Chapter 1

Plant Health Clinics

1.1 An Introduction

Many of you reading this chapter will have heard of plant health clinics (PHCs), and some of you may have experienced them firsthand. You will know that they are an attempt to help extension officers and farmers work together to reduce crops losses from pests, diseases and weeds, which FAO estimates to be between 20 to 40 percent annually. Certainly, if you include poor crop growth due to nutritionally deficient soils or damage from modern agricultural practices, the reduction is probably nearer the higher end.

But what you might not know is how PHCs started and why they have spread so quickly around the world. Looking at the origin of PHCs – why they were established in the first place and how they have developed – may give useful insights and ideas for use in the Pacific region. Here we give a brief account of how they started, taken from a story told by one of the people who was there at the beginning and, later, how they have developed in Pacific island countries[1] [2].

Let's set the scene. It's a small town, Tiraque, about 2 hours from Cochabamba, in Bolivia, South America, in December 2001. Next day is the weekly market (a so-called agricultural fair) when farmers come to town. Staff from two non-government organisations, one local (PROINPA[3]), the other international (CABI[4]) are discussing how to bring agricultural diagnostic and advisory services closer to farmers to play their part in reducing global poverty, an objective of the United Nations Millennial Development Goals, which had appeared the previous year. For this, they needed a new approach.

After much deliberation, it was decided to give an unannounced public demonstration of a diagnostic test for a crop disease to as many farmers as were interested. The test they chose was for root-damaging nematodes of potato, and what to do if the nematodes were present — crop rotation. Root nematodes are a major problem of potato, the staple food crop of the region.

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1 Boa E (2009) How the Global Plant Clinic began. Outlook on Pest Management: 112-116.

2 Bentley, Jeffery W., Eric Boa, Solveig Danielsen, Pablo Franco, Olivia Antezana, Bertho Villarroel, Henry Rodríguez, Jhon Ferrrufino, Javier Franco, René Pereira, Jaime Herbas, Oscar Díaz, Vladimir Lino, Juan Villarroel, Fredy Almendras & Saúl Colque (2009) Plant Health Clinics in Bolivia 2000-2009: Operations and Preliminary Results. Food Security 1(3):371-386.

3 PROINPA — Promoción e Investigación de Productos Andinos.

4 CABI – Intentional, inter-governmental, not-for-profit organisation, previously Commonwealth Agriculture Bureau International, now Centre for Agriculture and Bioscience International.

At this point, we should introduce the two representatives from CABI, as they appear later in this chapter. One was Eric Boa, head of the Global Plant Clinic that provided diagnostic and advisory services to developing countries, and Jeff Bentley, a CABI associate and resident of Bolivia. The representatives from PROINPA were agricultural technicians, experts in extension, both at ease with farmers and fluent in the local language, but neither were expert plant pathologists.

Although there was no warning that demonstrations would be held, large number of farmers came to hear about the diagnostic tests for potato nematodes. A similar interest was shown a few days later when diagnosis and advice were given on fruit crop diseases in a town close by. On that occasion, there was no market day, so talks were held at the bus station using a borrowed table!

So, the idea of mobile plant health clinics as they became known was born. Soon after, one of the international research organisations, CIAT[5], also became involved. CIAT already had an office in Bolivia and gave daily advice to farmers at a permanent building in a town not far from Cochabamba, which has a laboratory, so mobile PHCs were a natural extension to their on-going work. The connection between the so-called 'mobile' and 'fixed' clinics is important; they can be mutually supportive. Mobile clinics need expert diagnostic support, and labs can take advantage of mobile clinics with their access to crops of the neediest farmers, and any new problems as they arise.

The early success in Bolivia was sufficient for the Global Plant Clinic to partner other countries in trying out PHCs. The first countries were Bangladesh, Nicaragua and Uganda, followed by many more countries in Asia, Africa and Latin America. By 2009, there were 21 countries holding PHCs either regularly or testing them in pilot schemes. In some, NGOs took the lead, as had happened initially in Bolivia, in others, it was national governments, and sometimes a partnership between the two. Not all were successful, with some countries unable to find a suitable organisation to host the PHCs[6], but overall, the output has been extremely rewarding[7].

