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Plant health clinics in Bolivia 2000—2009: operations and preliminary results

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Abstract Smallholder farmers need information on plant diseases. Ten plant health clinics (*Postas para Plantas*) evolved in Bolivia after 2000 and are still operating due to the efforts of three local institutions. The plant clinics receive any problem, on any crop, and give written and verbal recommendations, immediately if possible. Many clinics are held at weekly farm fairs, where villagers from many surrounding communities can seek help. The clinic staff write fact sheets for farmers on common problems. From 2000 to early 2009 the clinics received more than 9000 queries on over 100 crops with potato comprising two thirds of the queries, followed by peach, tomato and broad bean. Potato tuber moth and potato weevil were by far the most dominant plant health problems in the high Andes, but not in lowland areas. The diversity of crops and problems are a big challenge to the clinic staff. With basic training and practical experience they learn to diagnose most problems. However, they need access to expert support to solve some of the more difficult problems and improve the quality of advice. Preliminary results show cases of poverty alleviation, reduction in pesticide abuse, increased harvests and other benefits. The plant health clinics in Bolivia enabled extension and research to reach more farmers with a timely low-cost service.

Keywords Plant health clinics · Bolivia · National plant healthcare systems · Research/extension links · Global plant clinic

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Introduction

No one knows exactly how much food is lost on farms due to diseases and pests, whether measured in thousands of tons, or billions of dollars (Pinstrup-Andersen 2000). Strange and Scott (2005) estimate that 10% of the world's harvest is ruined by disease alone. Of course data collection is difficult, even on the scale of just one county of a US state (Griffin et al. 2009). This favours broad extrapolation, but the world may be losing a third of the potential harvest to plant health problems.

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There are good reasons to focus on small farms. They yield more than large farms, applying greater amounts of labour and inputs per unit of land (Netting 1993; Geertz 1963; Carter 1984). Smallholders are the world's largest occupation. They have the potential to achieve higher yields than large farms.

The large commercial growers have many options for managing disease, e.g. hiring an agronomist, contacting a government agency, consulting with their contract buyer or a grower's association. The smallholders generally have to ask a neighbour or a chemical dealer (Davidson et al. 2001; Williamson 2003). However, this depends on the social context and type of cropping system. For example, Van Mele and colleagues report that for Vietnamese smallholder fruit growers, their own experience and media were more important sources of information than pesticide dealers and neighbours (Van Mele et al. 2002).

As an added complication, smallholders may have 60 plant species growing, just in their home garden (González-García and Gómez-Sal 2008; Denevan 2001). Smallholders typically harvest three or four crops to sell, but grow many more to eat—and all of these plants have diseases and pests. Yet most projects and research centres work with one or a few crops.

Advice for smallholders should come from modern agricultural extension, which began because governments saw the importance of agricultural production for increasing food, wealth and tax revenues (Jones and Garforth 1997). But over time the perceived need to support agriculture diminished, mainly because farming's contribution to national wealth declined as manufacturing and other sources of revenue increased in importance. By the 1970s and 1980s extension fads like 'training and visit' began to distract from the basics of solid extension programmes supported by national governments (Anderson et al. 2006). The extension fads were inadequate substitutes for basic extension: diagnose the problems, train farmers and extensionists, and consider crops holistically. Governments have over-taxed agriculture, taking out more than they give back (World Bank 2008). The high food prices of 2008, followed by food riots in several countries, reminded governments that they must support farmers with advisory services and extension. The Neuchatel Group (Chipeta 2007) says the best way to respond to farmers' needs is through demand-driven advisory services.

Agricultural research has forgotten some of the lessons learned in earlier generations. In 1940 British plant pathologist EC Large was comfortable writing about social conditions and agriculture in general in his history of plant pathology. He discussed 'plant doctors' and 'health services for plants' as if these were self-evident good ideas (Large 1940). This holistic thinking has been largely lost. Scientists have begun to undervalue extensionists and exaggerate their failings (Boa 2009).

Plant pathologists have recently begun to grapple with wider issues of the impact of disease threats and food security, often with an emphasis on diagnostics (Miller et al. 2009; Smith et al. 2008; Strange and Scott 2005).

The human healthcare system, including clinics, hospitals, pharmacies, research and universities, is used cross-culturally because it works (Levine et al. 2004). A similar model is standard for animal healthcare. There is every reason to assume that a clinical approach will also help improve plant health. The potential users of plant clinics are also patients in the human healthcare system, and grasp the analogy instantly. Plants suffer from diseases analogous to those of humans and animals, including viruses, fungi and bacteria (Anderson et al. 2004). Plant pathology's clinical practices were originally adapted from human medicine (Large 1940; Campbell et al. 1999).

Purpose of the paper Below we describe how plant health clinics (known as *Postas para Plantas*) for smallholders in Bolivia were established with help from the Global Plant Clinic (GPC), how they operate and some preliminary results. The role of the GPC in starting the *Postas* is described by Boa (2009) and its ongoing support is described in other sections of this paper.

Method

The description is based on qualitative information obtained through interviews with farmers, plant doctors and other actors as well as direct observation. The quantitative data (crops, clinic users, diagnoses etc.) were gathered from the clinic registers, kept by the clinic staff on paper and entered into an Excel spreadsheet later.

There is good evidence of farmer approval: many return to the clinics with new queries and say they are pleased to have saved their crop, saved money, or both as a result of a previous visit. The numbers of users and communities benefiting has increased. We do not know if the clinics will evolve into a stable, nationwide plant healthcare system, providing on-demand services for all farmers, but there are encouraging signs that local government recognizes the value of clinics and is willing to scale-up.

History of plant health clinics in Bolivia

Ten plant health clinics were established in Bolivia from 2000 to 2007 by three key institutions, CIAT (Centre for Tropical Agricultural Research), PROINPA (Promotion and Research of Andean Products) and UMSS (Public University of San Simón) (Fig. 1 and Table 1). This section

