
Plantwise Knowledge Bank: Building Sustainable Data and Information Processes to Support Plant Clinics in Kenya

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ABSTRACT: Plantwise supports plant health in developing countries through a combination of 'plant clinics' providing plant health advice to farmers, strengthened collaboration between different plant health stakeholders, and the Knowledge Bank database. In addition to providing free open-access tools for plant pest and disease management, the Knowledge Bank supports the plant clinics by providing secure data and information tools for managing and analyzing clinic data, and by working with them to learn to handle clinic data. While analysis of these data provides important insights into clinic performance, there are major challenges to collecting this data. CABI, in conjunction with the Ministry of Agriculture in Kenya, has been running a pilot to establish appropriate and sustainable data; data from all 15 districts running plant clinics are now being analyzed in the Ministry of Agriculture, and the Knowledge Bank team is using these lessons to work with other countries to develop locally-appropriate data and information systems.

RESUMÉ: Plantwise soutient l'état des plantes dans les pays en développement grâce à l'effort combiné des «cliniques des plantes» offrant des conseils sur l'état des plantes aux agriculteurs, d'une collaboration renforcée entre les différents intervenants de la santé des plantes, et de la banque de données Knowledge Bank. En plus de fournir des outils en libre-accès pour la lutte phytosanitaire et la gestion de maladies, la Knowledge Bank soutient les cliniques des plantes en fournissant des données sécurisées et des outils d'information pour gérer et analyser les données cliniques, et en travaillant avec eux pour leur apprendre à gérer des données cliniques. Alors que l'analyse de ces données fournit d'importantes indications sur les performances cliniques, il y a des défis importants pour la col-

lecte de ces données. Le CABI, conjointement avec le Ministère de l'agriculture au Kenya, a exécuté un projet pilote pour établir des données appropriées et durables; les données de tous les 15 districts ayant des cliniques en fonction sont actuellement en cours d'analyse au Ministère de l'agriculture, et l'équipe de la Knowledge Bank utilise ces leçons pour travailler avec d'autres pays pour développer des données et des systèmes d'information appropriés localement

RESUMEN: "Plantwise" apoya la sanidad vegetal en países en desarrollo mediante la combinación de "clínicas para plantas" que proporcionan asesoría en asuntos fitosanitarios para los agricultores, fortalecimiento de la colaboración entre los diferentes actores del sector de salud vegetal y la base de datos del Banco de Conocimientos. Además de proporcionar herramientas de acceso abierto en forma gratuita para el manejo de plagas y enfermedades en especies de plantas, el Banco de Conocimientos apoya a las clínicas para plantas no solo proporcionando herramientas de información y datos eficaces para el manejo y análisis de datos clínicos, sino también trabajando con las clínicas para que éstas aprendan a manejar datos clínicos. Mientras que el análisis de estos datos proporciona información importante sobre el desempeño clínico, existen grandes retos para la recolección de estos datos. CABI, junto con el Ministerio de Agricultura de Kenia, ha estado realizando un estudio a nivel piloto para establecer datos apropiados y sostenibles. Los datos de cada uno de los 15 distritos en los cuales operan estas clínicas para plantas ahora están siendo analizados por el Ministerio de Agricultura, y el equipo del Banco de Conocimientos está utilizando las lecciones aprendidas para trabajar con otros países para desarrollar sistemas de información y datos que sean localmente apropiadas.

Introduction

There are 870 million undernourished people in the world and yet progress in reducing hunger has slowed up since 2007–8 (FAO, 2012). In the competition for nourishment from crops, however, it is estimated that up to 40% of the food grown worldwide is lost to plant pests and diseases (Oertke, 2006). This problem is exacerbated by international trade, intensified production and climate change altering and accelerating the spread of plant pests. Clearly there is an opportunity to lose less and feed more by improving control of such pest problems, particularly in the developing world.

