Obstacles and Opportunities for Diffusion of Integrated Pest Management Strategies Reported by Bolivian Small-Scale Farmers and Agronomists

Environmental Health Insights
Volume 11: 1–14

DOI: 10.1177/1178630217703390

Erik Jørs[1,2], Antonio Aramayo[3], Omar Huici[4], Flemming Konradsen[5,6] and Gabriel Gulis[2]

[1]Clinic of Occupational and Environmental Medicine, Odense University Hospital, Odense, Denmark. [2]Unit for Health Promotion Research, University of Southern Denmark, Esbjerg, Denmark. [3]Fundación PASOS, Sucre, Bolivia. [4]Fundación Plagbol, La Paz, Bolivia. [5]Department of Public Health, University of Copenhagen, Copenhagen, Denmark. [6]School of Global Health, University of Copenhagen, Copenhagen, Denmark.

ABSTRACT: Integrated pest management (IPM) with an increased used of ecological farming methods and less and safer use of pesticides offers solutions to reduce risks of developing pest resistance, human poisoning, and environmental pollution. Despite being promoted by Food and Agriculture Organization and others, it has not spread readily in low-income countries. This article presents the opinions of Bolivian farmers and agronomists on perceived obstacles and opportunities for a diffusion of IPM. Focus group discussions revealed an increased workload without certainty of higher yields or better prices for products grown with IPM compared with traditional agriculture being hindrances for a spread of IPM. Moreover, IPM requires some new practices not that easy to learn by farmers. In favor of IPM was an increasing awareness of the importance of a healthy and sustainable food production, easiness to try out without expensive investments needed, and a higher quality of the products. A healthy and sustainable agricultural production should be promoted by support to farmers through IPM training, a certification, and better prices. Finding allies to such a promotion is not easy, though, according to both farmers and agronomists.

KEYWORDS: Pesticides, IPM, spreading, diffusion of innovation

RECEIVED: November 29, 2016. **ACCEPTED:** February 13, 2017.

PEER REVIEW: Five peer reviewers contributed to the peer review report. Reviewers' reports totaled 669 words, excluding any confidential comments to the academic editor.

TYPE: Review

FUNDING: The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: The research was funded by the Clinic of Occupational Medicine Odense University Hospital and by the Civil Society in Development through Danish foreign aid.

DECLARATION OF CONFLICTING INTERESTS: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

CORRESPONDING AUTHOR: Erik Jørs, Clinic of Occupational and Environmental Medicine, Odense University Hospital, Sdr. Boulevard 29, 5000 Odense, Denmark.
Email: erik.joers@rsyd.dk

Introduction

Pesticides can reduce crop losses in farming, but improper use of pesticides can result in the development of pest resistance and have negative impacts on human health and the ecosystem.[1–5] To confront the negative effects, hundreds of thousands of farmers have been trained in integrated pest management (IPM) on Farmer Field School (FFS) by Food and Agriculture Organization (FAO), International Fund for Agricultural Development, and a range of others.[4–7] Integrated pest management is generally defined as farming methods where pesticides are used to a minimum without hampering the harvest. The training has most often been on specific crops and typically taken place during a growth season using interactive and locally adapted learning processes.[4–7]

Most case studies and reviews found significant positive effects of IPM training such as improved knowledge and adoption of good agricultural practices, increased use of ecological methods for pest control, reduction in the amount of pesticides used, and increase in the yields and profits,[4,6–9] whereas a few others did not find such positive effects over time.[10,11] Several surveys found positive health outcomes when farmers adopt IPM with fewer reports of symptoms of poisoning after pesticide handling,[12–15] whereas a recent comprehensive review showed no convincing evidence of positive health outcomes.[8]

Despite these mainly positive outcomes, IPM is not mainstreamed as could have been expected. One reason is the difficulties of diffusion of IPM knowledge from trained farmer to neighboring farmers where surveys have shown mixed results.[8,15–22] Possible explanations for the low diffusion rates of IPM are many, such as "a lack of local leadership," "no supporting policy for IPM diffusion," "insufficient training and technical support to farmers," "farmers' low level of education and literacy," "IPM too difficult to implement," "powerful influence of pesticide industry," "benefits of pesticides are much more apparent than their negative effects," "shortage of funding for IPM," and "IPM requires collective action within farming communities."[7,8,23–27] It is argued that IPM knowledge is too complicated to diffuse compared with traditional agriculture that tends to focus on simple messages and practices such as adoption of improved seeds and application of pesticides and fertilizers.[8,28,29]

