Delivering messages from plant clinics

The influence of communication on farmer's perception and uptake of advice: Costa Rica

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June 2017

Acknowledgements

The Ministry of Agriculture and Livestock (MAG) provided logistical support. Thanks to all of the plant doctors, farmers and other people mentioned in this text who graciously spent time talking to us and showing us their work. Sol Danielsen, Yelitza Colmenárez and Abdillahi Alawy read and made valuable comments on a previous version of this report.

Plantwise is supported by

Ministry of Agriculture,
People's Republic of China

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Extension agent Didier Núñez writes a message for palm farmer Osvaldo Araya

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Summary

A study was carried out in Costa Rica in October 2016 to investigate the following: How do plant doctors and their client farmers communicate? How does this communication shape the farmers' response to the advice? The study team attended an extension event (a talk illustrated with slides), visited three extension agencies (Tucurrique, Naranjo, and San Ramón) and interviewed 10 farmers who had consulted the plant doctors.

The study showed that the verbal communication between plant doctors and farmers was generally accurate. The plant doctors tell farmers the diagnosis and explain how to apply the advice, and usually write it on the prescription form. They often tell the farmers the background reason, i.e. why the technology works.

Not all of the verbal advice enters the written record. Sometimes a farmer may forget a diagnosis or a recommendation, but forgetting is not exactly mis-communication, especially if the farmer keeps the visit form, with a summary of the advice. The plant doctors initially tried using the Plantwise prescription form, but abandoned it because it was double work. They also have to fill out a "visit form" (hoja de visita) for the Ministry (MAG).

The farmers do not always bring plant samples to their plant doctors, who sometimes have to identify the pest from the farmers' descriptions, or visit the farm to observe the problem in the field. Unlike some other countries, in Costa Rica the plant doctors make a serious effort to identify new plant health problems, conferring with experts within MAG for a diagnosis and management advice.

The plant doctors have some written materials at their disposal, for example a book on insect pests of perennial crops in Central America. They would like to have more reference materials, such as a field guide specific to the pests and diseases of crops in Costa Rica, in Spanish. The plant doctors write their own extension training materials, but not fact sheets in the Plantwise format. They have written some green-and-yellow lists with Plantwise, but they have not yet been printed, they are only available digitally.

The extension talk (intended for local farmers who grow ornamental plants) had room for improvement (i.e. a more organized outline, more appropriate visual aids and more simple, less technical words that everyone knows). But the one-on-one communication between farmers and plant doctors is generally clear. E.g. the plant doctors and the farmers who were visited all speak Spanish.

Of the 10 farmers visited, 9 said that they had used all the advice and one farmer some of the advice. In several cases farmers and plant doctors alike judged that the client had avoided large losses as a result of following the plant health advice from within MAG.

The plant doctors have a slight bias in favour of chemical control, but they are sensitive to farmers' demands and will readily recommend biological pesticides for farmers who are trying to farm organically. (Few of the interviewed farmers are certified organic, but several of them try to avoid highly toxic chemicals). Plant doctors sometimes recommend several technologies at once, although when farmers and plant doctors agree on using chemical control that is often the only recommendation given.

The study revealed no cases where technical advice was rejected only because of failed communication. Farmers engage creatively with the recommendations from their plant doctors, almost always finding something they can try on their own farms. They tend to adopt some or all of the agent's advice, although they may also seek other solutions from their reading or consultations with third parties.

1. Introduction

Adoption of agricultural technology is influenced by many factors, among these the type and quality of communication between the plant doctors and the farmers and how the messages are understood and perceived. Plant clinics give some of the most individualised technical recommendations of any agricultural extension method. In a plant clinic each farmer receives a message tailored to his or her problem—and gets a written prescription just for her or him. The plant doctors have to know how to diagnose the pests and diseases of their area, recommend an appropriate management strategy, and how to communicate this to a local audience of female and male smallholders.

The quality of communication between plant doctors and farmers is crucial for the delivery of a good plant clinic service. Much of Plantwise's extension training curriculum focuses on communication and human relations to enable effective transmission of sometimes complex messages. Messages about pests and diseases and specific control measures can be complex to some farmers who have minimal education. The format, language and vocabulary used by the extension agents as well as his/her attitude will inevitably affect how messages are transmitted. Therefore, the quality of these exchanges will depend on characteristics of both the extension agent the farmer as well at the message itself, whether written, visual or verbal.

CABI-Plantwise[1] commissioned a study with the purpose to assess how the delivery method and communication between plant doctors and male and female farmers affect the adoption of advice given at the plant clinics. Specifically, the objectives were to:

- describe the nature and quality of communication between plant doctors and plant clinic users of both genders, including questions such as: Are plant doctors using the right words to convey the technical message? Are plant doctors interacting appropriately and respectfully with farmers (e.g. listening enough)? Are plant doctors making good use of written materials such as fact sheets and other visual aids?

- assess how language, quality of communication and type of delivery method (verbal only vs verbal plus written) influence farmers' understanding and perception of the messages given and the adoption of advice.

The study was carried out in three countries in 2016: Malawi, Nepal and Costa Rica. This report presents the findings from Costa Rica.

2. Agricultural extension and plant clinics in Costa Rica

According to the agricultural and livestock census of 2014, 18.4% of Costa Rican farm families receive some type of technical assistance or agricultural training. The Ministry of Agriculture and Livestock (MAG) is the largest provider of technical assistance and training (36.5%), followed by cooperatives (28.5%), agro-input dealers (15.6%) and the National Institute of Vocational Training (12.5%) (INEC, 2015).

A fundamental part of MAG's mission is agricultural extension for the rural families of small and medium farms. The first division of MAG is the National Directorate of Agricultural and Livestock Extension, but there is also a National Plant Health Service (SFE), a National Animal Health Service

[1] Plantwise is a global programme, led by CABI, to increase food security and improve rural livelihoods by reducing crop losses.

(SENASA), a National Council of 4H Clubs (for youth and children), Agricultural and Livestock Information, and the National Institute of Agricultural and Livestock Technological Innovation and Transfer (INTA—for research). The National Extension Directorate covers eight regions and one sub-region, with 93 extension agencies in the country. An agency has a small building with offices and staff for community outreach. They have vehicles for farm visits. The extension agents give farmers individualized attention, besides talks and short courses (see www.mag.go.cr).

Individual farm visits are an important part of the extension work. Each extension agent visits 40 to 45 “regular” farmers who receive at least four visits a year, and “occasionals”, who walk into the office. The regulars are supposed to be smallholders, except in the case of coffee growers, who can have medium-sized farms. Besides extension visits, MAG also uses field days (días de campo) attended by up to 100 farmers, where many topics are covered, and demonstration days, where one theme is taught to a smaller group of 20 to 25 invited people.

In recent years, the plant clinics have achieved a complementary space in the agricultural extension system. The Methodological Guidebook for Agricultural and Livestock Extension (*Orientaciones Metodológicas para la Extensión Agropecuaria*) released by MAG in 2015 mentions Plantwise methods as relevant contributions to broaden the reach of extension services. The guide forms part of strengthening the agricultural and livestock extension system in the area of plant protection and diagnosis (MAG, 2015).

Plantwise started in Costa Rica in 2014 in partnership with MAG, which includes two separate divisions: the Extension Service and the State Plant Health Service. Eleven plant clinics have been established in two regions, Central West and Central East (Table 1). Various clinics also work with local partners such as the cantonal farmers’ centres (*centros agrícolas cantonales*). The plant clinics aim to improve the diagnostic capacity of the extension staff and allow them to reach more farmers.

Table 1. Plant clinics established in Costa Rica since 2014.

Plant clinics, Alajuela	Started	Plant clinics, Cartago	Started
San Ramón	January 2014	Turrialba	June 2014
Atenas	March 2015	Tucurrique, Jiménez	June 2014
San Pedro de Poás	May 2015	Tierra Blanca	November 2014
Zarcero	May 2015	Corralillo	June 2015
Naranjo, Alajuela	December 2014	Dota (San José)	February 2015
San Isidro, Heredia	December 2014		

The plant doctors are extension agents from the Ministry. They receive technical backstopping (especially identification of pests and diseases) from the State Plant Health Service. The 24 extension agents who participate in the initiative have received training for plant doctors (modules 1 and 2).

