Net income change obtained by farmers following advice received from plant health clinics

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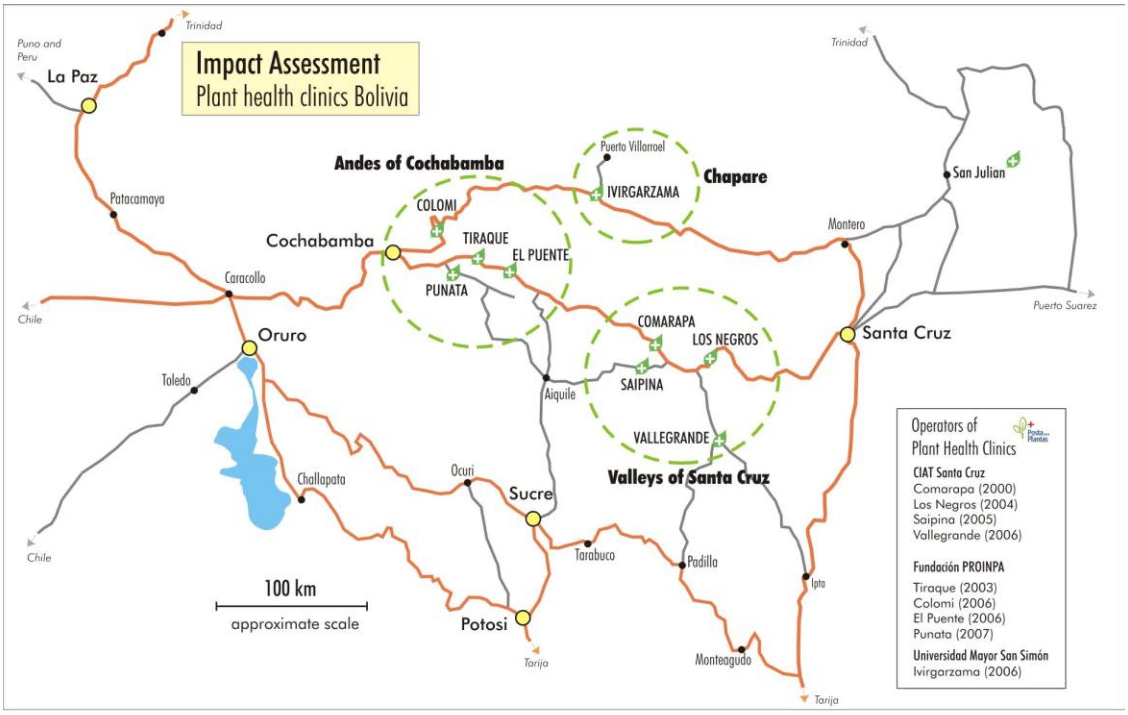
Background

Nine plant health clinics operate independently in three agro-ecological regions of Bolivia: the Andes of Cochabamba, the humid tropics of the Chapare and the temperate valleys of Santa Cruz (see map). One clinic began in 2000 and the others between 2003 and 2006. By early 2009 nearly 7000 farmers had made over 9000 visits to nine clinics, to seek advice on plant health problems. Farmers presented problems affecting 78 crops. The main crops consulted included potato, peach, tomato and citrus fruits.



The plant clinics were established with the assistance of the Global Plant Clinic (GPC)[1], which is managed by CABI with support from the UK Department for International Development[2]. The clinics are operated by three Bolivian organisations[3]. Since 2003 the GPC has trained plant doctors and laboratory diagnosticians, confirmed new plant diseases, supervised and monitored clinic operations and nurtured the expansion of the clinic network. The successes of the Bolivian plant clinics are due to the diligence of Bolivian plant doctors and technical support staff, coupled with a sympathetic and comprehensive knowledge of farmers and their agricultural practices.

[1] The GPC is an alliance of organisations that help farmers manage plant health problems in Latin America, Africa and Asia. The GPC trains plant doctors, helps establish clinics, does research on plant healthcare systems and provides an expert diagnostic service.