Drivers for the seemingly ever-increasing pesticide use are many, eg, growing crops highly susceptible to pest attacks, monoculture on big fields, high pest incidences due to climate, development of pest resistance, aggressive marketing by pesticide companies, a growing informal market for discounted pesticides, lack of extension services, lack of knowledge of

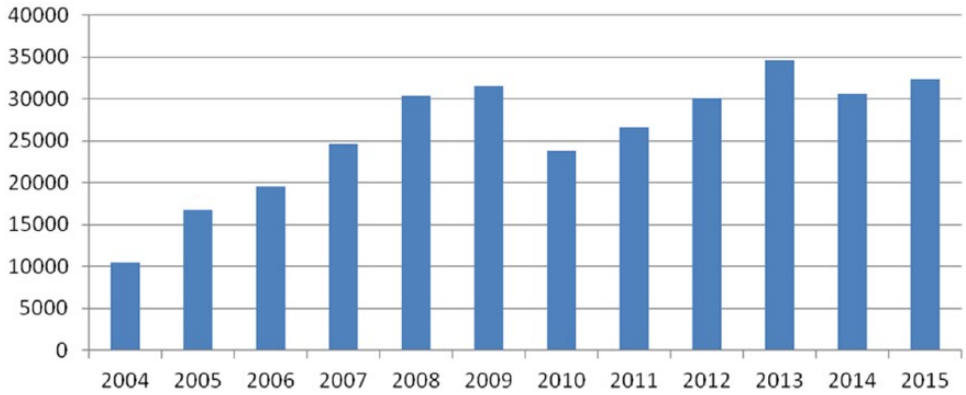

Figure 1. Tons of pesticides imported to Bolivia from 2004 to 2015. Adapted from SENASAG 2016.

alternative methods for pest control, and political priorities such as subsidies for pesticide use and loans for agricultural inputs tied to purchase and use of pesticides.[25,30–32]

The Bolivian context

Pesticides were introduced in Bolivia in the 1960s among big-scale farmers in the tropical areas with the implementation of the political plan "Colonization of the East" and were later taken up by small-scale farmers.[33,34] During the period 1990 to 2012, the import of agrochemical products multiplied in value from US $6.4 to US $185.1 million according to FAOSTAT (FAO statistical department).

The amounts of pesticides imported are seen from Figure 1.

Bolivia has shown the same picture as other low-income countries with the use of very toxic pesticides, inadequate use of personal protective equipment, and insufficient hygiene leading to frequent acute self-reported poisonings among farmers when handling pesticides.[35] Integrated pest management in Bolivian agriculture was introduced in the late 1990s through the International Potato Center and its partners focusing on research on potatoes and quinoa, with training and extension services in certain areas of Bolivia.[4,28,36]

From 2001 to 2013, the Bolivian nongovernmental organization Fundacion Plagbol promoted IPM by training smallholder farmers on alternative ecological farming methods to reduce the use of pesticides and to introduce the use of less toxic pesticides and an improved personal protection. The project also achieved a change in curriculums to mainstream IPM training in Bolivia's technical agricultural schools and at the faculties of agronomy.[34] The project facilitated a change in the policy of the Ministry of Agriculture from relying only on pesticides and having farmers trained by the pesticide industry to the actual focus on IPM training of smallholder farmers by the Ministry's operative branch National Service in Agricultural Health and Food Safety.[34]

The present survey explores the possibilities for IPM diffusion in Bolivia through focus group discussions (FGDs) with IPM farmers and agronomists. As a guide for the FGDs, the Rogers theory on "Diffusion of Innovations" was adapted.[37] This theory offers tools to describe how, why, and at what rate new ideas and technologies spread, including 4 elements of importance for a diffusion: the virtues of the innovation itself, the communication channels, a time factor, and the social system.

For this study, the theory was adapted to focus on IPM as the innovation and the possibilities to make alliances for the spreading of IPM.