3. Study design

This was a qualitative study based on interviews and direct observation with five plant doctors (one female and four males) and ten farm visits (five men and five women farmers) to discuss the plant health advice they had received from plant doctors. Sometimes the farmers had kept copies of the visit forms (*hojas de visita*) they had received from plant doctors in the past, and the study team was allowed to read these, and compare the written advice with the farmers' response to it (e.g. adoption, or modification). The farm visits included the use of semi-structured interviews, direct observation, and keeping a photographic record. The study team visited farmers in the company of MAG plant doctors, who introduced the team to the farmers. The sample included farmers who interact closely with the Ministry.

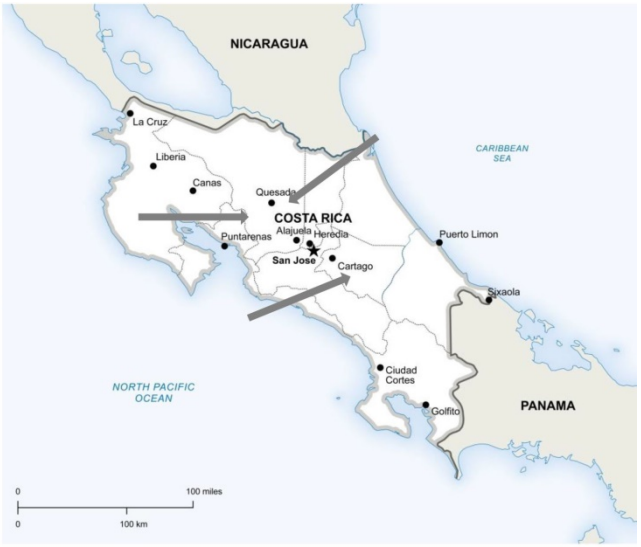


Fig. 1. Selected study sites (arrows) in Costa Rica

In Tucurrique, Jiménez, Cartago (Central East), the plant doctors gave the team a PowerPoint presentation on their work. The team visited three farmers (including one woman).

In Naranjo, Alajuela (Central West) the plant doctors explained how the digital data base works. The team visited the field with plant doctors and a person from the State Plant Health Service to collect insects and to prepare for their extension talk. The study team attended an extension talk on small arthropod pests (Thrips, mealy bugs and mites) for about 20 farmers (mostly women). This was an opportunity to see extension in practice; in a sense it was like seeing a plant health rally instead of holding a focus group discussion on a rally. The study team also visited four farmers (including three women).

In San Ramón, Alajuela (Central West) the study team visited three farmers (including one woman). The senior author also attended the weekly cantonal farmers' fair and discussed opening a plant clinic there with a local plant doctor and leaders of a local farmers' association (the *Centro Agrícola Cantonal*).

The study team also attended the national meeting of plant doctors in San José and gave a presentation (debriefing) on the preliminary results of this study. Personnel from the MAG regions (plant doctors) gave presentations on their work, which suggested that the agencies the study team had visited were among those that collaborated most closely with Plantwise and made the most effort to offer a quality plant health service.

No plant clinics were visited because the clinics didn't operate in the selected areas during the period of the study. For a description of the methodological tools used in this study, see Annex A.

The fieldwork was conducted from 12 to 21 October. The review meeting (debriefing) was held with CABI and plant doctors on 20 October.

4. Results

4.1 Plant clinic operations

Mode of operation

The plant doctors have adapted the plant clinic model to the Costa Rican context. Instead of going to a market or some other public place once a week, they receive visits from farmers in the agency (the office) from 8 AM to 4 PM, Monday through Friday (regular working hours). Rather than *plant clinics*, it was decided to call them "phytosanitary diagnostic clinics" (*clínicas de diagnóstico fitosanitario*), a term which not all members of the public understand, indicating that the concept needs more dissemination and/or a change of name.

The plant doctors often visit farmers in the field, and may receive samples there. The Tucurrique clinic was the only clinic the team saw that had a banner outside of the agency, announcing the plant clinic.

Banner for promoting of the plant clinics

Record sheets

All the MAG extension agents in Costa Rica fill out a visit form (*hoja de visita*) when they visit a farmer, are visited by a farmer in the MAG office or answer a query over the phone. The extension agent gives the original, clean copy to the farmer and takes the carbon copy back to the agency, where the duplicate is filed. There is a folder for each farmer, containing a copy of each visit form. The folder documents all of the attention that client has received. Most of the visit forms are clear and straightforward. A few are a bit confusing.

Initially, Costa Rica used the Plantwise prescription forms for some months, starting in 2014, but the plant doctors soon stopped filling them, arguing that it was double work to fill in their own visit form and the Plantwise sheet as well. Also a new national system was launched in 2016 to homogenize data management by the various agencies in the country. This was prioritized by the authorities in MAG and is still being adjusted.

Data base

MAG is now trying a digital version of these field visit forms. In Grecia, Alajuela, MAG agronomist Eduardo Lee created a program where the visit forms are entered electronically. It is still more or less a beta version, but there is another system, being introduced at the national level.

The study team saw a version of the Grecia system. It is fairly easy to find the electronic dossier of each farmer, and the records of the extension visits to him or her. Yet, there is no function to count cases or extract data on specific crops and problems. For example, we asked to see the number of crop protection cases by crop, but that information was impossible to extract automatically. The files

can be organised by certain topics, such as “technical assistance,” “training” and “information,” but the reader has to manually count the cases in each category.

The file for each farmer records the total number of visits, which are classed by “diagnostic,” “recommendation,” “follow-up” and “verification.” Each is listed by date, with a one-line description (e.g. “use of pest diagnostics and economic thresholds,” “soil sampling, interpretation and analysis,” and “use of chemical fertilizers.”) Each training activity is also listed in the data base (e.g. “agronomic management,” “production,” “talk,” or “coffee”).

Filing the visit forms in a paper folder was easy, but the plant doctors are finding it rather tedious to enter each page electronically. To adapt to this increased workload, the staff only type part of whole recommendation. (Obliging them to type it all might backfire, and encourage them to write shorter recommendations). Another weakness of the system is that it does not allow extension workers to directly access all data, the complete information, in an Excel sheet. This would allow anyone to make other analysis beyond the filters of their software.

When asked how this electronic data would be useful to them, the plant doctors did not seem to understand the question. They regard it as oversight, but not something that they could use themselves. So far, the system records 891 cases. This is a system devised in Grecia in 2014 or 2015. MAG is now building a similar national data base, based in part on this one. The information is used by management for monitoring, but seems not to be used for in-depth evaluation or analysis of the program.

Visit form (left). Note the large space for recommendations. Farmers get the original copy (right).

Written materials for farmers

The Costa Rican program decided not to write fact sheets with Plantwise model, because MAG already had literature for farmers. Instead, they decided to use the green and yellow list format, also provided by Plantwise, as a tool for the plant doctors as they form recommendations for multiple crops. Many of the extension documents that the team saw are difficult to read, because of their choice of

words. The literature is distributed at some talks and short courses and occasionally during farm visits, but several of the farmers visited had never received any. The literature includes booklets, posters and pamphlets on topics such as good agricultural practices, coffee production, maize growing, tree pruning, production of beneficial microorganisms, management of leaf miner on citrus, tomato yellow leaf curl virus.

Mr Orozco, plant doctor from San Ramón, says that he is comfortable writing extension literature for farmers, although he can't always print it in colour, because of the lack of ink, but he can usually print documents in black-and-white. He tries to have something written to distribute to each farmer.