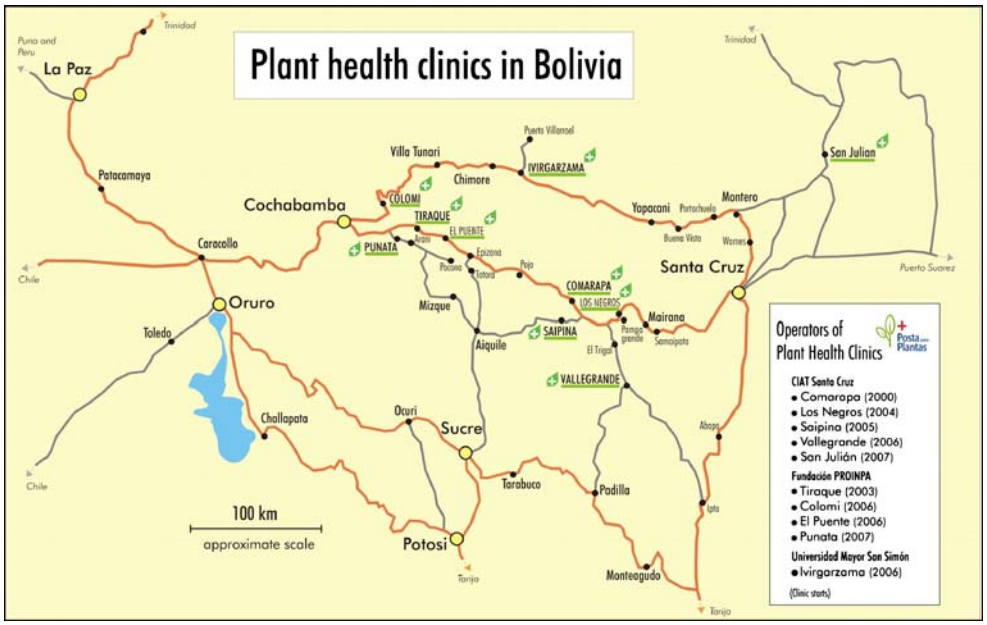

Fig. 1 Location of plant health clinics in Bolivia

describes the evolution of the clinics and how the three institutions responded to the early experiences and learned from each other.

The first key event The Bolivia plant clinics were inspired by two events. The first was CIAT's Comarapa lab (LADIPLANTAS) which first opened in the year 2000 (see Table 1). It was part of a DFID (UK Department for International Development)-funded project managed by CABI and CIAT, called MIP Papa (Integrated Potato Pest Management). The lab was equipped to diagnose potato diseases (especially bacterial wilt). It started as a typical research project, mainly concerned with one crop. Researchers randomly selected 50 farms and began to systematically survey their potato diseases. But the farmers left out of the random sample also had pest problems they wanted identified, and not just with potato. Farmers from all over the municipality started bringing diseased plants into the lab. The small-scale commercial farmers knew the lab staff. They had mutual respect for each other, and the staff could not easily turn the farmers away.

The municipal government of Comarapa supported the lab from the start, funding one of the salaries. The support gave the mayor's office a vested interest in being informed and in insisting on a certain quality.

Table 1 Institutions that host plant health clinics in Bolivia

Host institution	Plant health clinics
CIAT (Centro de Investigación de Agricultura Tropical, Centre for Tropical Agricultural Research), a public research and extension institution of the prefectural government of the Department of Santa Cruz	Comarapa; Saipina; Los Negros; Vallegrande; San Julián
PROINPA, (Promoción e Investigación de Productos Andinos, Promotion and Research of Andean Products) a privatised, public research institute, operating nationwide with headquarters in Cochabamba	Tiraque; El Puente; Colomi; Punata
UMSS, (Universidad Mayor de San Simón, Public University of San Simón), a public university with an agricultural college in the city of Cochabamba, and a farm campus in El Sajta, near Ivirgarzama in the Chapare (lowlands)	Ivirgarzama

A laboratory evolves into a plant clinic In 2001, the lab continued to evolve into a community service when the staff at CIAT decided that with more promotion, more people would use it. In 2002 the clinic started airing radio and TV advertisements. The municipality continued to support the lab. By 2002 the lab gave advice on any crop to anyone who asked for it. We refer to LADIPLANTAS as a community plant clinic to distinguish it from the weekly *Postas para Plantas* or *Postas* held in market places and described below.

How the plant clinic worked The clinic was open every day, especially Sundays, when it was most convenient for farmers to visit it. A receptionist received the farmers' samples if the agronomists were in the field. CIAT insisted that they bring samples. The lab had kits for identifying some viruses and bacteria. LADIPLANTAS asked smallholder farmers to pay only enough to replace the reagents or other

materials used directly in making the diagnosis. The minimum charge was one Boliviano (US$0.14).

If the clinic staff could not identify the sample immediately they asked the user to return a few days later for the written report (one page, typed, with the identification and recommendation). Careful thought was given to non-chemical management options but for fungal diseases, particularly on high value crops, the most suitable method often required chemicals.

Plant clinics strengthen links between extension and research: four new disease records have been published in a peer-reviewed journal (Jones et al. 2005a, b, c, d) and a major research article which describes a new phytoplasma from tomato (Arocha et al. 2007). Plant clinics give poor farmers in Bolivia access to the best diagnostic services in the world. See Table 2 for a timeline of the clinics in Bolivia.

Identifying phytoplasma in tomatoes (Arocha et al. 2007) allowed LADIPLANTAS to have a large impact. CIAT staff did not have the expertise or equipment to identify this new tomato disease. Once Phil Jones of the GPC confirmed the phytoplasma, CIAT was able to develop a management strategy that did not increase production costs: use the same insecticide as for whitefly, plant resistant varieties and avoid planting during the hottest, driest months. This strategy avoided unnecessary spraying, prevented farmers from being exposed to dangerous insecticides, saved money and improved yields.

PROINPA gets involved The second key event was in December, 2001 when PROINPA held a public demonstration at the weekly market fair in Tiraque on how to diagnose nematodes in potato using symptoms and a simple test. The 5-minute demonstrations were short, practical and repeated to different audiences over 3 h. Agronomist Daniel Vasques held a similar event at a truck/bus terminal in Sucre, explaining how to recognize peach pests and diseases. Steve Eguino and Olivia Antezana also hosted short demonstrations on diagnosing potato pests in the Comarapa market on 3 March, 2002. The new extension method became known as Going Public, and has been used in Africa and Asia for banana, rice, napier grass and other crop diseases (Bentley et al 2003).

Posta at Tiraque Inspired by the Comarapa clinic, and by the experience of Going Public at the farm fair, a team of seven people from PROINPA, CIAT and others met on 11 September 2003, at PROINPA's experimental station in Toralapa, Cochabamba to plan a different kind of plant clinic: one that would only be open for a few hours once a week, during the farm fair.

The next day the group went to the nearby town of Tiraque, which was filled with farmers attending the weekly Friday market fair. By previous arrangement with the municipal government, the group occupied a small space next to the *intendencia* (a small municipal office in the fair). They set out bottles of diseased potatoes (and had samples of healthy and diseased seed). Three members of the team gave impromptu talks in the local language (Quechua) on seed health, using the Going Public method.