Methods

Study area

Eleven farmers from villages in the municipalities of Caranavi (La Paz County) and Comarapa (Santa Cruz County) were included. First group consisted of coca and coffee farmers, the second group of vegetable farmers, and the third group of strawberry farmers. Two agronomists from the Faculty of Agronomy in La Paz and 3 from the Technical School of Agriculture in Caranavi took part in the study. In each group, some of the participants already knew each other, belonging to the same municipality or teaching institution.

The municipalities are located in the subtropical zone on the eastern slopes of the Andes Mountains in Bolivia and can be hard to access due to the mountainous areas and during the rainy season. Apart from the mentioned crops, a wide variety of subtropical crops are grown including maize, rice, and citrus fruits, among others.

Design

The study is based on the information gathered from 3 FGDs with farmers and 2 FGDs with agronomists. The Plagbol personnel invited participants with IPM experience from training and practice.

The FGDs were conducted by 2 agronomists—of whom one who was not part of the project but experienced in facilitating FGDs acted as facilitator in the discussions and the other recorded the discussions, observed and helped with practicalities. The FGDs took place in September and November 2013. The discussions were held in Spanish, tape-recorded, and shortly thereafter transcribed and systematized.

As we found that farmers often do not distinguish between IPM and ecological farming, this survey included farmers implementing only some IPM techniques as well as pure ecological farmers. Our experience is that many farmers trained in IPM switch to ecological farming in all or part of their production according to the market possibilities or their personal interest.

The FGDs included but were not restricted to the following themes as given by the Rogers theory for Diffusion of Innovations: (1) *comparative advantage*—evaluated by comparing IPM and traditional agriculture on the need of investments, labor demand, size, and value of the yield; (2) *compatibility*—evaluated by how well IPM fits into "preservation of Mother Earth" (local synonym for the environment), agricultural practices in use and norms and regulations given by the state for agricultural production; (3) *complexity*—evaluated by the ease of understanding the innovation and the complexity of the new method; (4) *trialability*—evaluated by the cost of trying out IPM, the ease of using the practices, and the ease of detecting short-term results; (5) *observability*—evaluated by the perceived size of the yields and the quality of the products; (6) *reinvention*—evaluated by the ease to improve IPM methods by adapting new ideas and experiments and trials; and (7) *the creation of alliances*—evaluated based on the ease to build relations and share the IPM experiences with others.

Each focus group (FG) was told to come up with 1 joint rating on each of the themes discussed, choosing between the following: (1) as advantageous in itself or compared with traditional practices (recorded as "higher," "high," or "easy"); (2) equal to traditional practices (recorded as "equal"); (3) less advantageous in itself or compared with traditional practices (recorded as "medium"); or (4) definitely less advantageous in itself or compared with traditional practices (recorded as "difficult" or "low"). In total, 80 scorings were recorded. To support the ratings, the groups were asked to provide arguments to support their rating, and 156 unique statements came up.

Ethics

All participants signed an informed consent form before participating in the discussions and had the right to withdraw during the FGDs. The project held a right to collect such information as part of the project activities.

Results

Ratings of IPM of the farmers and agronomists are shown in Table 1. All arguments made to support the ratings are available in Appendix 1 from where some arguments are cited below.

Comparative advantage of IPM in relation to traditional farming

The overall evaluation showed no big difference in comparative advantage between IPM and traditional agriculture when including all FGs and their ratings (see Table 1).

There was agreement among the 5 groups on IPM but being more labor-intensive compared with conventional agriculture. They found the direct costs to be lower in IPM—"as local inputs (materials and plants from the villages and surroundings) are used, these would have to be collected, prepared and applied; in the case of chemicals, however, they would only have to be bought and applied." One of the farmers' group found IPM to be more expensive, though, as they included the value of the extra labor needed to practice IPM.

Regarding the size of the yield, farmer FGs rated the yield "lower" to "equal," whereas the agronomist FGs rated the yields "equal" to "higher." The arguments forwarded by the farmers were "at the beginning, it is hard to produce and the yield is lower, but it becomes equal in time" and "the size of the fruit is smaller than the conventional one." The agronomists found that "the good fertility of the soil is a consequence of the IPM, which is why the harvests are more regular related to yields and more sustainable."

The value of the harvest was rated "higher" to "equal" depending on the type of crop grown by the farmers, where ecological coffee and strawberry apparently have better markets than vegetables. Coffee and coca farmers argued that "consumers pay for the quality of organic coffee and coca, they even look for them at the small farms." A problem is the certification of the products grown ecologically or using IPM, as stated by the group of agronomists "there is no certification that guarantees the quality of the product, which is why the consumers do not feel confident to pay more."