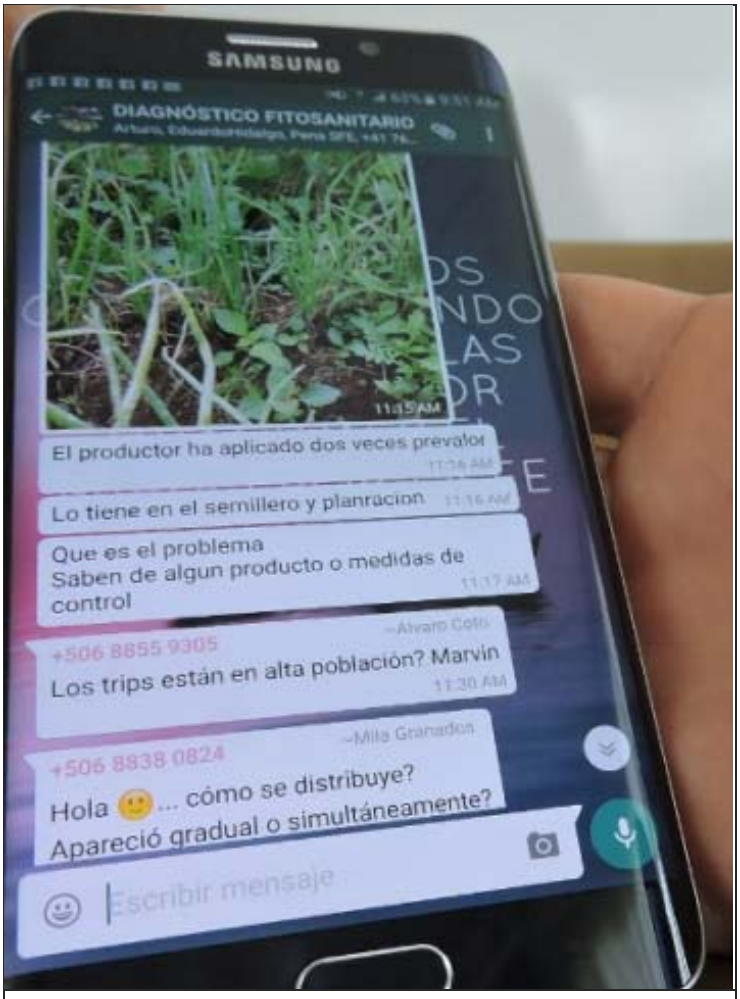
All of the extension agencies visited write and publish some material. Each agency keeps a bookcase with written material to distribute and reference material (such as books on agriculture published by other agencies). The plant doctors in two agencies complained that they did not have ink to print copies of written material for farmers. Communication should be improved between the plant doctors and the national coordinators and the CABI-Plantwise coordinator because there are funds from Plantwise which are managed by the regional offices to support the plant clinic activities, including for printing written materials. The plant doctors also seem frustrated that farmers don't appreciate the written material very much. During the national meeting in San José, one of the plant doctors announced that the "farmers don't like to read." Extension materials could be written with more illustrations, less text, and with the messages presented in clear language, aimed at farmers.

The plant doctors want more written material, especially hard copies, such as illustrated guides of pests and diseases, in Spanish (not in English). The plant doctors remember writing green and yellow lists in Plantwise training. They would like to have more copies and find it frustrating to visit farmers and not be able to give them a copy of the green and yellow lists, which the farmer would appreciate. The plant doctors do have some books on agronomy, which are valued, but are not as helpful as a guide to pests would be. The plant doctors need to use the resources provided by Plantwise such as the app for tablet and mobile phone which gives access to all of the fact sheets and green and yellow lists, not just the ones from Costa Rica, but from all of the Plantwise countries. The plant doctors should also use the portable library they received during training.

The agencies have literature, including a book on insect pests of fruit (Coto and Saunders 2004) in the centre of the shelf, but they need a field guide to pests and diseases

Innovation with cell phones

Many Costa Rican farmers have smart phones. This allows the plant doctors to interact with farmers in WhatsApp groups of about 20 farmers on certain topics of interest such as livestock, vegetables or peach palm (called *pejibaye* in Central America, scientific name: *Bactris gasipaes*).



Reaching farmers and connecting plant health experts

The plant doctors invite farmers to events using WhatsApp, and the farmers send in questions and photos of problems. If the plant doctors need more information about a plant health problem, they can visit the farmers and collect samples and more details.

The plant doctors pass on questions of their own to groups of experts, who discuss the problem and offer suggestions through the WhatsApp group "*Diagnóstico fitosanitario de Costa Rica*," which is very active answering queries between the plant doctors and invited experts. The farmers contact their extension agent via the WhatsApp group, or directly on the plant doctor's private WhatApp number.

The plant doctors in Tucurrique say that 40% of their queries come over the phone. The plant doctors can also ring the farmers up or send them a text message to give farmers the results of the query.

4.2 Farm visits

Plant doctors who work hand-in-hand with farmers, visiting their farms several times a year, are able to communicate well and induce some significant changes, for example the farmer in case 10 (Table 2), who moved his vegetable production to a higher, cooler climate as a result of the plant doctor's advice. As Table 2 shows, the farmers in Costa Rica followed almost all of the advice they received, thanks in part to the good communication between the plant doctors and farmers.

When farmers fail to use advice it is often because they are unable to: e.g. the farmer in case 6 was advised to reduce the water flowing from her sprinklers. But the irrigation system was purchased as a package, is controlled electronically, and she cannot get the dealer to return and adjust the equipment.

Table 2. Farmers visited, Costa Rica. Queries at clinic, diagnoses, recommendations, and farmers' responses

Farmer, place	Crop, diagnosis, date of clinic visit	Recommendation	Farmer's response	Analysis
1. Male Tucurrique, Jiménez, Cartago	Peach palm, Weevils 2015	Clear leaf litter & drench soil with *Beauveria* & *Trichoderma* to kill pupae. Trap adults with pheromones & apply insecticide in palm canopy as the plant flowers	Recommendation fully understood & adopted. Solved the pest problem	He learned the technique & background info in a special course organized by extension in response to the weevil diagnosis
2. Female Tucurrique, Jiménez, Cartago	Coffee, Anthracnose Ca. 2014	Apply a copper-based fungicide	Applied the fungicide. Solved the problem	The diagnosis was difficult, but the plant doctors did not give up easily
3. Male Tucurrique, Jiménez, Cartago	Lettuce, Fusarium 2015	Spray bicarbonate of soda in water, followed in 3 days by Trichoderma	Applied the Rx as advised & problem was solved	Another difficult diagnosis, aided by other experts
4. Female Naranjo, Alajuela	Violet, Thrips 2013	Insecticide	Applied as advised, problem solved	Farmers accept chemical control
5. Female Naranjo, Alajuela	Anthurium, Mealy bugs & mites 5 May 2016 & earlier	Insecticide (unspecified) mixed with oil	Applied 2 insecticides	She also received info from other sources
6. Female Naranjo, Alajuela	Ornamental plants, Fungus September 2016 & earlier	Use less irrigation water in greenhouse, apply fungicide	She tried the fungicide but could not adjust the water flow	Electronic irrigation system was too difficult to use
7. Male Naranjo, Alajuela	Celery, Mites October 2015	Chemical acaricides followed by an organic product to prevent a 2nd attack	He applied the products as recommended & saved his crop	His next celery crop was free of mites, without chemicals
8. Male San Ramón, Alajuela	Beans, Mites ca 2011	Acaricide	Used chemical successfully, then experimented with crop rotation	He adopted the Rx, but also tried crop rotation based on articles he read
9. Female San Ramón, Alajuela	Chayote, Thrips 2015	Pyrethrin (natural insecticide)	She applied the product, which solved the problem	Farmers tend to accept chemical Rx
10. Male San Ramón, Alajuela	Lettuce, Bacterial rot 2013 or 2014	Move vegetables to a cooler place	He moved his vegetables to a higher altitude, built a new greenhouse	Major change in cultural practices, based on sound grasp of the Rx

Tucurrique

Peach palm

Osvaldo Araya realized that he had a serious problem in 2015 when he began to cut open his peach palm fruits only to see that they were full of worms. Until then, the crop had been providing his family with a decent income. They sold the nut-flavoured fruits by the kilo (fresh or boiled). In 2015 all of his fruit was ruined, and don Osvaldo was able to sell none of it.

Don Osvaldo took the wormy fruit to the plant clinic, that is, to the MAG agency. The plant doctors did not have a ready solution, but they spent the year looking for answers, eventually finding help within MAG, from expert Arturo Olaso, the national director for citrus and papaya, who also had experience with peach palm. Mr Olaso organised a 10-session course for the organized group of 20 peach palm growers.

As don Osvaldo put it, the course gave him valuable background information. Now don Osvaldo knows that the worm is the larva of a weevil, and that it pupates in the soil at the base of the palm plant. When the adult weevils emerge, they lay eggs in the canopy, as the palm is flowering. The larvae hatch and burrow into the tender fruit.

