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Plantwise: an innovative approach to reduce crop losses by sharing plant health knowledge

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ABSTRACT: Strengthening plant health systems by building capacity to manage existing and emerging pests requires innovative approaches in agricultural advisory services. 'Plantwise', a global program led by CABI, delivers improved agricultural advice through networks of plant clinics supported by a knowledge bank (an open access gateway to online and offline plant health information). Plantwise is increasingly deploying ICT tools to ensure correct pest diagnoses and appropriate recommendations to farmers.

Together with partners, CABI is deploying SIM-equipped Android tablets to enable real-time capture of pest data and instant access to information that supports diagnosis and pest management advice. These tools enable 'plant doctors' to use the Factsheet Library app to access 10,000 factsheets on 4000 plants and 2500 pests. The tablets also allow 'plant doctors' to communicate via instant messaging services. At plant clinics, relevant data are logged online to enable CABI and partners to monitor the quality of recommendations, ensure that they are accurate and comply with best practice. Plant clinic data is instantly uploaded onto the Plantwise Online Management System where plant protection agencies can use it to track pest occurrences. Critical components of Plantwise include the use of ICT in training the 'plant doctors', the back-up from CABI's knowledge bases, the use of the evidence of impact of the interventions on crop losses as an indicator of potential to improve food security and farmer livelihoods, and the application of lessons learnt to improve the interventions. All of these are highly relevant to CABI's overall objectives that contribute to the UN's Sustainable Development Goals 2 and 17. This paper presents Plantwise as an innovation to reduce pre-harvest crop losses.

Keywords: ICT tools, knowledge bank, plant clinic, plant doctor, plant health systems

I am going to talk to you about a program called 'Plantwise', which is an innovative approach to reducing crop loss by sharing plant health knowledge. I work for CABI, based in Nairobi. CABI is best known to most people because of its publishing. Over time, however, CABI has had to evolve to remain relevant, and that is why we have gone into development work.

'Plantwise' is our response to the challenges of food loss and its negative impact on livelihoods. Information is important if these challenges are to be addressed, and the information provided needs to be relevant to all actors along whole value chains. Another justification for Plantwise is that it improves the capacity of small countries to deliver agricultural advice and thereby help in reducing crop losses.

This is an edited transcript of the presentation, with some of the powerpoint slides shown.



Figure 1. The three components of Plantwise.

Plantwise is implemented through government systems across three regions of the world – Africa, Asia, and Latin America and the Caribbean. Currently it has been piloted in 34 countries and is active in 32, meaning that the pilot phase did not succeed well in two.

Features and components

There are three components to Plantwise (Figure 1). First, the plant clinics. Plantwise operates through networks of plant clinics. A plant clinic is not a satellite lab; it is a simple structure in which extension officers, trained in visual diagnosis to become ‘plant doctors’, receive farmers who bring plant samples showing plant health problems. The plant doctors have support and relevant references to guide their work. Farmers can bring their problems to the clinic, where they are addressed, diagnosed and recommended solutions documented.

As an example, at a plant clinic the plant doctor talks with the farmer about the problem, and documents visual symptoms, the diagnosed problem and the recommendation given to solve the problem, in a prescription form. This can be paper-based or tablet computer-based.

The second component is the Plantwise Knowledge Bank, which is an online technical resource that the people serving the farmers can easily refer to for support. It provides them with fact sheets and pest-management decision guides, right on the spot. It helps them diagnose the cause of the plant health problem because they can use it as a readily accessible reference. Not all plant doctors will be able to diagnose all problems just from their own training; they often need to refer difficult or unfamiliar cases to other experts or laboratories. Here I am talking about diagnostics as opposed to identification. The latter regularly requires laboratory services.

An important feature of Plantwise is that the diagnosis is documented as part of data capture at the plant clinics; and the recommended solution for the problem is also documented. A farmer goes away with a prescription (Figure 2), and the information about the encounter remains with the plant doctor at the plant clinic and goes into the database for further validation and analyses for different uses.