[2] The opinions expressed here do not necessarily reflect those of DFID.

[3] CIAT Santa Cruz operates in the valleys of Santa Cruz; PROINPA in the Andes of Cochabamba; and Universidad Mayor San Simón in the Chapare.

This short report presents key results from the first impact assessment of clinics in Bolivia carried out in July 2009. The main indicator measured was net income from a crop before and after receiving advice from a clinic. Net income change is the difference between the two harvests.

In July 2009, Bentley of the Global Plant Clinic and Bolivian partners interviewed 238 Bolivian farmers who had consulted a plant health clinic at least once from the three regions where nine clinics operate (Table 1 and map). The interviewers were insiders, local agronomists well-versed in local crops and vernaculars, and able to interpret farmers' statements accurately.

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

	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 (n=9195)	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 m and higher, rainfall about 500 mm with little irrigation. Dry, cool and sunny	Altitudes of below 300 m, with rainfall nearly 6000 mm in places. Humid tropics	Altitudes of 1500 to 2500 m, 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

The clinic in Comarapa opened in 2000. Other clinics started between 2003 and 2006.

Farmer follow-up

Most of the farmers interviewed were men (91%), although there were slight regional differences (Table 2). The proportion of women using clinics before 2009 is not known, but is estimated at no more than 10% and similar to the gender balance of the study group. Three categories of well-being were defined and the percentage of all interviewees is shown in brackets: poor (24%); medium (63%); and not-poor (13%). Interviewees were asked how they knew about the clinics. In the Andes farmers came across clinics in public places, for example in a weekly fair; in the Chapare radio announcements were most important; in the Valleys of Santa Cruz users learned of clinics from television, friends and radio in equal measure.

The sample was opportunistic and the surveyors interviewed every clinic user they could find in visits to 96 communities in nine municipalities. This increased sample size at the possible expense of unintended bias towards farmers who spend more time near home, for example.

What we measured

Earning more money as a result of a clinic recommendation is a good indication that peoples' lives will improve[4]. In addition to measuring net income change, information was obtained on other benefits of clinics (e.g. reduction in pesticide use). These other indicators of impact will be discussed in an expanded report.

The interviews recorded crop data before and after receiving a recommendation from a clinic and noted those who adopted the advice. Adoption rates were high, with 86% of interviewees applying the advice given by the

[4] The interviewers did not ask how farmers spent extra money they earned from better control of plant health problems. This question was included in a second impact assessment of clinic users in Bangladesh.

plant doctors. Farmers were asked about area of land planted, plant protection costs (e.g. pesticides and other treatments), size of harvests and prices obtained in markets. Estimates of costs and benefits were made on a per hectare basis.

The interviewers asked the farmers for information from two years; the year when they first used the recommendation and the previous year. The study systematically under-estimated impacts, using low farm-gate prices, and only attributing one year of benefits to farmers, even though most had enjoyed several years of greater returns.

Table 2 Number of interviewees by gender, clinic and region

REGION	CLINIC	MEN	WOMEN	TOTAL
ANDES	El Puente	4		4
	Colomi	10		10
	Punata	1		1
	Tiraque	96	3	99
	Total	**111**	**3**	**114**
VALLEYS OF SANTA CRUZ	Comarapa	56	8	64
	Los Negros	5		5
	Saipina	10	2	12
	Vallegrande	12	4	16
	Total	**83**	**6**	**89**
CHAPARE	Ivirgarzama	23	4	27
	Grand Total	**217**	**21**	**238**

Potato yields varied greatly, reflecting the diversity of smallholder farming in the high Andes, with its patchwork of micro-environments. Yield data for other crops showed similar variation because of diverse growing conditions and farming practices. Mean net income change was calculated using a statistical technique known as 'bootstrapping', to reduce the distorting effect of large outliers in data sets.