Didier Núñez (rt) shows off a healthy bunch of peach palm fruit, grown by Osvaldo Araya (left)

The farmer clears the leaf litter from an area three meters in diameter around the palm and drenches the soil with a solution of entomopathogenic fungi (*Beauveria* and *Trichoderma*). This kills the pupae in the ground. The farmer traps the adults that do emerge with pheromone traps and kills any survivors with insecticide in the palm canopy, as the plant flowers. It is an integrated strategy based on a sound understanding of the pest's ecology.

Don Osvaldo's income has been restored, thanks to following this advice. A single palm yields between 50 and 100 kg of fruit and on three hectares he has 1,200 palms. A kilo of raw fruit sells for between 800 and 1,000 colones ($1.40 and $1.80). Steamed fruit is priced between 1,000 and 2,000 colones. This allowed the Araya family to earn between one and two million colones (between about $2,000 and $4,000).

Don Osvaldo had never received any written material on the peach palm weevil, but the plant doctor gave him one during the visit with the study team. Don Osvaldo was glad to get this four-page paper in black-and-white.

Coffee disease

Sonia Granados had a problem several years ago with her coffee plants. The leaves were turning yellow and she didn't know why. She had worked in a group of cattle owners with MAG for some time. As part of that group she had built a biodigester which converts pig faeces into methane gas. Doña Sonia is happy to use the smokeless gas for cooking, because she is allergic to wood smoke. (For a story on biodigesters see Bentley 2014).

Besides methane gas, the biodigester also releases a watery, organic sludge, which has to be disposed of in some way. Doña Sonia would drain some of the sludge into a bucket and pour a bit of it here and there at the base of her coffee plants. After a while she noticed that the plants with the sludge were healthier than the others. It could be that there were beneficial fungi in the sludge, or that the fertilisation simply helped to nourish the plants to better health.

Doña Sonia took the coffee problem to the MAG office and they sent samples to experts, who thought that the plants might have a nutrient deficiency. The plant doctors found this response unconvincing (MAG extension agent Marisol Díaz is herself a plant pathologist). Another lab diagnosed the problem as blight (*Ceratocystis fimbriata*), which the plant doctors suspected was wrong. The plant doctors sent samples to CATIE (Centro Agronómico Tropical de Investigación y Enseñanza, i.e. the Tropical Agricultural Research and Higher Education Centre). This was part of the exensionists' link with Plantwise, since CABI's country coordinator for Costa Rica (Eduardo Hidalgo) is based in CATIE. This time, the problem was correctly diagnosed as a disease caused by the fungus *Colletotrichum* sp.


Sonia Granados with her now healthy coffee plants

When the study team visited her, doña Sonia was still not quite sure what the problem was with her coffee. She could not recall if it was a disease or a nutrient deficiency. However, she did recall the recommendation: a copper-based fungicide and she knows that it cleared up the disease completely.

Doña Sonia and her husband also had problems with coffee rust, which they were able to solve recently with a fungicide recommended by the company that buys their coffee. Curing both of these diseases (*Colletotrichum* and rust) has paid off for the family. In 2015 they harvested 30 *fanegas* (about 2,300 litres) of coffee beans (*café oro*). So far in 2016 they have harvested 20 fanegas (some 1,600 litres) and they are not even half way through the harvest.

Doña Sonia has received some written materials from her plant doctors, but is not sure where she put the literature. She has not used it as reference material.

Vegetables

Juan Carlos Molina grows 1.5 ha of vegetables. He is part of a group advised by MAG. Juan Carlos has taken several problems to the MAG office, and has previously received a diagnosis and a chemical recommendation for *Alternaria*, a fungus. He was pleased with the results of the recommendation. Another time, MAG helped Juan Carlos test the pH of his water, and he is now using a pH corrector.

So when a strange disease appeared in his lettuce in 2015, Juan Carlos knew it was not *Alternaria* and was not a pH problem. He took a sample to MAG and the plant doctors consulted with one of their colleagues, a vegetable expert in the Ministry. The problem was *Fusarium*, another fungus. He

recommended spraying 1.5 kg of bicarbonate of soda in 200 litres of water, followed three days later by a gallon of *Trichoderma* in 200 liters of water, to control the disease.

Juan Carlos Molina, solving vegetable problems with the help of expert extension

Don Juan Carlos is not exactly sure why he had to apply bicarbonate of soda to his lettuce before applying *Trichoderma*, especially since he had already corrected his problem with soil acidity. (The study team is not sure why he had to apply bicarbonate of soda, either). But the problem was solved.

In his interactions with MAG, don Juan Carlos has come to realize that some of his previous practices may have had unforeseen consequences. Chemicals that he used to apply for nematodes may have been a short-term solution, but killed beneficial micro-organisms in his soil. So now he understands the importance of replacing this flora. (The local MAG plant doctors are keen on multiplying large batches of native soil micro-organisms, to apply to crops).

Don Juan Carlos has received several pamphlets on vegetables, and has put them away at home, along with his visit forms.

Naranjo

Anthuriums and violets

Ana Cecilia Araya Chacón grows ornamental plants under a roof of clear plastic sheeting, but without walls. These structures are common in Costa Rica, and obviously productive, because even a couple of thousand square metres is too much work for one person. Doña Ana and her husband are able to employ local women to help tend the plants. The farm uses precision drip irrigation to water each plant exactly.

Doña Ana recalls one problem in about 2008. The roots of her Anthurium flowers were dying. Anthurium is a valuable plant, grown for export as a cut flower. (Naranjo is just 47 km from the international airport of San José). Doña Ana had bought 5,000 of the small plants from a laboratory, a total investment of approximately 1.5 million colones (about $2,500). It was more money than she could stand to lose.

The plants were held in small pots when the roots began to die and the plants stopped growing. Fortunately for doña Ana, MAG extension agent Arturo Salazar came to visit. This was of course long before plant clinics started in Costa Rica, but the plant doctors regard Arturo as the top expert on ornamental plants.

Doña Ana showed her unhealthy Anthuriums to Mr Salazar. She recalls saying that she had a “root problem” and that he prescribed two products. She doesn’t recall what they were, but she knows that she applied them both, mixed together, in a drench, i.e. she used a watering can to soak the plants and the surrounding soil with chemicals. After this application, the Anthuriums recovered quickly and

completely. When the plants matured she was able to sell them for 750 colones each (two and a half times what she paid for them), except for a few plants which she kept. She still has those plants and she uses them as mother plants to reproduce Anthurium on her own.

Five years later, in 2013, doña Ana had a problem with violet, which Mr Salazar identified. Doña Ana remembers the name of the insect pest, Thrips, but not the insecticide she applied. As with each visit, MAG plant doctors write out a carefully penned recommendation, with the names of the product and the dose. Doña Ana kept the recommendation, but no longer remembers where she put it. Doña Ana was able to buy the chemical, apply it and successfully control her Thrips.

Sophisticated drip irrigation for violets

The teacher

Elizabeth Fonseca taught natural sciences in secondary school, but before she retired she began growing ornamental plants, especially Anthuriums. When doña Elizabeth first started growing ornamental plants, in about 1996, she assumed that chemical control was the best option to manage pests. But after a couple of years she was visited by an old high school friend named Alfredo Rojas who was selling organic products. More by persistence than by logical argument, on his third visit he convinced her to try the products he was selling.

Doña Elizabeth then spent 30,000 colones ($60) every two weeks on these products, until Alfredo died in 2015. The organics were not working anyway. Thanks to various fungi and aphids and mites that left scars on the thick, waxy petals of the Anthuriums, she was only able to sell half as much for export as she had sold when she used chemicals.

All the while, doña Elizabeth was receiving frequent visits from her MAG plant doctors, who by 2015 had been trained as plant doctors. Doña Elizabeth keeps a notebook where she records everything that she buys or sells, and where she keeps her visit forms from the plant doctors.

With the death of Mr Rojas, doña Elizabeth looked for someone to advise her on growing organic flowers. The plant doctors gave her the contact details of Dr Miguel Angel Obregón. (According to his Internet site, he has a private lab and a 1992 PhD in plant pathology from Bulgaria. He is also a specialist in organic pest control).

