to the development of regulations for safer plant protection products. The regulations are unlikely to be updated before the end of June 2022, but there are indications the government is making progress towards this.
	Policy briefs (crop specific/nationally adapted) produced and distributed	1 policy brief developed on regulatory process for low-risk plant protection products	Pakistan	**Q4 (on track)**	A policy brief has been submitted to the Government of Pakistan in order to make it easier to register safer plant projection projects. PlantwisePlus decided that Pakistan would be a good country to trial writing a policy brief, given the government has expressed concerns about the high level of chemical pesticide use and the effect this is having on human health, the environment and the potential to export commodities.
Output 4.3 New agricultural businesses for low-risk plant protection products established	Functionality of newly established pilot production facilities assessed against agreed business plans	2 plant protection agents identified for local production, targeting specific pests/crops in 2 countries	Kenya, Pakistan and Zambia	**Q4 (on track)**	Production facilities for two biocontrol agents have been established. In Kenya, the papaya mealybug parasitoid has been identified and approved for control of papaya mealybugs. This links with biological control developments under Specific Objective 3 (Pest preparedness), with a clear opportunity for community-level production. In Pakistan, the egg parasitoid Trichogramma has been selected for controlling leptodoptera pests on tomato. In addition, analysis is continuing on the opportunity for local production of the fungus Metarhizium to control FAW in Zambia, and baculovirus trails are being carried out against FAW in Kenya with the biocontrol manufacturer Andermatt Biocontrol.

Annex 2: 2022 PlantwisePlus milestones

Programme outputs	Logframe indicators	2022 milestones	Focus countries
Specific Objective 1: Farmer advisory			
Output 1.1 Digitally supported PlantwisePlus Toolkit developed to facilitate implementation of sustainable and safer plant health practices	Toolkit of tools developed and accessible for key users in each country	One new tool (five tools cumulative) accessible from the PlantwisePlus Toolkit platform, with evidence of use of the new tool in eight countries	Ghana, Kenya, Uganda, Zambia, Pakistan, Bangladesh, Nepal and Sri Lanka
Output 1.2 Effective data collection systems developed and tested for quality assurance and market intelligence through PlantwisePlus Toolkit	Proposed mechanisms for quality assurance of toolkit use and advice based on it	Data management system developed and providing insights from data captured from at least 2 tools in the PlantwisePlus Toolkit	Global
Output 1.3 Training and digital learning products created to support capacity building of agricultural service providers	New digital learning products developed on the basis of existing course materials (e.g. use of natural enemies in sustainable agriculture)	Digital learning content developed for 3 new courses	Global
Output 1.3 Training and digital learning products created to support capacity building of agricultural service providers	Existing digital learning and other training products ready for roll-out in local languages to agricultural service providers	4 new digital learning products (7 cumulative) rolled out to agricultural service providers	Global
Output 1.3 Training and digital learning products created to support capacity building of agricultural service providers	Feasibility for digital learning and training approach appraised	Assessment in 1 country of uptake and benefits of digital learning for agricultural service providers	To be determined

Programme outputs	Logframe indicators	2022 milestones	Focus countries
Output 1.3 Training and digital learning products created to support capacity building of agricultural service providers	Financing models assessed for digital learning products	Review financial models for digital learning products	Global but specific to each digital learning product
Output 1.4 Agricultural service providers equipped with new digital learning products and decision-making tools	Number of male and female agricultural service providers using PlantwisePlus Toolkit and digital learning products online and offline, per pilot country	15,000 men and women service providers using tools from the PlantwisePlus Toolkit and digital learning products in 2022, in 40 low and lower-middle-income countries	For example: Kenya, Ghana, Uganda, Burkina Faso, Côte d'Ivoire, Jordan, Bangladesh, etc
Output 1.4 Agricultural service providers equipped with new digital learning products and decision-making tools	Number of farmers supported with information about climate-smart agricultural techniques	475,000 women and men farmers receiving information/ advice in 2022 through direct use of tools or receipt of advice from agricultural service providers	Global
Output 1.5 Improved provision of gender-sensitive agricultural extension services	Number of women farmers accessing extension advice	100,000 women farmers reached in 2022	Global
Output 1.5 Improved provision of gender-sensitive agricultural extension services	Number of agricultural service providers adopting innovative approaches to reach women farmers	40 service providers across 2 countries trained in innovative approaches to reach women farmers	Ghana and Pakistan
Specific Objective 2: Pesticide risk reduction through safer and locally produced food			
Output 2.1 Domestic demand for safer produce increased	Proportion of stakeholders, including domestic consumers, aware of risks of pesticide residues in food (disaggregated by gender, age, etc)	Agreement made with policy-makers and other relevant stakeholders on target groups and messaging for awareness-raising campaign in 1 country	Kenya
Output 2.2 Farmers working to a voluntary crop production standard to deliver safer, environmentally friendly produce to higher value markets	Number of production standards identified, adapted and adopted for pilot agricultural value chains	Identify focal value chains for implementation of production standards, and PlantwisePlus intervention agreed with local partners in 1 country	Kenya or Ghana
Output 2.3 Job opportunities for young men and women in rural communities to provide agricultural services to local producers	Business models for agricultural service provision identified and tested, with best fit highlighted for roll-out	New partnership developed with 1 agribusiness initiative to enhance agricultural service provision	Kenya
Output 2.3 Job opportunities for young men and women in rural communities to provide agricultural services to local producers	Number of men and women (by age group) trained to become agricultural service providers, providing high-quality and appropriate climate-smart agricultural techniques	Training of agricultural service providers initiated in partnership with a rural employment initiative in 1 country	Kenya