Plantwise (www.plantwise.org) is a global programme, led by CABI, to support smallholder farmers with accessible, practical knowledge, so they can help themselves

to lose less of what they grow and provide more food for their families (Romney et al. 2013). The expected outputs from the programme include:

- innovative linkages established between key actors in a plant health system, including extension, research, regulation and input supply;
- national networks of plant clinics established to provide regular advice to farmers and facilitate pest surveillance through the collection and use of plant clinic data;
- a Knowledge Bank developed according to user needs for pest diagnosis, management and distribution, and available to national advisory services and organisations contributing to plant health systems;
- monitoring and evaluation schemes implemented for continuous learning, improving processes and quantifying outcomes and impact.

A key to the programme's success is the development of partnerships. Plantwise facilitates institutional change through strong partnerships with relevant government ministries and departments, especially those charged with extension and crop protection (often representing the National Plant Protection Organization). With national governments' agreement, Plantwise strengthens national plant health systems by linking in-country stakeholders, such as farmers and community-based organisations, extension services, diagnostic services, research institutions, agro-input suppliers, post-secondary educational institutions, and non-governmental organizations.

Linking Clinics and the Knowledge Bank

The Plantwise plant clinics work in a similar way to human health clinics with trained 'plant doctors' being available, backed up with close links to pharmacies, diagnostic services and laboratories. They are set up where farmers congregate, often at markets, and the plant doctors provide practical advice on how best to treat crop pests and diseases from the samples that farmers bring. At the same time, data is recorded about the farmer, location, problem and the advice given.

The Plantwise Knowledge Bank (<http://www.plantwise.org/KnowledgeBank>) is a comprehensive online resource developed according to user needs for pest diagnosis and distribution, as well as plant health management. As described elsewhere (Leach and Hobbs, 2013), the Knowledge Bank provides expert information that has been validated and checked and that can then be accessed by all in the plant health system. It delivers country-specific webpages, pest distribution maps, pest alerts, simple diagnostic tools, factsheets and pest management decision guides.

However, in developing the Plantwise programme it was recognized that data coming from the clinics were of high potential value and should also be collected, verified and analysed. As will be outlined in this paper, managing this data provides an entirely separate set of issues and practical problems that need to be resolved.

General Issues of Handling Plant Clinic Data

There are several reasons why collecting and analysing the plant clinic data could be highly beneficial. The information can document the work of the clinics, when they are open and how many farmers they support. It can also monitor quality of advice and provide insight into the improvement of service to farmers. Surveillance also can be made on what crops are grown and where, as well as what pests and diseases are attacking them. This in turn leads to helping predict outbreaks of common pests or identify new and emerging diseases, possibly suggesting where further research is needed. Importantly for all involved in a major programme such as Plantwise, the data can feed into the monitoring and evaluation of the effectiveness of programme activities in generating the desired outputs and outcomes.

However, such data from the field can also be highly sensitive. Trade can be severely impacted if a new quarantine pest is indicated as being present on a commodity crop. Similarly, prices can change if major pest outbreaks are predicted. As Plantwise does not run the clinics on a day-to-day basis, only providing training and start-up funding, the clinic data will belong to the organisations collecting them. The programme would therefore need to negotiate close partnership agreements with those actually collecting the data to be able to help in the process. Furthermore, records collected at the clinics would associate plant doctor names and telephone numbers with other valuable metadata leading to the potential for information abuse. Plantwise had to be able to understand, appreciate and work through these issues. This led to the establishment of cross-programme methodologies, tools and working practices. These were condensed into three Plantwise Policy Statements on Pest Reports, Use of Plant Clinic Data and Personal Data Protection (the link to Plantwise policies is at www.plantwise.org). In addition, a Policy on Intellectual Property Rights in the Plantwise Knowledge Bank was published (<http://www.plantwise.org/default.aspx?site=234&page=4363>). These policies collectively express how Plantwise would use clinic data in a fair and confidential manner and demonstrate to partners that they can trust sharing clinic data with CABI to allow the organisation to help actively in data management and analysis. To ensure full understanding, and as it was also hoped that countries might share the data widely, both in-country and internationally, data agreement templates were also prepared for signature by CABI and partners to identify how data might be used confidentially and, with permission, how and when these data might be further published in open access. These agreements describe options for partners to share data with the Plantwise Knowledge Bank and are to be signed by both partner and CABI. An example is given at <http://www.plantwise.org/default.aspx?site=234&page=4717>.