In 2011, the CABI plant clinics program, previously under the Global Plant Clinic, was transferred to Plantwise under Plant Health Systems Development, together with two other components: The Plantwise Knowledge Bank and Monitoring and Evaluation. By the end of 2018, approximately 3000 PHCs had been established in 30 countries, and more than 10,000 people trained to hold them[8]. Apart from PHCs, rallies were also held at town squares or in large streets providing farmers with information on topics that were known to be of interest to them.

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5 CIAT, Centro Internacional de Agricultura Tropical, Peru.

6 Ibid p. 115.

7 Impact Report 2011-2018. CABI Plantwise. pp. 58.

8 Plantwise Impact Report 2018. CABI, UK.

An idea, formulated on the eve of a market in Bolivia in 2003 to provide farmers with information on how to protect their crops against an important local pest, had become worldwide within 15 years. Today, we would say it had gone viral! Wherever PHCs were held, the format was similar: venues were farmer-friendly places, farmers brought samples of their crops with pest and disease damage, and locally trained extension staff — 'plant doctors' — made a diagnosis and provided verbal and written recommendations on management. Written instructions were given to farmers to retain, just like the prescription we get from a medical doctor. The similarity to clinics and health centres for humans was readily understood by farmers. It was an idea worth testing in Pacific island countries.

1.2 Plant health clinics in the Pacific — a start

Just as in many countries of Asia, Africa and Latin America, PHCs provided Pacific islands with a new approach. Technical support services for farmers with pest and disease problems were often ineffective, with farmers left without advice and having to deal with them as best they could. This often resulted in either nothing being done and the problem getting worse, or the use of inappropriate control measures. Further, as noted elsewhere, it had been challenging to create effective collaboration between all those involved in plant protection to build an effective plant health system that was so badly needed. This was of concern, especially at a time when agricultural production for local and export markets was being emphasised, demands for home use were growing, and more than 70 percent of the population in many Pacific island countries were relying on agriculture for their livelihood. A climate crisis with the potential to create epidemics of pests and diseases could only make matters worse.

News of plant health clinics reached the Pacific soon after they became established in Bolivia, and were being tested in Bangladesh, Nicaragua, and Uganda. At about that time, an ACIAR project to re-establish a plant protection capability in Solomon Islands, IPPSI[9], had started with the objective of increasing community awareness and understanding of plant pests and diseases, leading to improved and sustainable crop management. PHCs seemed an ideal way to achieve this, and with funding promised later, IPPSI began writing fact sheets on the most important pests and pathogens of the country in preparation, realising that if a sub-regional project eventuated, many of the fact sheets would have a wider significance.

The project did eventuate with the support of ACIAR. Phase 1, *Strengthening integrated crop management research in the Pacific islands in support of sustainable intensification of high-value crop production* (HORT/2010/090) began in 2011, implemented by the University of Queensland in association

[9] IPPSI, Improved Plant Protection for Solomon Islands (ACIAR funded).

with the Pacific Community (SPC). Along with Solomon Islands, the project partners were Fiji, Samoa and Tonga.

With agreement between the partners, the PHC program began as a pilot phase in Solomon Islands in May 2012 (Fig. 1.1). Eric Boa from CABI conducted the initial training, bringing experience in establishing PHCs elsewhere. He presented Module 1, Field diagnosis and plant clinic operations, a three-and-a-half-day course given to workshop participants who came from research and extension divisions of all four project partners. The idea being that at the end of the pilot phase, they would return to Solomon Islands and take part in an evaluation; this would help with the uptake of PHCs in their own countries. After the initial training given by Eric Boa, everyone took part in PHCs at markets to practise their newly-developed skills as plant doctors[10]. There was a short reflection where plant doctors shared samples brought by farmers and the diagnoses and recommendations that they had made.

Subsequently, more than 20 clinics were held in Solomon Islands on the islands of Guadalcanal and Malaita, followed by a three-week evaluation after 16 months. Jeff Bentley was the evaluator, visiting both islands and seeing clinics in operation. Jeff's report made interesting comments and recommendations.

The evaluation of the pilot phase showed that farmers face challenges in managing plant health problems and extension workers have difficulties giving advice. Biotic (pests and diseases) and abiotic (non-biological) causes lead to regular and often significant losses in crop production and quality. Diagnosis is difficult because of the diversity of symptoms and possible causes, meaning that choosing the best management options needs skill and careful consideration. On a more positive side, the pilot phase showed that there was high farmer satisfaction with the PHCs, and the plant doctors' knowledge and confidence improved substantially over the period.