The database, called Plantwise Knowledge Bank, supports the work of the plant doctors and also supports the diagnosis. The data collected from various farmers’ queries



Prescription form

- Paper version
- E-version
 - Use of tablets & SMS messaging
 - Link with other E-Systems in extension

Vision i.e. forward plan

- Scale up & sustainability
 - Country support & update
 - Justification: uses of pest data – surveillance, pest listing, pest reporting
 - Opportunity – EWS function of NPPOs

Figure 2. Data capture and use via the Plantwise prescription form

– about the farm, the crop, the pest, etcetera – is fed into the database within the Knowledge Bank, called Plantwise Online Management System (POMS), and is later validated and used to support the work of the plant doctors, besides informing decisions by stakeholders on management of plant health. Inbuilt in this is a monitoring and evaluation mechanism, because it is important always to use lessons learned to ensure there is continual improvement. This is the third component of Plantwise.

Monitoring and evaluation provide quality assurance used to give feedback to the plant doctors on their performance, and contribute to ensuring continual improvement of Plantwise activities.

Plant clinics are situated at locations easily accessed by farmers, their locations being determined by ease of accessibility but within rural locations. Plant clinics must be run on a regular basis: for instance, a particular location and a particular time at weekly, bi-weekly or monthly intervals.

Plant doctors are essentially extension officers trained in visual diagnosis and how to give good advice to farmers as pest management recommendations. The majority of them are government employees who have had basic training up to degree and diploma levels. Plantwise training gives them more focus on plant health, through short training on diagnosing common plant-health problems and their solutions. When farmers bring affected plants to the plant doctors, the latter should diagnose the problem and give satisfactory and practical advice. That advice is documented in a prescription form – an important feature. Those of you who are familiar with extension in developing countries will know that documentation and data capture are rare. Without data there is very little you can do to improve a situation or make informed decisions on plant health issues.

The Knowledge Bank is an information resource. It provides diagnostic support through factsheets and good recommendations, via what we call ‘pest management decision guides’ specific to crops and pests. These help the extension officers to give recommendations that are practical and do not promote any unwanted chemicals. Users of the Knowledge Bank include an array of people in the agricultural sector: extension services, farmers, plant health regulators, agricultural research organisations, academia, agro-input suppliers, and others. The Knowledge Bank is also a repository for plant clinic data, which is entered into the Plantwise Online Management System.

Plantwise e-version and benefits

Data capture using a paper form is one of the most unpopular tasks for plant doctors, so it is good that the e-version, using tablet computers, is working and moving forward. The e-version has contributed significant improvements in performance, and the information captured on tablets, including images, can be relayed very quickly – far away, such as from Kenya to Australia. Within a short time, you have a potential answer to the problem. This capability far outweighs what you can do with paper. As one plant doctor said: ‘It is not even comparable with the paper one ... wherever you go, this one is in the pocket’.

ICT tools therefore present an excellent opportunity to improve what can be done to manage plant health. Trials have been done in four countries – Kenya, Rwanda, Sri Lanka and India – and from those trials we have been able to make significant improvements in how data is collected and analysed, shared and used. Also, advice can be sent to a farmer as a short message using SMS, instead of being handed to them on paper. Training is required to enable that system to work, but once that is complete we find that the plant doctors themselves use the tablets to share a lot of information, and to support each other to improve how they work.

There are a number of ICT tools in Plantwise: for collecting, sharing and delivering agricultural data, and interlinking the range of actors in plant health. SIM-equipped Android tablet computers enable real-time capture of pest data, and instant access to diagnostic support and advice. The ICT tools also give plant doctors access to the Factsheet Library app, and let them communicate via SMS, and log relevant data online. This is important when there is a need to trigger prompt mitigation actions. The tablets are more efficient than working with paper, and they enable action to be triggered quickly whenever a new problem is detected. National Plant Protection Organizations (NPPOs) actually require that type of response.

In evaluations, 79% of farmers have reported improved production if they use the advice given from the plant clinics. That is 79% of farmers, not 79% reduction in crop loss. Also, 70% of farmers have reported better income after using the plant doctors’ advice.

An important final benefit is that Plantwise is combating a silent aspect of food loss. You may produce and place a visually very clean food on the market, but it is very heavily contaminated with pesticides and you eat it at your own peril. One of the things we have achieved by using integrated pest management via Plantwise is to minimise pesticide use (Figure 3).