Another area that had to be addressed was that of access to the plant clinic data from the Knowledge Bank. The content in the Knowledge Bank that provides help with diagnosis, treatment and distribution of pests is open access and freely available to all. This content is collected from CABI's repositories, those of content partners and from other open access sources. However, the clinic data, and the associated tools for processing and analysis, needed to be access-controlled so that only those users specifically identified by contributing partners could be allowed viewing rights. This resulted in the creation of an entirely separate access-controlled section of the Knowledge Bank, as illustrated in Figure 1.

Practical Considerations in Handling Plant Clinic Data

Collecting and managing data was clearly going to be a process that would require time and resources. Discussions needed to be held with countries implementing Plantwise

on the importance of the collection of data and the value to them of the information such data would provide. Commitment could therefore be made by the countries to what otherwise might seem to be a difficult and pointless task. Initial talks would build trust but also try to ensure that the incentives for data collection were understood, with CABI providing examples of the sort of analyses that could be undertaken to benefit all stakeholders. Plant doctors might be interested in getting information that would help them prepare their monthly reports, Ministry

officials might be interested in what crops were grown where and what pests are attacking them, etc. Once the value of the data was understood, the availability of staff resources, computer skills, hardware and software, etc. could then be taken into account for each country.

It was important in such discussions to have an idea of a workflow that could be understood by all who needed active in its implementation. As highlighted in Figure 2, a theoretical workflow was therefore devised and it was determined what might be needed at each stage.

FIGURE 1 – Schematic diagram of access controlled and open access sections of the Knowledge Bank