Recommendations from the evaluation suggested:

- pilot phases in other project countries for 18 to 24 months before widespread establishment of PHC programs
- a 'champion' with enthusiasm and commitment to PHCs should be selected within each country
- more pest and disease fact sheets should be written
- the sustainability of PHCs beyond the funding period should be a consideration at the outset, with clinics incorporated into department policies and workplans
- PHCs should be written into extension staff terms of reference, they were not to be thought of as unpaid extra work.

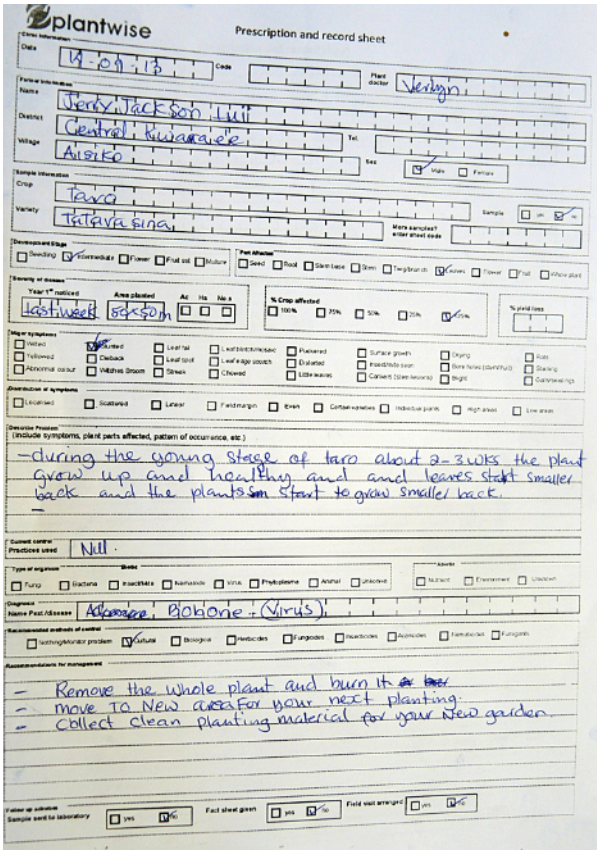
[10] Module 2 is on giving good management advice to farmers, Module 3 on writing pest fact sheets, and Module 4 Monitoring plant clinics.

Fig. 1.1 Introduction to the PHC, May 2012, Henderson, Guadalcanal.

An evaluation at the Honiara market with Jeff Bentley. Source: authors

A plant doctor giving advice to a farmer. Source: authors.

Representatives from Fiji, Samoa, Solomon Islands, Tonga (and Eric Boa). Source: authors.



CABI Plantwise prescription form (now replaced)

Overall, the pilot phase was considered a success. Clinics continued in Solomon Islands, Fiji and Samoa, all of which had sent representatives to the first workshop in 2012, and decided to start their own programs, even though support had not been budgeted under Phase 1. In Tonga, a start was made in 2018, and PHCs continued in all countries under a second phase of the sub-regional project, *Responding to emerging pest and disease threats to horticulture in the Pacific islands* (HORT/2016/185) (Fig. 1.2).

After three years, and during the COVID-19 pandemic, Vanuatu joined the program. Further, three regional universities: Fiji National University (FNU), University of Goroka (UoG) in PNG and Solomon Islands National University (SINU) undertook to include PHCs in their agriculture courses. This is a significant step forward for the sustainability of PHCs after funding ceases.

1.3 Plant health clinics take shape

So far, we have told the story of the beginnings of PHCs in Bolivia, their spread worldwide and their start in Pacific island countries. We have stressed they were different from the 'fixed' clinics that had gone before, and that are still practised in many countries to this day. Our interest is in the 'mobile' kind that are held at places where farmers normally meet, at markets, bus stands, fairs, shows, and the like. This is unique, just as is having trained plant doctors, and record keeping prescriptions, with copies going to the farmers. And we have said how much farmers welcome PHCs.

What we have not yet said is that there are two major concepts playing out as overarching themes that guide PHCs. One involves their relationship to human and animal health services, and the other is their link with IPDM[11] (integrated pest and disease management). Understanding the importance of these connections is explained next.

[11] The letter D has been included for 'diseases' as pests are often considered to be insects alone, not all the organisms that attack plants, i.e., insects, pathogens, weeds, birds, slugs, snails, etc.