Parameters	Pre-Plantwise: 2009 - 2012	Plantwise: 2013 - present
No. of pesticide sprays per crop	4-7x	2-3x
Total cost (in Baht) of insecticides per rai (6.25rai = 1ha) per season	฿650	฿350
Farmers using only pesticides (%)	80%	50%
Mean crop loss per crop per rai (%)	50%	10%
Income per crop per rai (Baht)	฿1,000	฿4,000

The results of a farmer survey conducted by the Thai national implementing partner undertaken in 2015 by plant doctors in 3 different regions. 6 plant doctors interviewed 90 farmers in total.

Figure 3. An important aspect of Plantwise is that it reduces reliance on pesticide sprays.



Figure 4. Acknowledgements.

Summary

In summary, Plantwise offers these opportunities: to take prompt action; to have instant access to pest-management information; to capture real-time data; and to link easily to other tools we have tried such as PestPoint and Plant Village. Through Plantwise there can be effective pest monitoring and active control to mitigate against loss.

Putting that to even better use is the next challenge we face, because most countries do not do that.

I want to finish by thanking the sponsors of Plantwise, as shown above (Figure 4).

Washington Otieno is the Plantwise Programme Executive at CABI. Prior to joining CABI, he was a consultant for phytosanitary capacity development at the International Plant Protection Convention (IPPC) (2011–2013), Agricultural Biotechnology Adviser with USAID-Kenya (2011), General Manager at Kenya Plant Health Inspectorate Service (KEPHIS) (2005–2010) and research scientist at the Tea Research Foundation of Kenya (1992–2005). At KEPHIS, he managed phytosanitary services and trade matters and was involved in sanitary and phytosanitary (SPS) capacity evaluation and development at national and regional levels. He represented Kenya at meetings of the WTO-SPS Committee and the IPPC between 2006 and 2010, and served as a developing country representative in working groups and policy committees of the STDF (2009–2011). Since March 2013, Washington has led coordination of Plantwise implementation in Africa. He holds Bachelor and Masters Degrees in Agriculture and Plant Pathology from the University of Nairobi, and a PhD from Wageningen University.

Session 2 Q&A – On-farm losses

With Brian Lipinski, Rodrigo Ortiz,
Madaline Healey & Dr Washington Otieno

Chair: Andrew Campbell

Q – Tim Fischer, *The Crop Trust (Norway)*

My question is to Madaline, and relates to Laos. Do you have any relationship with the National Gene Bank of Laos at all, through that particular project you've been working at? And secondly, as you move forward with that project, now that the seed vault in Norway has been operational for eight years and has over 120 countries involved, do you see it as a logical extension to encourage some of the more exotic, special and endangered seeds to be sent in that direction, through the national Genebank, to Svalbard in Norway?

A – Madaline Healey

No, in my experience with the program, that is not something we have been thinking about doing. I have no doubt that it is something that we will look at as the program moves on. At the moment, it's really just a fundamental on-ground project in building continuity, getting things moving. There's a lot of talk today about post-harvest loss as well, and that is probably something that will be looked at in the next stage of the project.

Q – Shumaila Arif, *Charles Sturt University*

My question is for Brian Lipinski. Do you think having a local market like a village mini mart in the developing countries would be one solution to on-farm loss? For example here in Australia we prefer to eat local food, but in the developing countries such as Pakistan where I come from, people prefer their food to come from the best place. Would it be a good thing to provide awareness regarding local food? Would having a local market in the village be one solution to these losses?

A – Brian Lipinski

I think that is definitely something that could help address losses, by having an additional market where farmers can sell their goods. This would also reduce transportation times, and loss can occur throughout the transport stage and during storage. So I think that idea is something definitely worth exploring. It is not something I am familiar with, but I think anything that shortens the distance that food needs to travel can reduce food loss and food waste. There is less opportunity for it to go bad or be attacked by pests or get bruised in transit – that sort of thing.

Q – Steve Lapidge, *South Australian Research and Development Institute*

A question for Brian Lipinski. You mentioned that US on-farm losses are still considerable. Does the US have a good understanding of what those figures are? Your chart shows 17%. Has that number been ground-truthed at all?