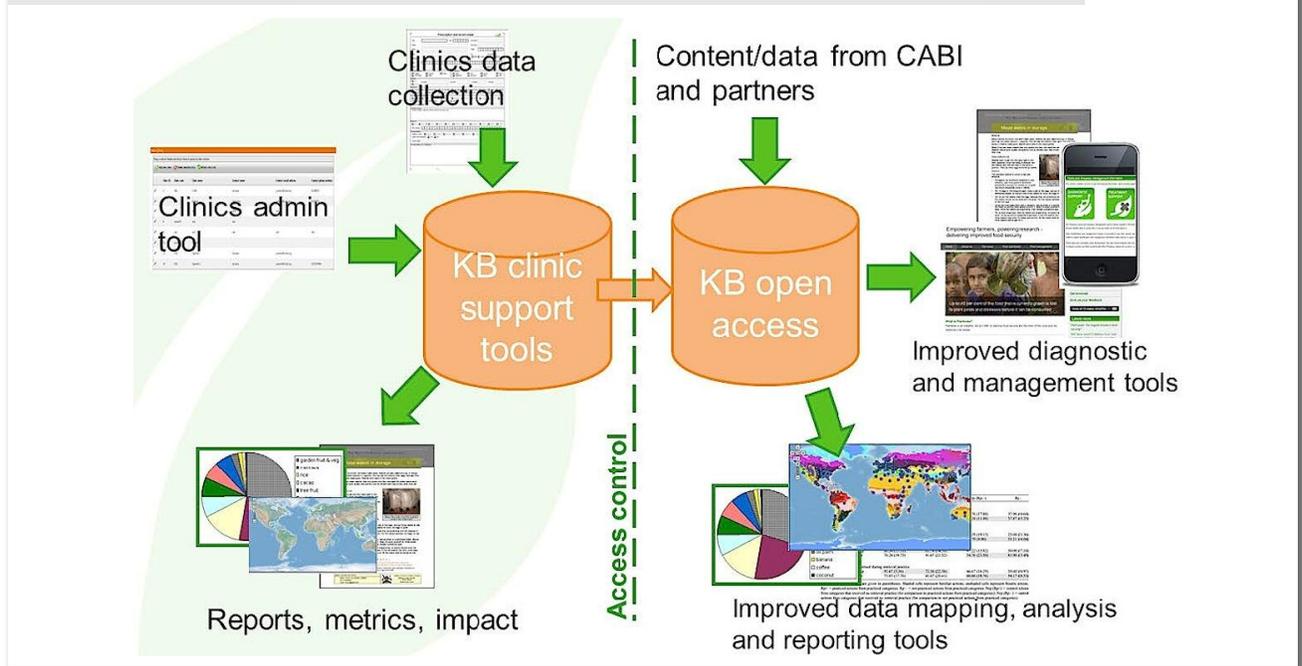
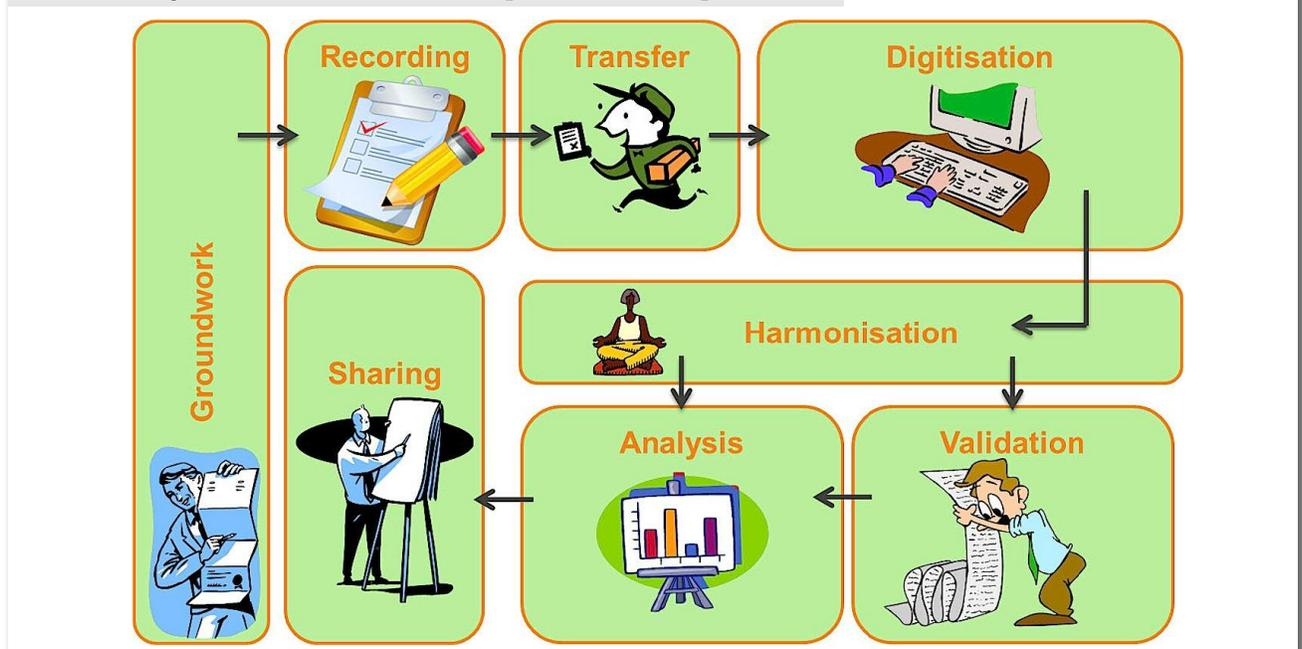


FIGURE 2 – Stages in a theoretical workflow to process data from plant clinics



Kenya Trial – Testing the Issues and Practicalities

While much thinking had gone into the whole concept of clinic data collection, and that individual ideas and separate workflow stages had been tested with individual countries, there was a need to ensure that an end-to-end solution had been thoroughly tested in practice. CABI has a regional centre based in Kenya and as this was one of the countries initially engaged with the Plantwise programme, it was decided to try to test the concept in its entirety there.