Interestingly, the influence of the products on health and environment also matters as stated by both farmers and agronomists: "The yield is important, but it is more important that the product is healthy, so we do not get poisoned when producing and consuming it."

Compatibility with existing values, regulations, and practices

There was agreement on rating the compatibility of IPM as "high": "Because it gives recognition to the ancient practices of respect to the Pachamama (Mother Earth)" and "in the past we took care of the soil, the water and the environment, but then we started producing only with chemical products. We realized that it was not good, that everything was receiving damage. Now we look for saving the environment, not damaging it" as expressed by the farmer groups.

Regarding compatibility with national regulations, the ratings varied. Those rating it "low" found that although regulations were in place, missing implementation and control make the regulations useless.

The compatibility of IPM with the practices that farmers commonly followed was rated as "equal" to "high." Farmer groups still found it demanding to practice IPM stating that

Table 1. Focus groups' ratings of IPM according to the Rogers theory for Diffusion of Innovations.

COMPONENTS EVALUATED	COFFEE/COCA FARMERS, N=3	VEGETABLE FARMERS, N=3	STRAWBERRY FARMERS, N=5	AGRONOMIST UMSA, N=2	AGRONOMIST ISTAIC, N=3
Comparative advantage					
How is the production costs of IPM compared with conventional agriculture?	Lower	Higher	Lower	Lower	Lower
How is the labor force needed in IPM compared with conventional agriculture?	Higher	Higher	Higher	Higher	Higher
How are the yields of IPM compared with conventional agriculture?	Equal	Lower	Lower	Equal	Higher
How is the value of the IPM crops compared with conventional agriculture?	Higher	Equal	Higher	Higher	Equal
Compatibility					
How is the compatibility of IPM with local culture?	High	High	High	High	High
How is the compatibility of IPM with the national production regulations (CENAPE, organic production)?	High	High	Low	High	Low
How is the compatibility of IPM with known agricultural practices?	High	Medium	Medium	Medium	High
Complexity					
How easy is it to understanding IPM practices?	Medium	Medium	Medium	Easy	Easy
How easy is it to use IPM?	Medium	Medium	Medium	Medium	Medium
Trialability					
How high/low are the costs of trying out IPM?	Low	Medium	Low	Low	Low
How easy is it to try out IPM techniques?	Easy	Easy	Easy	Easy	Medium
How visible are the results when trying IPM?	Easy	Medium	Medium	Easy	Medium
Observability					
How easy is it to observe an increase in the yield of IPM?	Difficult	Difficult	Difficult	Medium	Medium
How easy is it to observe improvements in the quality of the IPM products?	Easy	Easy	Easy	Easy	Easy
Reinvention					
How easy is it to incorporate new ideas for improving and adopting IPM based on own experience?	Easy	Easy	Easy	Easy	Easy
Alliances					
How easy is it to find allies to disseminate IPM?	Medium	Difficult	Difficult	Medium	Difficult

Abbreviation: CENAPE, Consejo Nacional de Produccion Ecologica; IPM, integrated pest management; ISTAIC, Instituto Agroindustrial Caranavi; UMSA, Universidad Mayor San Andrés.
Green—in favor of IPM, white—neutral, yellow—some disfavor, red—absolute disfavor.

"the practices are the same but IPM requires more knowledge on the root of the problems and how these can be overcome. Study, experimentation and tests are required to be sure of its usefulness" and "almost everything of conventional agriculture is useful, but IPM improves the agriculture a lot, although it is not so easy to put into practice, it is necessary to learn a lot of things and make decision to do things well."

Complexity to understand and use

The agronomist groups rated the understanding of IPM as "easy" while farmer groups found IPM more complex to understand.

> It is not easy to identify pests, to diagnose, know how to control them and dose pesticides. Because of our low educational level it is

> hard for us to memorize, we do not read much - that is why practice helps.

There was agreement of categorizing the IPM practice as "medium" complex. The arguments for this from the farmer groups were "The IPM activities take time, new complementary techniques are required. One activity is a precondition to the next, and isolated practices do not work" and "It is not complex but you should be dedicated, it is necessary to do things well and in due time." The agronomists were aware of the necessity to create awareness of the benefits of IPM regarding health and the environment and to use appropriate educational material accompanied by practices to overcome the difficulties in use of IPM.'