Counterfactual and assumptions

The counterfactual for this impact assessment – what would have happened if the farmer had not got advice from a clinic – is the net income farmers earned for a crop before the visit to a clinic.

Most of the differences observed, the greater harvests, were attributed to improvements in pest management that unlocked the crops' potential. Farmers were not making any other great changes (e.g. with fertilizers or irrigation) over the study period which would have boosted yields. The interviewers were insiders who knew many of the farmers in this study personally and had good knowledge of local farming practices.

Although a counterfactual to account for seasonal variation in crop yields is not available, three facts give us confidence that changes in yield are a result of using recommendations: 1) data were not all from the same pairs of years and positive seasonal effects on yields are expected to balance negative ones; 2) farmers were confident in attributing changes to use of recommendations; 3) the net income change for non-adopters of advice on potato problems was much smaller than for adopters of advice (Table 5).

Changes in labour costs were not included in the calculations, but other observations indicate that these rarely change when adopting recommendations. It takes the same amount of labour to apply a less-toxic chemical as to apply a highly toxic one. The cultural controls for the Andean potato weevil (e.g. digging up a few small areas of the field) took only a few minutes each to apply and were offset by lower labour costs for sorting tubers and discarding rotten ones.

As noted above, we do not know how farming conditions varied from year to year, and lack reliable data on pest and disease pressure in different years. However, all the key problems noted in Table 4 are endemic pests and diseases that have been present for many years. The problems presented by farmers at the clinics attack host crops each year. Tuber moth and potato weevil on potato are constant threats while strawberry, tomato and peach are regularly attacked by a damaging cocktail of pests and diseases.

Results and Conclusions

Farmers who consulted a clinic benefited with improved harvests, and often with lower plant protection production costs. Some farmers spent more on plant protection though the vast majority still showed net income increases after adopting a recommendation.

The farmers interviewed consulted the clinics on 21 different crops, especially potato but also tomato, strawberry, peach, citrus, peach palm, bell pepper and pea. Most crops were only grown in one region (Table 1), because of differences in altitude and ecology. The main crops consulted by farmers at all clinics up to 2009 occurred with a similar frequency in the crops consulted by interviewees, with the exception of strawberry (Table 3). In other words, impact data was collected from crops representative of all clinic users up to 2009.

Table 3 Main crop consulted by 238 interviewees by region compared to all clinic queries up to 2009

Crop	Andes (# queries)	Chapare (# queries)	Valleys (# queries)	% of queries by all interviewees	% of queries at all clinics to 2009
Potato	114		17	54.2	69.7
Tomato			24	8.8	4.3
Strawberry*			18	7.6	0.2
Peach			14	5.9	4.3
Citrus (orange, mandarin) **		15		4.6	1.3
Peach palm		6		2.5	0.4
Bell pepper			5	2.1	2.4
Pea			5	2.1	0.4
Other crops (1 or 2 queries)	1	6	13		
Total	**115**	**27**	**96**		n=6815

* The number of farmers interviewed who consulted on strawberry apparently exceeds all strawberry queries at clinics up to 2009 (as shown in Bolivia paper in Food Security). However, more strawberry queries were received than were shown in this paper ** Citrus is a more important crop in the Chapare than indicated by the number of queries received at all clinics up to 2009.

Some farmers interviewed brought several crops to the clinic, or came several times (Table 4). Even so, the interviewers only collected data on one crop per interviewee, concentrating on the most valuable crop in order to increase sample sizes and permit better comparison of results. Complete data required to calculated net income change were obtained from 176 farmers for potato, tomato, strawberry, peach and citrus. Of these farmers, 41% asked for advice on crops with more than one problem. The data from the other 62 farmers interviewed were either incomplete or from crops with six or fewer queries and are not analysed here.

Table 4 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	TYPES OF PLANT 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.