Table 2 Timeline of key events in the history of plant health clinics in Bolivia

2000	**CIAT** *On-going*
	Community plant clinic (LADIPLANTAS) starts in Comarapa. By 2002 it had become better known and the municipal government of Comarapa starts to provide funds in recognition of its importance to the community.
2001	**PROINPA and Daniel Vasques, agronomist** *December*
	First Going Public exercises in Tiraque, Sucre and Comarapa (Bentley et al. 2003) which prompted the idea of plant health clinics in markets.
2003	**GPC** *June;* **PROINPA and CIAT** *September*
	Eric Boa outlines ideas which led to a course given by Jeff Bentley on plant health clinics and creation of GPC-supported Plant Health Services initiative.
	PROINPA *September*
	First plant health clinic begins regular, weekly sessions in Tiraque (Figs. 2 and 3).
2004	**CIAT** *March*
	Second plant health clinic begins in Los Negros.
2005	**CIAT** *October*
	Third (mobile) plant clinic starts in Saipina: Each week clinic staff from Comarapa and the municipal agricultural chargé visit a different community.
2006	**UMSS** *June*
	Fourth plant health clinic begins at Ivirgarzama, the first in the Chapare. UMSS becomes the third partner in the Plant Health Services Initiative
	PROINPA *August*
	Fifth plant health clinic begins in Colomi weekly fair.
	PROINPA *August*
	Sixth plant health clinic begins in the weekly fair at El Puente, municipality of Pocona
	CIAT *September*
	Seventh plant health clinic begins in Vallegrande, run by local CIAL.
2007	**CIAT** *July*
	Eighth plant health clinic begins weekly service in San Julián which is accessible to 185 communities.
	PROINPA *February*
	Ninth plant health clinic begins in a fair at Punata, near Cochabamba.
2008	**CIAT, PROINPA, UMSS**
	Continue to operate clinics. Have also joined together to seek funding to train other institutions to sponsor plant health clinics

About 200 people visited the *Posta* the first day. That afternoon, PROINPA nematologist Javier Franco and the others designed a form to record the name, community, and problems of the people visiting the *Posta*. They also designed a prescription pad (Fig. 2) with a carbon copy built into it, so that the agronomist would write a recommendation and have a copy to keep.

PROINPA designed an attractive banner for the *Posta*, and made original posters and flyers to catch the eye of passers-by. After the first week, the agronomist (plant doctor) went alone to the fair, faithfully and consistently. He sat at a chair behind a table and waited for visitors, receiving four or five a week (Fig. 3). The PROINPA *Posta* in Tiraque did not insist that people bring in samples, but was good at discussing problems with people. Most of the time, the staff felt confident identifying problems from verbal descriptions. Compared to the large variety of pests in the lowland tropics, farmers in the high Andes bring in mostly potato pests, especially the Andean potato weevil, tuber moths and late blight.

Posta at Los Negros CIAT's LADIPLANTAS community clinic in Comarapa inspired the PROINPA *Posta* in Tiraque, which in turn motivated CIAT to start a *Posta* in Los Negros, about an hour by car from Comarapa. Fifteen farmers visited this first *Posta*, drawn in by Going Public presentations. The CIAT staff encouraged people to bring in samples, and the next week 53 farmers consulted the *Posta*. Three or four staff went every Sunday, which was their day off, and held the clinic on the front porch of a seed and agricultural input shop owned by Adhemar Alvarez.

Fig. 2 A written prescription helps users remember the recommendation. *Posta* at Tiraque

Fig. 3 The Plant Clinic at Tiraque runs from about 10 am to noon. René Pereira sits under a banner announcing the '*Posta para Plantas*'. He is surrounded by two boards, covered in colourful posters

CIAT in 2006 By 2006, two agronomists and a receptionist at LADIPLANTAS were covering four municipalities. The CIAT agronomists were still running the *Posta* in Los Negros (Fig. 4), every Sunday, with steady support from Adhemar Alvarez, now president of the municipal council of Pampa Grande (which includes the town of Los Negros). Agronomist and vegetable grower Alvarez still provided the *Posta* with space on the large porch of his seed-and-supply shop, and he also helped out personally when the *Posta* was busy.

Alvarez announced the *Posta* every week on the radio, but for all his interest and influence, the town council did not provide the space and an agronomist to run a plant clinic, as they said they would in January 2005. "They have other interests," as one CIAT staff put it discretely. Working with local government is crucial, but not always easy.

Fig. 4 Plant doctor Jhon Ferrufino (centre) uses CIAT's fact sheets to help farmers at the *Posta* in Los Negros

However, other municipalities were interested. Saipina, for example, hosted a visit once a week. Every Thursday the municipal chargé for agriculture and livestock would find a host community. A CIAT staff member spent one morning a week giving farmers practical lessons on whatever topic they wanted.

These visits combined the best of FFS (farmer field schools) and Plant Clinics. Training is in the field, with the crop—but by rotating communities, several villages are reached in a season instead of one. As with the clinics, the farmers chose the topics they will study, on any crop. For example, on one visit farmers said they had a problem with cumin, not a major crop, but commercially viable. The clinic staff uprooted sick plants, found nematode galls and discussed crop rotation for nematode control with the farmers (Fig. 5). The method sounds easy, but the staff has to be highly experienced to improvise talks and demonstrations on any crop. Years of working in the plant clinic have encouraged the staff to learn about many topics.

CIAT Posta opens in Vallegrande During a visit to Vallegrande in 2006, the new prefect of Santa Cruz promised the municipality a plant 'laboratory'. The townspeople were thrilled, and seizing the opportunity, the CIAT staff decided to start work as soon as possible with a *Posta* in Vallegrande.

However, the CIAT staff could not attend, because the weekly fair in Vallegrande is on Sundays, the same day as the fair in Los Negros. But CIAT agronomist Carlos Osinaga had been supporting a CIAL (local agricultural research committee, see Ashby et al. 2000) of peach growers for years. The farmers were sure they could run the *Posta* alone. They only asked for two things: money to buy snacks, and also some fact sheets. Even so, CIAT staff

Fig. 5 Olivia Antezana (left) shows Rodolfo Soliz how to look for nematode galls in the roots of cumin during her weekly visits to Saipina

Fig. 6 CIAL members and CIAT open the *Posta* in Vallegrande

decided to help the CIAL for the first few months. They wrote 11 fact sheets with photos for them, stressing preventative pest and disease management on topics which included crown gall, mealy bugs, fruit fly, rust, peach leaf curl and lichens in peach trees.

By 2008 the CIAL was still running the *Posta* in Vallegrande, with technical support from agronomists Sandra Muñoz and Carlos Osinaga every Sunday, seeing 15 to 35 farmers every week with problems on peach, apple, grape and potato, among others (Fig. 6).

CIAT 2008 After 3 years, the municipal government of Pampa Grande (Los Negros) gave CIAT funding for publicity (e.g. radio announcements) and an office of its own, and stopped holding the *Posta* on the porch of the input supply shop. Jhon Ferrufino and colleagues held the *Posta* every Sunday, in their office on a busy corner, receiving problems on a large range of fresh fruits and vegetables.

San Julián started a new *Posta*. It was held for the first time at the Agricultural and Livestock Fair on 23 July 2007, again at the national seed fair on 18 Sep 2007, and permanently starting on 28 Oct 2007, largely because of demand by organized farmers. San Julián has no weekly fair, and CIAT agronomists Dionisio Sosa and Alberto Gutiérrez held a *Posta* every Friday, receiving mostly problems of soy bean, citrus, tomato and sunflower. San Julián is a vast rural area, 90 km long and 30 km wide, with 185 communities. There were now four *Postas* within CIAT's mini healthcare system.