From the beginning, therefore, discussions with the Kenyan Ministry of Agriculture of Plantwise implementation had always involved data and information needs. At the official Kenyan launch of Plantwise, attended by interested parties from all over the country and arranged jointly by the Ministry and CABI, presentations were given on the potential value of clinic data, showing some preliminary analysis of some real clinic data to incentivise all. A Data Agreement was signed by the Ministry and CABI that allowed data to be shared and reviewed by each partner, in part, through the access-controlled section the Knowledge Bank. A staff member, known as the National Data Manager, was allocated by the Ministry to be responsible for the data and a country-wide data plan was then devised by and agreed on by the Ministry and CABI.

The CABI and Kenyan members of the Plantwise team were then able to determine the necessities at each stage of the workflow: what was needed to be done, how it would be done, who would do it, where it would be done, and what was needed in terms of resources (see Table 1). It was then ensured that these necessities were developed and were understood by each of the participants.

To record the information gained and advice given by the plant doctors at the plant clinics, prescription forms were devised, printed and distributed. Thirty-five clinics were organised around fifteen hubs and five hubs were provided with scanning equipment, as it had been decided to try to electronically capture the information on the form as a way of reducing manual input. A central processing office was set up in Nairobi; initially this was in the CABI office, but part of the trial also involved establishing, equipping and training the National Data Manager's office in the Ministry. Training was given across the board, according to each person's place in the workflow. At the same time as this on-the-ground activity was taking place, the CABI Knowledge Bank team was working to build the processes and tools that could effectively handle and analyse high volumes of clinic data. As this was more a trial of logistical issues, it was agreed that the validation and sharing stages would not be tested at this time.

Once this foundation work was in place, the trial started in earnest. After a plant clinic had taken place, completed forms were collected and sent to the local clinic hubs. From here they were consolidated and sent to the central processing office in Nairobi either by courier or through use of the scanner. For the latter, high quality scans of the forms were made and emailed onwards. At the central processing office, data were either entered manually into an Excel spreadsheet or passed through Intelligent Character Recognition (ICR) software that had been purchased.

Guidance from the trial coordinators was given where necessary. For example, initial feedback was given to plant doctors on the legibility of forms and all involved

TABLE 1 – Essential ingredients and responsibilities for each stage of the data management workflow in Kenya

	What	How	Who	Where	Needs
Groundwork	Supply of clinic prescription forms and training to all involved at each stage	Printing and distribution of forms and training sessions	CABI or in-country staff	In country	Financial support and time from all stakeholders
Recording	Entry of relevant data from farmer interviews	Form which can be scanned by computer or viewed by humans. Follows interview format	Plant Doctors and/or clerks at the clinics	Clinics	Forms, black pen
Transfer	Consolidation of clinic forms, start of entry of data into digital format, and transfer to central database	Forms collected and EITHER scanned and emailed to central processing facility OR sent via courier	Data Transfer Managers	Clinic hub	Power, PC, scanner, email access
Digitisation	Correction of characters recognised by Intelligent Character Recognition software or entered through Excel	Data entry through EITHER ICR software OR manual Excel entry	National Data Manager	Central processing office	Power, PC, good internet access
Harmonisation	Clean up of data and standardisation of terms (e.g. orange, oranges, orange trees)	Access to Knowledge Bank tools or use of Excel processes	National Data Manager	Central processing office	Power, PC, good internet access

in the workflow were regularly helped with any questions or problems. After three months the results of the trial were collected and lessons learned reviewed in order to make recommendations for the future.

These results showed that the prescription form was universally accepted and used by the plant doctors. However, while all clinic hubs could transfer data successfully to the central facility by courier, no forms were flowing from those hubs provided with scanners. The ICR software, it was found, needed forms to be scanned very accurately and in high quality, so much so that the size of the emails containing the scans made them very difficult to send by email. The central processing office was successful in entering the data from the forms manually but where the ICR software was trialled, the complexity of its use made it impossible to use universally. There was also a considerable amount of IT time needed to try to make the ICR work effectively on scanned material. The National Data Manager's office was successfully set up to handle the flow of data through manual entry and so was able to take on full on-going responsibility for the workflow. However, there was recognition of the value that a central facility like the Knowledge Bank could have in proving technical tools for data harmonisation, analysis and reporting. Above all, when initial data started to be analysed, it was shown that while getting the entire system to work was extremely hard work, it was definitely worth it in terms of the information revealed.