A – Brian Lipinski

As far as I know, there are some estimates from the US Department of Agriculture, but I don't know the extent to which they have been ground-truthed. My guess is that they have not. As I mentioned, it is not a priority area in many of the relatively rich countries at the moment, which is a shame, because I think there really is a lot of potential for reducing those losses and generating income and making that food go somewhere where it's actually used as food, instead of being ploughed back into the soil or composted.

It's something that I'm hoping we'll see more of, because the US has announced a target for reducing food loss and waste that's consistent with Target 12.3 of the Sustainable Development Goals, for a reduction of 50% in retail and consumer waste by 2030. There's no number specifically assigned to farm losses, in either the US target or in the SDG target. That may change if we end up with a change in the US administration in 2016, but you never know. I think we should start to see more attention to on-farm loss, because the target has helped to elevate the profile of this issue.

Q – Jack Hetherington, Australian Centre for International Agricultural Research

My question is also for Brian Lipinski. You showed a chart showing the different losses across the process–supply chain. Say if there was a loss of funds and resources for R&D and potentially an ever reducing amount of funds, where do you think you would get the best 'bang for your buck' in directing your funds? Would they be more effectively used in the developed world where a lot of the losses are at the consumer end? Or would the funds be more effectively used to counter developing-world losses in the production and the value chain?

A – Brian Lipinski

That's a really good question. The best work I've seen so far on that in the developed world is by a group in the US called ReFED (see www.refed.com). Those people created a cost curve – a type of a cost–benefit analysis – of a number of different interventions: what reductions you get, based on investment. In their study, things like changing confusing date labels on packaging, and increasing consumer awareness, actually achieved quite a bit of benefit for the cost, but even if all of the activities that are cost-effective were applied, they still didn't achieve the target the US has set. There are some difficult questions about who would pay for such interventions. It is not always the person who pays for them that gets the benefit out of it.

In a developing country context, I think it is hard to say, because it is hard to lump developing countries together and say that one specific type of intervention would give you the best bang for your buck. The contexts are so different between countries, even though we tend to have this split between developing and developed countries. Someone else on the panel maybe has some thoughts on this? You have a bit more on-the-ground experience than I do on this topic.

Q – Simon Lockrey, RMIT University

Brian Lipinski, we are doing a lot of research with food producers on the farm, tracking their resource flows and linking their costs of business to resources they don't use. There's certainly an emergent theme along the lines of the comment you made about inter-wovenness and market inter-wovenness and the ugly food conundrum. Could you comment a little more on what supermarkets are doing in that space, the 'ugly fruit' program you mentioned? What sort of market mechanisms are they looking at, such as via pilot trials by retailers with 'the odd bunch'? How do they link to data, and have you seen Walmart using consumer data to determine what they are doing, such as whether they are targeting the organic-oriented hipsters, or the empty-nesters who are looking for real produce, or the young professional parents packing lunch boxes for their kids every day?

A – Brian Lipinski

Yes, I can comment on that to some extent, though it's not something I'm particularly involved with yet. Walmart in the US does have a zero-waste policy, and food is included in that policy of zero waste to landfill, but they do not yet have a specific food waste management policy. They are not specifically looking at food waste separately.

The program of selling different types of fruits and vegetables in their markets: I think they are doing that almost as a pilot to see what consumers are interested in, and what they are willing to accept. Walmart got a fair amount of negative press in the US when the program was announced because there was a perception that they were trying to sell poorer-quality food.

Globally, the retailer that we have seen do the most is Tesco, based in the UK. Tesco has been publishing food-waste data for the past three years for their operations, on their website, and they are now reporting in conformity with the *Food Loss and Waste Accounting and Reporting Standard* which I mentioned. They are actually leading the way as a retailer in this space.

I cannot answer some of your more specific questions, because I am not sure even Walmart is sure yet what their strategy is on that front.

Q – Margaret Hartley, Australian Academy of Technology & Engineering (ATSE)

This is a question for Rodrigo Ortiz. Congratulations on this great approach to innovation, looking at the end use and letting the research come through to answer and solve problems. I am interested in how much further that has gone, not only as benefit to the farmers in the immediate storage issues. Have you had any breakthroughs in technology development that can be further commercialised? Are there additional returns from new technologies that might have been found in relation to particular storage, and can they be further distributed beyond your pilots?