Trialability—easy and not too costly in time and money to try out

The ability to test the IPM methods was judged "easy" to "medium." All but one FG found no major economic obstacles to try out IPM. The FG indicating "medium" difficulty to test IPM argues

> The costs are low considering that all the required material is close (in the community), but it takes time and is laborious. Testing is cheap, because almost everything you need can be found in the field, but you should be strict, do things well and on time to see results.

Similarly, there was consensus between all but one FG about the easiness of testing the IPM techniques in a practical way. One agronomist FG found it "medium" difficult to test, stating that "Sometimes, making a necessary product takes 3 months; that is why the producers should anticipate the situations and be prepared."

The capability of the IPM techniques to show results in a short time was rated from "medium" to "easy." "There are quick results in some cases, but the final result is only known when the harvest is obtained and that takes time," as stated by the vegetable farmers' FGDs. Similarly, "In the cases of light and color traps, the results are immediate. However, results take place based on the sum of the actions or techniques applied," as stated in the agronomists FGDs.

Observability—immediate and visible positive effects

The size of the yield observed with IPM was rated as equal to lower among the farmer FGs and equal to higher among the agronomist FGs.

The farmer FGs stated that "it takes time and effort to apply the IPM and the yield is not always higher" and "the yield is lower but it can be compensated with the longer useful life of the plants." The agronomist FGs found "an interesting yield is achieved if there are good conditions, that is, if there is a good start of having soil with good characteristics."

Again, the size of the yield was argued not to be the only thing that matters, as a healthy production avoiding environmental damage matters as much.

Regarding the quality of the products, the FGs said that the product attributes were "easy" to notice, most of them could be perceived through the taste and texture of the product. Several FGs pointed out that the size and visual quality of IPM products were not always the best compared with traditional agriculture.

Reinvention—the possibility of incorporating new elements based on practical experience

All FGs found it "easy" to add their own ideas and experiences, and most felt that they had contributed in some way to the adaptation and improvement of the IPM techniques in their local setting. The following opinion supports this: "New experiences are made available for technicians and farmers, they test them and in this way they are disseminated. We are always trying new things. The good results are shared with the promoters and everyone gets to know them."

Alliances—support and relations that can be created to promote the dissemination of the innovation

It was rated as "difficult" to create alliances to diffuse IPM by all FGs due to lack of support from the local political systems:

> It was difficult to find allies. The Mayor's office which is supposed to care more about these subjects, has not done much in the last two years, and now it is worse because it is not working for two months already.

and "the Mayor's office only contributes to the training of other farmers. It does not provide enough support to the strengthening of the association of organic producers." Experiences with relations to authorities were mixed, sometimes good and sometimes without results in spite of good intensions. The agronomist FGs stated that

> There were difficulties at the university to find allies among the authorities and the professors. It is easier outside the university, among the professionals carrying out rural extension activities. There is favorable institutional context and generalized awareness for the dissemination of IPM.

Discussion

In summary, there was full agreement among the 5 FGs on IPM as being more labor-intensive, not always compensated by higher yields and requiring extra knowledge to practice compared with conventional agriculture—all issues talking against diffusion of IPM. Moreover, finding allies to spread IPM was seen as difficult.

However, IPM was found to give products of a higher price (for some products), to be in line with traditional culture conserving the environment, to be cheap to try out, and to give products of a higher quality regarding smell and taste.

However, the question remains with what weight the various aspects contribute to the decision of a farmer whether or not to adopt IPM strategies.

An apparent major obstacle for adopting IPM is the extra workload required by IPM techniques. Most farmers are looking for farming techniques that give them less workload with more time to cultivate more land and increase their income or to dedicate some of their spare time to other income-generating activities.

The growing industrial production in low-income countries, making people move to the cities, leaving fewer hands to cultivate the land and still feed an increasing population, is not favoring the introduction of more labor-intensive agricultural practices with lower to equal yields.

In Bolivia, the demand for higher food production has increased the size of cultivated land especially in the tropics where large areas of virgin land are taken under the plow these years.[30] This picture might be different in countries with little arable land and could be one of the reasons why there is apparently more success with IPM in Asia.