PROINPA expands in 2006 In August, 2006, PROINPA hired veteran extension agent Oscar Díaz to help René

Fig. 7 *Left.* Oscar Díaz uses Going Public (e.g. drawings and short talks) to draw a crowd and to explain plant health problems in the high Andes. *Right.* Learning about weevil life cycle with vials of insects

Pereira with the *Posta* in Tiraque, and to open two new ones, in Colomi and El Puente. Pereira and Díaz often distributed fact sheets, especially one on Andean potato weevil and one on tuber moth.

People often came to the *Posta*, got information, and said that they wished that the Plant Doctors could come to their village. In 2006 Pereira and colleagues from PROINPA visited 75 of the 110 communities of Tiraque to give short extension messages (often on Andean potato weevils and tuber moths).

Oscar used a style similar to Going Public (Fig. 7). He made some handsome drawings of the life cycle of the tuber moth and of the Andean potato weevil. And he had specimens in vials, which helped people see the sizes of the creatures, and to realize that each insect has four, very different-looking life stages.

PROINPA 2007 During 2007, PROINPA received 2365 queries, 97% of which were related to potato, especially the Andean potato weevil and the tuber moth. A new *Posta* opened in Punata in February 2007.

PROINPA 2008 Oscar Díaz continued to cover four *Postas* on his own, rotating with the weekly fairs in Colomi, El Puente (Pocona), Tiraque and Punata. Oscar took the bus to the fairs, which helped to keep operating costs low.

UMSS starts a clinic in 2006 On 13 January 2006, Juan Villarroel, dean of the UMSS College of Agriculture, visited the PROINPA *Posta* in Tiraque, with Fredy Almendras, who had been working on DFID-funded projects at UMSS. The visitors were impressed and the next week, Villarroel and colleagues began negotiating with local authorities to start a plant clinic in the Chapare (tropical lowlands of Cochabamba). Even though the mayor liked the idea from the start, and soon visited the university to express interest, the talks went on patiently for 5 months.

On 11 June 2006, Fredy Almendras and Saúl Colque (both agronomists) opened a plant clinic in Ivirgarzama, municipality of Puerto Villarroel, in the Chapare, sponsored by the UMSS. The local mayor's office provided office space, in a room next to the police station.

The clinic was open every Sunday (Fig. 8). The clinic was advertised over the radio, which helped to bring in people. Most came with samples, because they had heard on the air that they should. The clinic was in a simple room with tables and chairs, in a one-storey building on one of the main streets of this small town. Frequent, heavy rains would have made an outdoor location uncomfortable.

UMSS 2007 From 11 June 2006 through 4 February 2007, the *Posta* at Ivirgarzama logged 177 queries, from 123 users, covering a wide range of tropical crops, including banana, citrus, rice, coca, and papaya.

Fig. 8 Plant doctors are good listeners. Fredy Almendras takes notes at the *Posta* in Ivirgarzama, while Susana Condori tells him about her problem with coconut trees losing their fruit

UMSS 2008 Saul Colque was running the Ivirgarzama *Posta* until the end of December, 2007 when his (shoe-string) budget ran out. He started again in mid 2008 with another drop of funding. The Ivirgarzama *Posta* was a 'joint venture' between the university, which graciously lent its good name, and Fredy Almendras, who ran it on seed funding from the GPC. Saúl helped Fredy and when Fredy left to take a full-time job, Saúl continued on his own.

Saúl moved out of the room next to the police station. It was highly visible, but clinic users were reluctant to go there. "People see us going in and think we're in trouble with the police." Saúl moved into the Central Sindical de Colonizadores, a large, grass-roots organisation of settlers.

Clinic services

Ways of operating Plant Clinics are open access services. Any community member can seek help there, unlike traditional projects, where outsiders or local elites often chose who would participate. Only one of the clinics (LADIPLANTAS in Comarapa) is open every day, in an office. One of the clinics, Saipina, is truly mobile, operating each week in a different community of the municipality. Most of the clinics are only open one morning a week, although they work out of the same place every week, usually a stall in a farmers' market.

In early 2009, a farmers' association (Asociación Productiva Agropecuaria Punata) opened a plant clinic in their existing veterinarian supply shop, in Punata. About the same time, former CIAT agronomist, Jhon Ferrufino, re-opened the clinic in Los Negros, with support from the Prefecture of Santa Cruz (departmental government) and the municipality, with service on Monday through Friday for just 1 h (when many farmers are in the small town), from 7 AM to 8 AM.

Clinics that request samples, receive samples Often simply asking clients to bring samples in is enough. Farmers are motivated to get good diagnoses and respond warmly to coaching. They soon understand the importance of a fresh sample with various plant parts intact.

Written prescriptions work These help people remember instructions and the names of unfamiliar fungicides, for example. Even if the farmers cannot read they have a permanent record of their recommendation, which they can take to a shop or ask a household member to read to them. Although rural Bolivia has fairly low levels of formal schooling, all of the clinics continue to give written prescriptions, because they are so practical.

Location is key Architecturally, all a plant clinic really needs is a table, a couple of chairs, and some shelter from the sun and rain. But it must be held in a place that is really public. A market is an excellent place. The market fairs are like social magnets. The small towns fill with thousands of farmers from the countryside. Not every country has (or needs) weekly fairs. They are not even found in all of Bolivia. But every country has public spaces which can host clinics.

Publicity is important In Bolivia all of the clinics at least have a sign. It should be weatherproof and painted on cloth, so it can be folded away. The sign lets the public know that the clinic is in session. Radio and television advertisements also help to bring in clients.

All of the plant clinics work with local government At the very least the municipality loans the weekly clinic a small place in the market, and somewhere to store equipment. Some municipalities are much more engaged, providing technical or financial support.

Plant doctors are good listeners Listening does two things; first it brings in additional information about the plant sample. Clues like planting date or pesticide use are not obtainable from the sample. Second, listening itself is a valuable service to the public. Plant health problems are serious issues for smallholder farmers, who depend on those plants for a living. Farmers instantly understand the concept of 'plant clinic'. Sometimes the plant doctor has sad news for the farmer: there is no cure or control for the peach trees with a phytoplasma disease or the tomatoes with virus. But the clinic always has useful information for improving the next crop, and people invariably leave the clinic more relaxed than when they came in, just because someone listened to their very real problem.

Links to labs CIAT has its own small lab, LADIPLANTAS, in Comarapa, where plant samples could be referred. There were other entomologists and plant pathologists at the experimental station of Saavedra (about 300 km away, near the city of Santa Cruz), who can be contacted for help with diagnoses. The Global Plant Clinic has trained CIAT and PROINPA staff in diagnostic techniques and receives plant samples in the UK which require analyses unavailable in Bolivia (e.g. viruses and phytoplasmas).

PROINPA also has its own labs, but rarely received samples. PROINPA continues to work on well-known problems, especially Andean potato weevils and tuber moths, because the problems are serious indeed for the farmers, and also because the staff have much experience with them.