A – Rodrigo Ortiz

Yes, we've actually found two major streams technologically. One is the adaptation of existing solutions to the conditions and the requirements of

smallholder farmers. In other cases, there has been development of new technologies. For example, a couple of storage-solution providers from Uganda who were working with the World Food Programme are now competing in the Kenyan environment, supplying some of these new technologies. Technologies that have been developed include multiple-barrier hermetic bags and devices that have an insecticide impregnated into the plastic liner, on which we have seen a very quick evolution.

Given the very stringent requirements in the Eastern province, because of the prevalence of the Large Grain Borer, we initiated a test to ensure these devices worked. Some of the solutions didn't pass, so they cannot compete in that province any more. The others have continued and are moving forward and we are seeing the idea evolve constantly.

Q – Denis Blight, Crawford Fund

Thank you for a fantastic session, and I love the way it flowed from the overview paper on to each of the three speakers presenting case studies. My questions are to Rodrigo Ortiz and to Washington Otieno. Rodrigo, in a sense, isn't the market the prize? Some would argue that your intervention is a recognition of market failure, and that the prize would be the getting of a bigger market share. Why do you need a cash prize?

Washington, I have heard that Plantwise is trialling a serious games idea, the training game. I wish you would give us a sentence at least on that, because I think that had its origins in Australia.

A – Rodrigo Ortiz

Addressing the market, we could say that the traditional market was the larger for medium-size producers. They had the economic opportunity to analyse the possibilities. What was always an unknown factor was the capacity of smallholder farmers to actually buy these products. A traditional storage bag, with no mechanisms to prevent contamination, may cost one dollar, whereas one of the improved bags may cost up to three or four dollars – a substantial outlay on the part of the smallholder farmer. Yet, by creating affordable solutions for them, the smallholder market has reacted very quickly and they are adopting these storage solutions. They are finding that the cost–benefit of these solutions is large, relative to the losses they were achieving before. This is opening a completely different segment of the market that traditionally would not have been developed without providing an incentive for the private sector. This required quite a bit of marketing in production and training on the use of the products.

A – Washington Otieno

Yes Denis, that is the 'Plant Doctor Simulator'. Under Plantwise, we saw the need to have something that can be used digitally to build capacity or train on what Plant Doctors do. Working with Bondi Labs in Australia, we have been able to develop Plant Doctor Simulator 1 (PDS1) and we are developing a second serious game targeting plant doctors giving advice for managing plant health (Plant Doctor Simulator 2). Plant Doctor Simulator 1 is just focused on diagnosis

using pictorials, and Simulator 2 which is being rolled out later in 2016 is focused on recommendations. These are tools that can be used by academic institutions for training across a range of situations. They are some of the products of Plantwise.

Andrew Campbell, Chair

I note that ACIAR has a project called MAD, Mobile Acquired Data, led by Jack Hetherington. I think we shall see this kind of technology increasingly in our projects with the ubiquitous take-up of smart phone technology in many countries, including developing countries.

Q – Sara Blake, South Australian Research and Development Institute

Brian Lipinski, you mentioned a standard that supermarkets have. Here in Australia we have a bit of a duopoly between Coles and Woolworths and their standards are quite stringent. Who do you think should be putting pressure on the supermarkets to alter their standards so the different types of quality food can be available to the public?

A – Brian Lipinski

That is a good question. I think what happens is that retailers say they are just selling what consumers want, and that the reason they do not sell some other things is because consumers will not buy them. So there needs to be some sort of demonstration from the consumer level that there is a market for these so-called 'sub-standard products', which we know are not sub-standard.

I think we are starting to see that more, and that is why you are seeing some retailers in some countries adopting a policy of selling 'odd' fruits and vegetables. It is tricky though, because there can be a feedback loop where the supermarket only sells what the consumer wants, and the consumer becomes so used to perfect shiny apples that they then do not 'demand' the slightly bruised apples. The difficulty is in where you start with the 'odd' fruit policy: perhaps you need a brave retailer that is willing to pilot something like that. Maybe they find out that it has been profitable for another retailer, so they try it in a few stores and see if it becomes a larger program. I think there also is some opportunity for consumer campaigns and advocacy, but it is easy for those campaigns to get painted into the corner as being 'left-wing', 'green', and not representing the average consumer. It is a tricky sort of chicken or egg question.