Fig. 1.2 A plant health clinic.

Farmers come with samples to have their problems diagnosed and to receive recommendations for management from plant doctors – trained extension staff.

A table, a chair (some shade) and a prescription form are essential equipment.

The summary form gives location, date, how many farmers attended, and information on the main insect pests, diseases and weeds.

Source: Ministry of Agriculture & Water, Fiji.

LABASA PHC - DREKETILAILAI, FIJI

MINISTRY OF AGRICULTURE

11th MAY, 2023

This Plant Health Clinic was held at Deketilailai about 20 minutes drive from Labasa town. The clinic started at 9am and concluded at 12pm. Nineteen (19) farmers attended; 3 females. Farmers came from Dreketilailai and Lekutulevu. A few farmers brought samples and some came with more than one problem There were 25 problems diagnosed including 1 unknown.

The problems include kava dieback , anthracnose on eggplant and chilli, scales on cassava and eggplant, bacterial wilt on eggplant, wilting of amaranthus, leaf spots on eggplant, leafminer on bele, snails and slugs on tomato and pumpkin, mealybugs on eggplant, red spider mites on bele, cluster caterpillar on dalo, powdery mildew on eggplant, banana bunchy top, ladybird beetle on eggplant and plaintain not bearing fruit (unknown).

Plant doctors from Crop Extension were Reshmi Lata, Saula Tavitani, Beren Teresia, Rajneel Lal, Sera Tuiwainunu Leweniqila, Nikhil Chand, Losana Nakato, Swastika Devi, Jocami Soronamata and Alefina Matagasau. Those from Crop Research include Toloi Vasuidreketi, Lusiana Seru, Takala Talacakau, Paula Koroikata, Anare Caucau, Vilikesa Tokaduadua and Semi Seruvakula from SPC. Alefina Matagasau was the clinic manager.

Prepared and reported by the Ministry of Agriculture. For more information, contact Alefina Matagasau Extension Labasa. Mob: 9571478; amatagasau@gmail.com. Plant Health Clinics are held as part of a sub-regional ICM/IPDM project (HORT/2016/185) – *Responding to emerging pest and disease threats to horticulture in the Pacific islands*, with support from the Australian Centre for International Agricultural Research, Canberra.

1.3.1 A medical model for PHCs

PHCs have done well in a short time, but many see them progressing further. They could underpin the development of plant health systems, bringing together extension, research, biosecurity services, regulatory bodies, education institutions, and agricultural input suppliers[12]. After all, each of these is involved in, or provides support to, PHCs.

To develop the collaboration that is required for an effective plant health system, different models have been considered, and the one used by medical services is an obvious candidate. After all, such services contain practices that are just as appropriate to plant health as they are to human or animal health. The notion has become more compelling with the development of the One Health concept. But more about that in Chapter 3 on soils.

Processes and practices based on human health systems are useful for thinking about the role of PHCs as part of an effective plant health system. Although there are obviously major differences between human and plant health there are also many similarities.

They can be summarised in six stages as follows:

- **prevention** — growing healthy plants that are less likely to be affected by pests depends on building a healthy agricultural ecosystem with fertile soil and the use of cultural controls, rather than toxic chemicals
- **personal** — a good plant doctor can give accurate, personalised advice to suit each farmer's situation, instead of the same solution for everyone
- **predictive** — an effective plant health system uses monitoring to predict the likelihood of pest and disease outbreaks based on weather conditions or biosecurity breaches (farmers are on the front line, bringing new or unrecognised pests and diseases to the attention of extension staff through the PHCs)
- **participatory** — accepting that the farmer is an active participant, attending PHCs to alert extension staff but also to find solutions together, rather than accepting recommendations with little explanation.
- **partnerships** — an effective plant health system relies on the cooperation of all relevant agencies — particularly extension, research, biosecurity, training divisions, farmers' organisations and pesticide retailers
- **treatment** — when a problem arises, depending on its seriousness, the plant doctor at a PHC starts by giving management advice that is least harmful to the agricultural ecosystem, such as those based on IPDM methods, before resorting to pesticides.

[12] Eric Boa, Javier Franco, Malvika Chaudhury, Patrick Simbalaya, and Elna Van Der Linde (2016) Note 23: Plant health clinics. Global Forum for Rural Advisory Services (GFRAS). Lausanne, Switzerland.