Table 3 Number of queries received at 10 plant clinics from 2000 to March 2009

Clinic [a]	LP	TQ	SA	LN	IV	EP	CO	VG	PU	SJ	*Postas* only	Total
Date started	Feb 2000	Sep 2003	Oct 2003	Jan 2004	Jun 2006	Aug 2006	Aug 2006	Oct 2006	Feb 2007	Jun 2007	Sep 2003	Mar 2009
2000	150											150
2001	128											128
2002	166											166
2003	298	99	DM [b]								99	397
2004	571	122	DM	76							198	769
2005	539	82	DM	129							211	750
2006	381	340	DM	97	175	148	159	165			1084	1465
2007	209	706	DM	255	21	447	601	113	611	DM	2754	2963
2008	242	426	78	323	DM	116	332	67	314	89	1745	1987
2009	54	96	DM	DM	DM	DM	61	122	87	DM	366	420
Total queries	2738	1871	78	880	196	711	1153	467	1012	89	6457	9195

[a] LP—Ladiplantas; TQ—Tiraque; SA—Saipina; LN—Los Negros; IV—Ivirgarzama; EP—El Puente; CO—Colomi; VG—Vallegrande; PU—Punata; SJ—San Julián

[b] DM—data missing (any samples collected in Saipina were analyzed at Ladiplantas and recorded there). Most other gaps were from temporary closures of the *Postas*

The UMSS *Posta* in Ivirgarzama had less access to a lab, but the staff could generally count on sympathetic faculty members in the city of Cochabamba to help identify diseases. However, by 2009, the different institutions had realized that they needed to work more closely together, and be able to refer problems from one lab to another.

Fact sheets After receiving a short course from the Global Plant Clinic in 2006, CIAT slowly but surely began to write more fact sheets and by 2009 had over 50 of them published in a book and as single sheets, in runs of 1000. The topics are mostly plant diseases, e.g. phytoplasma in tomato, root disease (rhizoctonia) in potatoes, peach leaf curl, and soy bean rust, but they also include insects, e.g. thrips, whitefly and fall armyworm in maize. Nematodes, weeds and lichen growth on fruit trees are also covered.

PROINPA has a long history of publishing and did not take the Global Plant Clinic course on writing fact sheets. PROINPA has continued to publish for farmers, including some large posters on Andean potato weevils, packed with illustrations and control information.

In 2009, with encouragement from the Global Plant Clinic, UMSS began to write one fact sheet a month, e.g. on mildew in roses and seed health in papaya.

The Prescription for Andean potato weevil and tuber moth IPM These are the most-often mentioned problems. PROINPA already had advanced research on these in

Table 4 Plant health clinic attendance. Period covered, number of queries, clinic days and users

Clinic	Data available		Months since start	Regularity	Queries (Q)	# clinic days	Mean/ Q/clinic day	Users
	From	Until						
Ladiplantas (LP)	feb-00	mar-09	73	Constant	2738			1646
Tiraque (TQ)	sep-03	mar-09	67	Minor gaps	1871	219	8.54	1524
Los Negros (LN)	jan-04	nov-08	58	41 months	880	142	6.20	367
Ivirgarzama (IV)	jun-06	feb-07	9	Constant	196	35	5.60	124
El Puente (EP)	aug-06	may-08	22	Constant	711	94	7.56	673
Colomi (CO)	aug-06	mar-09	32	Constant	1153	139	8.29	1077
Vallegrande (VG)	oct-06	apr-09	31	8 months	467	29	16.10	338
Punata (PU)	feb-07	mar-09	26	Constant	1012	107	9.46	903
San Julián (SJ)	feb-08	aug-08	7	Patchy	89	16	5.56	86
Saipina (SA)	mar-08	oct-08	8	Some gaps	78	20	3.90	77
Total					9195	801		6815

1995, including Matapol, a kaoline powder laced with an entomopathogenic virus. Later, PROINPA added Bt to the mix. Farmers pour a 125 g bag of the powder into a gunny sack with 50 lb. of potatoes and shake the sack until the tubers are coated. If kept in a clean store, the potatoes will be healthy at planting time, although there is still not a good strategy for food potatoes.

For potato weevils, PROINPA has tried CIALs and field schools and formal research, gradually reaching a suite of recommendations, applied over the cropping season. When farmers harvest potatoes they pile the potatoes on the soil for a few days. Some of the larvae pupate there. So farmers go back to these spots and dig them up. Farmers also spray insecticide early in the season, at the base of the plant. This kills adults which are laying eggs under ground. Farmers also hill up earth, high around the plant, to keep weevils from digging to the tubers. There are other recommendations, also based on the insect's ecology, but these three are the ones farmers find most practical and functional.

Follow-up visits CIAT makes follow-up visits to some of the nearby farmers, to see if the recommendations have worked well. This is a type of quality control, but also a type of extension. Before 2006 PROINPA used to make many follow-up visits, when PROINPA only had one *Posta* and it was run by the director of the experimental station, who was interested in earning goodwill in the municipality. Since hiring one person to run several clinics, he has not had time (or a car, or money for fuel) to visit communities.

Clinic attendance and coverage

The data presented in this section give the frequency of crops and problems presented to clinics. The data are compiled from clinic registers kept by clinic staff. Tables 3 and 4 summarize the queries received at the clinics from their start.

More than 9000 queries were received from 6815 users (clients) from 2000 to 2009. About 6500 queries were from the *Postas*. In 2002, LADIPLANTAS in Comarapa received 166 plant health queries via samples brought to the lab. In 2003 and 2004 it received 298 and 571 plant health queries, almost all with samples and including material sent from the *Postas* at Los Negros and Saipina. Since the CIAT *Postas* started in 2003 there has been a noticeable increase in the number of queries received by LADIPLANTAS, though other projects have also sent samples.

There are some gaps in the data set, partially due to irregular operation of some of the clinics and partially due to lack of records. A good, simple record-keeping system for the clinics is a work in progress. Like other work at the clinics, recording queries has evolved in an *ad hoc* manner, based in part on learning by doing and also informed by experiences from Nicaragua (Danielsen and Fernández 2008). LADIPLANTAS' first registers were one-page recommendations, stored on the hard disk of the lab's computers. In 2003 the clinics started keeping registers on paper only; today they all enter the queries electronically after recording them first on paper. The next step is to harmonise the formats and ensure uniformity in the data entry.

Most of the clinics kept working once they started although Vallegrande, San Julián and Saipina have operated more irregularly (Table 4). According to the electronic registers, a total of 801 clinic days have been held over the entire period, which corresponds to an average of 3.9–16.1 queries received per clinic day. Most clinic users only come once, but some have come as many as eight times. Repeat visitors do not necessarily bring in more complex problems, rather they bring in queries from different crops. E.g. since 2007 Andrés Rojas in Los Negros has visited a *Posta* for help with bell peppers, tomatoes, celery, and green beans. The clinic staff often get to know return visitors by name, and may make follow-up visits to their farms.

