Benefits of Plant Health Clinics to Farmers

Bigger Harvests in Bolivia

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The Global Plant Clinic

The GLOBAL PLANT CLINIC (GPC) is an alliance of plant health and agricultural organisations in Latin America, Africa and Asia and is managed by CABI. The GPC helps to establish independent plant health clinics and strengthen plant health systems which link farmers to extension, research, regulation and input suppliers. There are currently over 90 clinics in nine countries, with expansion to new regions and countries. The GPC trains plant doctors and scientists, introduces quality control systems, monitors impact and does research on plant health services and extension. The GPC alliance maintains vigilance of plant diseases through clinic records backed up by CABI's expert diagnostic service. The aim of the GPC alliance is to create durable plant health services for those who need them most.

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Front cover
Domingo Copa harvests potatoes, produced with advice from the plant clinic in Los Negros.

Value for money: do plant clinics work in Bolivia?

The GPC helped to start plant health clinics (*Postas para Plantas*) in Bolivia in 2003 and this is the longest standing clinic scheme amongst a group that now comprises nine countries. Five new countries will start plant clinics in 2010 with support from CABI. Bolivia and other early adopters of clinics, such as Bangladesh and Nicaragua, have been a critical source of information and results that have encouraged and convinced others to run their own clinics.

The UK Department for International Development (DFID) has been the main funder of the GPC since the first clinics were established. Other donors who have sponsored the GPC include DANIDA and IFAD in Nicaragua and now ACIAR and SDC. But there are many other contributors to the running costs of clinics. The Government of Sierra Leone funds clinics and private companies in DR Congo and India are using clinics to help customers and do better business. Clinics are now official policy of the Government of Uganda.

Interest in plant health clinics and public plant health systems is growing quickly and new sources of funds are being identified which could aid a dramatic expansion of schemes. Bolivia has already increased from nine to 18 clinics in the short time since the present study was completed, with the support of new organisations and modest funding. The government of the Department of Santa Cruz has given funds to the plant clinics in Santa Cruz, Bolivia from the outset and increased its support in 2009, encouraged by the success of the initial nine clinics described here.

***The cost*.** Before assessing the benefits of the plant clinics, bear in mind that the cost for setting these up was low. The ideas and original model for the clinic emerged from other projects that CABI was involved in from 1997 to 2002 although that was not their goal. For example, a potato IPM project helped involve Pablo Franco and Olivia Antezana of CIAT with laboratory diagnosis. Eric Boa had a DFID-funded tree health project (which Jeff Bentley worked on) which we did with CIAT and PROINPA circles. We were pleased with the outcomes but work stopped when funds ended.

Since 2003 small grants from the GPC to three clinic organisations have supported training, start-up of clinics and independent operations. Regular analysis of results has helped improve how clinics are run, identify wider linkages to regulation and input suppliers and sustain local commitment to running them. Bolivian institutions make key contributions: their staff run clinics, supervise operations, write reports and collate clinic records. CIAT integrated clinics into their normal work plans from an early stage. Now the extension service of Santa Cruz and the Department for Food Safety run their own clinics, supported by CIAT.

The GPC kept up this low investment for many years and was flexible in our responses (e.g. allowing the local institutions to spend the money on how best this suited their needs). The institutes in turn were flexible in using other internal resources to support clinics. The costs of running clinics are low – half a day a week for two or possibly three staff – and the operations fit well with other farmer support activities and research.

Consider what else one could accomplish for £7,000 ($10,000) a year and excluding the cost of GPC staff time. One could fund about a four farmer field schools (FFS) in Bolivia for this amount[1]. Or the money would buy part of a year's university training for a Bolivian colleague in the UK, or some lab consumables and basic equipment. The point is, the clinics were run for modest amounts of donor funding and closely matched by local contributions, though it's difficult to calculate these exactly. Farmers paid a small amount to use the lab in Comarapa.

Small funding spread over years can have a big impact if you react to events. For example, we realized that CIAT had a successful clinic in the small town of Comarapa, but that clinics could reach more people if they met once a week at farmer markets. With a little practice at a two-day workshop, Proinpa and CIAT both started weekly clinics at fairs. We took the idea to Nicaragua, and the Nicaraguans came back with several ideas we then took to Bolivia, e.g. an excel sheet for entering data, the idea of a diagnostic network (Danielsen et al. 2006.) Boa and Bentley helped the Bolivians with some occasional short courses, advocacy and some write-up, but they were on their own most of the time, innovating, working over-time for no pay and generally doing a fantastic job.

Did we get our money's worth? This is our main question, to put it bluntly. DFID and several Bolivian agencies invested funds and staff time in the plant clinics in Bolivia. The farmers spent cash and labour to try the recommendations. The authors and other people in Britain and Bolivia put heart and soul in the clinics, later taken up with conviction by many people in Nicaragua, Bangladesh, Uganda, DR Congo, Vietnam and elsewhere.

But Bolivia is mainly interested in benefits to farmers from clinics. There are after all other ways to give support. When GPC staff give talks on the plant clinics, many in the audience find the idea intuitively appealing, but others ask "have you measured the impact of the clinics?" It's a fair question. Development experts are getting wiser and in the past we have given our enthusiasm too freely to schemes which were later shown to have flaws.

Impact assessment is a hot topic in development and we are slowly learning the methods and tools used by economists for many years to assess social welfare projects, for example. This is the GPC's first attempt to quantify the benefits of plant clinics to farmers anywhere. It is not, strictly speaking, an impact assessment since we lack baseline data and comparison or control groups (the 'counterfactual'). The report contains original data which allows the reader to make up their own mind if clinics are 'value for money'. However, the authors believe there is compelling evidence of major financial gains made by farmers who used clinics and supporting qualitative data which shows improved access and outreach of services

[1] Assuming an annual salary of $7,000 for the technical person ($500 a month for 14 months—as reckoned for twelve months plus bonuses), plus $1,000 for travel and per diem, and $2,000 for operating costs of each FFS ($500 each). A técnico can teach four field schools a season at a total cost of $10,000.

CONTENTS

Money

Values are expressed in Bolivianos (Bs) and in US dollars, converted at the rate of $1 = 7 Bs.

Summary

Between 2000 and 2006, Bolivia opened eight plant clinics[2] in three different agroecological areas (Andes, lowlands, and valleys). As of 2009 over 6000 farmers consulted the clinics with 9000 queries on problems chosen by the farmers themselves.

In 2009 a survey of 238 Bolivian clinic users found that nearly all of them (82%) adopted the recommendations they received at the clinic. Even farmers who only visited the plant clinic, and had not had intensive training via other methods (e.g. they had not also been visited by extensionists, or taken farmer field schools), adopted the recommendations 82% of the time.

Farmers who followed the recommendations usually saved money, i.e. they spent less on production costs. This was especially true for fruit and vegetable growers, who tended to spend far too much on pesticides. They often wasted money on the wrong pesticide, or used too much, or bought the most expensive one under the false logic that the more it cost, the more effective it was.

But many farmers spent more money than previously in order to solve their plant health problem, especially for certain crops like potato, citrus and peach palm, where farmers were used to spending much less than on other crops. Usually a modest increase in pesticides helped these farmers improve the quality and quantity of their harvest. There was wide variation in production costs depending on the problem, geographical area, wealth etc., but the poorest farmers tended to be the ones who most frequently saved money by following the clinic recommendations.

Overall, farmers in all areas and all wealth groups improved their incomes dramatically by following clinic recommendations. The poorest farmers enjoyed the greatest increase in income per hectare of land. Harvests increased dramatically; IPM (integrated pest management) recommendations for the Andean potato weevil helped farmers to increase their harvest by a third or more.

In the future baseline data should be collected from clinic users (e.g. via exit interviews) and control groups identified that allow a meaningful comparison with non-users. Regular assessments say every two years would allow those paying for the clinics to evaluate their contributions to agriculture and livelihoods. We underestimated the time and effort needed to undertake what we initially called an impact assessment. A small budget limited the scope of investigation and reflection, though the final effort expended is far in excess of monies available. More funds are needed for future assessments, with regular evaluations supporting more thorough surveys.

This is the first time anyone has attempted to measure the benefits of a plant health advisory service in Bolivia and there are many things we did not know or understand at the start. We are not aware of any similar efforts in other countries in Latin America. A lack of data may explain why 'extension' receives such bad press. The Bolivia experience belies this casual criticism. Extensionists who are allowed to use their knowledge and skills to maximum effect can do a fine job.

An important outcome of this study is to improve methods for assessing benefits and impact. Our methods and iterations are described in detail throughout to help others learn lessons and try themselves to measure the benefits of farmer support programmes.

[2] This excludes LADIPLANTAS, which is also a plant health clinic. It differs from the *Postas para Plantas* in having a fixed location, an attached laboratory and being open seven days a week.

1 Introduction

1.1 Plant health clinics in Bolivia

The plant clinics (*Postas para Plantas*) began in Bolivia in the year 2000 when CIAT (Centre for Tropical Agricultural Research, of the departmental government of Santa Cruz) opened a laboratory called LADIPLANTAS in the small town of Comarapa. LADIPLANTAS soon became a community plant health clinic (Bentley & Boa 2004). By 2003 CIAT and PROINPA (the Foundation for the Promotion and Research of Andean Products) had created plant clinics in weekly farmers' fairs, first in Tiraque, then in Los Negros and elsewhere (Boa 2009).

In 2006 a clinic opened in the tropical lowlands, in the town of Ivirgarzama. By 2009 there were eight plant clinics operating fulltime, a few that started and stopped, and great interest in expanding clinics all over Bolivia. The clinics had logged over 9000 queries from around 6000 people, for over 100 crops in 800 communities (Bentley et al. 2009).

The plant clinics were not a development project: they were a new service, a new way to share information with farm households. The clinics had little money and no intended end date. They were run by three Bolivian institutions: CIAT (local government research), UMSS (Public University of San Simón) and PROINPA (privatized agricultural R&D agency with a public mandate). Local municipalities made some contributions in every case; at the very least the municipalities gave the clinics a place to operate.

The clinics received a small grant from the Global Plant Clinic to cover some operating costs. The clinics were an example of what Duncan Green considers the right mix for successful development: active citizens working with competent public agencies (Green 2008).

How clinics function. Except for the clinic at Comarapa, which is open every day in CIAT's regional office, most of the clinics are open just one day a week, usually on fair day, when farmers come into the small towns to buy and sell. For example, in Tiraque, there is a fair every Friday. Most rural households send someone to the fair two or three times a month. The goal is to take something to sell, in small amounts, such as two bags of potatoes, or a few pounds of dried broad beans, or a sheep. The fair goers sell what they have brought (usually to wholesalers) in a pavilion, and then move to another section of the fair where small-scale retailers sit with a few baskets of fruit, hardware, cooking oil, almost anything a rural family would want to buy. After doing a bit of shopping some fairgoers chat with friends, have lunch, maybe a drink and then go home. The fair is an eminently public place, crowded with smallholder farmers and low income vendors.

Pesticide dealers also go to the fair, and offer competition to the plant clinic.

The plant clinic sits in the middle of this fair, and is just a few chairs and a table, with some posters and a sign to catch people's attention. The agronomist who runs the clinic waits for farmers to drop by, hopefully with a sample of a sick plant. The agronomist listens to the farmers' plant problems, and gives them advice, and summarizes the advice in a written recommendation, like a prescription.

The other place to turn for advice is the agrochemical dealers, most of whom operate out of the backs of trucks. They sell pesticides and other chemicals on request to farmers and promote the virtues of products to others. Some of these dealers are more scrupulous than others, but all are there to sell a product. There is an inherent bias in favour of products they have in stock and some may promote the more expensive ones. There is no incentive to explain cultural controls, like digging up the soil where weevils pupate, and destroying them. Any advice given by dealers is unsupervised. They lack the training of pharmacists, for example, though efforts are being made by CIAT, PROINPA and others to change this, also supported by the GPC.

1.2 Measuring impact and benefits

There are two main ways of examining the impact of clinics. The first relates to the services offered and intelligence gathered and the second to the benefits that farmers gain from recommendations.

1. SERVICES

- **Access**: are the clinics available to the poor, to women, to indigenous people?
- **Quality:** is the advice accurate, reliable and useful?
- **Vigilance and surveillance**: do the clinics convey pertinent information to national plant protection organisations (e.g. SENASAG in Bolivia), to alert them to farmer problems and coordinate responses to new outbreaks?

2. FARMER BENEFITS

- **Adopt recommendations**
- **Lower production costs**
- **Increase harvests**

There are other benefits which could be added to the above list, e.g. environmental (reduced use of pesticides; greater use of environmentally friendly technologies e.g. Matapol, an effective biopesticide for tuber moth, a major potato pest). There are also social benefits; the clinic staff are motivated by seeing the greater self-confidence of farmers, who now stroll into shops to buy a specific product, rather than going to the farm supply store to "get sold" something. (*Van a comprar, no a que se les venda.*)

The Bolivian plant clinics had a third impact in strengthening plant health systems, for example:

3. NETWORK AND ALLIANCE BUILDING

- **Inspiring other organisations** to start new clinics
- **Obtaining new sources of funding**
- **Improving links** to diagnostic labs and regulatory bodies for plant health

However, the purpose of this study is to measure the benefits of the advice (recommendations) given at plant clinics and to discuss how Bolivian farmers gained, mainly by lowering production costs or improving harvests.

PHOTOSHEET 1

Locations of Plant Health Clinics in Bolivia

The Chapare, foothills of the Andes in the Amazonian lowlands. Clinic run by Universidad Mayor de San Simón.

LEFT, BELOW: Stacks of barley in Boquerón Q'asa, in the **Andes of Cochabamba**. Clinics run by PROINPA.

RIGHT, BELOW: Potato field in Los Negros, in the **Valleys of Santa Cruz**. Clinics run by CIAT Santa Cruz.

2 Method

This is the first assessment of benefits of plant health clinics to farmers. An important part of the study was to test methods and find out which questions elicited useful data. For a wider discussion of history and context, see Bentley et al. (2009).

Here we describe how methods were improved as they were tested, including recommendations on how to do future impact studies. The narratives in Annex 3 illustrate the use and evolution of methods.

2.1 Indicators

It is important not to try to answer too many questions in a single study, and to focus on a few indicators that show the effect of the program (Catley et al. 2008, Ravallion 2001). Less is more.

This assessment only considered the outcomes of recommendations given to farmers who consulted the clinics[3]. Our main indicators were:

- change in production cost
- change in value of harvest

From these data we derived the net financial benefits to farmers included in our study group.

As the mayor of Comarapa, Noel Rojas, told us in April 2009, his local government supported the plant clinic because it saved people money and improved harvests. This study presents results which provide the first evidence to support that impression.

2.2 Measuring benefits, estimating harvests

Norton and Swinton (2008) and related studies (Moyo et al. 2007, Mauceri et al. 2007, Ricker-Gilbert 2008) outline steps to measure impact of IPM (integrated pest management) programs, stressing adoption of a few recommendations. They do not calculate the benefits of the program directly for each farmer, but extrapolate them, based on calculations from costs and yield done on-station, in an IPM plot (in a collaborating farmer's field), or even in an interview with scientists and extension agents.

In reality each farm is complex and must be measured on its own. In our study we asked about the benefits derived from the clinic (change in cost of pest control, and change in value of harvests) farm by farm. Plant health clinics deal with many different crops, each with its own health problems.

We asked farmers how much they had planted and harvested. We accepted their answers. Smallholders are often suspicious of outsiders' motives and tend to underestimate harvest figures as a way of protecting their privacy. We doubt that farmers exaggerated their harvests. We estimated the increases in income conservatively. For example, if a farmer said he had planted eight bags of potatoes, and we thought he had planted 20 (based on our estimation of his farm size) we took him at his word and wrote down 'eight bags.' We used slightly low harvest prices.

[3] In this report 'farmers' refers to clients of plant clinics interviewed for this study, unless stated otherwise.

2.3 Sampling

Bolivia has plant clinics in three contiguous, but geographically different areas: the Andes of Cochabamba, the Amazonian lowlands of the Chapare, and the Valleys of Santa Cruz (photosheet 1, Table 1). We used opportunistic sampling, that is, we interviewed every clinic user we could find. This led to an over-sampling of those who were:

- easier to find (e.g. closer to the road near the centre of a community)
- known to the interviewers
- in large communities, near towns, from communities with many clients of the clinics
- and people who spend more time at home.

So in the Andes area we got an oversampling of the provinces of Tiraque and Colomi, which both have communities on the highway, and where our interviewers knew more people. We under sampled Punata, which is on the road, but where we had fewer contacts. And we interviewed no one at all from Pocona, a remote province of Cochabamba. We missed many people from the most remote places, but in just a month we were able to interview 238 farmers. The interviews were held from 22 June to 29 July 2009.