There were 48 different problems consulted on potato, tomato, strawberry, peach and citrus. Most problems had a biotic cause (pests and diseases), and key examples are given in Table 4. The percentage of queries that farmers presented with problems that were high impact (capable of causing significant yield losses) is given in Table 5, and is a general indication of the potential extent of damage that farmers face. High impact is used here with the implicit meaning that such problems can be treated in one growing season. 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. A few serious and damaging problems on citrus could not be resolved in one year.

Table 5 Potato: mean net income change for adopters and non-adopters of clinic advice

CROP	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 all potato farmers interviewed was 1.34 ha and the standard error was 0.09

Potato and tomato crops faced the greatest threat from pests and diseases, with 95% and 94% of problems classified as high impact. Solutions were available which, if applied, could significantly reduce those losses in the current growing season. Yet farmers either did not know about alternative management options or were using ineffective control measures prior to visiting the clinic. Although only 75% of problems were high impact on strawberry and peach, diseases such as tomato mildew and spider mite are capable of causing big losses. Citrus problems were less likely to show major improvements in yields, either because the pest had little effect on fruit production (e.g. aphids), trees were already suffering from root diseases that were systemic and beyond effective treatment (e.g. phytophthora root rots; new trees should be planted) or trees produced few fruits for because of general poor management (e.g. lack of pruning).

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.

The key impact results are shown in Tables 5, 6 and 7. Potato results are shown separately from the other four crops. Peach and citrus are not included in Table 7 because it was difficult to estimate areas planted from the number of trees that farmers reported that they owned. The range of mean net income gains per hectare are shown graphically in Figs 1 and 2.

Table 6 Mean change in net income after adopting clinic advice for four crops

CROP	TOMATO	STRAWBERRY	PEACH	CITRUS
Number of interviewees 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 7: Mean net income change by well-being status and crop consulted

MEAN NET INCOME CHANGE IN US$/HA AND STANDARD ERROR	WELL-BEING 1		WELL-BEING 2		WELL-BEING 3	
	POOREST	N	**MIDDLE GROUP**	N	**LEAST 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)	