More than 100 crops were brought to the *Postas* (Table 5) and LADIPLANTAS. Potato is by far the most frequently

Table 5 Frequency of crops brought to the nine *Postas*

# queries	Crop
4511	Potato
277	Peach
275	Tomato
222	Broad bean
166	Pepper (hot)
157	Bell pepper
84	Orange
60	Maize
54	String bean
41	Onion
31–40	Apple, Soybean, Mandarin
21–30	Cucurbit, Beans, Lettuce, Peach palm, Pea, Citrus, Carrot, Celery, Sunflower, Watermelon (10 crops)
11–20	Brocoli, Passion fruit, Papaya, Lemon, Rice (5 crops)
1–10	Cherry, Strawberry, Carrot, Plantain, Squash, Pumpkin, Cauliflower, Grape, Cucumber, Pepper, Cabbage, Swiss chard, Roses, Custard fruit, Coca, Groundnut, Wheat, Flowers, Pine, Sesame, Cassava, Coffee, Barley, Carnation, Dahlia, Spinach, Vegetables, Lime, Melon, Pineapple, Black bean, Courgette, Garlic, Alfalfa , Tree (poss. *Diptyrex*), 'Small Chinese tree', Oats, Banana, Cacao, Fruit (*Myrciaria dubia*), Coconut, Guava, Mango, Oca (*Oxalis*), Avocado, Pasture grass, Parsley, Lupin, Prickly pear (50 crops)

presented crop (69%) especially in the high Andes where it is a staple food and a cash crop. Some of the clinics (e.g. Tiraque, El Puente, Colomi, and Punata) were held in or near the potato wholesale section of the farmers' fairs, so it was handy for potato farmers. Despite the dominance of potato, Table 5 shows that farmers depend on many crops for food, income and feed as well as other purposes. Note that cumin, mentioned above, is not listed in Table 5. Cumin did not enter the system's formal data bank because the clinic staff identified the problem in the field and did not record it (a visiting anthropologist wrote about it). It has taken years for the clinic staff to see that recording data is part of their job, not something extra, and many of their services to the community have not been documented.

Table 6 lists the plant health problems identified in the two most frequent crops, potato and peach. The incidence of potato tuber moth and weevil is many-fold higher than for any of the other problems. The data highlights the huge challenge the plant doctors face when diagnosing problems. With basic training and practical experience most of the problems can be diagnosed by symptoms, such as tuber moth, weevil, late blight, scab, nematodes (when nodules are formed), rusts, aphids, powdery and downy mildews and other. In contrast, more general symptoms such as wilt, yellowing, leaf curl and rot are more complicated to identify and may require a lab test and expert support.

The plant doctors already had a broad knowledge of crops and their problems before they started at the *Postas*. They improved their diagnostic skills by seeing the results from laboratory analyses, training from the Global Plant Clinic and regular exchange of experiences at the *Postas*. The increased accountability of clinic staff to farmers has stimulated new learning.

The lists of problems raise new questions that need further investigation. Are virus problems really so rare in potato, or do the data reflect limited capacity of the plant doctors to identify viruses? Problems with tuber moth and weevil remain so frequent (see next section) because they are nagging problems and because PROINPA is comfortable working on them. The clinic registers contain a wealth of information that, used properly, can be used for a range of operational and strategic purposes to improve quality and scope of the clinics. (Danielsen and Kelly 2008).

Examples of impact

Estimates of impact from the clinic data are crude because we lack details of the importance of the crops to the farmers (area grown, contribution to food security and income), besides the yield increases and the production costs saved because of the advice received. Advice helps to reduce immediate losses but also benefits farmers in following years as they plant resistant varieties, improve crop rotations, make proper fertilizer applications or adopt other agronomic practices.

Farmers use clinics because they have problems they cannot solve. They generally come in asking for diagnoses. The examples in this section suggest that sound advice leads to:

- reduced cost of control measures (e.g. buying less pesticides)
- improved human health (less intoxication of people who apply pesticides, lower pesticide residues)
- improved yields (e.g. pest control, appropriate fertilizer use)
- food security (as rural households grow more food and save cash expenses).

Alleviating poverty with tomatoes From 2004 to 2006, CIAT conducted a project (a PITA, i.e. an agricultural technology extension project funded by the Bolivian government with support from DFID and other donors) for 151 smallholder tomato growers in Omereque, Cochabamba. The CIAT extensionists taught basic techniques such as organic fertilizer and tying tomato plants to stakes, but the most important innovation was sending samples of pests and diseases to LADIPLANTAS in Comarapa.

Peste negra (literally 'black plague', associated with TSWV, tomato spotted wilt virus) and nematodes were serious pests in tomatoes in Omereque. CIAT's LADIPLANTAS identified them and did pot trials to test varietal resistance to nematodes and TSWV, eventually selecting the most resistant hybrid to recommend to farmers. Adopting this variety increased yields significantly (Table 7).

By the end of the project, many of these impoverished, indigenous (Quechua) farmers had made so much money on half a hectare of tomatoes that they were able to build two-storey brick houses. Farmers installed drip irrigation, paid for with their own money. They formed their own association and continue to sell tomatoes in 2009. Proper identifications of pests and diseases by the plant clinic allowed the farmers to apply fewer, less toxic and cheaper agrochemicals while increasing their yields. See Table 7. The returns on five or six hectares of tomato would pay the operating and staff costs of LADIPLANTAS.

Less pesticide As mentioned above, Adhemar Alvarez is an agronomist who sells agricultural inputs and who has collaborated with CIAT's plant clinic. In 2009 he told the authors that some farmers in Los Negros, Santa Cruz were spending half as much money on pesticides in 2008-2009 compared with previous years, when there was no plant clinic. He reported one case of a farmer who had been spending 14,000 Bs. ($2000) every season on ¼ hectare of

Table 6 Plant health problems identified in the two most important crops presented at the *Postas* [a]

Crop	Diagnosis	#	Cause [b]
POTATO	Tuber moth	2970	I
	Weevil	2101	I
	Blight	205	F
	Late blight	174	F
	Rosario	106	N
	Pasmo negro (roughly 'black disease'), necrotic tissue often associated with *Phytophthora infestans*	41	Ns
	Pasmo amarillo (roughly 'yellow disease'), leaf yellowing often associated with *Alternaria* spp. especially on tomatoes	28	Ns
	Nematodes	22	N
	Wilt	22	Ns
	Nutrient deficiency	15	A
	Bacterial wilt	8	B
	Pulguilla (adult *Epitrix* spp. Coleoptera: Chrysomelidae)	8	I
	Hail or frost damage	7	A
	Scab	6	F
	Rhizoctonia	4	F
	Weeds	4	W
	Aphids	3	I
	Lacato (white grubs)	3	Ns
	White fly	3	I
	Smut	2	F
	Virus	2	V
	Alternaria, Cochinilla (scale insects), Cogollero (fall armyworm), Fruit fly, Gusano alambre (wire worm), Gusano cortador (cutworm), Insects, Mites, Monilia, Noctuid larvae, Aphids	1	F, I
	Not identified	41	Ns
PEACH	Mites (arañuela)	71	I
	Leaf curl (torque; musuru)	27	F
	Monilia	19	F
	Aphids (pulgones)	18	I
	Fruit fly	16	I
	Powdery mildew	11	F
	Tiro de munición (literally 'shotgun blast' i.e. the fungus *Stigmina carpopila*)	11	Ns
	Viruela (literally 'smallpox', refers to diseases causing spots on fruit, e.g. *Asperisporium* in papaya)	10	I
	Nutrient deficiency	7	A
	Cochinilla (scale insects, mealy bugs)	2	I
	Crown gall	2	B
	Gummosis, Leaf miner, Oidium, Mites, Nematodes, Pasmo (necrosis of leaves), Rust, Salvajina (lichen)	1	various
	Not identified	17	Ns