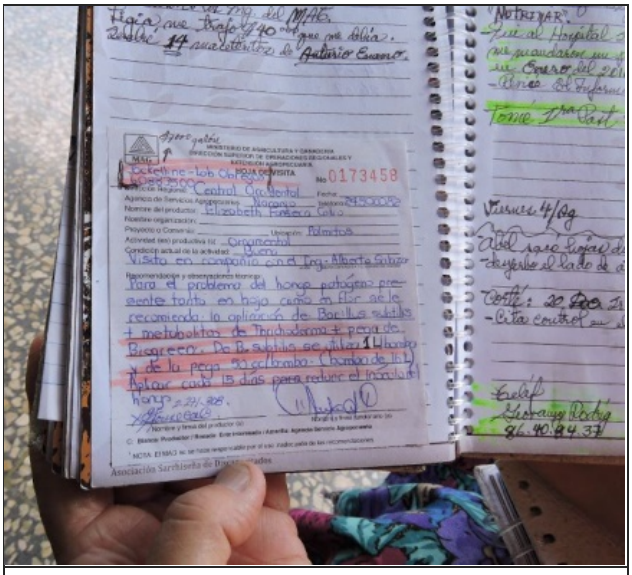
Doña Elizabeth visited Dr Obregón and was soon spending 7,000 colones ($14) for each gallon of organic insecticide. She sprayed it a litre at a time in a backpack sprayer. This is a much higher dose than one would use with a chemical, but she saw little effect.

During their visits in 2015, the plant doctors noticed various problems, from mealy bug to fungus, and encouraged doña Elizabeth to keep using the organic products from Dr Obregón. She complied scrupulously, but during a follow up visit on 5 May 2016, the plant doctor found mealy bugs on her Anthuriums and suspected that there was also mite damage, and recommended a chemical insecticide mixed with oil. But this is not what doña Elizabeth remembers. Even though she has the

recommendation pasted into her notebook, she only recalls that she was given a recommendation for organic pesticides.

The plant doctors explain that when a client like doña Elizabeth is trying to be an organic grower, the plant doctors recommend only organic products. In this case they must have thought that the problem was serious, to recommend a chemical.

In this case, even a science teacher who meticulously writes down all her transactions may not remember everything. Doña Elizabeth forgot she was prescribed a chemical, and probably did not apply it. But she does remember how frustrated she was, and that she sought help from a large-scale grower, a Danish exporter she calls don Oli. Doña Elizabeth asked don Oli's assistant for advice, saying "He's worked for don Oli for 12 years, so he is practically an engineer!"



Doña Elizabeth keeps her recommendations and highlights key messages

The assistant suggested two chemicals, Excalibur (a pyrethroid) and Helopdrid (a neo-nicotinoid), both yellow label (highly toxic). The organics had been slow working, but these chemicals killed the pests immediately, plus they were cheap, only 10,000 colones ($20) for both bottles. Thus doña Elizabeth has come full circle, back to where she was 20 years ago. She only recently started using chemicals again, and they worked. For her it was an important decision, not easily reached.

Too much water

Susana Rodríguez has one of the smallest farms one is likely to see, about 200 square meters. The study team met her by the edge of the driveway to her house, where she was on hands and knees digging out the weeds between some ornamental plants. She was pleased to see the visitors, especially the plant doctors from MAG, Eduardo Losilla.

Eduardo Losilla measures the water in an imaginative approach to communication

Doña Susana led her visitors into a greenhouse behind her house, where she had planted cuttings of vines in pots. She called them passiflora, and said that she was raising them to sell. The leaves were growing a thick, wet, green fungus. The fungus was so aggressive it was even growing on the metal table. Eduardo Losilla took one look at it and said that the problem was caused by too much water. Doña Susana seemed to be expecting that answer.

She has an electronic watering system. Every 17 minutes, the 10 small nozzles emit a mist of water onto her tables of plants. Doña Susana bought the system from a company in San José. The firm sold so

many of the gadgets that the field technician cannot service them all. The irrigation system is farmer-unfriendly. Doña Susana is frustrated that she can't regulate the water, which is drowning her plants.

She bought the system because she wanted to work in her greenhouse and take care of her children at the same time. She told her visitors that before she bought the system, if she had to go to a meeting at her children's school, she would have to ask a neighbour to water the plants.

Eduardo Losilla uses a creative way of communicating with Susana. He asks her for a measuring cup. When the water comes out of the sprinkler (at one of its 17-minute intervals) he holds a vial up to the spout and measures how much water comes out. One nozzle releases 10 ounces of water (about 300 ml). The water comes on 85 times a day and releases 25 litres from each nozzle, onto a space about the size of a kitchen table. "It's too much water," Eduardo tells Susana.

Doña Susana goes into the house and gets one of the prescription forms that she has kept from a previous visit from her plant doctors, from 5 May 2016. That recommendation clearly explained the background information: there is too much water on the plants, which is why the roots are rotting.

Susana understands the background information, but has a user-unfriendly irrigation system

After that visit in May, doña Susana also received a visit in September of 2016, when the plant doctors told her that she had too much water on the plants, but also recommended a chemical. She doesn't remember the name of the chemical, but she applied it. Doña Susana's husband works for a large nursery, and Susana got a bit of the chemical from her husband's boss to try. She says that it worked, a bit.

Counting the visit today, this is the third time that her plant doctors have urged doña Susana to reduce the flow of water in her greenhouse, and she hasn't done it.

Eduardo Losilla is sympathetic. The irrigation system is so complex that she cannot adjust it. It is basically run by a computer that has to be reprogrammed. "I could adjust it; I know how," Eduardo explains, but he adds that if he does that, and anything should go wrong, the company might say that the warranty is void, because a third party touched the equipment. This electronic mist irrigation system is intended to save labour, but instead it has become a problem.

The team also takes advantage of the visit to ask doña Susana what she recalls from the extension talk the day before, which she attended. She can't recall what it was about. When she is reminded that one of the topics was Thrips, she asks us which of the three pests was Thrips. "Is that the one that curls the leaf?" she asks. The talk clearly failed to get its point across. Then doña Susana says "What I liked best was the part about the plant clinic."

Rural correspondent

Jesús Valverde is an unusual kind of farmer. He makes his farm available to MAG to bring visitors to see his vegetables, grown under plastic shelters. He is also a correspondent for a radio station (Radio Sideral, broadcast from San Ramón on frequency 1340 AM—and available on line at http://tunein.com/radio/Radio-Sideral-1340-s10340/). When CABI's Eduardo Hidalgo visited Naranjo earlier in 2015, don Jesús recorded a short interview with Dr Hidalgo about the plant clinics. Later, don

Jesús played the clip on the radio. Don Jesús gathers material every day for his 4-minute slot on the 6AM community service program about agriculture, *Atizando el Fogón* (lighting the wood stove).

Don Jesús had met Dr Hidalgo in October of 2015 while visiting MAG with a celery problem. During the October visit, Eduardo Losilla and Eduardo Hidalgo had shown don Jesús the celery mites using a microscope, and recommended a chemical solution. A year later, when this study team visited, neither the farmer nor the plant doctors could quite recall the names, but it was a recommendation for several chemicals, applied one after the other "a shock treatment" (un programa de choque) as Eduardo Losilla calls it. The chemicals were followed by an organic product, to keep out the mites.

Jesús Valverde prospering with celery

Don Jesús bought the products and applied them and has never had mites again. He was quite relieved too, because the mites were ruining his celery, turning the stalks yellow. The problem was spreading to the whole lot. Don Jesús grows a fine, supermarket-quality celery. He buys 1,000 plantlets at a time for 13,000 colones ($26). He eventually harvested a healthy crop and sold it for 500,000 colones ($1,000). Sometimes a recommendation can be worth a lot of money.

Although in this case, the farmer really did visit the plant clinic at the agency and was able to see the problem under the microscope. (Seeing the mites through a scope is part of the diagnosis, not background information, but it does seem to have helped don Jesús to understand the mites more clearly).

San Ramón

Almost organic

Gerardo Quirós is a born teacher, who is dedicated to what he calls "semi-sustainable," family farming. He is pragmatic, not strictly organic, but definitely with an ecological outlook, which is based on a creative blend of local knowledge, his own observations, and books he has read, along with articles from the Internet. For example, he observed that the whitefly never bothers his ginger plants, or basil. He began making botanical insecticides of these spices, to discourage whitefly on his other crops.