Lessons Learned and Recommendations

As a result of this trial, changes were made to the recommended mechanisms for data management for implementation in all Plantwise countries. All CABI staff responsible for initiating Plantwise work in countries were required to begin discussions with the appropriate in-country organisation and work with them to develop data processing plans and partnerships. They would be fully supported by information experts from the central Plantwise Knowledge Bank team. Full consultation with national stakeholders also needed to result in appropriate data agreements being signed. All plant clinics were required to start using the new prescription forms, which were then translated into all necessary languages. In-county printing of forms was to be encouraged. Scanning and emailing of forms was not a recommended transfer method nor was the ICR software recommended as an in-country data entry solution. Instead, a simple data entry template was designed in Excel as a way of speeding up manual data entry and improving its accuracy. This template mimicked the format of the prescription form at data entry but effectively placed all content into appropriate Excel cells. The basic model of manual transfer (e.g. courier) followed by data entry into Excel using this Plantwise data entry template was adopted globally. Validation protocols still needed to be developed

and communicated as they were not tested in this trial. This also applied to extensive data sharing. Mechanisms needed to be created for returning data analyses to all stakeholders to keep them incentivised. It was also identified that coordinated training courses and support tools needed to be developed along with improved technical tools for harmonisation (e.g. using Google Refine), which was a very complicated and lengthy manual process. Regular feedback was also required to all involved in the workflow to improve the quality and effectiveness of the process. To make all of this happen, a dedicated data processing project team across Plantwise was set up led by the Knowledge Bank team.

Conclusions and next steps

Work done by Plantwise in Kenya demonstrated to the government not only the value of having trained plant doctors providing pest control advice to farmers but also the value of collecting and analysing the data that could be collected from these consultations. Close collaboration by all partners then showed that the practical difficulties in processing the data could be overcome. In three months' trial, the data from over 400 clinic prescription forms were processed from the thirty-five clinics that are spread out across Kenya.

For Plantwise, the trial provided an ability to modify the concepts of the standard template for data management that it provided to other collaborating countries. Such modifications have now been put in place and include: the requirement of a clustered hub approach to collecting data; no use of ICR technology; a central National Data Manager's office being established with full on-going operational responsibilities; and mechanisms to ensure that offline, as well as online, reports are available from the central Knowledge Bank for circulation to all stakeholders.

While workflows need to be based on simple processes using minimal technology, trying to integrate scanners and ICR software was too complex for overall use in the field. It was noted, however, that many stakeholders and farmers were very familiar with using mobile phones, and it has therefore been decided that as a next step there will be a plan to run a pilot for data collection using mobile devices which will be interfaced closely with the Kenyan government's new e-extension proposals.

A preliminary study of the depth of the information collected on the forms indicated the many different analyses could be undertaken. As hoped for in the planning of the data collection, information was available on pests seen, crops grown, gender of farmers, treatment advice, etc. that gave a survey picture otherwise not available. The potential value was substantial but, recognising that data validation had not been a part of the trial, there was a need for this validation and further professional investigation. This resulted in the Ministry and CABI deciding that a further next step would be to bring together other key stakeholders in the Plant Health System to

study the data carefully in a Data Validation and Analysis Workshop to be held when more data had been acquired. Experts and statisticians from universities, research institutions, the Ministry, pesticide regulating bodies and inspection agencies could then focus on the quality of the data.

This successful trial can be held up to the other countries as a clear example of the ability to overcome difficulties of getting data management and analysis in place and the value of the information to all stakeholder in the national plant health system once data coming from the plant clinics is successfully analysed. The system, with suitable modifications according to local needs, is now being rolled out to all countries implementing Plantwise.

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