[a] The data do not include LADIPLANTAS

[b] Cause: A—abiotic; B—bacteria; F—fungus; I—insect (mite); N—nematode; NS—no information, not sure; W—weed

tomatoes. With Alvarez's advice, patterned after the *Posta*, the farmer was able to cut his pesticide bill to 7,500 Bs. ($1,070). CIAT agronomists confirmed that this was typical for farmers who had sound advice on pests and inputs.

Saving harvests Andrés Rojas, local farmer and president of the irrigators' association is a frequent visitor to the *Posta* in Los Negros. In 2008 Mr. Rojas had about ¼ hectare patch of bell peppers. He was rapidly losing money on it. He would go into a shop and tell them the flowers were falling off the plants, and the shopkeepers would sell him something expensive. Mr. Rojas would buy it, and spray it, and then go back to the shop to explain that the product did not work. "That's because you did not apply it the way I told you to," they would say. "But buy this other one. It is good."

Table 7 Changes in tomato growing in Omereque, with advice from the plant clinic

	Before	After
Expenses for agro-chemical inputs	$740/ha	$490/ha
Yield	18.4 t/ha	44.57 t/ha
Net income	$15	$1466

Source: tomato project survey of 151 farmers

And it wouldn't work either. Then he went to the *Posta*. Olivia Antezana told him his crop had thrips, a bacterium and a fungus. She wrote him a prescription. He bought it, and it worked and he was able to harvest 40 bags of peppers, almost enough to pay the cost of the expensive, toxic, insecticide he had applied in vain.

Harvesting staple food crops The highlands of Cochabamba are the 'potato basket' of Bolivia. Indigenous smallholders there grow potatoes to feed their families, and to sell. However, Andean potato weevils have been a persistent problem. Although the weevils are endemic (Ortiz 2006), they have been getting steadily worse in recent years, in part because farmers are growing more potatoes, so the weevils find it easier to migrate to new fields, and also because it has taken farmers and agronomists several years to adapt new technologies to on-farm conditions.

However, in 2009 several farmers told us they are now able to control weevils. Julián López of Cebada Jich'ana, near Tiraque, said that a few years ago the people of his community used to lose almost all of their potatoes to weevils. He usually plants 50 *cargas* of seed (about 5 tons) in the main season, and 1 year he only harvested five bags, about 1% of the expected harvest. He tried to feed the rotten potatoes to his sheep, and they got diarrhoea and almost died. He almost lost his sheep and his potatoes. But in 2004, under advice from PROINPA, the whole community started to dig up the sites where they sort potatoes at harvest.

In 2005 PROINPA sponsored farmer field schools (FFS) on Andean potato weevils and tuber moths in two communities near their research station at Toralapa. PROINPA had previously conducted CIALs to study these pests and produces a biological insecticide for tuber moths, called Matapol. During a field school (FFS) taught by Oscar Díaz, the farmers learned that after harvest the weevils escape from the potatoes to pupate in the soil. By digging up the spots where the tubers were piled, people can kill most of the insects. Now the people of Cebada Jich'ana are growing potatoes again, and have solved their problem with weevils. Díaz now teaches these techniques to dozens of farmers every week at the three plant clinics he attends in Cochabamba. As this example shows, farmer field schools are best for honing technologies with farmers, and can be productively combined with other extension methods (Bentley 2009).

The mayor of Comarapa Noel Rojas, is an agronomist. He says his municipal government supports the clinic, because otherwise Santa Cruz would be the closest place to go for advice (250 km away). Without the clinic, farmers would have to put themselves into the hands of the pesticide sellers. One of the most helpful things is that the plant clinic gives immediate answers, with a written recommendation.

The mayor said that the plant clinic has helped farmers save money, and increase profits. He said that pesticide use has declined for mites, whitefly, moths and virus. "Before, people would apply fungicide for a virus."

Mayor Rojas said he knows the clinic is important because he sees the annual reports, and the number of queries answered.

The vice-mayor (*oficial mayor*) Jhonny Andrade added that farmers see the plant clinic as a public place, where they are welcome. Mr. Andrade also said that they needed a clinic permanently because agriculture was dynamic, new pests always appear.

Seed producer's association Renzo Quiroz, a teacher, farmer and vice-president of the Association of Seed Potato Producers of Comarapa (APROSEMCO) said that the lab results from the clinic help the seed growers to choose the plots that are appropriate for seed, because they analyze the soil for pathogens. "We save money in the applications, because if we have rhizoctonia and we apply the wrong product, we could lose 200 Bs. ($29)." He said the clinic helps them with potato, tomato, beans and other crops.

Social impact Farmers now feel more power to negotiate. The farmers who work with the clinic no longer go to the shop to "get sold" (*a que le vendan)*. Now they go in to buy something. And if the shop does not have it, the farmer goes elsewhere. If they cannot find the recommended product anywhere, they go back to the clinic and ask for another recommendation. Staff, local leaders and shop-keepers all noticed the change in attitude.

Environmental impact The current generation of chemicals are much less toxic, and more specific. When farmers were applying pyrethroids in Comarapa, there were no beneficial insects in the fields. For aphids the clinic now recommends an insecticide that only kills homopterans. Green lacewings (*Chrysopa* spp.) and other beneficial insects are being seen once again in the fields, after having been missing for years.

Of course the clinic recommends other control measures, not just chemicals. They promote hot water treatment for vegetable seedbeds, for example.

Organizations link clinics to their other extension programs By 2009, the first person in charge of a weekly plant clinic, René Pereira, was managing PROINPA's organic pesticide and fertilizer factory, creating a growing line of products which are promoted at PROINPA's plant clinics. The clinics also teach various PROINPA extension messages, which have improved over the years: control of weevils, of tuber moths, late blight, and recipes for homemade foliar fertilizer, among other topics.

The CIAT plant clinic has supported various other CIAT projects, including two tomato PITAs: one in Omereque and another in Saipina and Comarapa where farmers' yield increased from 20 to 35 t/ha, an SDC (Swiss) cherimoya project and a potato project funded by INNOVA (see Bentley et al. 2007 for a discussion of INNOVA).