We wanted to interview a similar number of clinic users from each area, however the Chapare had far fewer clinic users compared to other areas, just 196 queries out of 9000 queries received by all plant health clinics from 2000 to 2009. The farmers were farther apart and harder to find than in other areas, so we interviewed fewer people in the Chapare than we wanted to. The hard ones to interview were in town or in their home community back in the Andes: the people of the Chapare are settlers from the Andes, who colonized the tropical lowlands, especially after 1960 and even more so after 1984 (Blanes 1983, Buzzone Pizarro 1990).

Although we only interviewed 27 clinic users in the Chapare, this was a higher percentage of all users than in the other two areas. Our sample from the valleys of Santa Cruz is more balanced, with more farmers from more municipalities, because CIAT has regular contact with farmers and staff in various towns . Olivia Antezana of CIAT also trained various colleagues to do the interviews (section 2.10) and took a week to interview people in the municipality of Vallegrande.

Table 1: Clinics, surveyed farmers and clinic use up to 2009

AGRO-ECOLOGICAL AREA	ANDES OF COCHABAMBA	THE CHAPARE	VALLEYS OF SANTA CRUZ
FARMERS INTERVIEWED (n=238)	114	27	97
CLINIC CLIENTS UP TO 2009 (N=6815)	4177	124	2514
CLINIC VISITS UP TO 2009	4747	196	4252
MAIN CROPS CONSULTED BY INTERVIEWEES	Potato	Citrus, palm	Tomato, strawberry, potato, peach
MAIN CROPS GROWN	Potato	Bananas, coca, citrus, palm	Temperate fruits and vegetables
CLINICS	Tiraque, Colomi, El Puente, Punata	Ivirgarzama	Comarapa, Saipina, Los Negros, Vallegrande
GEOGRAPHY AND CLIMATE	Altitudes of 3000 metres and higher, rainfall about 500 mm with little irrigation. Dry, cool and sunny	Altitudes of below 300 meters, with rainfall nearly 6000 mm in places. Humid tropics	Altitudes of 1500 to 2500 meters, rainfall over 500 mm but seasonal. Irrigation in some areas. Temperate
LANGUAGE AND CULTURE	Primarily Quechua, native Andean peoples	Quechua and Spanish. Andean settlers in the Amazonian lowlands	Spanish-speaking family farmers with a long tradition in the area

2.4 Control group or counterfactual

To measure the impact of an intervention, one must isolate it from other events which could influence outcomes. In other words, how would farmers have coped with plant health problems if they had not consulted a plant clinic?

'Counterfactual' means '*what would have happened without the intervention*?' In a normal scientific experiment the counterfactual is the control group: the guinea pigs that do not get the medicine. In research with human subjects, control groups are logistically difficult and ethically questionable. If an intervention is beneficial to a group of people it is heartless to split them into two groups at random and deny the intervention to one of the groups, like say, giving milk to one group of malnourished babies, but not to another group. With a community service, like plant clinics, the beneficiaries themselves are free to walk in or not. Because the clinic users select themselves they are not chosen at random. There may be inherent differences between those who do visit a plant clinic and those who don't. For example, clinic users may be more curious, more dependent on agriculture than on off-farm income, or they may have worse plant health problems. These native differences between clinic users and their neighbours confound the comparison between them.

Sometimes researchers collect baseline data collected before the work begins, to compare changes between the people who did opt to work with the project and those who did not. This is called a 'double comparison' and it is a standard counterfactual (Ravallion 2001). But a baseline survey is expensive to do, and the survey itself may influence people and thus confound the results. For example if the project intervention is to encourage people to boil their drinking water, and survey-takers keep coming around to ask people if they boil their water or not, the locals may realize that they should boil their water (or at least say that they do when asked by probing outsiders).

PHOTOSHEET 2

Finding interviewees and handling data

1. Local resident Clemente Baltazar (L) tells Oscar Díaz where to find people from Boquerón Q'asa who visited the clinic. Fredy Almendras (R) checks the names against our list.

2. Fredy Almendras enters his survey data in the evening after fieldwork. We entered all the text from questionnaires. In future we would only record key information.

3. Oscar Díaz interviews a man attending his monthly *sindicato* meeting. Interviews lasted for about 10 – 15 minutes.

4. A *sindicato* meeting in the Andes. These were useful for finding people.

5. Surveys collected in the field and never analyzed (in another project, not with the GPC). It is easier to collect data like this than to process it.

MAKING BEST USE OF TIME

In the Andes of Bolivia, farm houses are usually hundreds of meters apart, up steep hills. Most of them are over 3000 meters in altitude, making the walk even more strenuous. Finding people takes time. Two interviewers could easily spend the whole day on the back roads and only interview five people.

In Cochabamba, Fredy Almendras and Oscar Díaz soon realized that the best way to meet people was at their *sindicato* meetings. In Bolivia most rural communities (especially in the Andes) are organized as a *sindicato*, a sort of village council with elected officials, bylaws, and monthly meetings attended by a representative from each household.

Fredy and Oscar would ask each community when the *sindicato* meeting was (usually Saturday or Sunday), ask for permission to attend, and call farmers out one at a time to be interviewed. This increased the sample size, although it meant that the team worked every weekend for a month.

Even in communities where the interviewers knew people, they did not know everyone on their list of clinic clients. The interviewers would usually find someone they knew, or meet someone, and spend some time going through their list of clients in that community, asking where each one lived, which ones were home , and then walking o their homes, often to find that they were not there.

It was easier for the CIAT interview team to find clinic clients to interview because many are regular users of LADIPLANTAS and because CIAT has staff and offices in the valleys. But it still took perseverance, dedication and long drives on dirt roads to complete the interviews.

Furthermore, agricultural and social interventions evolve over time. Their goals and methods become sharper, and their outcomes become clearer. In all honesty, we would not have been able to ask the specific questions in 2000 that we asked in 2009. So we do not have baseline data. It did not occur to us to have a control group or counterfactual until we did the impact assessment.

Asking a counterfactual directly of the program beneficiaries is difficult. The interviewer can ask "*How would you have behaved without the program?*" but the interviewee may not really know. For example, a project may offer poor households a subsidy to keep their children in school. School attendance increases, yet this could be influenced by a general improvement in the economy (making child labour less needed) and by public awareness campaigns urging parents to send children to school. A survey taker can well ask parents "*Would you have sent your children to school without the subsidy?*" But the parents may not be able to tease the causes apart and weigh the subsidy objectively (Ravallion 2001).

However, it is more reasonable to ask hypothetical questions about farming. Farmers are anxious to control pests and diseases, but have few opportunities to seek impartial advice. Also, farmers "carry their control group in their head;" they are used to comparing each year with the last (Box 1988). They routinely assess more than one variable at a time (e.g. this year we fertilized the potatoes more but it rained less, and the yield was more, so we think fertilized potatoes will do even better in a normal year). Farmers make holistic assessments and use multiple criteria which are not possible in conventional science (Lyon and Harris 2008).

In this study we asked farmers how their costs and harvests changed as a result of receiving advice (recommendations) from the clinic. Usually the farmers were quite clear about the changes, although sometimes they admitted that they did not know, usually because this was their first year growing the crop on this piece of land. This "before and after" comparison is the benchmark for assessing farmer benefits. It is not a counterfactual since we lacked control groups on non-clinic users and their contemporaneous data for harvests and production costs.

During the study we learned about a farmer field school at Cebada Jich'ana. This gave us the opportunity to compare clinic users in one part of the Andes area who had received additional training and those who had not.

PHOTOSHEET 3

Well-being status

POOR: House in the Andes thatched with straw

MEDIUM: Homestead of a farm family, with more rooms, tiled roofs

'NON POOR': farmers' house with a tractor, a truck
and a garage, and cattle

MEASURING PROSPERITY OR WEALTH

We were well aware of participatory methods for determining well-being, such as wealth ranking (Grandin 1988). These methods can be intrusive. a bit tedious, and we simply did not have time to use them. Instead, we ranked interviewees ourselves on a scale of 1 to 3.

1. **Poor.** Owns little or now land. Has a small house, usually owns no livestock.
2. **Medium.** Farms less than 5 hectares. Has a larger house, livestock and may have a piece of machinery, e.g. an old, cheap car.
3. '**Not-poor'** or wealthy. Farms over 5 hectares. Has a large house, often with a garage and several pieces of machinery e.g. a truck and a tractor.

The interviewers found it easy to determine well-being using this scale. The results correlated well with other survey data during the analysis. We recommend this method for the future.

2.5 Study ethics

We followed the spirit of the AAA (American Anthropological Association) code of ethics for research on human subjects research. The main principle is to do no harm to the people we study. We were careful to respect their time, to ask their permission for the interview, and not to frighten them by arousing suspicions. We explained why we were doing the study (to evaluate the clinics). Interviews were brief, usually 10-15 minutes long. If people refused the interview we respected their wishes, although almost everyone was glad to see us. We did not reward them for their time, but we often gave them advice, if they asked for it, and they often did. They were usually keen to take advantage of our visit to ask us about plant problems on their farms.

2.6 Study questionnaire

The key message for designing a questionnaire is: keep it simple. Robert Chambers wrote of the pitfalls of questionnaires in 1983, and what he said is still true today (Chambers 1983). Questionnaires tend to be too long, with too many questions that sound good when you first think of them. Questionnaire data are so difficult to code and write up that most survey forms never leave the cardboard box once they are put there (photosheet 2). The surveys that are analyzed are often not very insightful.

The remedy to this was supposed to be the participatory rural appraisal (PRA), but it was not quantitative. Questionnaires are a necessary evil for quantification. But researchers typically make two mistakes. They overestimate how many questions they need to ask, and they underestimate how large a sample they need (Bentley and Baker 2002).

Our questionnaire to evaluate impact was one page long, and it still had too many questions (see Annex 1). It started with some basic information:

Q 1. *Farmer name*

Q 2. *Code*

Q 3. *Community*

Q 4. *Interviewer*

Q 5. *Date*

Q 6. *Municipality*

Q 7. *Query code(s) from the clinic register*

Q 8. *Recommendations from the clinic*

'Code' was a unique serial code for each interview. 'Query code from the clinic register' was the number assigned to the farmers when they visited the clinic. If they had been several times, they had several codes. The query code and recommendations were recorded in an Excel spreadsheet after the farmers visited the clinics. The interviewer copied Q7 and Q8 from the spreadsheet, which encouraged the interviewers to review the client's case before (or at least soon after) the interview.

The interviewers filled out Q1 – Q8 before starting the interview. Q9, Q10 and Q11 were the first questions we actually asked the clinic user. There was space on the questionnaire to write down the answer in prose, rather than ticking a box. These verbatim responses were difficult to code, and even more tedious for the interviewers to type in.

Q9 *What did they recommend to you in the clinic?*

> This question worked quiet well. The farmers explained the recommendation, and we used this to code how well they remembered it, on a scale of 0 to 3.

Q10 *What did you do?*

> This question worked fairly well, although farmers often discussed the recommendation and how they implemented it in the same breath. We used this information to code for adoption (Table 2).

Q11 *Why did you do it like that?*

> This question was pointless. We included it so farmers could tell us why they chose not to implement some technologies. But in fact adoption rates were high, so farmers found the question dull and replied "because I wanted to control the pest".

Tact is crucial when talking about money, and people may become defensive and suspicious. This is one reason why we kept questions on costs and income short, although in future studies we should find out more about production.

As soon as we started the interviews we realized that many people had had previous contact with extensionists from PROINPA, CIAT and other institutions, which (we hypothesized) could have influenced their choice and use of pest control options. So we added Q12 to indicate whether the farmer had had contact with extension and if so which organisation was involved. This allowed us to compare clinic clients who had and had not received additional training.

Q12 *Receives training in addition to the clinic?* YES (CIAT/ Sedag/DSA/ PROINPA/Other) or NO

The questionnaire included a line about well-being, where the interviewers checked off a box to rank the interviewees on a scale of 1 to 3 (photosheet 3). This seat-of-the-pants wealth ranking was quick, and later it correlated well with other data we collected. The scale was:

1. **Poor.** Owns little or now land. Has a small house, usually owns no livestock.
2. **Medium**. Farms less than five hectares. Has a larger house, livestock and may have a piece of machinery, e.g. an old, small, cheap car.
3. **Non-poor or 'wealthy'**. Farms over five hectares. Has a large house, often with a garage and several pieces of machinery, e.g. a truck and a tractor.

At the end of the questionnaire we asked where people had heard of the clinic, which is moderately interesting and easy to ask.

We started with a needlessly complicated coding scheme for the adoption of technologies recommended by clinics. There were originally seven categories, later reduced to two: no adoption and adoption. In future studies include a code for partial adoption (Table 2).

Table 2: Coding schemes for adoption of recommendations given to clients by clinics

A: ORIGINAL CODES		B: USED FOR THIS STUDY		C: TO USE IN FUTURE STUDIES	
0	no adoption	0	no adoption	0	no adoption
1	adoption	1	adoption	1	partial adoption of recommendations
2	adoption with reconfirmation			2	full adoption of recommendations
3	could not afford to adopt				
4	did not have time to adopt				
5	adopted but did not continue				

Jeff suggested coding adoption to include farmers who 'verified' clinic recommendations through personal observations or experiments, as this would suggest which farmers had really taken the recommendations on board. At first it seemed straightforward. In the early interviews we had several cases like Clemente Baltazar, who told us that he observed that planting broad beans around his potato field kept out Andean potato weevils, so we scored that as 'verification'. Several farmers reported experiments with insecticide, e.g. spraying the ground after harvest where weevils were pupating. (The original recommendation was to dig up these hot spots, not spray them. And while we did not approve of these experiments with insecticide, they are evidence that farmers understand the basic principles involved, and are working with them creatively).

However, the interviewers rarely coded farmer experiments and so we dropped the idea of farmer verification. The lack of labour and capital (codes 3 and 4 in Table 2) are classic constraints to adoption, but few people mentioned them. (Time and money were probably not realistic barriers to adoption in this case).

The two main impact indicators we measured were changes in productions costs[4] and harvests after receiving clinic recommendations. We did not try to measure people's creativity, knowledge, self-esteem, or attitudes or attempt to correlate adoption of recommendations with personal traits, such as farmers' age, number of years spent at primary school, or off-farm jobs. Our main aim was to learn if the recommendations had done people any *economic* good. So we asked two questions, which appear in their original wording.

> *Did the recommendation save you expenses or increase your costs? How much?*
>
> *How much did you avoid loosing because of the recommendation, or how much would you have lost if you had not applied the recommendation?*

At first these two questions failed. The interviewers did not understand them, and got confused asking them. In retrospect, the second question is especially poor because it does not even say 'harvest'. After working in the field with the interviewers, we hit on a style of question that was easier to understand.

> Q 13a *Production costs before using the recommendation* **and** Q13b *Production costs with the recommendation*
>
> Q 14a *Harvest before using the recommendation* **and** Q 14b *Harvest with the recommendation*

Now the interviewers understood the questions, and crucially they asked them in a way the farmers understood. The interviewers never asked the questions verbatim. In Cochabamba, Fredy and Oscar would phrase the questions in colloquial Quechua. In Santa Cruz, Franz Ortiz had grown up on a farm in the area and knew just how to phrase the questions in the local Spanish. For example, when asking about the weekly strawberry harvest, in Santa Cruz one does not say "How much do you harvest every week?" (*¿Cuánto cosecha cada semana?*), but rather "¿Cuánto saca cada feria?" (How much do you take [during] each fair?)

The farmers explained how much their harvests had improved since they started using the clinic recommendations. In Cochabamba we assumed low prices for potatoes at 150 Bs. a bag ($21.42 for 100 kg); at times the price can rise to 220 Bs. ($31.43) In Santa Cruz crops and markets were more complicated (e.g. tomato prices change weekly) and we tended to ask what price people had actually received.

The question on how many years the farmer had used the recommendation was easy to ask. We did little with the results in the current report. Even a short questionnaire garners more information that one can always digest. We may review the data later for a proposed paper.

The last question on the questionnaire was a failure.

> Q 19 *Why will you keep using the recommendation (or why did you stop using it)?*

Farmers invariably said "I will keep using it because I want to control the pest." We recommend deleting this question in the future.

---

[4] Production costs refers to measures taken to control pests and diseases or mitigate soil and other abiotic causes of ill-health or low productivity in plants.