The finding of a lower to equal yield in our study is not what is seen in most other studies generally reporting a higher yield after training in FFS.[4,6–9] The difference might be due to the type of crops grown, as many of the positive reports stem from rice farming in Asia, having seen massive pest resistance to pesticides from the late 1980s and where IPM was found to be a very valuable tool.[5,20] Other factors responsible for the increased yield reported could also be due to climatic differences, variance in pest resistance, and a better conduct of FFS.

A higher price of IPM products can compensate for a more labor-intensive production and a lower yield, but it depends on market demands and the vicinity to the markets of the big cities, and customers requiring ecological products are crucial for IPM to become a success.

In our study, the type of crop seemed to be important, as indicated by coffee farmers, coca farmers, and strawberry farmers who reported better prices for their ecological products. The vegetable farmers complained of a lack of awareness of the quality of their products among consumers and a lack of a certification that made it difficult to charge consumers a higher price for their products.

In a master thesis from the University of La Paz, a study was set up comparing the input and outcome of traditionally grown cabbage.[38] This study confirms the findings from the FGDs showing that more labor was needed with IPM farming and that the harvest was not as big as with conventional farming. The input for the IPM farming, however, was much less costly due to the need for pesticides in conventional farming.[38] An initiative to improve the chances of farmers making economically sound choices in their farming would be the introduction of a more complete accountability, as most smallholders do not calculate the value of hours spent in the field, the price of agrochemical inputs purchased, and their income when selling the crop.

On the Plagbol project, studies have shown variable results comparing profits by IPM farming sometimes surpassing conventional farming and sometimes not when including relevant variables such as purchased input, hours spent farming, and value of crop (O. Huici, personal communication, 2015).

The techniques of IPM were found not to be that easy to learn, although some are quite similar to conventional and ancient farming techniques, whereas others may require new skills as reported from various field studies.[5,7,8,16,23,26] Regarding this, the lack of sufficient extension services for farmers in general and especially on IPM issues is a hindrance for the diffusion of IPM. Challenges are the general low educational level of the farmers that must be addressed by having good facilitators, producing adequate training materials and practical learning in the fields.[4,8,23,24,27]

One way of diffusing knowledge is to use IPM-trained farmers to train other farmers, and the farmers trained by Plagbol are found to be playing an active role in spreading IPM among their fellow farmers by taking part in certifying IPM and ecological products in the municipalities. They also conduct courses financed by the municipalities, thus extending IPM to other farmers.[34]

It seems difficult to find allies who can support the diffusion of IPM, and this is critical because the existence of government policies to support an innovation by taxes, prices, quotas, and other regulation factors is crucial for the diffusion of an innovation.[23,31]

In Bolivia, several policies and activities for mainstreaming IPM and ecological production have been initiated during the past years, but although there are laws and regulations in favor of IPM, these have to be followed up by sufficient control and support if positive results are to be seen.

Awareness about health and environmental issues is of increasing importance, and in this respect, IPM products have an advantage as they are found healthier and better for the environment as mentioned by the FGs. In Bolivia, certain segments of the population, mainly from the big cities, are now looking for alternatives to conventional farm products, probably influenced by the international trend in consumer attitudes with increased awareness of pesticides' harming effects on health and the environment favoring ecological products.[34] This trend can be reinforced through communication of market development of IPM products, where it is argued that once convinced that IPM products are better, consumers will be willing to pay a premium price, and this could be one of the most important tools for a massive diffusion of IPM.[39]

Another hindrance for diffusion is the lack of a clear definition of IPM, and this makes it difficult to distinguish IPM products from conventional ones, in contrast to ecological products having a stronger brand by the right to claim "zero pesticides." As it is now, even the pesticide industry can claim they promote IPM although they often pay their salesmen according to the amount of pesticides sold, which is in clear

contradiction to the intention of IPM strategies to reduce the amount of pesticides.[25,40]

The fact that there are no actual incidents of pests becoming resistant to pesticides may also be a hindrance for spreading IPM. Farmers, agronomists, and politicians do not see any drastic decrease in productivity and so have no urgent need to change current practices. Radical changes in pest control practices are much more likely to come about and can happen quickly when there is an urgent need if such a resistant pest seriously damages the harvest.[41]

In the Code of Conduct by the United Nations on the Distribution and Use of Pesticides, several important articles relate to the promotion of IPM and emphasize the responsibilities of stakeholders including governments, pesticide manufacturers, farmers, researchers, consumer groups, and donor agencies. In this Code, the main message is that every effort should be made to promote IPM, and activities leading to increased and unjustified use of pesticides are not acceptable. If the Code of Conduct were taken seriously by especially Governments and Pesticide Companies, the increasing health and pollution threat from pesticides would not be such a serious issue.