How diagnoses interact with local knowledge The clinics help farmers with a diagnosis. Farmers make diagnoses of their own, which can be deep, shallow, missing or mistaken (adapted from Bentley and Rodríguez 2001). How farmers react to advice depends in part on the nature of their own diagnosis, as illustrated below.

Deep (culturally important and easy to observe): hail damages the potatoes and peaches; the farmers accurately assess the damage, and track it over time. Long after the hail melts the farmer knows that the plants were battered by hailstones, but a visiting plant pathologist may not immediately grasp the cause of the plant's ill health. Farmers tend not to come to the clinic for problems which they have already accurately diagnosed.

Shallow (culturally unimportant and easy to observe): Farmers are skilled observers of vascular plants, and can easily give a folk name to each botanical species of flowering annual, if they have a reason to. Smallholders name hundreds of plants, including crops and weeds. But if a plant causes no harm, but has no known use either, farmers often leave it unnamed. It is 'just a plant' (*monte no más, planta no más* in Spanish, *qhoralla* in Quechua) (Bentley et al. 2005). Farmers occasionally come to the plant clinic asking for advice on weed control, but they do not seek information on useless, harmless plants.

Missing (culturally unimportant and difficult to observe): Molle (*Schinus molle*) is a common tree in the Andean valleys. The leaves are often dotted with sessile psyllid insects. When we first saw the spots we could not tell if they were caused by a pathogen, an insect or if they were an organ of the tree itself (i.e. the spots are difficult to observe). However, the trees thrive even with their load of psyllids, so the spots are not culturally important. Farmers do not bring molle leaves into the clinic, asking for a diagnosis of the spots. In the same vein, Bolivian smallholders are unaware of microscopic phytoliths and mitochondria.

Mistaken (culturally important, but difficult to observe). This kind of local knowledge may lead the farmer to make a wrong diagnosis, and apply the wrong treatment. This is the type of local knowledge where farmers often know they need help, and ask for it at the clinic. Bolivian smallholders have a concept of plant disease (e.g. Spanish *enfermedad*, Quechua *onqosqa*), but do not generally know about causal agents e.g. fungi, viruses, bacteria (Bentley et al. 2009). Farmers may bring in a sample and ask for an identification *of the disease*.

Sometimes farmers think they have made an accurate diagnosis, when in fact they have not. Insects may be confused with disease for example, as when peach farmers mistake aphid damage for peach leaf curl, and may call both by the same name (Bolivian Spanish *churquera*, Quechua *musuru*). Farmers do not always bring these problems to the clinic, but are interested in learning about them. There is a greater role here for extension to reach out to farmers with accurate information on these topics, which farmers may not bring to plant clinics.

At other times farmers identify a disease, but not its contributing causes. For example Bolivian farmers recognize a disease of onion leaves they call *kamanchaka* (includes various fungi, e.g. powdery mildew), without realizing that the disease is exacerbated by thrips feeding on the leaves before the disease appears. Smallholders accurately understand that moisture contributes to a disease without usually realizing that the causal agent is a fungus.

Farmers often come to the clinics complaining that their tree or crop is not producing (Spanish *no produce*, Quechua *mana poqonchu*). The farmers admit that they do not know if the problem is a disease, crop management, or the environment.

Discussion

What the data tell us There is a demand for a service that identifies the causes of plant health problems, including abiotic examples, and gives recommendations on demand.

Farmers work with dozens of crops; agricultural scientists and projects tend to work with one or a few crops. Plant clinics take in major crops, but also all the minor ones such as oregano, palm, and mint which all form part of our food system. As mentioned above, the plant clinics made dramatic improvements in the farm economy with tomato recommendations. But CIAT also identified an aphid attacking cypress trees in Vallegrande, which helped the townspeople save these valuable shade, wind-break and timber trees. The plant clinics can broker information between farmers and specialists.

What is missing The Global Plant Clinic is now sponsoring a study of the impact of the clinics. It will be reported

separately, but initial results suggest that most farmers save production costs and harvest more due to the recommendations they receive from the clinics. Local authorities also see the benefits of the clinics, and have supported several of them. All of the clinics operate with some local support.

Behavioural change Clinics empower smallholder farmers, who can go into a supply shop with a written recommendation, and a technical diagnosis. This enables them to deal with pesticide dealers on a more equal footing. Responsible agrochemical dealers realize that it is better to sell less pesticides and keep their customers than to lose customers by over-selling. The clinic staff feel good about being able to help local farmers, and are enthusiastic about keeping the clinics running.

What needs to be done The clinics need to be expanded so that more people have access to them. They will organize into formal networks for diagnosing problems and sharing management recommendations. They need to consistently write recommendations for common problems as fact sheets, and print inexpensive copies to distribute to farmers. They must share findings for common problems over the radio and on municipal television channels to help everyone who is losing food and money to these pests and diseases.

The Bolivian plant health clinics stimulated other countries to start their own versions (Boa 2009). There is no universal formula for establishing a clinic but there are key lessons from the Bolivia experience. The managers of organisations must give permission to staff who want to run the clinics. A few hours a week is enough, but it must be a regular commitment if the clinic is to function well. Clinic staff must have a broad knowledge of agriculture and farmers. Specialist knowledge of crop protection is helpful but not essential if the clinics can call upon additional expertise when needed.

Plant clinics lay the foundation for plant health systems. The next stage is to link individual clinics into groups so that they can share experiences, knowledge and resources. This took a few years in Bolivia and could have happened more quickly with greater investment. As this article went to press, some local governments in Bolivia began to plan for more investment in clinics, which have taken a few years to demonstrate their worth to local decision-makers. New clinic programmes will only emerge when farmers and governments are convinced of their value. Bolivia played a key role in showing that plant clinics can reach smallholder farmers with information that improves food security and livelihoods.

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Conflict of interest Eric Boa is head of the Global Plant Clinic and is employed at CABI. Jeff Bentley and Solveig Danielsen are CABI associates, and work on a part-time consulting basis for the GPC.

Pablo Franco, Olivia Antezana, Henry Rodríguez and Bertho Villarroel are employed at CIAT and are actively engaged in managing plant clinics there. Jhon Ferrufino now works for the prefecture of Santa Cruz and operates the plant clinic in Los Negros.

Javier Franco, René Pereira, Jaime Herbas and Oscar Díaz are employed at PROINPA and are actively engaged in managing plant clinics there.

Vladimir Lino is employed at PROINPA and has supported the plant clinics at CIAT.

Juan Villarroel is dean of the Agricultural College (Facultad de Agronomía) at UMSS, and oversees the UMSS plant clinic. Fredy Almendras and Saúl Colque manage the UMSS plant clinic.

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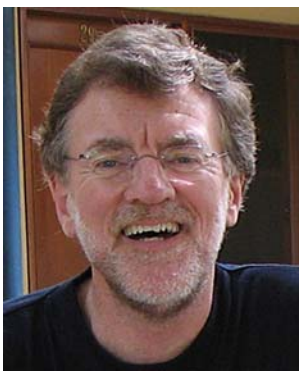

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