In 2007, the WHO established a health system framework based on six basic 'building blocks',[13] namely:

i. a sustainable financing mechanism, which averts impoverishment of people due to healthcare costs
ii. a sufficiently healthy workforce having the right skills and motivation
iii. a reliably healthy information system for policy and program decision making
iv. well-maintained facilities with adequate medicines and appropriate technologies
v. robust mechanisms to deliver quality health services, and
vi. a robust stewardship to lead and steer the health systems[14].

The WHO framework seems an ideal way of evaluating PHCs in Pacific island countries. It also shows the connection between the two systems of plant and human health. This is, perhaps, not surprising, we want to build a plant health system that is properly financed, well led, underpinned by PHCs, supported by farmers, extension services, regulatory bodies, education and research institutions, and agricultural input suppliers. We want to be able to monitor pest outbreaks and forecast any threats to come.

To quote the WHO, but having plants in mind not humans, we can say our goal is:

> *"A [plant] health system [that] consists of all organizations, people and actions whose primary intent is to promote, restore or maintain plant health[15]"*

Interestingly, the framework in a slightly modified form has been applied at the PHC level to assess performance of PHCs in Uganda. A set of variables (i.e., sub-components) was used to define each of the WHO components, allowing the identification of 'key' features that affected PHCs and their context[16]. This could also be used to evaluate PHCs in Pacific island countries.

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13 WHO (2007). Everybody's business: strengthening health systems to improve health outcomes: WHO's framework for action. Geneva: World Health Organization.

14 A slightly modified wording of the framework appears on the WHO website for South-East Asia https://www.who.int/india/health-topics/health-systems-governance

15 Ibid.

16 Solveig Danielsen, Eric Boa, Moses Mafabi, Emmanuel Mutebi, Robert Reeder, Flavia Kabeere, Robert Karyeija (2013) Using plant clinic registers to assess the quality of diagnoses and advice given to farmers: Uganda. Journal of Agricultural Education and Extension 19(2): 183-201.

1.3.2 Integrated pest and disease management

In recent years, IPDM has become a popular method of plant pest and disease control. It is considered healthier and more environmentally sustainable as it does not rely solely on the use of synthetic pesticides. IPDM involves cultural practices and pays attention to biological control – the natural way that insects (and pathogens) are controlled by predators and parasites.

Cultural control practices are integral to IPDM. There are many that can be used, for instance, healthy soil, healthy planting material, crop rotation, isolation of crops, crop hygiene, time of planting, resistant varieties. When several are applied together, the cumulative effect is often far greater than when applied individually, resulting in lower insect damage and incidence of disease.

Biocontrol by natural enemies is also an important aspect of IPDM. It works by convincing farmers to avoid using broad-spectrum pesticides that kill all insects, both 'good' (beneficial) and 'bad' (pest). Control by natural enemies is also increasingly applied to plant pathogens. There is growing use of fungi, bacteria and nematodes, species that are naturally antagonistic to plant pathogens — *Trichoderma, Beauveria, Bacillus, Pseudomonas, Steinernema,* although many need to be reapplied repeatedly.

However, IPDM does not prohibit the use of pesticides: it suggests they are used only as a last resort when other methods have been tried and found insufficient to obtain the desired level of control. IPDM also maintains that pesticides should be used at levels that are economically and ecologically justified, according to the manufacturer's instructions, and at minimal risk to human health and the environment.

The last point is particularly important: in all situations it is best to avoid the use of pesticides that are broad-spectrum nerve toxins, gut poisons or hormone mimics, and are a danger to beneficial organisms as well as human and other animals. So-called biorational products — botanicals (neem, chilli, garlic, vegetable oil), microbial pesticides (Bt, spinosad, *Beauveria* and other examples mentioned above), minerals (kaolin clay, ash, insecticidal soap) and insect growth regulators — that are relatively non-toxic, are considered a better fit for an IPDM strategy.

1.4 PHC Resources

1.4.1 The manual

This manual forms part of a PHC program that trains extension staff (and others) to identify pests and diseases and to give advice to farmers in a local context through a PHC. In addition to providing advice, plant clinics capture on-the-ground intelligence about what is happening in a particular region, thus giving PHCs a unique ability to contribute to early warning of new pests. The databasing of clinic information is also essential here, and the use of KoboToolbox and KoboCollect in this regard can be found in Chapter 4.