Fig 1: Estimate of average change in net income per hectare of production

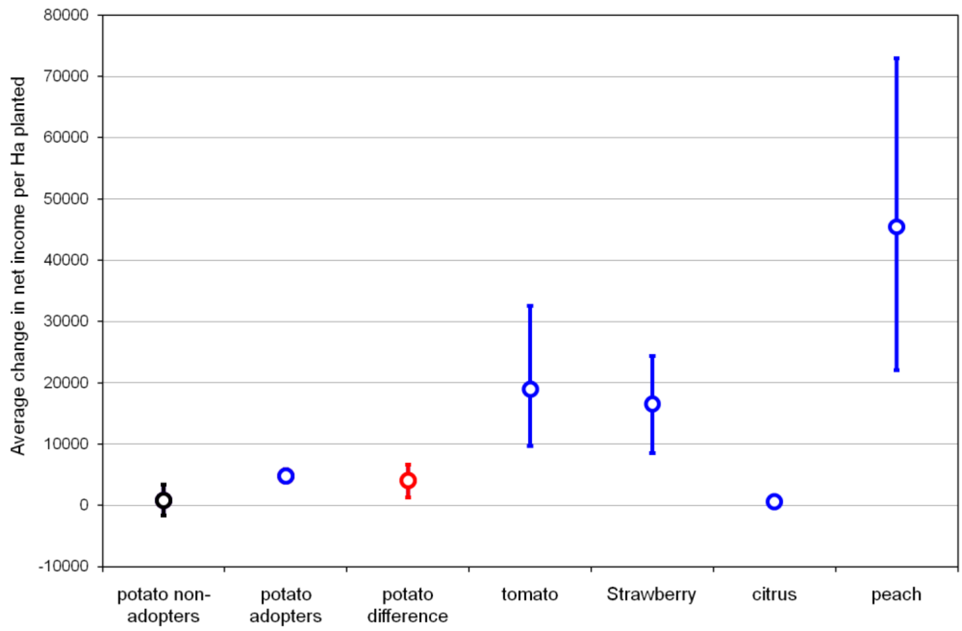
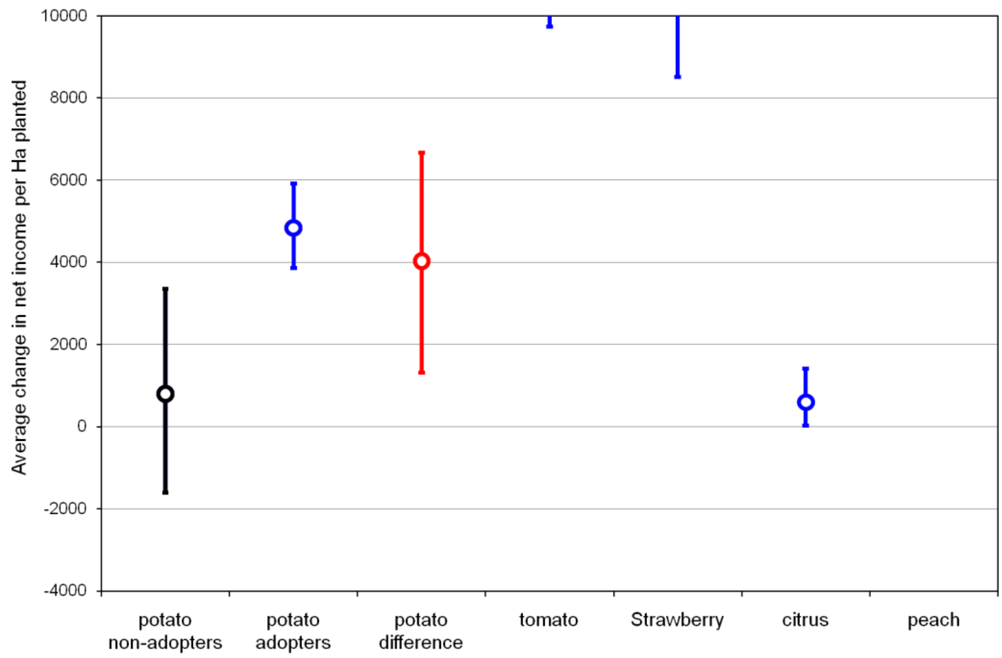


Fig 2: Estimate of average change in net income per hectare of production



Note that the graphs in Figs 1 and 2 contain the same data. The scale on the y axis in Fig 2 has been expanded to better show the range of means for potato

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 good quality 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.

APRIL 2010

Acknowledgements

This impact assessment was a major undertaking, with dedicated efforts by skilled interviewers in Bolivia and lengthy analysis and discussion of results. We wish to thank Fredy Almendras, Olivia Antezana, Oscar Díaz, Pablo Franco, Franz Ortiz, Sandra Muñoz, Henry Rodríguez, Jhon Ferrufino, Bertho Villarroel, Edwin Iquize for collecting data and Roy Macarthur of the Food and Environment Research Agency for statistical advice and analysis.

Dannie Romney and Solveig Danielsen of CABI reviewed drafts of this report and both plus Rob Reeder commented on drafts of the full impact assessment report from which this summary has been prepared.

Invaluable contributions to clinics in Bolivia have been made by Pablo Franco of CIAT and Javier Franco of PROINPA. They oversee clinic operations for their respective organisations.

Further information

Further information about Bolivia and clinics is available from www.jefferywbentley.com and www.research4development.info. For those interested in Bolivian plant clinics please see:

Bentley JW, Boa E, Danielsen S, Franco P, Antezana O, Villarroel B, Rodríguez H, Ferrrufino J, Franco J, Pereira R, Herbas J, Díaz O, Lino V, Villarroel J, Almendras F, Colque S, 2009. Plant Health Clinics in Bolivia 2000-2009: operations and preliminary results. *Food Security* 1, 371- 386

As explained earlier in this report, a full account of methods and other findings is available from the GPC, together with other publications about Bolivia and the GPC.

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