Since 2008, don Gerardo has also experimented with the little greenhouse-like sheds that are called "protected environments." These structures make it easier to use drip irrigation, and they are a comfortable place to work, out of the rain, but they can also be, as don Gerardo put it, "a five-star hotel" for pests.

In 2008, don Gerardo built such a protected environment for chilli. He made artificial soil (substrate) by mixing legume fibre (crop residue) with barnyard manure and coffee pulp. This last ingredient is one of the biggest contaminants in Costa Rica, and is often dumped into streams and rivers. Don Gerardo was proud to be able to recycle it as a growth medium for his plants.

The chilli performed so well that don Gerardo planted it six times in a row. After four seasons, he started to notice some strange damage, so he took a sample to Juan Vicente Orozco in the MAG office in San Ramón. Mr. Orozco is an experienced plant doctor who has been at this post since 1997. He identified the problem as mites. He then went to a lab, borrowed a lab coat and a microscope and did some more research before ringing up don Gerardo with a recommendation to apply a chemical called Acaramik, but by then don Gerardo had already gone to a shop and bought a generic acaricide, which he sprayed once or twice.

Don Gerardo says confidently that the generic pesticide is the same as the brand name version, but cheaper. He says that once he knew the name of the pest, he was able to control it. However, buying an acaricide did not set don Gerardo on the pesticide treadmill. He did some independent reading, and found that chilli could be rotated with beans, so after growing chilli another two times he began to rotate it with beans. He grows one crop of chilli, followed by two of beans and says that this is enough to manage mites.

Ecological observation: don Gerardo grows ginger plants under his blackberries to control pests

The diagnosis (mites) was all that don Gerardo needed to manage his problem in the short term, with chemicals. Background ecological information that he learned by reading on his own enabled him to control the pest without chemicals in the long term. His chilli harvest is worth about one million colones ($2,000), so don Gerardo is grateful for the diagnosis that he received from the plant doctor.

Don Gerardo adds that he gets some written material from MAG, but not very much, and that he would like to get more. While the literature that don Gerardo read was not from the Plantwise Knowledge Bank, this case does show that a few farmers are starting to look for information on the Internet.

A problem with chayote

Mr Orozco has known Hada Rodríguez Morales for years. She lived in the neighbourhood where he grew up. She is also an influential person, a leader in several self-help groups for women. Mr Orozco communicates in a courteous, respectful way with everyone, but especially with doña Hada.

Doña Hada grows chayote. Chayote (*Sechium edule*) is an unusual crop, not widely grown at the global level, but it is common in Central America. It is a small, forest-green cucurbit (squash) with a single, large seed. Costa Rica is a leading producer of chayote. San Ramón is especially devoted to the crop.

In 2015, when doña Hada noticed some strange streaks or scars on her chayote, she took a sample to the MAG office and Mr Orozco looked at it. “It was a mite,” doña Hada tells her visitors.

“It was Thrips,” Mr Orozco interjects softly. He tailors his recommendations to his clients. He knows that doña Hada tries to be an organic farmer. She is not certified, but she practices organic agriculture. So he recommends pyrethrin—a natural insecticide. A written prescription does help. She was able to buy the product because she had the name written on her visit form. Otherwise she might not have remembered the name. Doña Hada bought the product and hired a man to spray it on her chayote. She says that that was the end of the problem.

These plant doctors are socially and culturally close to the people they serve. For example, when doña Hada shows Mr Orozco her grafted citrus seedlings, he takes an interest, examines them closely and asks in what phase of the moon were they grafted. She says during the waxing moon. He says that a waning moon is the best time to graft trees. This may not be a strictly scientific concept, but it shows that the local plant doctors sympathize with the farmers and their world view.

The plant doctors know their clients: Juan Vicente Orozco and Hada Rodríguez

Doña Hada doesn’t recall if she has received written material from the MAG or not, but she would like to get written solutions on farming. Sometimes when she needs information she asks a daughter or a grand-daughter to help her find something to read on the Internet. This is an opportunity for agricultural communication. Farm families in the tropics are starting to access electronic media, which can be packaged for them.

A young friend

Farmers can and do walk in off the street into the MAG office to demand services. Some of these farmers develop a relationship with the agency, until they become ‘regulars’. One of these is José Ramírez, a young vegetable grower and the son of a local coffee farmer. José’s father, Juan Miguel Ramírez, never grew vegetables commercially, so José did not learn horticulture at his father’s knee.

The lettuce, celery, cilantro and other plants are growing on raised trays, in a bed of course gravel. José buys the stone at the hardware store, washes it in a detergent and bleach solution (to disinfect the gravel). He buys trays of plantlets from a commercial nursery and plants them with his bare hands in the jagged stone.

José explains that there are several advantages to this unusual system. One, the stone is free of disease. Second, there are no slugs (molluscs); consumers are disgusted when they find slugs in lettuce. And third, there are few if any weeds in the gravel bed.

When the team asks José how he learned this unusual farming system, he is a little tight lipped, saying just that he got some ideas from other farmers, and that he invented some of it on his own. For instance, he has an irrigation hose, fitted with the head of a watering can.

“He’s never had a course on this,” José’s father adds.

The vegetables however are bright green, crisp and healthy. MAG can take some responsibility for that. In 2013 or 2014, José came to the MAG office and said that he wanted to know if a technical

person could come to his house to see his lettuce. This was José's first contact with the plant doctors. Juan Vicente Orozco was glad to pay José a visit.

Mr Orozco immediately saw that the lettuce was rotting from a bacterial infection of the roots. He also realized that the problem stemmed from the lettuce's immediate environment. The lettuce was covered with a low plastic roof, and it was too hot. They discussed ways of growing the lettuce in a cooler place and José transferred his vegetable beds to his father's coffee farm, higher up in the mountains. It was cooler there, with enough space to build a higher roof which allowed more cool air to circulate.

Most regular farmers get four visits a year from MAG, but José gets five or six, because he demands information constantly. For example, in 2015, José had a problem with root disease in cilantro. He rang up Mr Orozco, who went to the farm and took a sample, identifying the causal agent as *Fusarium oxysporum*.

José doesn't remember the name of the disease, but he does recall that the recommendation was a product called Butrón. (The authors cannot find a reference to a product by that name). At any rate, José applied the recommended fungicide and was so pleased with the results that he still uses it, applying it directly in the "sand" as he calls the rough-hewn gravel. The fungicide prevents diseases and is cheap, at only 11,000 colones ($22) for a bottle. José uses very little of it at a time. Thanks to the recommendation, he periodically harvests 550 bunches of cilantro which he sells directly to consumers in the farmers' market for 150 colones a bunch (total 82,500 colones, or $165).

Invention: hose for irrigating with plastic tube and head from watering can

Farmers do learn some plant health ideas from written material, even without facilitation. A friend of José's took a course at INA (the National Institute of Learning) on hydroponics, and returned with some written material on irrigating with certain "salts," or mineral fertilisers. José applies salts A, B and C, mixed in the irrigation water, through a hose. Salt A is magnesium sulfate with potassium nitrate and mono-potasium phosphate. Salt B is a compound fertilizer (Fertilón Combi) with boric acid. Salt C is calcium nitrate. José has a schedule for fertilising twice a day.

Information like this, containing such specific details, including products with unfamiliar names and dilution rates are communicated accurately in writing. (At least some farmers pass on literature to others, who read it and use the ideas creatively).

Discussion of farm visits

Compared to Malawi and Nepal, Costa Rica is striking because farmers tend to adopt almost all of the advice given, whether it is for pesticides or alternative control measures (Table 3). This may reflect the close contact between the plant doctors and their regular farmers. The team also visited farmers who the plant doctors knew well and visited frequently.

Recall that the one outlier, Case 6, was for computerised irrigation sprinklers that the farmer could not adjust without help from the technician from the company that installed the system. This is reminiscent of the computerised milking robots in NW Europe and Australia, where the software is too complicated for all of the farmers to adjust, and the computer technicians do not understand the farming context (Eastwood et al. 2017)

Table 3. Farmers' technical responses by type of technology, Costa Rica [a]

Farmer response	Cultural and biological controls	Chemical controls
Used the advice	Entomopathogenic fungi (cases 1, 3)	Insecticide (cases 1, 4, 5, 7, 8, 9)
	Move vegetables to cooler place (case 10)	Fungicide (cases 2, 6)
Rejected the advice	Reduce the amount of irrigation water (case 6)	

[a] The case numbers refer to Table 2

4.3 Group extension

The team attended an afternoon talk in the conference room of MAG in Naranjo. The farmers were all smallholder growers of ornamental plants—women and men, mature people. The team had spent a couple of hours with the extension agents in the morning, looking for small insects (mealy bugs especially) to show them. The plant doctors mounted these insects on microscope slides and invited people to look at them, but few people looked through the microscopes.