Strengths and weaknesses

This study is one of very few that actually asked the local farmers and agronomists on their view on IPM and its possibilities for diffusion, a perspective missing in most discussions on problems with IPM diffusion.

The Plagbol project has worked in the area for many years and this has created a local confidence giving way to easier access and more honest answers to survey questions in a closed native culture.

But when interpreting results, the weaknesses of this survey must also be kept in mind. First of all, the number of participants is small and more participants could have given a broader picture and/or a better basis for drawing conclusions. Therefore, generalization of the results is difficult.

We think that the labor required to do IPM, the size of the harvest, and the income generated are issues of major importance for a farmer when he has to choose farming method, but we might be wrong as stated by one of the FGs that "health and preservation of nature" might be more important for some farmers. This weakness could have been solved by asking the FGs to prioritize the different factors according to their importance.

The farmers and agronomists taking part in the study were not randomly selected but invited by the Plagbol project as they were known to have IPM knowledge and ability to reflect on complex issues. This lack of representativeness is usual in qualitative studies using FGDs and key informants but still a weakness and especially in the actual study due to the small number participants.

Conclusions

The most important issues that might explain a lack of diffusion of IPM have to do with the "comparative advantage" of IPM with conventional agriculture where the extra workload and the equal to lower yields not always compensated by higher prices of the products seem to be major hindrances. The "complexity" of understanding and practicing IPM techniques is less pronounced hindrances but still of importance as long as efficient extension services do not exist in most low-income countries.

The creation of "alliances" to spread IPM such as government institutions and pesticide companies seems to be lacking. The reason for this might be the mentioned lack of comparative advantage and complexity that conflicts with the current demand for increased agricultural productivity by many governments. The conflict of interest with the pesticide companies is obviously making them difficult allies in a spread of IPM.

In favor of IPM diffusion is the "compatibility," "trialability," and possibilities for "re-invention" together with an increasing demand for healthy and sustainable products creating a higher value of certain crops.

After more than 30 years with training on IPM in various parts of the world without being able to spread on a large scale, it seems obvious that diffusion must be politically driven. This can be done by investing in adequate national extension services and introducing a certification system for IPM and ecological products. An effective control with imports and the sale and banning of the most toxic pesticides must be a national priority and would also promote IPM as an alternative sustainable farming method.

Acknowledgements

The authors thank the participants in interviews and the PLAGBOL staff for making data collection possible. They also thank Dialogos for facilitating contacts.

Author Contributions

EJ, AA, and OH conceived and designed the study. EJ and AA analyzed the data. EJ wrote the first draft of the manuscript. EJ, AA, OH, GG, and FK contributed to the writing of the manuscript and agree with manuscript results and conclusions. EJ, AA, and GG jointly developed the structure and arguments for the paper. All authors reviewed and approved the final manuscript.

Disclosures and Ethics

As a requirement of publication, authors have provided to the publisher signed confirmation of compliance with legal and ethical obligations including but not limited to the following: authorship and contribution, conflicts of interest, privacy and confidentiality, and (where applicable) protection of human and animal research subjects. The authors have read and confirmed their agreement with the ICMJE authorship and

conflict of interest criteria. The authors have also confirmed that this article is unique and not under consideration or published in any other publication, and that they have permission from rights holders to reproduce any copyrighted material. Any disclosures are made in this section. The external blind peer reviewers report no conflicts of interest.