2.8 Entering the data

The field teams filled in the one-page questionnaire during the interview and later, usually the same day, copied details into an Excel sheet. This helped to ensure that the information was still fresh in the interviewers' minds and reduced transcription errors. We included columns for production data taken from prose sections. We probably put too much emphasis on entering all text on production. It did have the advantage that we were able to refer back to it, if we thought a figure was unrealistic, but in the end we only used crunched the numbers, not the textual answers.

2.9 Language

All the interviews in Santa Cruz were held in Spanish. Most of the ones in Cochabamba were held in Quechua. The Cochabamba team wrote the answers in Spanish, but began to add more words and phrases in Quechua when the exact meaning was hard to capture in Spanish.

The interviewers were asked to record the exact words used by farmers, but were initially reluctant. One day there were three farmers to be interviewed at once, so Jeff did one of the interviews alone, and filled in the form. When the data was entered into the computer Jeff wrote that the farmer said he had sprayed the potato's 'white butt' (*yuraj siki*). Both of the agronomists laughed. "You misunderstood him," they said. "He must have said *yura sikinman* (at the base of the plant)". That broke the ice and after that the team was happier to write what farmers said, in their own words.

2.10 The interviewers

All interviewers had technical education in agriculture. To obtain data on production and harvests they also had to know a lot about local agriculture. Ten people did at least two interviews. Three people did most of them. Franz Ortiz was the only one who had not previously worked with the clinics although he had been a client.

Interviewer	Interviews done	Brief bio
Oscar Díaz	75	Runs clinics in Andes of Cochabamba. Speaks Quechua and knows the communities. Worked for a month on the survey and is based at PROINPA.
Franz Ortiz	66	Raised on a farm near Comarapa. He is currently finishing technical school. Hired for a month for this study.
Fredy Almendras	62	Runs the plant clinic in the Chapare. Speaks Quechua. Knows the communities in the Andes and the Chapare. Worked for six weeks on the survey and is based at UMSS.
Olivia Antezana	14	Runs LADIPLANTAS in Comarapa and is locally recognized as the expert in plant disease. Works for CIAT. She supervised Franz, and trained others listed below.
Sandra Muñoz	7	Runs the clinic in Vallegrande. Agronomist with CIAT.
Jeff Bentley	5	Agricultural anthropologist, Global Plant Clinic, based in Cochabamba.
Bertho Villarroel	3	Works on plant clinics in Saipina and Los Negros. Agronomist with CIAT.
Ervin Morales	2	Colleague, volunteer.
Henry Rodríguez	2	Works on plant clinic in Saipina. Agronomist with CIAT.
Jhon Ferrufino	2	Runs the plant clinic in Los Negros. Agronomist, works for DSA (plant health agency, government of Santa Cruz).

2.11 Data analysis

We used the following variables in our analysis of individual farmers. 'Crop consulted' refers to the problem presented by the clinic user.

FARMERS
- number interviewed
- sex (male, female) of interviewee
- well-being status (photosheet 3)
- number who received additional training

USE OF CLINIC
- number of visits to the plant clinic per person
- number of farmers per crop consulted at the clinic
- how farmers learned about the plant clinic

RECOMMENDATIONS
- number of farmers who recalled the recommendation from the clinic
- number of farmers who adopted (all or part of) the recommendation
- change in pest management production costs for the crop consulted at the clinic
- change in income for the crop consulted at the clinic
- how many years each farmer used the recommendation

We used the following variables to define different farmer groups:

- Geographical area (photosheet 1)
- Training (intensive extension contact besides the plant clinics)
- Recall of recommendation from the plant clinic
- Adoption of recommendation (yes/no)
- Crop consulted at the plant clinic
- Gender (men and women)
- Well-being (poor, medium, not poor)

We originally analysed data using a variety of statistical tools: a generalized lineal model was applied, using poisson, binomial, multinomial and gamma distribution for quantitative variables (money) (Montgomery, 2003; Kachman, 2000; SAS Institute 2004), according to simple and multiple classification of analysis of variance (Steel and Torrie, 1992). But with small and variable data sets the results did not reveal new insights or help define certainties of relationships. Comparing numbers of women with men statistically confirmed the 'obvious': too few women were interviewed to disaggregate their financial benefits and compare with males.

There are techniques we were unaware of before the study (e.g. propensity matching score) which may prove useful in future with availability of suitable data.

There were a few poetic moments during the survey. For example Giovana Cayo explained how she had dug up the soil to kill weevil pupae, and she called them "wawas k'irusqa" (babes in swaddling clothes). It was obvious that she had killed enough weevils to observe their pupae.

3 Results

3.1 Access and geographical areas

There was a wide variation in the number of people interviewed per municipality (Table 3). Proportionately more women were interviewed in Comarapa and Vallegrande than in other municipalities. Perhaps this was because we had women interviewers in those two municipalities (Olivia and Sandra, who also run clinics there). The gender differences per municipality were similar. More women were interviewed in Santa Cruz than in the Andes. But in general there were too few women included in the study sample to make any meaningful conclusions about differences in financial benefits received from adopting recommendations.

Table 3: Farmers interviewed by municipality

AREA*	MUNICIPALITY	MEN	WOMEN	TOTAL
ANDES	Arani	4		4
	Colomi	10		10
	Punata	1		1
	Tiraque	96	3	99
VALLEYS OF SANTA CRUZ	Comarapa	56	8	64
	Pampa Grande	5		5
	Saipina	10	2	12
	Vallegrande	12	4	16
CHAPARE	Puerto Villarroel	23	4	27
	Total	**217**	**21**	**238**

Table 4: Farmers interviewed by geographical area

AREA	ALL	MEN	MEN (%)	WOMEN	WOMEN (%)
Andes	114 a	111	97.4 a	3	2.6
Valleys of Santa Cruz	97 a	83	85.2 b	14	14.8
Chapare	27 b	23	85.6 b	4	14.4
Total	**238**	**217**		**21**	

Only about 9% of the people interviewed were women. We do not have data on the gender of all the people who have visited the plant clinics in Bolivia, so we do not know if this is representative. It is possible that women farmers are more likely to visit clinics run by women. It is clear that the Bolivian clinics need to try harder in the future to reach women farmers. For most of this report we group results by the three major agro-ecological areas and not municipalities (Table 1).

The poor had access to the clinics, although that varied by region (Table 5). In the Chapare there are no very poor (because everyone has access to land and jobs) and there are far more poor in the valleys of Santa Cruz, where many landless people work as sharecroppers. In the high Andes there are few very poor and few in the top category. The clinics garnered clients from a representative cross-section, and no group was excluded.

Table 5 Well being status by geographical area

WELL-BEING GROUP	ANDES	CHAPARE	VALLEYS	TOTAL
1	8		48	56
2	100	23	28	151
3	6	4	20	30
na			1	1
Total	**114**	**27**	**97**	**238**

3.2 Use of plant clinics

We defined a 'visit' as a single trip to the plant clinic. For example, if a person went once with three problems (queries) we counted that as one visit. We reasoned that if clients returned to the clinic they were pleased with the results they got. A person who went four times was probably more satisfied than a person who went once with six queries and then never returned (Table 6).

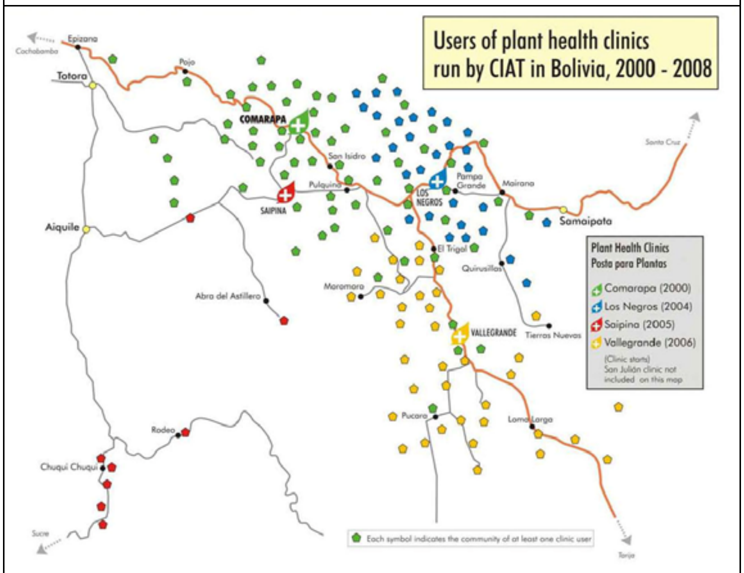
Table 6: Farmer visits to clinics by municipality

Area	Municipality	Farmers (users)	Visits by all users	Average number of visits per user	Maximum visits by a clinic user
Andes	Arani	4	8	2	4
	Colomi	10	10	1	1
	Punata	1	1	1	1
	Tiraque	99	178	1.8	8
Valleys of Santa Cruz	Comarapa	64	256	4	39
	Pampa Grande	5	23	4.6	12
	Saipina	12	48	4	13
	Vallegrande	16	40	2.4	10
Chapare	Puerto Villarroel	27	41	1.5	4
	Total	**238**	**605**		

People in the valleys of Santa Cruz visited the plant clinics more frequently than in the other two areas (Table 6). One possible reason is because of the regular interaction between CIAT and farmers and CIAT's strong public mandate. There is also a hard core of satisfied customers who like LADIPLANTAS in Comarapa, which has its own lab and is open every day.

The benefits of attending a clinic are spread over a wide area. Clinic users from CIAT's plant clinics in Comarapa, Vallegrande, Saipina and Los Negros come from an area about 150 km wide, including all of the valleys of Santa Cruz. Most major communities in the area are represented in the roster of clinic users. For a similar map of the clinics in Cochabamba, see the last page of this report. Bolivian clinic users come from 800 different communities, 96 of which were sampled for this study (see Annex 4).

Figure 2: Location of communities of clinic users in Santa Cruz



The farmers surveyed consulted the clinic for 21 different crops, especially potato but also for tomato, strawberry, peach, citrus, peach palm, bell pepper and pea (Table 7). We only interviewed them for one crop, even if they had taken in several.

Table 7 Main crops consulted by interviewees and region

Crop	Andes (# queries)	Chapare (# queries)	Valleys (# queries)	% of crops consulted by interviewees	% of crops consulted all clinics to 2009
Potato	114	0	17	54.2	69.7
Tomato	0	0	24	8.8	4.3
Strawberry	0	0	18	7.6	0.2
Peach	0	0	14	5.9	4.3
Citrus (orange, mandarin)	0	15	0	4.6	1.3
Peach palm (palmito)	0	6	0	2.5	0.4
Bell pepper	0	0	5	2.1	2.4
Pea	0	0	5	2.1	0.4
Other crops (1 or 2 queries)	1	6	13		
Total	**115**	**27**	**96**		

We had some sampling bias in our survey. In Santa Cruz we over-sampled strawberry, which is grown near Comarapa, where interviewers were based. In the Andes, broad beans were under-sampled, because the interviewers (and the farmers) favoured potatoes. If a person had been to the clinic for potatoes and broad beans, the interviewers asked him about potatoes, not broad beans.

The difference between crops queried by our farmer sample and crops presented by all clinic users from 2003 – 2009 (Table 7) reflects our sampling bias in favour of bigger, easier to sample communities with many clients. However, it also reflects some missing information. We have still to add crop query from Santa Cruz, which would increase the number of strawberries in the number of queries.

There is little overlap in crop between the areas. The Andes are devoted to potatoes, which accounted for 99% of queries consulted by interviewees there. The Chapare queries were mostly citrus (41%) and peach palm (22%), and queries the Valleys of Santa Cruz were for fruit (e.g. peach 14%, strawberry 19%), vegetables (21%) and some potatoes (16.5%). Because of differences in climate and altitude the three areas are

Table 8 Number of visits to clinics by well-being status

Visits	Poor	Medium	Non-poor	na	Total
1	30	95	8		133
2	10	23	5		38
3	4	11	3		18
4	4	10	4		18
5	3	3	4		10
6	1	2	1		4
7	3	1	2		6
8		1	1		2
9		1			1
10		2			2
12	1		1	1	3
13			1		1
17		1			1
39		1			1
Total	**56**	**151**	**30**	**1**	**238**

quite distinct ecologically.

Their repeat visits to the clinic suggested that the poor were as likely as any other group to go back several times, suggesting that they found the service useful, and that they felt welcome (Table 8).

There were more repeat visits to the clinics in the valleys (Table 9), which have the longest history and which have the most institutional support. The fewest repeat visits were to the clinics in the Chapare, which have operated for two years instead of six or nine.

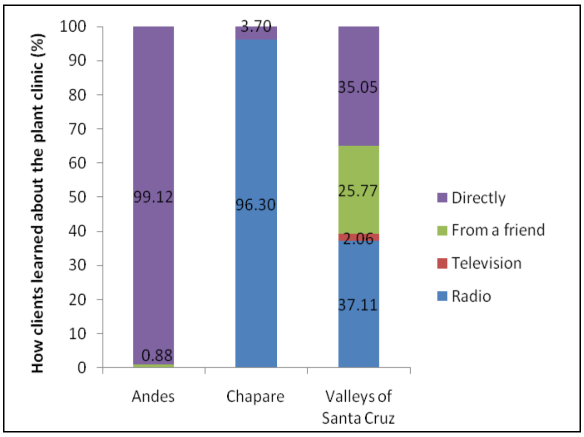
Table 9 Number of visits to clinic by region

Visits	Andes	Chapare	Valleys	Total
1	78	19	36	133
2	16	4	18	38
3	10	2	6	18
4	5	2	11	18
5	1		9	10
6	1		3	4
7	2		4	6
8	1		1	2
9			1	1
10			2	2
12			3	3
13			1	1
17			1	1
39			1	1
Total	114	27	97	238

3.3 How clients learned about the clinic

In the Andes there was little publicity for the clinics, and most users said they learned about the plant clinic when they visited their local fair. Almost everyone we interviewed in the Chapare learned about the clinic on the radio, an effective means for rural areas. Also in Santa Cruz where CIAT has regular radio spots. CIAT broadcast TV ads for the clinic, but these attracted far fewer clients. Santa Cruz was the only area where many people were referred to the clinic by friends. A sizable minority simply approached the clinic directly, reconfirming that it is important to have a sign and to site the clinic in a farmer-friendly, public place (Figure 3).

Figure 3: How clients learned about the clinic



3.4 Changes in production costs

Table 10 Change in production cost after visiting plant clinic and well-being status

WELL BEING	NO DATA	SAVED MONEY	NO CHANGE	SPENT MORE	TOTAL
1 Poorest	8	28	7	11	54
2 Middle	16	23	6	105	150
3 Least poor	1	10	1	17	39
NA		1			5
Total	25	62	14	133	238

We wanted to know if the recommendations made by plant clinics helped clients save money. First we wanted to know how production costs had changed. We found that the poorest farmers were the most likely to save money on production costs, after visiting the clinic (Table 10). The data was extremely variable, reflecting the real differences in Bolivian farming. Some people are growing half a hectare of expensive and risky tomatoes, while others are growing two hectares of less risky but solidly profitable potatoes and others have ten hectares of low-maintenance peach palm now lacking a market.

Table 11 shows that the clinics helped farmers save money on most crops, especially fruits and vegetables, where farmers (especially in the valleys) tend to use too many pesticides, and the wrong pesticides, often buying the most expensive ones under the impression that they are the best. However, potato, peach palm and citrus growers tended to spend a bit more to adopt the clinic recommendations, in part because they were using little pesticides to begin with for these crops. The cost increase was usually modest. For example, potato farmers might buy three litres of insecticide instead of two, but spray them at the right time and place, and reap a much improved harvest (Table 11).

Table 11 Changes in production costs for those who adopted recommendations

CROP	SAVED MONEY	NO CHANGE	SPENT MORE	TOTAL
Tomato	14	2	6	24
Strawberry	9	4	4	17
Bean	4	1	1	6
Pea	4		1	5
Sweet pepper	2	2		5
Achojcha (Andean squash)	1			2
Broad bean (faba)	1		1	2
Watermelon	1			1
Wheat		1		1
Potato	20	11	90	131
Peach	5	3	6	14
Orange		1	10	11
Peach palm		1	5	6
Coffee			1	1
Passion fruit			2	2
Tangerine			1	1
Nursery plants			1	1
Cucumber			1	1
Black pepper			1	1
Grand Total	62	27	133	218

Excludes four farmers who grew the crop for the first time, and so had no 'before' comparison.

Four farmers planted the crop for the first time. Information is incomplete for 12 farmers. Four queries were removed that listed multiple crops and it was unclear which ones the production costs referred to.