One plant doctors gave three short talks (in just over an hour), illustrated with PowerPoints. He cared about his topic, and knew much about it, yet he tried to cover too much material too quickly. He spoke to his audience respectfully, and obviously enjoyed being with them, but he often rushed through his slides, which were full of irrelevant detail (e.g. the origin of the name of the order Thysanoptera).

The information was expressed in academic terms. For example, the plant doctors said that the Thrips insects were 0.8 to 1.5 mm long, but people didn't understand how small that was. At the end of the talk people asked if the insects could be seen with the naked eye, and they asked questions about information that had been covered in the talks, e.g. "What is the difference between mites and aphids?" The audience simply had not understood the message, which was not tightly organised into a logical sequence. The descriptions of each pest were presented separately, making it difficult for people to compare and contrast each type of these animals.

The background information contained much irrelevant content (such as a dense chart on the lifecycle of the insect). There was little information on pest management, except that the plant doctor lamented that the Ministry couldn't recommend insecticides. This was odd, because the plant doctors do recommend pesticides frequently. Adding to the confusion, he showed a slide with the name of an insecticide and said that it was a good one (people rushed to write down the name, and told him not to change the slide until they had all copied it down).

Then almost as an afterthought, the plant doctor wrote the brand name of a liquid dish-washing detergent (1 to 2 cc of Ultra Joy). It was not clear what the point was. The study team understood it, because the plant doctor had explained the concept that morning during the search for samples. The message about the insecticide and the detergent should have been outlined in three parts, as follows:

Diagnosis. Cochineal (or mealy bug) is a small insect that damages ornamental plants.

Background information. The mealy bug covers its body with a waxy layer that protects it from insecticide and other dangers. Insecticide slips off the wax and often fails to kill the mealy bug.

What to do. Apply soapy water to wash off or break through the waxy layer on the insect's body. Then you can apply an insecticide of your choice to kill the mealy bug. (Your plant doctor cannot recommend an insecticide, but you can ask an agro-dealer that you trust).

This logical message was largely lost during the twists and turns of the overly complex talk, which did not include a management recommendation for mites or Thrips.

The next day during the visit from the study team, the discussion about Thrips reminded doña Ana of the talk she had attended the day before at the MAG office (about Thrips, mealy bugs and mites). With no prompting, doña Ana said how much she liked the talk. When asked what she liked about it, she said simply that it helped her to remember some things that she already knew, but she couldn't recall any specific details from the talk, nor any advice on how to control Thrips.

Even if the speaker could have organised his thoughts better, he had an obvious affection for the audience, speaking to them, not down to them, modulating his voice. While the rain poured down outside, the group gathered in the kitchen for coffee, cakes and guanábana juice. There was the comradery, and the satisfaction of asking questions. This may lead people to have a favourable impression of an event, even if they didn't learn much.

5. Discussion and conclusions

The Costa Rican plant doctors often understand the importance of explaining background information, i.e. why the advice works. For example, the plant doctors explained new information on the palm weevil which helped Osvaldo Araya to understand a fairly complex, step-wise set of recommendations. Knowing what the problem is and when to attack it has given don Osvaldo the understanding to convince him to use the control methods that MAG suggested. As he said, his only regret was that not all of the farmers in the community were able to get the information about the weevils. The palm weevil information was valuable and the course was apparently excellent, but it only reached a few of the people who needed it. Mass communication strategies would be useful to complement.

The chemical recommendations are the easiest ones for people to relate to and try, not always needing background scientific information to make them convincing (it is a poison). But the farmer Juan Carlos Molina, seemed to be accepting a recommendation to spray bicarbonate of soda based on his trust in the plant doctors, due to satisfactory previous experiences.

Some of the farmers (e.g. Sonia Granados and Elizabeth Fonseca) seek information from multiple sources, of which MAG is only one. Two farmers who did further reading to learn new things to try out in their greenhouses (Gerardo Quirós and José Ramírez), which goes beyond adopting advice from plant doctors. Farmers are able to blend local knowledge, with own observations, and information they receive from outsiders.

The plant doctors modify their recommendations to suit each client, for example depending on whether they are organic or conventional farmers. They seek help from experts within MAG to identify unfamiliar plant health problems, and to design technical advice. They also pay attention to farmer's own experiments. For example, agronomist Marisol Díaz listened when Sonia Granados described the health reaction of her coffee plants to being doused with an organic sludge from the bio-digester. Ing. Díaz used the idea to write a project to use sprayers to apply this residue.

The plant doctors are respectful and attentive with their clients and good listeners as well. They communicate with their clients in plain Spanish. Their personal, one-on-one communication is clear and open. The plant doctors are socially and culturally close to the people they serve. Frequent farm visits and close communication between plant doctors and farmers may help to ensure both that farmers understand the advice, and that the agronomists understand the problems. Such good communication no doubt aids in the uptake of new technology.

Giving group advice is more challenging for the plant doctors. In the extension event that the team observed, the plant doctors had a clear idea in mind but were unable to give an effective presentation. There were problems with vocabulary, visual aids and organisation of the topic.

The study uncovered no clear cases of mis-communication. Sometimes the farmers could no longer remember the name of the pest or of the recommended product, but forgetting is not the same thing as mis-understanding. Written prescriptions are a useful aide to memory for farmers. Except for the one case of the ornamental plant grower who understood the advice, but could not get her sprinklers fixed, all of the farmers followed the advice.

Overall, the farmers seemed satisfied with the recommendations. Several of the cases showed that farmers and plant doctors alike judged that the client had avoided large losses as a result of following the plant health advice from within MAG.

There was an attempt to use the Plantwise prescription form, but the plant doctors saw it as double work. They use the MAG visit forms (which are for all visits, not just for plant health problems). The form has a large, lined space for writing a moderately long recommendation. Normally the plant doctors write down the problem (diagnosis) also. The visit forms are generally written clearly, with good handwriting (legible). The top, original copy is given to the farmer. Not all of the clients can find their visit form (and sometimes they forget the names of diagnoses or of recommended products).

The information from the forms is not available electronically which makes it difficult to use the data for e.g. monitoring pest prevalence and movements, monitoring quality of the advice and to support decision making at various levels.

The plant doctors' verbal recommendations are (naturally) longer and more complete than the written ones. The plant doctors find it easier to talk to their client farmers than to write. Speaking is faster and the simultaneous feedback from one's partner in conversation makes it easy to know if one is being understood. Written records (e.g. prescription forms) may be useful, but do not always include all of the information that farmers received.

The programme has made green and yellow lists in Costa Rica, but has not written fact sheets (in the Plantwise format). Both farmers and technical staff highlighted the need for more fact sheets written in a simpler language and with recommendations that are locally available. The green and yellow lists are seldom used in the field. There are few printed copies.

The plant doctors use WhatsApp and cell phones to communicate with the farmers and to invite them to events. There are groups of plant doctors and farmers on WhatsApp, a sign of efficiency and social inclusion. There is a support group for diagnostics that uses WhatsApp in which the plant doctors can request support, uploading photographs of problems that they cannot diagnose. The group is made up mainly of plant doctors and collaborating experts from specialties such as entomology, plant pathology and acarology.

The Facebook for the MAG clinics shares useful materials for diagnostics, news, events or queries with photographs. Although some of the publications have reached as many as 638 users, farmers and staff could publish more on this page. The page should maintain a constant flow of information, to keep users interested and to strengthen the promotion of the clinics. See the page at: https://www.facebook.com/clinicasPWCR/

6. Recommendations

The following recommendations come from the study team's interaction with farmers and plant doctors. Although communication between plant doctors and farmers in general is good, these recommendations may help to point the way forward to even more effective communication in the future.

1. Talks and written material. The plant doctors could have better results if they organised plant doctors around just one theme.

Written material (publications) should be clearer, using words that everyone knows, using a logical, systematic organisation.