Q – Ali Roush, Flinders University

This is a general question for the panel. In monocultures, what role do you think there is for the older varieties of grains and other crops, from the viewpoints both of dealing with pests and diseases and also for production? We have moved away from them these days, but do you think there is room for shifting back to some of the more diverse older varieties for use in production and cropping?

A – Washington Otieno

I can give you examples of what we call African indigenous vegetables. These are plants that in certain parts of the world, even in my days in secondary school,

were classified as weeds. For a long time, people who were getting better educated stopped consuming them. But over time, people have realised that those plants are not easily damaged by the most common pests, and so people are going back to them.

Based on that example, I foresee a situation where people will go back to some old varieties and landraces and find ways of improving them, while retaining some of the traits that have made them very stable and adaptable. The best example I can give you is with sorghum and millet. The very red type is not very popular, but if you are in areas where killer bugs are crawling around, eating all the popular grains, you do not want to compete with them; you go back to what the pests will not take from you.

Q – Xixi Li, CSIRO

These have been very interesting presentations, and I see that most of the food loss initiative is directed towards reducing the losses of foods that reach the consumer. What about the losses that are not avoidable, like the parts of fruits or vegetables that are left on the farm, that are edible and rich in nutrients? Do you see our food processing and food engineering bridging those gaps and food losses, and bringing this biodegradable material – which could stand transport and storage conditions – into different parts of the world? Where could that play, and how important do you think it is?

A – Brian Lipinski

It is true, especially in places like the US and Australia, that attention so far has been on the ‘food waste’ side of things, close to the consumer. I think that is why it is so important that we start paying more attention to the on-farm side of things. As we start to see food loss and waste being on the agenda more and more, as a topic, we are going to see opportunities for ‘entrepreneurship’ – really innovative methods of processing, and innovative uses for products. We are starting to see novel uses for various parts of foods which might be considered inedible in some parts of the world, yet in other parts of the world the people eat them all the time.

The trouble with those innovative uses is that they are not scalable to the market level; people are not seeing market opportunities, and therefore it can be more cost-effective just to leave those components on the farm and plough them back into the soil and get some soil nutrient out of them that way. If they put in the effort to try and process them into something, they might end up losing money in the end. In other words, those sorts of innovative technologies need to be more cost-effective I think, before we really see a big shift in that area.

Q – Brenna Moore, World Bank agricultural program in the Pacific

Thank you to all the presenters for your very interesting presentations. I have a question for Rodrigo Ortiz on the AgResults Program in Kenya, which I think is a program very applicable to our region as well. My question is on the pricing. You mentioned that companies can charge a price that both gives them a profit and still is affordable for smallholder farmers. That is quite an interesting and unusual outcome. My question is in two parts. First, are the companies

differentiating their prices between smallholder farmers and medium or large-scale commercial producers? Do they take into account the farmer's ability to pay when they are setting the price? Second, do you think that this low price is sustainable, going forward, as these companies perhaps move into new areas beyond the pilot regions?

A – Rodrigo Ortiz

They are maintaining a consistent pricing structure, and as part of our verification process we have an external verifier, which validates and ensures that there is not a differential pricing scheme or a dumping of any sort. For instance, sales support through donor/giveaway programs does not qualify for the prize, so we have put into effect a verification scheme to ensure pricing remains fair.

I think that, over time, the benefits will spill over into other regions that produce maize outside the Rift and Eastern regions. The benefits are becoming very obvious, so we feel that will spill over.

I also think that, over time, the prices of the products will go down, because there is a lot of competitive pressure that did not exist there before.

Andrew Campbell, Chair

I am very sorry but we need to call this extremely illuminating session to a close. I agree with Denis Blight's comment that there has been a terrific flow of information, with a masterful keynote and then the overview and then some solutions and success stories from the field. There is a rich ecosystem of possibilities out there.