The farmers themselves realise that the clinic saves them money. When Henry Rodríguez went to interview Froilán Arana in Chilón, near Comarapa, don Froilán thought that the survey was aimed at deciding if the lab (LADIPLANTAS) at Comarapa should be moved to another place. Don Froilán was so alarmed at the thought of the lab moving that he said "I have a bullet, and I am going to threaten anyone who wants to take it (the lab) away. We cannot plant if we do not have a lab in our province." Colourful rhetoric aside, this statement does suggest that the farmers value the clinics, and want to keep them in the area.

3.5 Net income gains for clinic users

For each farmer surveyed we calculated the change in income resulting from the recommendations given for one crop. We would have liked to ask them about all crops consulted but this would have taken much more time for interviews and for data analysis. Net change in income is the change in the value of the harvest, minus the change in production costs after adopting the recommendation. The following example shows how income changes were calculated.

Luis Merubia is a medium-sized farmer in Los Negros, in the valleys of Santa Cruz, who has visited the plant clinic 39 times, more than anyone else in Bolivia. He began coming in 2004 and has brought in bell pepper, potato, tomato, and watermelon. We interviewed him for a recent query about watermelon. He was advised to apply Kasumín (a biological fungicide-bactericide) and Priori, a green-label systemic and contact fungicide of 'natural' origin. The recommendation saved him 200 Bs. ($29) in pesticide expenses and he estimates that his harvest is the same as with the previous fungicides he used. We scored his benefit as just $29, and made no attempt to calculate his total benefits for all his crops. That is, we only interviewed him for watermelon, not for the other crops he took to the clinic. We erred on the side of caution when calculating economic returns to clinic visits. A man who went to the clinic 39 times surely got more than $29 worth of benefits, or he wouldn't have kept coming back.

Of the farmers we surveyed, 25 (11%) did not adopt the recommendations (Table 12). The adopters include farmers who reported a loss or no change in income after adoption. The total benefits are shown to illustrate general differences but there are few if any conclusions to draw from either the total benefits or the average benefits. Farm size varied, people grew different crops and the severity of problems varied. We don't know enough about access to inputs or affordability or the motivation or skills of adopters and non-adopters.

Table 12: Net income gains by adoption of the clinic recommendation

Apply recommendation	Sample size	Total benefits (US $)	Average benefits	
			Bolivianos	US $
No adoption	25	600	170	24
Adoption	213	304,803	10023	1431

Similar points apply when net income gains are aggregated by region. Data are shown in Table 13 for illustration and include adopters and non-adopters. Farmer benefits were undoubtedly higher in Santa Cruz, with high value fruits and vegetables, and lower but still important in the Andes of Cochabamba with potatoes. Total benefits were lowest of all in the Chapare, where some incomes from peach palm had reached zero.

Table 13: Net income gains by farmers in different regions

Area	Sample size	Total benefits (US $)	Average benefits	
			Bolivianos	US $
Andes	114	114,456	7026	1004
Valleys of Santa Cruz	97	213,206	15388	2198
Chapare	27	5157	1336	191
Totals	238	332,189		

Tables 12 and 13 were produced during the first analysis of results. They reveal little useful information (other than the total sum of benefits). That prompted fresh thinking on what data to present data and a subsequent decision to concentrate on major crops. Another difficulty we faced was that some interviews yielded incomplete data because farmers were unable to remember details. However, while some could not remember exact costs and harvests, they could recall whether they'd spent more or less following the recommendation. Table 14 combines changes in production costs and changes in income by categories. Only 19 farmers had a net loss in income after consulting the clinic, while 76 earned more money.

The farmers themselves know that the clinics help them produce more. On 12 July 2009 when Oscar Díaz and Fredy Almendras went to the community of Sank'ayani, in Tiraque, Cochabamba, the mayor of Tiraque, Fidel Félix Salazar, happened to be there at the meeting. The mayor is a smallholder farmer from Sank'ayani. The rhetorical style at these meetings is often to complain and criticise, so it was a pleasant surprise when one farmer, Toribio Orellana, rose to address the mayor in public saying: "The plant clinic is a benefit for the community. It is a way to solve the community's problems and it should continue, because sometimes the institutions forget us, and do not come. It is difficult to find an agronomist."

Table 14 Production cost change and income change by categories following advice received in clinics

	INCOME CHANGE				
PRODUCTION COSTS	NA	EARNED LESS	NO CHANGE	EARNED MORE	TOTAL
Not available	5		9	2	16
Spent less	1	1	4	56	62
No change	3		11	13	27
Spent more	4	6	13	110	133
Total	13	7	37	181	238

Four farmers had not planted the crop before. This table includes non-adopters. 23 have incomplete data.

3.6 The importance of crop problems consulted by farmers

We obtained enough data to calculate net income change from 176 farmers: for potato, tomato, strawberry, peach and citrus (See Annexes 5 to 9 for details on these crops). Of these farmers, 41% asked for advice on crops with more than one problem. The other 62 cases are omitted, either because the data was incomplete or because the farmers brought in problems from minor crops (with six or fewer queries) (Table 15).

Table 15 Plant health problems on five selected major crops consulted by 176 interviewees

CROP (# FARMERS)	FARMERS WITH ONE PROBLEM PER CROP	FARMERS WITH >1 PROBLEM PER CROP	# OF HEALTH PROBLEMS	TOTAL PROBLEMS CONSULTED	% OF HIGH IMPACT PROBLEMS *	EXAMPLES OF KEY PROBLEMS
Potato (n=104)	55	53	11	168	95	Tuber moth, weevil, early and late blight, nematodes
Tomato (n=24)	17	7	12	33	94	Bacterial blight/leaf spot, Mildew, TSWV, mites
Strawberry (n=18)	13	5	8	22	73	Botrytis, spider mites, Phytophthora root disease
Peach (n=12)	9	3	9	15	75	Brown rot, fruit fly, leaf rot, powdery mildew
Citrus (n=14)	9	5	8	20	25	Aphids, phytophthora-like root and trunk diseases
TOTAL (n=176)	103 (59%)	73 (41%)	48	258		

Plant health problems include pests, diseases and abiotic disorders.
* High impact problems are those capable of causing significant losses **and** for which solutions recommended by clinics will lead to yield improvements in one year. This excludes potentially serious diseases such as Phytophthora-like root problems in citrus and crown gall in peach, both of which are best managed in advanced infections by replanting.

The surveyed farmers queried 48 different problems on potato, tomato, strawberry, peach and citrus. Most problems had a biotic cause, i.e. pests and diseases. For all major crops except citrus, most of the queries that farmers presented were for high impact problems: those capable of causing significant yield losses, and can be treated in one growing season (Table 15). It is not possible to calculate net income change over two years for problems that need longer term management e.g. replacement of plants infected by viruses, or fruit trees with systemic diseases, both of which are common with citrus trees.

Potato and tomato crops faced the greatest threat from pests and diseases, and we deemed 95% and 94% of their problems to be high impact. The clinic staff could recommend solutions to significantly reduce losses in the current growing season. Although only 75% of problems were high impact on strawberry and peach, diseases such as tomato mildew and spider mite can cause big losses. Recommendations for citrus problems were less likely to lead to great improvements in yields, either because the pest had little effect on fruit production (e.g. aphids), because trees were already suffering from systemic root diseases and beyond treatment (e.g. phytophthora root rots) and should be chopped down and replaced; or because the recommendations were for general management (e.g. lack of pruning) which would take more than a year to take effect.

Andean potato farmers faced two devastating insect pests: the Andean potato weevil and the tuber moth (several species of each one). The weevils were so serious that many farmers were considering emigrating or giving up potato cropping. The clinics recommended a pragmatic blend of cultural controls and limited use of insecticide, early in the season, allowing dramatic increases in production and slight increases in production costs. Most farmers surveyed adopted these functional recommendations.

Table 16: Potato: mean net income change for adopters and non-adopters of clinic advice

	ADOPTERS	NON-ADOPTERS
Number of interviewees with full data available (n=104) *	95	9
Mean area planted in ha (standard error)**	1.31 (±0.09)	1.69 (±0.58)
Mean net income change per ha	US$691	US$115
95% confidence interval for mean net income gains	552 to 845	-229 to 479

* full data means area planted, plant protection costs and harvests before and after use of clinic advice; ** mean area planted for potato farmers surveyed was 1.34 ha; standard error was 0.09

The key financial benefits are shown in Tables 16, 17 and 18. Potato results are shown separately from the other four crops. Peach and citrus are not included in Table 19. The range of mean net income gains per hectare are shown graphically in Figure 4.

For a Bolivian potato farmer, $691 is a lot of money. The minimum wage in Bolivia is 647 Bs. ($99) but the average rural income per worker is less, just 460 Bs. ($66 (INE 2010). An increase of $691 is equal to ten months income for many farmers.

Table 17 Mean change in net income after adopting clinic advice for four crops

CROP	TOMATO	STRAWBERRY	PEACH	CITRUS
Farmers with full data available *	20	16	10	12
Mean area planted in ha (standard error)	0.76 (±0.07)	0.52 (±0.06)	0.71 (±0.33)	1.9 (±0.38)
Mean net income change per ha	US$2704	US$2362	US$6494	US$85
95% confidence interval for mean net income gains	1390 to 4648	1215 to 3481	3158 to 10420	4 to 203

* full data means area planted, plant protection costs and harvests before and after use of clinic advice. Areas for peach and citrus derived from number of trees owned by farmers.

Table 18: Mean net income change by well-being status and crop consulted

MEAN NET INCOME CHANGE IN $/HA AND STANDARD ERROR	POOREST	N	MEDIUM	N	NON-POOR	N
Potatoes: net income change	$801 (±342)	12	$720 (±71)	72	$973 (±439)	6
mean area planted (ha)	0.81 (+0.217)		1.15 (±0.070)		2.09 (±0.513)	
Tomatoes: net income change	$2681 (±1028)	7	$1289 (±440)	7	$1733 (±693)	3
mean planted area (ha)	0.71 (±0.101)		0.89 (±0.074)		0.75 (±0.25)	
Strawberry: net income change	$3411 (±811)	11	$2063 (±1295)	2	$7258 (±2896)	3
mean area planted area (ha)	0.48 (±0.069)		0.38 (±0.125)		0.75 (±0.144)	

Figure 4a: Estimate of average change in net income per hectare of production

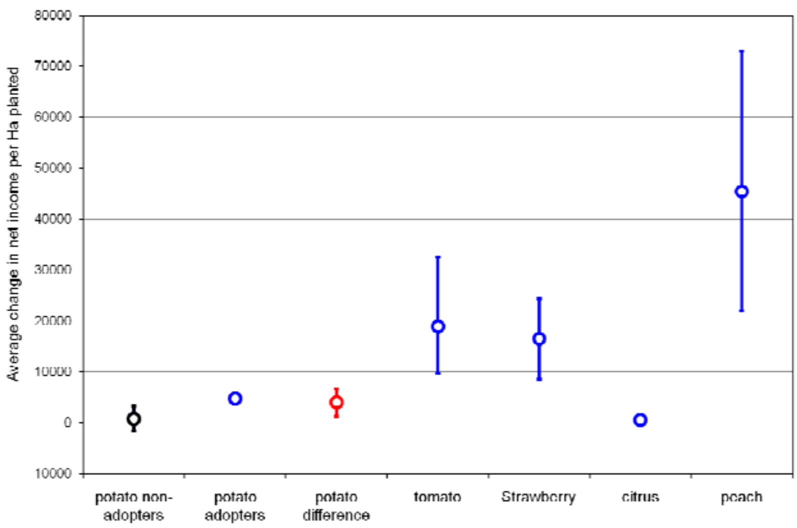
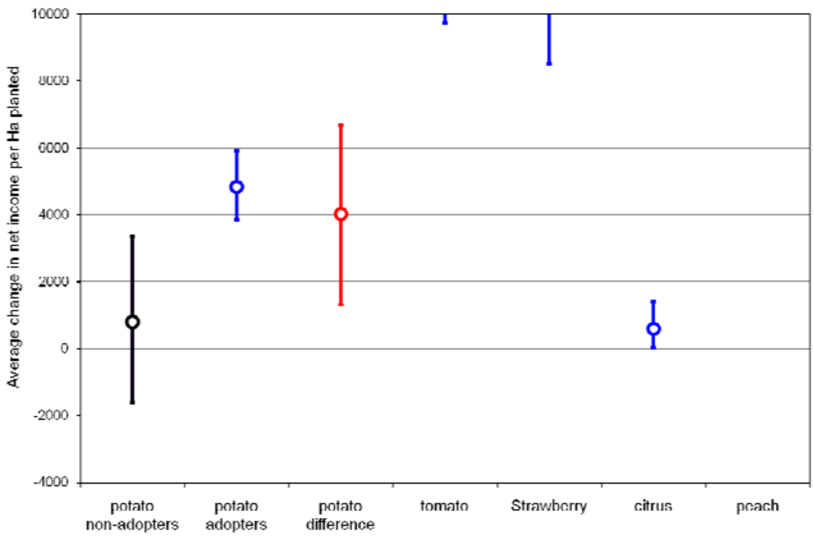


Figure 4b: Estimate of average change in net income per hectare of production (y axis expanded)



There were no non-adopters of advice for tomato, strawberry or peach. The mean net income gains per hectare were an impressive $2704, $2362 and $6494 respectively. It is difficult to compare results by well-being status because sample sizes are small.

The returns for peaches seem high, but are realistic. These are top quality peaches for the urban market. A hectare can net $10,000 in a good year, and the quality can easily be spoiled by pests and diseases. Tomatoes and strawberries are also choice crops for the urban market, but less profitable. Bolivian farmers have planted citrus in many areas; the quality is variable, disease pressure is high and the market has become saturated with the fruit.

3.7 The effects of additional training on clinic users

Of the 238 farmers we interviewed, 98 had received training (e.g. from farmer field schools) from PROINPA, CIAT or other institutions. We compared the two groups to see if training affected adoption of recommendations and net income gains. There were significantly more clients with other training from the valleys of Santa Cruz than from the other areas (Table 19, Annex 2).

People who had additional training all said they adopted the recommendation from the plant clinic. However most farmers without additional training also adopted the clinic recommendations. (Table 21) The people who had received additional training remembered more of the clinic recommendation than the others, although the improved response was not statistically significant (Figure 5). (Chi square 1.09, P> 0.3064). In other words, people who also had other training were more likely to recall and adopt the recommendations, but even those who had little or no other contact with agricultural extensionists still remembered and adopted much of what they learned at the plant clinic. It is possible that other training helps to reinforce recommendations from the plant clinics, and it is equally possible that people who take additional training are self-selected, and more included by 'nature' to adopt innovations.

Table 19: Clinic users who received additional training by area

AREA (TOTAL INTERVIEWEES)	SAMPLE SIZE	% ADDITIONAL TRAINING
Andes	114	33.3 a
Valleys of Santa Cruz	97	54.6 b
Chapare	27	25.9 a

Averages with the same letter are not statistically different at P: 0.05

Table 20: Adoption of clinic recommendations with and without additional training

CLINIC USERS	SAMPLE SIZE	% ADOPTED RECOMMENDATION
No additional training	140	82
Additional training	98	100

Figure 5: Recall of clinic recommendation with and without additional training

In the Andes of Cochabamba we thought that some farmers may have learned IPM from their neighbours who had attended farmer field schools, not from the clinic. So we separated communities that had had FFS or some other intense training experience, usually with PROINPA (Table 21) and compared three types of clinic users:

- NO ADDITIONAL TRAINING. Clinic users with no direct experience or indirect exposure to training via neighbours. They had only visited the plant clinic.
- TRAINED. Clinic users who had received additional training.
- COMMUNITY TRAINING. Clinic users who had not had intensive training, but who lived in communities where some people had.

Table 21: Communities in the Andes of Cochabamba who received training

SOME PEOPLE RECEIVED TRAINING	NO TRAINING IN COMMUNITIES
Boquerón Q'asa	2ª Sora Sora
Canco	2º Aguirre
Cañacota	Ch'ullku Mayu
Cebada Jich'ana	Chullpani Grande
Ch'aki Qhocha	Corani Pampa
Dami Rancho	Cotani Alto
Pie de Gallo	K'aspi Kancha
Plano Pista	Lagunillas
Qhochimit'a	Mishka Mayu
Qolqe Qhoya	Ormachea

SOME PEOPLE RECEIVED TRAINING	NO TRAINING IN COMMUNITIES
Qowari	Plano Bajo
Rodeo Chawpisuyu	Potrera
Sank'ayani	Pucará
Tiraque	Punata
Villa Flores	Suraj Mayu
Waylla Phujru	Tutulaya
	Tuturuyu Alto
	Uchuchi Kancha
	Vacas

Because of wide variation in the sample sizes, there were no significant differences in production cost changes between the three categories of clinic users. Farmers who only visited the clinic spent an average of 65 Bs. ($9) more, while those who had additional training spent an average of 107 Bs. ($15) more. Additional training did not help farmers save money (Table 22). Clinic users with additional training had larger increases in the value of their harvest (Table 23) and made average net gains of US$ 919, much more than those without additional training (Table 24). However, those who only visited the clinics reaped the same income increases as those who visited clinics and also lived in communities where some people had additional training (Table 25). In other words, one derives no additional benefit from neighbours who receive additional training.