Always explain the background information along with the diagnosis and the recommendation, for example, using the following order: *Diagnosis***.** Identify the problem, *Background information***.** Why the recommendation will work, *What to do***.** The management recommendation

2. Database. The information from the visit forms should be digitalised so that the plant doctors and their managers can make better use of the data. It may be premature to judge the database, since it still seems to be a beta version, and few or no analyses have been made using it. The Costa Rican database is fed by the visit forms, which are designed more for the farmers, and less for analysis. On the other hand, the Plantwise prescription form is designed more for analysis and less for farmers. The Costa Rican form is mainly a large space to write a prose recommendation for farmers. The Plantwise form contains multiple check boxes, and a small space to write a recommendation for farmers.

3. Fact sheets. There are many fact sheets in Spanish from other countries in the Plantwise Knowledge Bank which could be easily revised for Costa Rica and made available to the plant doctors. They are available at www.plantwise.org.

4. Handbook. Publish (or re-publish) and disseminate a field guide to pests and diseases. Print more of the written materials that already exist.

5. Samples. The farmers should be encouraged to bring samples to the clinic. Unlike Malawi and Nepal, in Costa Rica farmers often come to the MAG agency empty handed, expecting to simply describe their plant health problem to the plant doctors. Good samples help the plant doctor to understand the problem soon and offer better advice.

6. Share information widely. MAG has much valuable information on crop protection (e.g. for peach palm weevils) which need to be widely shared. Videos, plant health rallies and radio programs are just some of the ways that could reach the audience that needs this information.

7. Try different ways of promoting plant clinics. Flyers, TV spots, radio, newspaper adverts and other mass media may help to promote the clinics. Some advertising are cheap, for example: improve the presence of plant clinics on Facebook and other web spaces. Put up signs outside of the MAG agencies. Announce the clinics at meetings with farmers.

8. Encourage the inclusion of plant clinics at agricultural fairs. Every canton in Costa Rica has a weekly agricultural fair where many farmers come to sell their produce. The extension agencies should be encouraged to run plant clinics at these fairs in order to expand their clientele and enhance the visibility of the plant clinics.

References

Bentley, Jeffery 2014 “The Guinea Pig Solution.” http://www.agroinsight.com/blog/?p=240

Bentley, J.W. & E. Boa 2013 “The Snowman Outline: Fact Sheets by Extensionists for Farmers.” *Development in Practice* 23(3):440-448.

Bentley, J.W. & G. Rodríguez 2001 “Honduran Folk Entomology.” *Current Anthropology* 42(2):285-301.

Bentley, Jeffery W., Eric Boa, Solveig Danielsen & A.K.M. Zakaria 2007 “Plant Clinics for Healthy Crops,” *Leisa Magazine* 23(4):16-17.

Boa, Eric, Javier Franco, Malvika Chaudhury, Patrick Simbalaya and Elna Van Der Linde 2016 Plant Health Clinics. Note 23. *GFRAS Good Practice Notes for Extension and Advisory Services*. GFRAS: Lausanne, Switzerland.

Coto, Daniel & Joseph L. Saunders 2004 Insectos Plagas de Cultivos Perennes con Énfasis en Frutales en America Central. CATIE, Turrialba.

Eastwood, C., L. Klerkx, & R. Nettle 2017 “Dynamics and Distribution of Public and Private Research and Extension Roles for Technological Innovation and Diffusion: Case Studies of the Implementation and Adaptation of Precision Farming Technologies.” *Journal of Rural Studies* 49:1-12.

INEC. 2015. VI Censo Nacional Agropecuario: Actividades Pecuarias, Prácticas y Servicios Agropecuarios. Instituto Nacional de Estadística y Censos, Costa Rica.

MAG. 2015. Orientaciones Metodológicas para la Extensión Agropecuaria. Ministerio de Agricultura y Ganadería, Dirección Nacional de Extensión Agropecuaria. Costa Rica.

Annex. Study tools

1. Interviews with extension agents (plant doctors and others)

Something to say

This visiting researcher often relies on the good graces of extension agents to visit farmers. Extension agents are often willing to play the role of gatekeeper, but they often have something to say, and if they are not allowed to say their piece, they may interrupt the farmers with clarifications. What the extension agents have to say is often useful to know. They are often proud of their work and want to describe it. They sometimes feel that some of their actions must be justified (e.g. why they don't hold a clinic in a weekly market).

Before going to the field straight away, it is a good idea to let the extension agents talk. Some of them will make a formal presentation. Others will speak unscripted. The researcher can also ask a few questions (semi-structured interview). If you do go to the field right away, you can ask a few questions in the car.

Never have more than six or seven questions, or the interview may turn into an interrogation or a questionnaire. The goal is to chat about the topic at hand, with the extension agent, so that you better understand what the farmers say.

Some illustrative questions

What are the most common plant health problems that farmers ask about?

What material (or methods) do you use to communicate with farmers?

What kind of written material do you use to communicate with farmers?

What sorts of communication problems do you have with farmers?

What do you need in order to communicate better?

What do you do when you come across a plant health problem you do not recognize?

2. Attending an extension event

Paying attention to the lesson

This method works best if you speak the language. If you don't and someone translates to you, it may interrupt the flow a bit. Some interpreters can whisper a simultaneous translation during an event (see Bentley 2014 for more on whispered translations).

Participate in the event as though you were one of the more attentive (but less talkative) members of the audience. Arrive on time, or a bit early.

The extension agents may introduce you to the audience, which is fine. But then sit down and listen to the talk and take notes. A formal talk is usually one of the places where it is culturally quite acceptable to take notes, so if you don't like to take notes during interviews, this is a good place to get some practice.

You may also take a photo or two, especially if the farmers are taking pictures with their cell phones, but don't photograph every slide.

You are in the audience, not part of the extension team, so don't interrupt the speakers or correct them.

Paying attention to the audience

Listen to the comments and questions by the farmers in the audience. Questions reveal not only what people want to learn, but gaps in their knowledge. Pay attention as well to the extension agents's responses to the questions.

Does the audience seem attentive and interested? Or do they only sit up and notice when the extension agent writes down the name of a chemical?

How was the event?

Was the talk organised in a simple, straightforward way (e.g. like a snowman—Bentley and Boa 2013) or did it skip all over the place?

Did the extension agents take their time or did they rush through the material?

Are the visual aids (e.g. photos of plants or insects) sharp and clear?

Does the speaker address the slide or does it detract from the talk?

Is the language clear, in words that everyone knows? Or is it laden with jargon?

3. Farm visits

Selecting farmers

Ask the plant doctors to see the clinic register. Select farmers from the register. You may have criteria, e.g. you may be interested in a certain place, or people who have brought in certain crops. It is best not to ask the plant doctors to select the farmers to visit, as the plant doctors may select people who are not representative. They may choose farmers who live nearby, or who are friendly and articulate, or people who come to the clinic often.

Choosing people from the register is one way to ensure that you speak with female farmers, and that you get a range of plant health problems (not only tomato, for instance). You can also select farmers who visited a year or two previously, who have had time to use the recommendation in their work.

Of the farmers from the log that you are going to visit, note the diagnosis and recommendations that each one was given. Compare this to the answers that farmers give in the field.

Pragmatics often limits how many farmers you can visit and where. For example, in this study there was not enough time to visit more than 10 farmers. The regions were chosen in consultation with local staff, with three or four farmers to interview in each region. In future studies, with more time, researchers can make more of an effort to interview a more or less random sample of farmers from all areas where clinics operate.

Meeting the farmers

Explain to the farmers who you are, your names, and that you work with the plant clinics and that you want to visit some of the farmers who attended the clinic.

Main questions asked on farm visits

These questions in this semi-structured interview are intended to build a narrative as to what happened: the farmer had a plant health problem, sought help from the clinic, received advice and then responded to this advice (e.g. used it in some way). The researchers can ask other questions as well, to clarify answers, to bring farmers back to the point, or to delve deeper into interesting areas. Try to get an idea of what the farmers learned at the clinic, how much they remember, and how this perception influenced the decision the farmer took to protect her crop.

1. What problem did you have?
2. What was the advice?
3. What did you do?
4. What were the results, what happened to your crop after you tried the advice?
5. Did you receive written material from the clinic? If so, what did you do with it?

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