Programme outputs	Logframe indicators	2022 milestones	Focus countries
Specific Objective 3: Pest preparedness			
Output 3.1 Decision support system established for national authorities to prioritize pests for monitoring and management	In-country decision support system designed, refined and updated regularly	Insight reporting system expanded to include an additional 2 countries (3 cumulative) and/or pests	Ghana and Zambia
Output 3.1 Decision support system established for national authorities to prioritize pests for monitoring and management	In-country decision support system designed, refined and updated regularly	CABI's horizon scanning tool used to prioritize invasive species for monitoring and surveillance in 3 countries (6 cumulative), including at least 1 fragile state	Burkina Faso, Niger and Zambia
Output 3.1 Decision support system established for national authorities to prioritize pests for monitoring and management	In-country decision support system designed, refined and updated regularly	CABI's PRA tool used to prioritize invasive species for management in 2 countries (5 cumulative), including at least 1 fragile state	Burkina Faso, Niger and Zambia
Output 3.2 Coordinated pest preparedness, prevention and management through use of newly established decision support system	Number of pests prioritized by national systems	Evidence notes on impacts of 2 invasive pests generated and management systems prioritized in 2 countries/ regions (5 cumulative)	Zambia and southern Africa
Output 3.2 Coordinated pest preparedness, prevention and management through use of newly established decision support system	Number of pest prevention and management plans for high-priority pests using decision support systems agreed, implemented and regularly updated based on lessons learned	Response plan implemented for an established invasive species with national partners in 2 countries (3 cumulative)	Kenya and Pakistan
Output 3.2 Coordinated pest preparedness, prevention and management through use of newly established decision support system	Number of biological control agent release applications submitted	Evidence of classical biological control agent efficacy and risk analysis documented and used to inform management in 1 country (3 cumulative)	Uganda
Output 3.2 Coordinated pest preparedness, prevention and management through use of newly established decision support system	Number of biological control agent release applications submitted	Release applications submitted in 2 new countries (4 cumulative)	Uganda and Burkina Faso
Output 3.2 Coordinated pest preparedness, prevention and management through use of newly established decision support system	Number of biological control agent release applications submitted	Biological control agent release permitted in 2 countries and post-release evidence of impact on the target species measured	Kenya and Pakistan

Programme outputs	Logframe indicators	2022 milestones	Focus countries
Specific Objective 4: Pesticide risk reduction through promotion of low-risk pest control approaches			
Output 4.1 Enhanced capacity among agro-input dealers following voluntary standard on integrated pest management and pesticide risk reduction	Business models for a voluntary standard for agro-input dealers developed and rolled out	Business concept developed for voluntary standard for agro-input dealers	Global
Output 4.1 Enhanced capacity among agro-input dealers following voluntary standard on integrated pest management and pesticide risk reduction	Number of agro-input dealers (disaggregated by gender, age, etc) trained on low-risk plant protection advice/products and accessing related information through the PlantwisePlus Toolkit, digital learning course and other information sources	Develop and test initial training modules in 1 country	Uganda
Output 4.2 Regulators engaged towards registration of low-risk plant protection products and use with a focus on specific crops	Recommendations on fast tracked registration of low-risk plant protection products (for pilot agricultural value chains)	1 new country (2 cumulative) identified and engaged on improving registration of safer plant protection	To be determined
Output 4.2 Regulators engaged towards registration of low-risk plant protection products and use with a focus on specific crops	Policy briefs (crop specific/nationally adapted) produced and distributed	Policy brief developed on regulatory process for low-risk plant protection products for 1 new country (2 cumulative)	To be determined
Output 4.3 New agricultural businesses for low-risk plant protection products established	Functionality of newly established pilot production facilities assessed against agreed business plans	Scale up production and release of safer plant protection products in 2 target countries	Pakistan and Kenya

PlantwisePlus enables countries to confidently face the challenges of plant health threats in a changing climate by empowering smallholder farmers to increase income, food security and food safety by producing more and higher quality food.

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