Table 22: Average change in production costs with and without additional training

CLINIC USERS	SAMPLE SIZE	AVERAGE PRODUCTION COST INCREASES	
		BOLIVIANOS	US $
No additional training	28	65	9
Additional training	33	107	15
Community training	44	89	13

Table 23: Average change value of harvest with and without additional training

CLINIC USERS	SAMPLE SIZE	AVERAGE VALUE OF ADDITIONAL HARVEST	
		BOLIVIANOS	US $
No additional training	28	3790	542
Additional training	34	7794	1113
Community training	43	3881	554

Table 24: Average net income gain with and without training

CLINIC USER	SAMPLE SIZE	AVERAGE NET INCOME GAIN	
		BOLIVIANOS	US $
No additional training	27	3868	553
Additional training	31	6434	919
Community training	40	4005	572

Table 25: Average net income gain, for clinic users surveyed, in 1 with and without training

CLINIC USERS	SAMPLE SIZE	NET INCOME GAIN	
		BOLIVIANOS	US $
No additional training	132	2743	392
Additional training	91	6937	991

We compared net income gains for all of the farmers surveyed in all three regions. Farmers who had additional training gained higher net income increases than those who only visited the clinic (Table 25). However, even those who only visited the clinic reported earning an average increased income of $392.

4 Discussion

It is difficult to show impact for any particular extension program. It is easy enough to show that farmers have improved their incomes and quite another to attribute the extra cash to the program. The farmers who visited the plant clinics also had other sources of information, like media, neighbours, personal experience, salesmen and extensionists. Farmers near roads or with irrigation, for example, may have been able to take advantage of the new ideas more than the more remote households.

The most innovative farmers are also more likely to join a group, take a course or visit a plant clinic. This self-selection is called 'endogeneity' and it introduces an inherent bias into studies. Program farmers may harvest more than their neighbours just because the most progressive or wealthier people in the community signed up for the program.

While we must acknowledge the limitations listed above, studies reveal high rates of return to extension, often over 500 % (Davis 2008). The world has harvested massive increases in food ever since the 1960s, much of it by small farmers. Virtually all of this change is attributable to new agricultural technology. Farmers learned about this new technology somehow, and agricultural extension has played some part in this.

Most of the people we surveyed reported improvements in yield and in the quality of their produce, which they attributed to extension and to the plant clinics. In our study almost all farmers adopted the clinic recommendations, and continued to use them year after year. This suggests that the recommendations were profitable. IPM is rarely subsidized, and farmers do not adopt it unless it is profitable (Norton and Swinton 2008).

- Plant clinic in the potato wholesale market in Punata, Cochabamba. Oscar Díaz (right) explains how to control Andean potato weevils. Notice the interest in the faces of the people listening

Before conducting the study we hypothesised that the plant clinics helped farmers save money, but some farmers actually spent more on production (e.g. fungicides and insecticides). Others saved money, especially in the valleys of Santa Cruz, where pesticides for vegetables were often excessive, expensive, and not always working.

After visiting the plant clinic, farmers in the Andes of Cochabamba tended to spend a little more on pest control, because they had been spending less to begin with. But their small investments (especially to control the Andean potato weevil) helped them to reap much larger harvests. The clinics in Bolivia recommended essentially the same technologies as the IPM program in Ecuador, as described by Mauceri et al. (2007), for the same three pests: Andean potato weevils, tuber moths and late blight.

Farmer field schools are an excellent way to teach a complex IPM topic to a small audience (Mauceri et al. 2007, Ricker-Gilbert et al. 2008), but the FFS farmers rarely teach the new ideas to their neighbours, casting doubt on the cost-effectiveness of FFS (Anandajayasekeram et al. 2007, Davis

2006, 2008, Bentley 2009b).). In Bangladesh, Ricker-Gilbert et al. (2008) found high positive returns for FFS, but even higher ones for other conventional extension and written material.

During our study farmer field school graduates vividly described teaching technologies from the FFS to their neighbours, and encouraging them to use the innovations. But we found that the Andean farmers who merely attended the clinic improved their potato harvest as much as did the neighbours of farmers with intensive extension experience.

In the Andes of Cochabamba, the plant clinics specialized in potato problems. After 2006 they were run by Oscar Díaz, who had a talent for attracting and engaging with an audience. But he recorded perhaps 10% of the people who listened to his effective talks about weevils. He might have had a dozen people at any one time listening to him, but when he paused to ask them their names most of the people would walk away before he could record who had talked to him.

Oscar spent three years visiting fairs in the area (Tiraque, El Puente, Colomi, and Punata) telling anyone who would listen how to control weevils. Oscar had large, clear drawings, years of experience, fluent Quechua and ample patience. He reached at least five thousand farmers, perhaps ten times that many. It is just possible that this one effort allowed farmers in four provinces to raise their income by a few hundred dollars each, for several years.

- Fredy Almendras (left) tells Agapito Vallejos (right) how to control weevils in the plant clinic at Tiraque. Oscar Díaz used this method to reach thousands of people, and it made a difference in their livelihoods

5 Conclusions

The plant clinics in Bolivia were later emulated in Nicaragua, Bangladesh, Uganda, Vietnam, Nepal and elsewhere, with technical support from the GPC. The GPC is one of several international efforts to improve plant health services (Miller et al. 2009), but the only one helping to exchange ideas between grassroots extension people in developing countries.

The plant clinics themselves are an innovation for the extensionists, just as the pest control information is new for the farmers. This is the first quantitative study of the benefits of clinics to farmers. As a first attempt it went well enough, although there are some things we should do differently the next time.

One problem was the sampling bias. In future studies we may also use an opportunistic sample, because of the difficulty of finding a random sample of farmers to survey. But next time we will try harder to sample people from all provinces of the impact area. We should improve the questions on production figures and adoption. We may want to add a question or two on production costs and yields. We should also distinguish between partial and full adoption.

More importantly, we need to collect baseline data and identify non-clinic users who are similar to users. Such control or comparison groups allow a clearer measurement of impacts due to the programme (ie. running clinics).

During this study we were surprised by the high financial benefits. Smallholder farmers often feel vulnerable about their land, animals and harvest, and tend to underestimate their wealth and income when talking to outsiders. We were fortunate to have really good interviewers. Some of the farmers already knew and trusted them, and all of our interviewers were personable, experienced and respectful. They tended to inspire trust, which may have led farmers to respond honestly about their income gains. We certainly were not fishing for high numbers; on the contrary, we systematically underestimated economic returns to the clinics in several ways:

- We assumed low farm gate prices for farmers' products
- We only ascribed farmers one year of benefit for recommendations, even if they had used it for several years (and they usually had)
- We only tallied the benefit for one crop, even if the farmer had consulted the clinic for several crops.

A little help goes a long ways. In Venezuela, remote Indians living far from the river suffered three times more infant mortality than Indians living along the river, who had more food, and who received occasional visits from medical teams. Infant mortality was 346 per 1000 births on the savannah, but 132 on the river. Improvements in food supply, soap, even sporadic medical attention caused a big difference in mortality rates (Kramer & Greaves, 2007). If this is true for medicine, the analogy may hold for agronomy, where key advice at just the right moment may save a significant amount of a crop.

Bolivian farmers benefited immensely from the clinics. And the clinics are unlike conventional extension, where an extension agent takes a concept to farmers. The clinics work the other way around. Farmers take a problem to get an answer, which sometimes saves their whole crop, or at least next year's crop. The clinics are "a demand-driven advisory service" (see Birner et al. 2006).

Even the farmers who told us they did not remember the recommendation often reported improved harvests. But then, in some cases they had visited the clinic five years before the interview, and they probably did adopt the recommendation at the time. They are like people who remember visiting their doctor five years previously. They may not remember what the doctor said, but they know they followed her advice and got better.

The plant clinics contributed to the adoption of technology which has been extremely profitable for the farmers themselves.

Recommendations for future studies

- Create comparison groups who represent the counterfactual – what would have happened without the clinics.
- Look more closely at qualitative indicators: accuracy of diagnoses, outreach of clinics, how many knew about the clinic.
- Keep the questionnaire to a maximum of one page.
- Involve the statistician from the start of the study, so he or she can make suggestions and can anticipate what the data set will look like. (This is actually a standard recommendation, but it is difficult to do. In Bangladesh in September of 2009 once again we simply launched into the study without consulting a statistician).
- Enter the data in Excel at the end of every day.
- Enter some prose in Excel, but not too much. It is tedious to enter. In the future we recommend using less of it. To make up for this loss of qualitative information, perhaps future impact studies could end with a writers' workshop, where interviewees write up some of the qualitative insights that came out of their fieldwork.
- Sample farmers from all geographical areas of the impact area.
- Improve questions on production costs and yields.
- Distinguish between partial and full adoption.
- Impact studies should be held more often, perhaps every two years. Plan as part of regular clinic activities (i.e. ask returning users what happened with previous recommendations).

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Annex 1

Impact Study Questionnaire, Plant Health Clinics, Bolivia 2009

1. Nombre ______________________

4. Encuestador ______________________

2. Código ______________________

5. Fecha ______________________

3. Comunidad ______________________

6. Municipio ______________________

7. Código(s) de bitácora ______________________

9. Recomendaciones según la bitácora

9. ¿Qué le recomendaron en la posta?
10. ¿Qué hizo?
11. ¿Por qué lo hizo así?

12. Recibe capacitación además de la posta?	No		Sí, de CIAT		Sí, de Sedag		Sí, de DSA		Sí, de Proinpa		Otro	

13a. Costos de producción antes de usar la recomendación	13b. Costos de producción con la recomendación
14a. Cosecha antes de usar la recomendación	14b. Cosecha con la recomendación

15. ¿Cómo supo de la posta?	radio		tele		amigo		directo		otro	

16. Nivel de bienestar	1		2		3		otro	

17. ¿Cuántos años usó la recomendación?
18. ¿Por qué lo sigue usando? O ¿por qué ya no lo usa?

Annex 2

Additional training and plant clinics

Cebada Jich'ana roughly translates as 'overflowing with barley'. It is an old name, from centuries ago when the area was probably part of an *hacienda*, a large farm where Indians were exploited for their labour, when barley harvests were generous.

The farmers say the soil became 'tired'. By the 1980s Andean potato weevils were eating half to three fourths or more of the harvest. Farmers were desperate and some emigrated to Spain.

Some of the local people worked as part-time labourers on the experimental station at Toralapa, which belongs to the Bolivian government and was on long-term loan to Proinpa. This was a delicate situation and Proinpa always tried to be a good neighbour to the smallholder farm communities surrounding it. If they had disliked the station they might have invaded, and permissive Bolivian policies may have allowed them to stay.

- The station of Toralapa, as seen from the Cebada Jich'ana, in the Andes of Cochabamba

In 2004 Proinpa organized farmer field schools (FFS) for Cebada Jich'ana and Dami Rancho, and a few other communities near the station. FFS is a perfect way for technical staff and farmers to get to know and respect each other (Bentley 2009a). Previously, in 1995, Proinpa had organized these communities as CIALs (local agricultural research committees) (see Ashby et al. 2000).

Some five years later, in 2009, as part of this impact study, Jeff Bentley went back with Fredy Almendras and Oscar Díaz, both of whom had worked at Toralapa. Oscar had run the field school. We asked about the plant clinics, but the people of Cebada Jich'ana wanted to talk about their earlier experience with the FFS. Field school is obviously more impressive. A visit to the clinic takes a few minutes. An FFS includes a weekly session and practices in the field from seed to harvest, some five months in the case of potato. A clinic visit is a hundred times briefer than a season of FFS, and costs less as well.

We drove into Cebada Jich'ana in the kind of small taxi common in the countryside. The land was bare, rising from the road to the mountains. The houses were dispersed farmsteads, and everyone could see us coming, but no one paid us any attention. We parked the car and walked.

Jeff was pleasantly surprised when the first men we met hugged us and said "If we had known you were coming we would have cooked you lunch."

A warm welcome means a lot here. Indigenous Andean communities are private places. Casual visitors are often rebuffed with: "Who are you? What are you doing here? Why do you want to talk to people here?" (See Weismantel 2001, Orlove 2002). We were welcome because Oscar had taught the FFS. "These are my former students," he said simply.

The Andean potato weevils are brown, flightless beetles with long, curved snouts. They lumber around the field, eating potato leaves and laying eggs at the base of the plant. The eggs hatch into grubs which tunnel underground, eating the tubers and leaving a filthy mess in their place.

Although the weevils are native, they became serious pests in the twentieth century as farmers began growing more potatoes, leaving shorter fallows and larger fields (see Ortiz 2006). The farmers began spraying insecticide with little effect in the 1980s and 90s. Before taking the FFS, some farmers in Cebada Jich'ana were thinking of abandoning potatoes altogether, here in the potato's native habitat.

"We didn't even know that the weevil laid eggs which turned into the white bug", said Leonardo Montaño of Dami Rancho. They learned that in the FFS. With help from Oscar, the farmers figured out half a dozen strategies to control the weevils.

- Leonardo Montaño shows us the weevil-free potatoes, carefully covered in straw in his phina in Dami Rancho

To put a bit more history on it, Proinpa had inherited a menu of 16 control strategies from CIP (the International Potato Centre) in the early 1990s. But farm research is slow. Each experience takes a year, and each year is different. Over the years, the farmers and scientists honed the list of weevil-killing methods. Oscar's field school was part of this.

The farmers in Cebada Jich'ana told us about their two best weapons, both based on their new knowledge of weevil behaviour. At harvest farmer pile the potatoes in the field. Those spots are called *qayanas* in Quechua. Then the people move the potatoes to more permanent storage places called *phinas*. The weevil grubs sense when their potato has been harvested. So the weevils abandon spud, and dig into the soil, either in the *qayana* or the *phina*. In the FFS the farmers learned to dig up the soil with a pick, after removing the potatoes. Then the chickens come eat the grubs. "It only takes have an hour to dig up a *phina*," Leonardo Montaño said. It is important, because "each weevil can lay 600 eggs," Filemón Orellana said.

Second, instead of spraying late in the season, in the FFS, farmers learned to spray their insecticide where and when it was the most deadly, at the base of the plant, when the potato plants are just starting to come up.

Some farmers said they sprayed a little more. Others said they sprayed just the same. They weren't spraying less, just spraying smarter.

It is heresy to recommend insecticides in an FFS, a teaching method founded to control the brown plant hopper in Indonesia by simply abandoning insecticides and letting the spiders and other natural enemies eat the pests (Winarto 2004). Such natural pest control is wonderful when it works, but it doesn't always. And as far as methods go, FFS can be used to teach the rational use of insecticides use just as handily as it can discourage pesticides.

"I used to harvest 40 bags of potatoes, and now I harvest 50," said Pascual Baltazar.

With few exceptions, the farmers said they were harvesting more. (The only ones who insisted they were harvesting less were recalling decades ago, before the weevils were such a problem, when farmers could harvest a crop with little or no fertilizer).

Harvests increased by a conservative estimate of several hundred dollars each (see the following section "what the neighbours say"). Smallholder farmers under-report their earnings (even to interviewers they like), as a self-defence strategy. They may have increased their earnings four times that much, a lot of money for a family working a small farm by hand.

Sixteen people started to take the FFS in Cebada Jich'ana and six dropped out because it took up too much of their time. The ten men who finished the school in Cebada Jich'ana later convinced the *sindicato* (a community council where each household is represented at a monthly meeting) to impose a 30 Boliviano fine ($4.29) on anyone who did not dig up and spray weevils.

FFS graduates do not usually teach what they learn to others (Bentley 2009b). But here is a counter-example. Rural Bolivians have been highly organised since the revolution of 1952, and even before (Dunkerley 1984, Gotkowitz 2007). They often use fines or other sanctions to enforce behaviour within communities.

Making laggards pay is not an option for FFS graduates in every country. As Winarto noted, FFS graduates in Java could not teach their neighbours because they lacked a venue and the authority to do so. Bolivian farmers have monthly meetings, by-laws and a *sindicato* for ramming a point home.