The need for the manual was first recognised at a project advisory group meeting in April 2018[17]. If a group of regional trainers was to be formed, they needed technical information relevant to PHCs and, importantly, how to teach it based on what we know about adult learning. Few of the trainers had teaching experience, although it was their task to train national trainers.

However, although everyone at the April meeting realised that a training manual was key to the training of extension staff, previous experience in the region suggested that manuals were written but often not used. This being the case, the regional trainers decided they should design and develop the manual themselves. In doing so, they were guided by the needs of those who would potentially receive the training, and how they would deliver it (Fig. 1.3). They considered this would ensure a strong degree of relevance, and likely a sense of ownership. At the April meeting, an outline was agreed, and chapters allocated to volunteer authors.

Once drafted, the manual was workshopped in each country by members of the regional team, together with extension and research personnel, who had not been involved in its development, to see if it worked. The first workshop was in Samoa in October 2018, after which revisions and amendments were once again made. This was followed by workshops in Tonga (November 2018) and Solomon Islands (May 2019), by the end of which, the revised manual was finalised and printed.

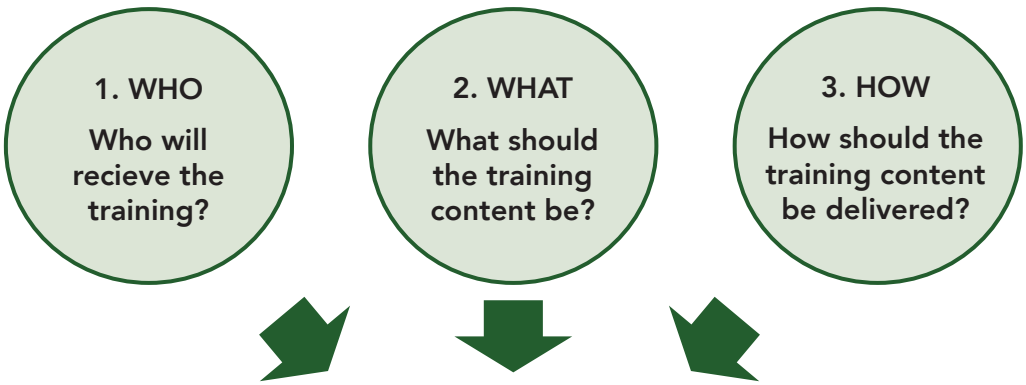

Fig. 1.3 PHC training manual design.

[17] Caroline Smith *et al*. Developing a training system for Plant Health Clinics in the Pacific region by and for regional trainers.

1.4.2 Layout of the manual

The manual consists of nine chapters and an appendix. It is written for trainers of plant doctors and aims to build on the PHC concept:

- **Chapter 1:** Introduction to PHCs, and how they developed
- **Chapter 2**: Pest and disease identification and diagnosis
- **Chapter 3**: Soils
- **Chapter 4**: The treatment of 'unknowns' using digital applications
- **Chapters 5 & 6**: IPDM
- **Chapter 7**: The planning and running of PHCs.

Each of these chapters contains a list of materials that trainers will need, technical information, and a range of exercises, practical work and quizzes designed to facilitate learning.

- **Chapter 8** contains information for trainers on effective teaching strategies and practices.
- **Chapter 9** contains the answers to the exercises and quizzes.
- **The appendix** contains forms and other resources for trainers.

1.4.3 The Pacific Pests, Pathogens & Weeds app

The Pacific Pest, Pathogens and Weeds app is in its 12th edition. The premise behind its development is that when crop pests occur, farmers want help and advice immediately. They don't want to wait, and in many cases they cannot wait. If they do not act quickly, they may lose the crop.

The app has 555 fact sheets, the majority are focused on pests and pathogens from the region, and the weeds are exclusively so. However, it includes some pests and pathogens not yet present but near enough to the region and important enough not to be ignored. Apart from full fact sheets, there are also mini ones, summaries, especially written for extension staff for occasions when they need concise information when discussing a pest, pathogen or weed with farmers at a PHC and there's no time to read a full account. Details of the app and how to use it efficiently can be found in Chapter 4.

In addition to new pests, the app has country translations of common pests and diseases, those that farmers frequently bring to the PHCs.

Each country, Fiji, Samoa, Solomon Islands, Tonga and Vanuatu, has chosen 20 mini fact sheets and translated these into local languages. In the case of Fiji, translations are both in Fijian and Hindi.