Proinpa also taught FFS in a neighbouring community, Dami Rancho, which is starting to fine community members who are too soft on weevils.

The FFS did two good things. It helped a few dozen poor farmers in a few communities to make a decent living. "Now that we've controlled the weevil, people are coming back from Spain," Leonardo Montaño said. And the FFS helped the agronomists figure out practical ideas that worked on farms.

In 2003 Proinpa started a weekly plant clinic in Tiraque, the nearest small town to Toralapa and Cebada Jich'ana. René Pereira, head of station, ran the clinic personally in an effort to show local farmers that Toralapa was their ally. Oscar Díaz took over from René in 2006 and opened other clinics in nearby towns of Colomi and Punata. René and Oscar were profoundly influenced by their FFS experience, so in the pilot clinics they taught weevil control to anyone who would listen. The FFS graduates often stopped by the clinics to say hi, where they got a refresher chat on weevils, and ended up in our clinic log.

Farmers who also had intensive training, including FFS (mainly with Proinpa and CIAT) improved their harvests by twice as much as farmers who only went to the clinic, although both groups enjoyed greatly improved harvests (see Tables 24 through 26). The next step was to compare farmers who had only visited the clinic with others who had visited the clinic and were also neighbours of FFS farmers. The hypothesis is that FFS farmers, and others with additional training, share information with their neighbours. That hypothesis had added credibility in our case, since the field school graduates explicitly told us that they had taught their neighbours to use weevil IPM techniques and had even fined community members who did not control weevils.

Annex 3

Some stories to illustrate the method

1. Tamborada B

After a long walk from the road, Jeff, Fredy and Oscar met Filiberto Colque, a farmer who had visited the clinic in Ivirgarzama, in the tropical lowlands of Cochabamba. He had gone to the clinic with samples of three tropical fruits: papaya, camu camu and achachairú, but he said he never got an answer back. That was discouraging, but that is one reason we were doing the study, to learn about problems like that.

Since we were in his field, don Filiberto asked us to see his camu camu, so we did. He was unhappy with it. He had planted it as part of a development project, as an alternative to coca, but it was clear at first glance that the plants were growing poorly.

- A branch of camu camu, overloaded with fruit and breaking

Fredy noticed that some of the branches were so loaded with fruit that they were bending and breaking. He told don Filiberto to prop up the branches with a stick.

Some of the other little trees were dying. That was the problem that sent don Filiberto to the plant clinic. He said they looked healthy, they bore fruit and then they suddenly dried up and died. The dead trees were surrounded by fallen fruit.

Fredy dug up a tree by the roots and saw that it had been killed by a fungus. He recommended a fungicide, and don Filiberto seemed pleased. At least we were able to salvage some of our pride. The clinic had received samples and not been able to submit them to a laboratory, which is why don Filiberto never got his answer back.

This case shows that the plant clinics need better connections to laboratories, something the Bolivian clinics are now doing.

The farmer who did not have a control group in his head. The clinic in Los Negros, in the Valleys of Santa Cruz, is open every morning from 7 to 8 AM. For the rest of the day Jhon Ferrufino gives advice to farmers in organised groups. The municipality of Pampa Grande rents the room for the clinic, which also doubles as Jhon office. Jhon works for the DSA (the Direction of Agricultural and Food Health) of the prefecture of Santa Cruz.

- Don Filiberto shows Fredy Almendras the root of his camu camu

Jhon took Olivia Antezana (CIAT), Franz Ortiz (interviewer) and Jeff Bentley to do some of the first interviews in the Valleys. We went to talk to some of the farmers in Jhon's groups, who had also visited the clinics. This is typical of extension agents. They develop friendships with a few farmers and invariably take visitors to see these people.

During this visit we realized that we needed to add a line to our questionnaire to indicate whether the farmer has also had intensive interaction with the technical staff.

Domingo Copa was harvesting, and he was in a good mood, obviously relieved that his potatoes had turned out so well. He was about half way though harvesting his small field and he had a nice collection of *chaparas*, the word for the biggest size of potatoes. (See front cover).

Domingo was reluctant to say how much he thought he would harvest. He owns no land. So he sharecrops. The landowner buys the chemicals, and at harvest splits their cost (and the harvest) with the sharecropper.

Domingo had sprayed fungicides that Jhon had recommended for *t'ojtu* (late blight), but he said that what made the most difference was fertiliser. Jhon had suggested he apply chemical fertiliser (15-15-15) and he did, seven bags of it, which is why he thought the tubers were so large.

"So what would you have harvested without the recommendation?" Jeff asked. "I have no idea," Domingo said. "This is the first time I've planted potatoes here."

Later Jhon said "He had no control group." A farmer's control group is his experience from previous years with this same plot of land. Sharecropping someone else's land, and for the first time, means there is no way to tell what the harvest would have been like without the fungicide and the fertiliser. This is the exception that proves the rule. When farmers do work the same land year after year they have a counterfactual in their head (without the recommendation from the plant clinic I would have harvested …).

When we quantified this case we added in the cost of the fertilizer, but we still had no idea how much the harvest would have been without the fertilizer. So even though the farmer was clearly pleased with the results, in our data set this case is missing the numbers for "change in income due to the recommendation from the plant clinic."

MISSING PRODUCTION COSTS

Andrés Rojas was harvesting tomatoes when we went to see him. He was pleased to see us, and yes he could spare a few minutes for an interview. With a little thought he could estimate how much his tomatoes had yielded, thanks to the recommendation from the clinic, and how much they would have yielded without the advice he got.

- Andrés Rojas takes a break at the edge of his tomato field to be interviewed

But he could not recall even vaguely how much he had spent of pesticides this year or previously. "Jhon tells us we should write this down." He said.

It was not always possible to estimate how much the recommendations save farmers, even for recent expenses. This case also had a missing variable, for change in production costs.

Earning more from tomatoes. We interrupted Faustino Benavides while he was harvesting maize with his wife. He told us about his tomatoes, and he said because of Jhon's recommendation he was saving a little on pesticides. "Before I used to spray pesticides just to spray them." He said. He was still spraying fungicides and insecticides, but with more accurate timing and better products his harvest had gone from 480 boxes of tomatoes to 600, at no extra cost. At an average price of 40 Bolivianos per box ($5.71), he had earned an extra 4800 Bs. ($686). It was a solid return on his investment.

These were our first experiences with the questionnaire in Santa Cruz. The quality improved sharply after that. For one thing, Franz and Olivia did not really understand the questions on the interview until they heard Jeff try to ask them of the farmers, and then to try to tease more information out of Franz and Olivia after the interview. Once Franz and Olivia grasped the questions, they were able to ask them in a way that made a lot more sense to the farmer, and we got less missing data after that.

- Faustino Benavides, in the valleys of Santa Cruz

We also improved the questionnaire after these interviews. Originally it had a blank box where the interviewer was supposed to ask how much more (or less) the farmer had harvested because of the recommendation. There was a similar question for saving on costs (or spending more). After that day, we split both boxes in half, with a line from top to bottom.

PEACH PALM STORY

On 1 October 2006, Raúl Huiza, ex-miner from the high Andes, now settled in the humid tropics of the Chapare, brought two samples of peach palm to the plant clinic in Ivirgarzama. One was from his nursery, and the other was from the field. According to the clinic log, he told the plant doctor that holes appeared in the leaves and then the roots rotted. The plant doctor did not write down what advice he gave; the log said only "answer pending."

When Fredy, Sol Danielsen and Jeff went to talk to Raúl Huiza in his field of palms, don Raúl admitted that he had been disappointed with the plant clinic. He had expected to find a cure, not tips on preventing the disease in the future. He told us that he still had the disease in his palms and that he could do nothing about it, except to clean the weeds from around the palms and remove the damaged leaves. Don Raúl was annoyed that the plant doctor told him "there is no fungicide; it is too expensive and too hard to find."

- Ailing palm leaf

Refusing to quit, don Raúl bought laundry detergent and an inexpensive fungicide, his own idea, and sprayed those. He also cut off the diseased leaves "like banana" (the way farmers have learned to cut off diseased banana leaves). Then he burned the diseased plants, which he said the plant doctor had told him to do (although it is not written in the clinic's log).

This cured some of the disease, but not all of it. After a while don Raúl saw that the fungicide made little difference. He began to notice that the disease was a nuisance, but not so bad, because several shoots would appear per plant and if one died, the others often lived.

It took don Raúl and his wife, doña Julia, a week to cut out the sick leaves, but they were willing to do it because clearing out the sick, spiky leaves made the grove easier to work. Cutting leaves did not cost them any cash, but we valued their labour at 300 Bs. ($43) and added the cost of the fungicide at 60 Bs., even though the clinic did not recommend it, just to err on the conservative side.

However, income from palm was devastated, not because of plant health, but because of the chaotic global economy. In 2006 the cannery paid 1.50 Bs. ($0.21) per palm heart. "We had two hectares and four harvests a year." Then the world economy staggered and consumers stopped buying luxuries like heart of palm. Now the cannery only pays 70 centavos (US 10 cents) per heart, and buys one harvest per year. Because they harvest less frequently don Raúl and doña Julia can take 2500 palms per hectare instead of 2000, but by 2009 they had 14 hectares instead of two.

- Palm hearts stacked. A whole palm yields one heart, now selling for just 10 cents US each

That is a lot of change, which often happens on a small farm. But the palms' health is about the same in 2009 as it was in 2006. So we scored their production gains as 0. In other words, on paper we scored this farm as experiencing a net loss after visiting the clinic.

Still, don Raúl was glad he had gone to the *Posta*, where he had learned about pruning which he kept doing for two years, even though the bottom has dropped out of the palm market. He still cuts off diseased leaves and weeds the ground around the palms, "I still do it, so it will grow well. It is ugly when the branches cross."

The value of follow-up visits. After this interview, Fredy said that the problem could have been avoided in the first place by properly sterilising the soil in the nursery. The disease was a complex of bacteria and fungi, carried from nursery to field. It was too late to cure it now, but this gave us an idea for an extension topic, and we planned to write a fact sheet on it for other farmers. After all, one day the price of palm hearts may recover.

Fredy told don Raúl that even though he wouldn't want to hear it, with palm hearts at 70 centavos it make no sense to buy Bavistín (fungicide) at 600 Bs. ($86) a litre. Fredy had urged don Raúl to continue to clean the damaged palms, but to dedicate one machete for cleaning sick ones, to go through the grove once cutting out the sick ones, before the harvesters came, so the workers would not use their machetes to use their machetes on the healthy plants after cutting out the sick ones, spreading the disease.

- Raúl Huiza and Julia Condori in their palm grove

Even though there was no net change in output, don Raúl and doña Julia were happy with the results, because they had learned about the disease, they now had some ideas about how to manage it, and they would be able to improve their palms if the price rebounded.

Results like this defy quantification. Farmers are upset when their crops are sick, and information helps the people to feel better, as well their plants.

In future impact studies it might be useful to ask farmers outright if they were satisfied with the results from their visit(s) to the clinic, ranking on say a five point scale from 'very satisfied' to 'very disappointed'.

Crop rotation: On 15 July 2009 Olivia Antezana, Franz Ortiz and Jeff Bentley went to Pulquina Arriba, Franz's home community. We interviewed Yasmany Quiroz, who remembered Jeff from a visit in 2003 (see Bentley and Boa 2004). He joked with us, and asked if Jeff had brought coca again this time. Jeff hadn't this time, but we had a nice interview even with no coca leaves to chew. Yasmany had had a problem with nematodes in seed potato. The lab (Olivia at Ladiplantas) had diagnosed it for him. She recommended crop rotation, which Yasmany adopted.

But Yasmany soon realized that seed potato was unprofitable. Because his seed was not certified, it was selling for the same low price as other informal seed. So Yasmany moved his potatoes to another plot the following year, and he earned slightly more than the year before, but then he stopped growing seed altogether, and switched to vegetables. Yasmany had been doing something no one else in our sample had done. He was buying certified potato seed, and raising high-quality non-certified seed to sell. Farming allows for infinite variations, which is why there is such great variation in costs and income in this impact study.

In 2003 Bentley had interviewed Víctor Quiroz (Yasmany's father) in his potato field. So we went to see him again. In 2003 he had visited Ladiplantas to identify some small, sucking insects. Olivia had identified them as *Russelliana* (Homoptera).

- In Pulquina Arriba, near Comarapa in Santa Cruz, Víctor Quiroz (centre) tells Olivia Antezana (right) how he has controlled his insect pests, while Franz Ortiz fills out the survey form

He eventually went to the clinic ten times for various crops. Olivia recommended insecticide and in 2006 advised don Víctor to add laundry detergent and bleach to the chemicals. He was delighted with the results. Before, he had been spending $300 to $350 on insecticides. Now he spent just $200, and had gone from harvesting 100 bags of potatoes to 150, for an increase in earnings of 1250 Bs ($129), and a net benefit (cost savings plus improved harvest) of $196.

Don Víctor had been applying the current recommendation in potato for four years. In our calculations we assigned him the benefits for just one year. We did not multiply the benefits by four or six years, although in all fairness we should have. We have been overly conservative in attributing benefits to the farmers from the plant clinics. Even so, the benefits are impressive and high.

Technology for poor people. One farmer in the Andes (case EPC-111 in our sample) reported harvesting 33750 Bs. ($4821) less potatoes now than before he went to the clinic. His case is worth a second look. He is one of the 'wealthy' farmers in our sample. He plants about 45 sacks of seed, enough for four or five hectares. At the plant clinic he learned about Matapol to control tuber moths, but Matapol takes some labour to use. The powdered Matapol has to be shaken into the seed potatoes in gunny sacks, in 50 lb batches. For 45 sacks that would be 180 batches.

Instead, the farmer used more insecticide. The clinic's recommendation demanded too much labour for this wealthy farmer. At least some recommendations are more suited to medium farmers and smallholders.

Some people still had not heard about the clinic. On 27 July 2009, near Colomi, Fredy, Jeff and Sol Danielsen walked up to don Marcelino, sitting in a tool shed in his small house, with a two-year old girl. He left the toddler playing quietly and came over to great us. Fredy explained the questionnaire, and the plant clinic, but don Marcelino didn't remember every going to the *Posta*. Fredy gently tried to start the questionnaire, but don Marcelino didn't understand what it was for, since he had never been to the clinic.

So Fredy explained it in more detail, and the more he said, the more interested don Marcelino became. "What a good idea," he said. "But don't just talk to me. Let's get the whole *sindicato* in on this." (We did not have time to visit the whole *sindicato,* at least not right then).

- Papalisa with a diseased crust (left) and healthy tubers (right)

He was interested in the *Postas*; he had just never been to one. Someone else with the same first name and must have been recorded incorrectly on the clinic log. These mistakes happen, especially because while attending at the clinic it seems more important to help people with their problems than to get everyone's name jotted down. Fortunately, we found few mistakes like this.

Still, we had to exit gracefully, so Jeff asked don Marcelino if he was planting potatoes on the slopes above his house. The land had been ploughed and the seed sacks were placed here and there in the little field.

"Not potatoes, *papalisa*" (ulluco, a native Andean tuber), don Marcelino said, "but they have *cáscara*". *Cáscara* is Spanish for "bark, skin of fruit", but Jeff had never heard it used as a disease name. Don Marcelino was probably translating a term directly from Quechua. "Qarasqa?" Jeff asked.

Yes, that was it, and don Marcelino went to get some tubers to show us. He thoughtfully brought back healthy ones to contrast with the diseased tubers, something that even plant pathologists occasionally forget to do.

"This is how they are supposed to be, pretty like this, not covered with this *cáscara*," don Marcelino said as he began to patiently peel off the dark growth on the skin of the tubers, showing us the flaky texture of the symptom as well as what it looked like.

Fredy said it was Rhizoctonia and he prescribed spraying a fungicide in the furrow at planting time. That was a technology from Innova, an earlier project some of the authors worked on (Bentley et al. 2007).

Don Marcelino thanked us, and hinted that he had to go back to work. He said he would look for the plant clinic in the fair at Colomi.

Annex 4

Clients and communities sampled

Clients surveyed from 96 communities and the clinics they used

Community	CL	CL, TQ	EP	IV	LN	LP	LP, EP	PU	PU, EP, TQ	PU, TQ	SA	SA, LP	TQ	VG	Grand Total
2ª Sora Sora	1														1
2º Aguirre	2														2
Agua de Oro														1	1
Ayopaya				2											2
Bañado de la Cruz						3									3
Bañado del Rosario						2									2
Barrio Nuevo					2										2
Boquerón Alto													1		1
Boquerón Q'asa		1	1					5	1	1			12		21
Cabra Cancha						1									1
Cañacota								1		1			5		7
Cañada de Arroyo														1	1
Canco	3														3
Cebada Jich'ana								1		5			1		7
Ch'aki Qhocha													4		4
Chasquis				1											1
Chilón						1					1				2
Chirguanañan														1	1
Chucupial						3									3
Ch'ullku Mayu													1		1
Chullpani Grande	1														1
Colonia Tunari				1											1
Comarapa						7									7
Corani Pampa	1														1
Cotani Alto	1														1
Cristal				2											2
Dami Rancho								1		2			2		5
Dos de Marzo				1											1
El Proletario					1										1
Esmeralda				1											1
Estancia Huaico														2	2
Estancia Vieja						2									2
Germán Bush				1											1
Guadalupe														4	4
Gualberto Villarroel				1											1
Ivirgarzama				1											1

Community	CL	CL, TQ	EP	IV	LN	LP	LP, EP	PU	PU, EP, TQ	PU, TQ	SA	SA, LP	TQ	VG	Grand Total
K'aspi Kancha													1		1
Kayallana														2	2
La Jara						1									1
La Pista						5									5
La Pista, Mataralito						1									1
La Yunguilla						1									1
Lagunillas										1					1
Lampazar						1									1
Lanza-Lanzar						1									1
Liwi Liwi					1										1
Los Negros					2										2
Mishka Mayu													2		2
Moco Moco						1									1
Molleaguada														1	1
Montegrande						1						1			2
Ormachea													2		2
Pampas						2									2
Pie de Gallo	1														1
Pinos						1									1
Plano Bajo													3		3
Plano Pista													4		4
Potrera													1		1
Pucará													1		1
Pulquina Arriba						10									9
Punata								1							1
Qhochimit'a													5		5
Qolqe Qhoya													6		6
Qowari													2		2
Quiñales						2									2
Rayuela														1	1
Río Arriba						10									10
Río San José						1									1
Rodeo Chawpisuyu													1		1
San Isidro						1									1
San José de la Capilla						5									5
San Mateo, La Pista, Comarapa						1									1
San Rafael											2				2
Sank'ayani													4		4
Sank'ayani Alto													1		1
Sank'ayani Baja								1					1		2
Santa Ana														2	2

Community	CL	CL, TQ	EP	IV	LN	LP	LP, EP	PU	PU, EP, TQ	PU, TQ	SA	SA, LP	TQ	VG	Grand Total
Santa Rosita														2	2
Suraj Mayu			1										3		4
Tamborada A2				2											2
Tamborada B				1											1
Tiraque													4		4
Torrecillas						1									1
Tutulaya										1					1
Tuturuyu Alto													1		1
Uchuchi Kancha													1		1
Vacas								2					1		3
Valle Ivirza				4											4
Valle Sajta				3											3
Verdecillos						3	1								4
Villa Flores													1		1
Villa Imperial				4											4
Vueltadero				2											2
Waylla Phujru								2		1			3		6
Zona de Expansión												1			1
Grand Total	10	1	2	27	6	68	1	14	1	12	3	2	74	17	238

In Andes of Cochabamba 38 communities used the clinics.

In the Chapare, 15 communities used the clinics.

In the Valleys of Santa Cruz, 43 communities used the clinics.

The interview sample represented 96 communities.

Clinic abbreviations: CL (Colomi), EP (El Puente), IV (Ivirgarzama), LN (Los Negros), LP (Ladiplantas, Comarapa),
PU (Punata), SA (Saipina), TQ (Tiraque), VG (Vallegrande)

Annex 5

Potato queries: production cost, harvest and net income changes after receiving a recommendation from a clinic

These data contrast conditions before (year 1) and after (year 2) receiving a recommendation from a clinic. Most of the 98 of the 11 farmers interviewed were from the Andes of Cochabamba, the others were from the Valleys of Santa Cruz.

Seven farmers increased the number of bags they planted and we assumed they planted a larger area. Changes in production costs, harvest and income were adjusted to match the area (bags) planted in year 1.

The majority were able to recall production costs and harvests. A few said they had profited from adopting the recommendation but could not say by how much or could not recall production costs. Net income gain is therefore not available though net income type can usually be given.

Some farmers said that harvests did not change but did give the actual amounts.

Net income gains only apply to one year's change

Income changes were calculated using a constant price of 150 Bs per carga (a bag weighing around 100 kgs) even though potato prices tended to be higher in year 2.

The two main pests in the Andes were weevil and tuber moth. In the Valleys of Santa Cruz a wider range of problems were consulted. They included early and late blight, mite damage, bacterial and fungal diseases and nematode attack.

Non adopters of recommendation (11 farmers)

Farmer code	Well-being	Production cost change (Bs)	Harvest Y2-Y1 (cg)	Harvest change % Y1	Yield Y2 (cg/cg)	Pests	Net income gain (Bs)	Net income type
EPC-009	2	na	17	35%	8.1	G, P, N	na	more (nd)
EPC-006	2	0	0	na	na	nk	na	none
EPC-111	3	300	-225	-25%	15	G	-34050	less
EPC-002	2	0	0	na	na	P	0	none
EPC-004	2	0	0	na	na	Gen info	0	none
EPC-023	2	0	0	0%	na	P	0	none
EPC-039	2	10	3	25%	2.5	G	2690	more
EPC-114	2	40	24	29%	9	P	3560	more
EPC-113	2	80	30	40%	7	G	4420	more
EPC-021	1	0	8	19%	5.9	P	5400	more
EPC-036	2	100	150	100%	10	P	22400	more

Well being: 1 (low, poor); 2 (medium, moderately well-off); 3 (high, wealthy/non-poor). Bs – bolivianos (US$1 = 7Bs); na – not available; nk – not known. cg – carga (bag of ca. 100kgs); yield expressed in bags harvested per bag planted. Pests: G – gorgojo (weevil); P – polilla (tuber moth); N – nematodes

Adopters of recommendations (100 farmers)

FARMER CODE	WELL-BEING	PRODUCTION COST CHANGE (BS)	HARVEST Y2-Y1 (CG)	HARVEST CHANGE % Y1	YIELD Y2	HARVEST + YIELD UNITS	PESTS	NET INCOME GAIN (BS)	NET INCOME TYPE
EPC-010	2	more	5	125%	na	cg	G	na	more(nd)
EPC-011	2	na	-9	-47%	na	cg	nk	na	less(nd)
EPC-012	2	na	50	33%	4	cg/cg	G, P, N	na	more(nd)
EPC-016	2	na	288	800%	18	cg/cg	G, P	na	more
EPC-017	2	na	75	60%	20	cg/cg	G, P, N	na	more(nd)
EPC-106	2	55	-80	-50%	4	cg/cg	G, P	-12055	less
EPC-096	2	80	-32.5	-8%	17.9	cg/cg	G	-4955	less
EPC-085	2	130	-22	-8%	12	cg/cg	P	-3430	less
EPC-090	2	200	-20	-11%	8.5	cg/cg	P	-3200	less
EPL-055	1	-50	-5	-17%	10	ar/cg	EB, Ru	-700	less
EPC-100	1	-20	4	10%	5.5	cg/cg	G, P	-580	less
EPL-056	3	550	0	0%	10	cg/cg	Poor seed	-500	less
EPC-109	2	90	0	0%	9	cg/cg	G, P	-90	more
EPC-065	2	10	0	0%	7	cg/cg	G, P	-10	less
EPC-038	2	50	1	2%	8.8	cg/cg	G, P	100	more
EPC-053	2	-150	0	0%	na	cg	G, P, LB	150	more
EPC-035	2	300	3.5	11%	6.9	cg/cg	G, P, LB	225	more
EPL-012	2	500	678	7%	11300	kg/ha	Mi	500	more
EPC-095	2	70	5	5%	11.5	cg/cg	G, P	680	more
EPL-042	1	-200	2	20%	36.4	bo/ha	Erwinia	830	more
EPC-040	2	150	7	18%	4.7	cg/cg	G,P	900	more
EPL-010	1	-700	0	0%	98	bo/ha	N, V, F, M	940	more
EPC-057	2	0	7.5	10%	5.5	cg/cg	G, P	1125	more
EPC-082	2	55	10	8%	13	cg/cg	P	1445	more
EPC-005	2	0	10	25%	na	cg	G, P	1500	more
EPL-036	1	-150	5	25%	100	bo/ha	F, M, N	1500	more
EPL-063	1	-100	5	13%	90	bo/ha	LB	1540	more
EPC-076	2	70	12	20%	12	cg/cg	P	1730	more
EPC-087	2	35	12	20%	6	cg/cg	P	1765	more
EPC-066	2	30	12	33%	8	cg/cg	P	1770	more
EPC-067	2	20	12	21%	8.5	cg/cg	G, P	1780	more
EPC-014	2	200	15	33%	na	cg	G, P	2050	more
EPL-011	2	-875	50	50%	150	bo/ha	EB, M, Ve, F, R	2125	more
EPC-052	2	80	15	60%	8	cg/cg	G, P, N	2170	more
EPC-047	2	25	15	11%	15	cg/cg	G, P	2225	more
EPC-051	2	10	15	31%	10.5	cg/cg	G, P	2240	more

Farmer code	Well-being	Production cost change (Bs)	Harvest y2-y1 (cg)	Harvest change % y1	Yield y2	Harvest + yield units	pests	Net income gain (Bs)	Net income type
EPC-081	2	80	16	25%	10	cg/cg	P	2320	more
EPC-072	2	50	16	29%	9	cg/cg	G	2350	more
EPC-032	2	20	16	18%	13	cg/cg	G, P, R	2380	more
EPC-018	2	0	16	40%	7	bo/bo	G, P, N	2400	more
EPC-049	2	160	20	na	na	na	P	2840	more
EPC-084	2	90	20	17%	14	cg/cg	LB	2910	more
EPC-045	2	60	20	33%	8	cg/cg	P	2940	more
EPC-061	2	50	20	20%	12	cg/cg	G, P	2950	more
EPC-139	3	-242	20	15%	15	cg/cg	P	3242	more
EPC-103	2	-350	20	8%	14	cg/cg	G	3350	more
EPC-048	2	90	24	67%	10	cg/cg	G	3510	more
EPC-089	2	80	24	50%	9	cg/cg	P	3520	more
EPC-071	2	75	24	38%	11	cg/cg	P	3525	more
EPC-094	1	75	24	100%	6	cg/cg	G, P	3525	more
EPC-054	2	56	24	133%	7	cg/cg	G, P	3544	more
EPC-098	1	20	24	150%	5	cg/cg	G, P	3580	more
EPC-060	1	40	25	125%	9	cg/cg	G, P	3710	more
EPC-056	2	160	na	na	na	na	G	3840	more
EPC-007	2	0	26	18%	na	cg	G, P	3900	more
EPC-028	2	10	27	39%	6.4	cg/cg	G	4040	more
EPC-108	1	30	28.9	29%	11.6	cg/cg	G	4300	more
EPC-064	2	90	30	60%	8	cg/cg	G	4410	more
EPC-079	2	70	30	33%	12	cg/cg	G	4430	more
EPC-088	2	70	30	29%	9	cg/cg	G	4430	more
EPC-092	2	60	30	60%	8	cg/cg	G	4440	more
EPC-073	2	15	32	57%	11	cg/cg	P, N	4785	more
EPC-030	2	120	16	27%	7.6	cg/cg	P	5130	more
EPC-075	2	80	36	50%	9	cg/cg	G	5320	more
EPC-091	2	15	36	90%	9.5	cg/cg	G, P	5385	more
EPC-083	2	70	37.5	36%	9.5	cg/cg	P	5555	more
EPC-070	2	75	40	67%	10	cg/cg	G, N	5925	more
EPC-104	2	70	40	125%	9	cg/cg	G, P	5930	more
EPC-077	2	40	42	78%	8	cg/cg	G, P	6260	more
EPC-078	2	75	48	80%	9	cg/cg	P	7125	more
EPC-105	2	110	50	71%	6	cg/cg	G, P	7390	more
EPC-050	2	40	50	100%	10	cg/cg	G, P	7460	more
EPC-046	2	-20	50	42%	17	cg/cg	G, P	7520	more
EPL-027	1	-250	27.5	122%	200	bo/ha	LB	7675	more
EPC-031	2	50	53	50%	10.5	cg/cg	G	7750	more
EPL-029	3	-2100	35	18%	225	bo/ha	F, V, EB,	8085	more

Farmer code	Well-being	Production cost change (Bs)	Harvest Y2-Y1 (cg)	Harvest change % Y1	Yield Y2	Harvest + yield units	Pests	Net income gain (Bs)	Net income type
							Ru		
EPC-013	2	400	60	300%	4	cg/cg	G, P	8600	more
EPC-107	2	160	60	44%	13	cg/cg	G	8840	more
EPC-086	2	120	60	50%	12	cg/cg	P	8880	more
EPL-052	1	0	29	15%	76.3	bo/ha	N	8932	more
EPC-020	2	40	10	7%	7.5	cg/cg	G	8960	more
EPC-034	2	330	31	96%	5.2	cg/cg	G	8970	more
EPC-069	2	20	72	113%	17	cg/cg	G	10780	more
EPC-074	2	100	30	22%	11	cg/cg	G	10850	more
EPC-058	2	65	75	125%	13.5	cg/cg	G, P	11185	more
EPC-059	2	750	80	29%	9	cg/cg	G, P	11250	more
EPC-112	2	710	80	31%	17	cg/cg	G, P	11290	more
EPC-093	3	600	80	17%	14	cg/cg	G	11400	more
EPL-047	2	550	60	80%	135	bo/ha	EB, F, V	12140	more
EPC-080	2	355	90	129%	16	cg/cg	P	13145	more
EPC-037	2	180	90	29%	22.5	cg/cg	G, P	13320	more
EPC-102	2	230	100	50%	15	cg/cg	G, P	14770	more
EPC-099	2	-30	120	53%	23	cg/cg	G, P, ND	18030	more
EPC-062	2	20	127	61%	14.5	cg/cg	G, P	19030	more
EPC-025	2	200	130	186%	10	cg/cg	G	19300	more
EPC-110	3	85	130	28%	14.8	cg/cg	G, P	19415	more
EPC-029	2	50	130	87%	9.3	cg/cg	G	19450	more
EPC-097	2	180	142.5	95%	19.5	cg/cg	P, LB	21195	more
EPC-101	2	1080	210	41%	24	cg/cg	P	30420	more
EPS-006	3	2800	200	133%	175	bo/ha	nk	42200	more

Well being: 1 (low, poor); 2 (medium, moderately well-off); 3 (high, wealthy/non-poor). Bs – bolivianos (US$1 = 7Bs); NA – not available; NK – not known; ND – no data. CG – carga (bag of ca. 100kgs); YIELD expressed in bags harvested per bag planted for year 2 (after recommendation received); arrobas per bag ar/cg; sack per hectare bo/ha; kilograms per hectare kg/ha. Pests: G – gorgojo (weevil); P – polilla (tuber moth); N – nematodes; EB/LB early or late blight; F - ; V - ; Ru – Russelliana, mite damage; Ve – Verticillium; M - .

Annex 6

Tomato queries: production cost, harvest and net income changes after receiving a recommendation from a clinic

These data contrast conditions before (year 1) and after (year 2) receiving a recommendation from a clinic. All of the 25 farmers interviewed were from the Valleys of Santa Cruz. Two farmers planted tomato in year 2 only so the sample size for comparing before and after recommendations is only 23 farmers. The majority were able to recall production costs and harvests. A few said they had profited from adopting the recommendation but could not say by how much or could not recall production costs. Although absolute net income gains cannot be calculated where data is missing, the type of change can usually be given.

Harvests are measured in cajas, a box containing around 17 kg. A carga is around 100 kg and an arroba is about 11 kg. Yields have been calculated for year 2 only using the harvest units quoted by farmers. Areas planted varied from 0.25 – 1 ha and stayed constant. Two farmers gave number of rows planted and yields cannot be calculated.

Pests and diseases of tomato reduce quality of produce for sale as well as yields. Market prices also vary because of competition between buyers and for other reasons unrelated to quality. Net income gains were compared using a) prices at time of harvest in year 1 and year 2, known as full gain, and b) year 1 price for both harvests. This shows the contribution of changing prices to farmer profit and loss. Further investigation is needed of why market price varies.

Net income gains only apply to one year of using the recommendations. Tomatoes are attacked by a large range of pests and diseases, many of which cause major losses. Several growers reported more than one problem. Wilts and blights were the most frequent causes of losses and reduced quality, revealing the scope for dramatic improvements in net income gains once successful management is introduced.

Adopters of recommendations (25 farmers)

FARMER CODE	WELL-BEING	PESTS	PRODUCTION COST CHANGE (BS)	HARVEST CHANGE Y2-Y1	HARVEST CHANGE %Y1	YIELD Y2	HARVEST + YIELD UNITS	NET INCOME GAIN FULL (BS)	NET INCOME Y1 (BS)	NET INCOME TYPE
EPL-023	1	Vi	-250	100	20%	1200	caja	-750	5250	pos
EPL-061	2	LB	-200	nd	na	1200	caja	200	na	pos
EPN-004	2	Po, Wf	na	30	25%	na	caja	900	na	pos
EPL-019	2	EB	0	100	8%	1733	caja	4500	4500	pos
EPN-005	2	LB, Po	na	120	25%	na	caja	4800	na	pos
EPS-001	3	GV, Fu, Ba, Mi, Mg	1000	150	50%	1800	caja	5000	5000	pos
EPL-018	2	EB, Ts	-700	150	10%	1650	caja	5950	5950	pos
EPS-004	1	ST	-700	270	20%	1620	arroba	7450	7450	pos
EPL-002	2	EB, Vt, Fu, Ru	-1000	200	14%	1600	caja	8000	8000	pos
EPL-039	1	PN	0	100	20%	600	caja	9500	3500	pos
EPS-002	3	Fu	-2000	200	13%	1800	caja	10000	10000	pos
EPL-020	1	Ts	300	250	45%	1600	caja	10950	10950	pos
EPL-033	2	Ne, Fx, Vt	-250	15	12%	140	carga	12738	3288	pos
EPL-048	1	Po	-1050	200	50%	na	caja	12850	2650	pos
EPL-008b	1	Mi	-210	125	21%	1450	caja	17898	5210	pos
EPL-046	3	Fu	-1400	800	80%	1800	caja	21400	21400	pos
EPS-007	3	Ba	-9100	400	36%	na	caja	25100	25100	pos
EPS-003	1	Fu	-2100	600	48%	1850	caja	26100	20100	pos
EPL-009	2	Ts	2800	653	60%	1739	caja	34180	16790	pos
EPN-002	1	EB, Ba	1200	1200	67%	10000	caja	34800	34800	pos
EPL-028	2	Fu	-3500	443	33%	1770	caja	46644	15669	pos
EPL-049	3	Po	-700	4800	400%	na	caja	381100	39100	pos
EPL-051	1	Ba	na	new	new	na	caja	new	new	new
EPL-050	2	EB	na	new	new	810	caja	new	new	new

WELL BEING: 1 (low, poor); 2 (medium, moderately well-off); 3 (high, wealthy/non-poor). Bs – bolivianos (US$1 = 7Bs); NA – not available; NK – not known; ND – no data.; YIELD expressed in designated units for year 2 (after recommendation received).

PESTS: Ba: 'bacteriosis' – either bacterial wilt of bacterial blight; EB: early blight (*pasmo amarillo*); Fu: Fusarium (wilt); Fx: Fusarium oxysporum (wilt); GV: geminivirus; LB: late blight (*pasmo negro*); Mg: Meloidogyne (nematodes); Mi: mites (includes *acaro blanco*); Ne: nematodes; Po: moth (?Helicoverpa – *polilla*); Ru: Russelliana (mites); ST: seed streatment (unknown); Ts: tomato spotted wilt virus TSWV or *peste negra*; Vi: virus (not specified); Vt: Verticillium (wilt); Wf: white fly (*mosca blanco*)

Annex 7

Strawberry queries: production cost, harvest and net income changes after receiving a recommendation from a clinic

These data contrast conditions before (year 1) and after (year 2) receiving a recommendation from a clinic. All of the 18 farmers interviewed were from the Valleys of Santa Cruz. The majority were able to recall production costs and harvests. A few said they had profited from adopting the recommendation but could not say by how much or could not recall production costs. Although absolute net income gains cannot be calculated where data is missing, the type of change can usually be given.

Strawberries are harvested weekly for eight months, or 32 separate collections and sales. Yields have been calculated for year 2 only using the harvest units quoted by farmers. Areas planted varied from 0.25 – 1 ha and stayed constant. Pests and diseases of strawberry reduce quality of produce for sale as well as yields. Market prices also vary because of competition between buyers and for other reasons unrelated to quality. Net income gains were compared using a) prices at time of harvest in year 1 and year 2, known as full gain, and b) year 1 price for both harvests. This shows the contribution of changing prices to farmer profit and loss. Further investigation is needed of why market price varies. Net income gains only apply to one year of using the recommendations.

Strawberries are attacked by a several key pests and diseases, and major losses occur. Several growers reported more than one problem. Thrip damage and Phytophthora root disease caused much damage prior to going to the clinic. Successful management, once established, delivers big gains to farmers.

Adopters of recommendations (18 farmers)

Farmer code	Well-being	Pests	Production cost change (Bs)	Harvest change kgs Y2-Y1	Harvest change %Y1	Yield Y2, kg/ha	Net income gain full (Bs)	Net income Y1 (Bs)	Net income type
EPL-008a	1	Wf	-100	1152	43%	na	10852	7012	pos
EPL-066	3	In	-1400	1536	25%	15360	13688	13688	pos
EPL-024	1	Mi, Th	-150	1152	100%	6982	13974	4758	pos
EPL-064	1	Fg, Th	0	384	11%	15360	2304	2304	pos
EPL-059	2	Ph, Th	0	384	14%	12288	2688	1152	pos
EPL-016	1	Ph	-200	1536	20%	18432	33992	6344	pos
EPL-038	1	Th	-150	2304	17%	21504	37014	12822	pos
EPL-014	1	Ph	600	3840	56%	21504	37032	26280	pos
EPL-015	1	Fu	1000	1536	22%	16896	37400	3608	pos
EPL-041	1	Th	-100	2688	21%	15360	39268	16228	pos
EPL-017	2	Th	-1000	1536	17%	21504	39400	7144	pos
EPL-044	1	In	-1050	3072	36%	23040	49818	21018	pos
EPL-045	1	Bo, M	0	576	50%	5236	5760	2304	pos
EPL-034	1	Th	-50	576	60%	4655	6482	2642	pos
EPL-057	3	LSF	700	5760	33%	23040	68420	22340	pos
EPL-058	3	Ph	1500	9984	186%	20480	73764	58404	pos
EPL-003	1	Fg	-300	9216	20%	46080	na	na	pos (nd)
EPV-011	1	Th, N	0	0	0%	na	na	na	none

Well being: 1 (low, poor); 2 (medium, moderately well-off); 3 (high, wealthy/non-poor). Bs – bolivianos (US$1 = 7Bs); na – not available; nk – not known; nd – no data.; yield expressed in designated units for year 2 (after recommendation received).

Pests: Bo: Botrytis; Fg: fungi (unspecified); Fu: Fusarium (soil fungus); In: bugs or insects (bichos); LSF: Low soil fertility; Mi: Mites; Ne: Nematodes; Ph: Phytophthora or red crown disease (*corona roja*); Th: thrips; Vi: viruela'; Wf: whitefly (*mosca blanco*)

Annex 8

Peach queries: production cost, harvest and net income changes after receiving a recommendation from a clinic

These data contrast conditions before (year 1) and after (year 2) receiving a recommendation from a clinic. All of the 14 farmers interviewed were from the Valleys of Santa Cruz and three did not adopt advice. The majority were able to recall production costs and harvests. A few said they had profited from adopting the recommendation but could not say by how much or could not recall production costs. For some it was possible to say the general trend type of change that occurred (more, less, none). Yields have been calculated for year 2 only using the harvest units quoted by farmers. Farmers quoted the number of trees they harvested and number of fruits obtained. Indirect data suggested that there were around 600 trees per hectare on one farm, though spacing will vary.

Pests and diseases of peach reduce quality of produce for sale as well as yields. Market prices also vary because of competition between buyers and for other reasons unrelated to quality. Net income gains were compared using a) prices at time of harvest in year 1 and year 2, known as full gain, and b) year 1 price for both harvests. This shows the contribution of changing prices to farmer profit and loss. Further investigation is needed of why market price varies.

Net income gains only apply to one year of using the recommendations. Peach trees are attacked by a several key pests and diseases, and major losses can occur in yields and qualtiy of fruit. Several growers reported more than one problem. Leaf curl, aphid attack, brown rot and powdery mildew are common problems.

Non-adopters of recommendations (3 farmers)

FARMER CODE	WELL-BEING	PESTS	PROD. COST CHANGE (BS)	HARVEST CHANGE	HARVEST CHANGE %Y1	YIELD Y2	NET INCOME CHANGE FULL (BS)	NET INCOME CHANGE Y1 (BS)	NET INCOME TYPE
EPV-007	2	Tz	0	0	0	na	0	na	none
EPV-008	1	nd	0	0	0	na	0	na	none
EPV-012	1	LC, PM	0	0	0	na	0	na	none

Adopters of recommendations (11 farmers)

FARMER CODE	WELL-BEING	PESTS	PROD. COST CHANGE (BS)	HARVEST CHANGE	HARVEST CHANGE %Y1	YIELD Y2	NET INCOME CHANGE FULL (BS)	NET INCOME CHANGE Y1 (BS)	NET INCOME TYPE
EPL-026	1	Ne, Fu, Mi	-250	315	71%	6	41200	22300	pos
EPL-035	1	CG	-75	20	25%	2.5	1275	1275	pos
EPL-037	1	FF	-25	45	100%	3	1375	1375	pos
EPV-001	2	LC, Ap	300	2800	100%	2	139700	139700	pos
EPV-002	2	BR	300	150	100%	0.75	16200	16200	pos
EPV-003	3	nd	2000	50	33%	0.25	5000	1000	pos
EPV-004	3	Mi	300	980	na	3.5	48700	-300	pos
EPV-005	3	LC	300	-1200	-67%	1	na	na	na
EPV-006	2	Ap	-175	415	8300%	6	33525	20925	pos
EPV-009	3	CG	600	1748	1748%	3.5	86800	86800	pos
EPV-013	1	PM	-900	500	167%	na	40900	40900	pos

WELL BEING: 1 (low, poor); 2 (medium, moderately well-off); 3 (high, wealthy/non-poor). BS – bolivianos (US$1 = 7BS); NA – not available; NK – not known; ND – no data.; YIELD: fruit harvested per tree in year 2.

PESTS: Ap: aphid; BR: brown rot; CG: crown gall; FF: fruit fly; Fu: Fusarium; LC: leaf curl (*torque*); PM: powdery mildew; Mi: mites; Ne: nematodes; Tz: rust (‘*Transzchelia*’)

Annex 9

Citrus queries: production cost, harvest and net income changes after receiving a recommendation from a clinic

These data contrast conditions before (year 1) and after (year 2) receiving a recommendation from a clinic. All of the 14 farmers interviewed were from the Valleys of Santa Cruz and three did not adopt advice. The majority were able to recall production costs and harvests. A few said they had profited from adopting the recommendation but could not say by how much or could not recall production costs. For some it was possible to say the general trend type of change that occurred (more, less, none). Yields have been calculated for year 2 only using the harvest units quoted by farmers. Farmers quoted the number of trees they harvested. Indirect data suggested that there were around 600 trees per hectare on one farm, though spacing will vary.

Pests and diseases of peach reduce quality of produce for sale as well as yields. Market prices also vary because of competition between buyers and for other reasons unrelated to quality. Net income gains were compared using a) prices at time of harvest in year 1 and year 2, known as full gain, and b) year 1 price for both harvests. This shows the contribution of changing prices to farmer profit and loss. Further investigation is needed of why market price varies.

Net income gains only apply to one year of using the recommendations. Peach trees are attacked by a several key pests and diseases, and major losses can occur in yields and qualtiy of fruit. Several growers reported more than one problem. Leaf curl, aphid attack, brown rot and powdery mildew are common problems.

Non-adopters of recommendations (2 farmers)

Farmer code	Well-being	Pests	Prod, cost change (Bs)	Harvest change Y2-Y1	Harvest change %Y1	Yield Y2	Net income gain full (Bs)	Net income Y1 (Bs)	Net income type
EPC-121	2	RR	85	nd	nd	na	na	na	neg
EPC-128	2	SM	0	nd	nd	na	na	na	none

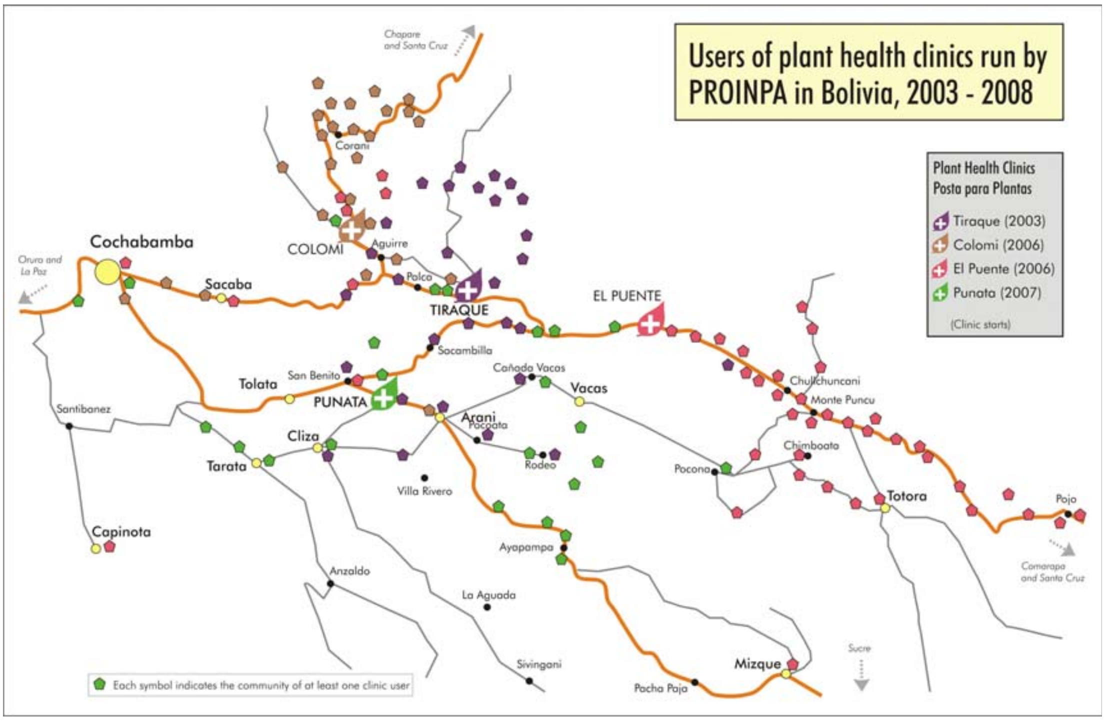
Adopters of recommendations (11 farmers)

FARMER CODE	WELL-BEING	PESTS	PROD. COST CHANGE (BS)	HARVEST CHANGE Y2-Y1	HARVEST CHANGE %Y1	YIELD Y2	NET INCOME GAIN FULL (BS)	NET INCOME Y1 (BS)	NET INCOME TYPE
EPC-132	2	Gu	105	-6000	-20%	12000	-285	-1005	neg
EPC-120	3	Ap, Gu	120	0	0%	na	180	-120	
EPC-118	2	In	150	2000	11%	20000	190	190	pos
EPC-125	2	Gu	240	3000	20%	na	210	210	pos
EPC-123	2	Ap	70	2000	14%	na	750	270	pos
EPC-124	2	ND, Lv	350	4000	20%	na	850	370	pos
EPC-126	3	Ap	280	6000	50%	na	1160	800	pos
EPC-129	2	Ce	130	4000	20%	8000	1310	590	none
EPC-122	2	FR, CR	80	nd	nd	na	1920	na	pos
EPC-131	3	Gu, Ce	800	8000	10%	22000	4800	400	pos
EPC-115	3	Gu, Ce, Ps	180	nd	nd	na	4820*	na	pos

WELL BEING: 1 (low, poor); 2 (medium, moderately well-off); 3 (high, wealthy/non-poor). Bs – bolivianos (US$1 = 7Bs); NA – not available; NK – not known; ND – no data.; YIELD: fruit harvested per tree in year 2.

PESTS: Ap: aphids; Ce: chicken-eye (fungal leaf spot); CR: collar rot (Phytophthora?); FR: foot rot (not sure how this is different from CR – also Phytophthora?); Gu: gummosis (probably Phytophthora); In: insects (not specified); Lv: larvae (not specified); ND: nutrient deficiency; Ps: pasmo (possibly mildew?); RR: root rot (similar to collar and foot rot?); SM: sooty mould (usually associated with aphid attacks)

* data from original JB report.



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