REFERENCES

1. Oerke EC. Crop losses to pests. *J Agr Sci*. 2006;144:31–43.
2. Gunnell D, Eddleston M, Phillips MR, Konradsen F. The global distribution of fatal pesticide self-poisoning: systematic review. *BMC Public Health*. 2007;7:357.
3. Jeyaratnam J. Acute pesticide poisoning: a major global health problem. *World Health Stat Q*. 1990;43:139–144.
4. Braun AR, Jiggins J, Röling N, van den Berg H, Snijders P. *A Global Survey and Review of Farmer Field School Experiences*. Wageningen, The Netherlands: International Livestock Research Institute (ILRI); 2006.
5. Peshin R, Dhawan AK, eds. *Integrated Pest Management: Innovation-Development Process*. Berlin, Germany: Springer; 2009.
6. Peshin R, Dhawan AK. *Integrated Pest Management: Dissemination and Impact*. Berlin, Germany: Springer Science and Business Media B.V.; 2009.
7. Pontius J, Dilts R, Bartlett A. *From farmer field school to community IPM: ten years of IPM training in Asia*. RAP/2002/15 FAO Regional Office for Asia and the Pacific, Bangkok. pp.106.
8. Waddington H, Snilstveit B, Hombrados J, et al. Farmer Field Schools for Improving Farming Practices and Farmer Outcomes in Low- and Middle-Income Countries: A Systematic Review. *Campbell Syst Rev*. 2014;6. DOI: 10.4073/csr.2014.6
9. Davis KE, Nkoya E, Kato E, et al. *Impact of Farmer Field Schools on Agricultural Productivity and Poverty in East Africa*. Washington, DC: International Food Policy Research Institute; 2010. http://www.ifpri.org/publication/impact-farmer-field-schools-agricultural-productivity-and-poverty-east-africa.
10. Yamazaki S, Resosudarmo BP. Does sending farmers back to school have an impact? revisiting the issue. *Develop Econ*. 2008;46:135–150.
11. Feder G, Murgai R, Quizon JB. Sending farmers back to school: the impact of farmer field schools in Indonesia. *Rev Agr Econ*. 2003;26:45–52.
12. Orozco FA, Cole DC, Ibrahim S, Wanigaratne S. Health promotion outcomes associated with a community-based program to reduce pesticide-related risks among small farm households. *Health Promot Int*. 2011;26:432–446.
13. Mancini F, Jiggins JL, O'Malley M. Reducing the incidence of acute pesticide poisoning by educating farmers on integrated pest management in South India. *Int J Occup Environ Health*. 2009;15:143–151.
14. Cole DC, Sherwood S, Paredes M, et al. Reducing pesticide exposure and associated neurotoxic burden in an Ecuadorian small farm population. *Int J Occup Environ Health*. 2007;13:281–289.
15. Hruska AJ, Corriols M. The impact of training in integrated pest management among Nicaraguan maize farmers: increased net returns and reduced health risk. *Int J Occup Environ Health*. 2002;8:191–200.
16. Van den Berg H, Jiggins J. Investing in farmers—the impacts of farmer field schools in relation to integrated pest management. *World Dev*. 2007;35:663–687.
17. Ooi PAC, Praneetvatakul S, Waibel H, Walter-Echols G. *The Impact of the FAO-EU IPM Programme for Cotton in Asia*. Hannover, Germany: Development and Agricultural Economics School of Economics and Management, University of Hannover; 2005.
18. Mauceri M, Alwang J, Norton G, Barrera V. Effectiveness of integrated pest management dissemination techniques: a case study of potato farmers in Carchi, Ecuador. *J Agr Appl Eco*. 2007;39:765–781.
19. Jors E, Konradsen F, Huici O, Morant RC, Volk J, Lander F. Impact of training Bolivian farmers on integrated pest management and diffusion of knowledge to neighboring farmers. *J Agromedicine*. 2016;20:200–208.
20. Rola AC, Jamias SB, Quizon JB. Do farmer field school graduates retain and share what they learn? an investigation in Iloilo, Philippines. *J Int Agr Extens Educ*. 2002;9:65–77.
21. Tripp R, Wijeratne M, Piyadasa VH. What should we expect from farmer field schools? a Sri Lanka case study. *World Dev*. 2005;33:1705–1720.
22. Feder G, Murgai R, Quizon JB. The acquisition and diffusion of knowledge: the case of pest management training in farmer field schools, Indonesia. *J Agr Econ*. 2004;55:221–243.
23. Anandajayasekeram P, Davis K, Workneh S. Farmer Field Schools: An Alternative to Existing Extension Systems? Experience from Eastern and Southern Africa. *J Int Agr Ext Edu* 2007;14(1):81–93.
24. Parsa S, Morse S, Bonifacio A, et al. Obstacles to integrated pest management adoption in developing countries. *Proc Natl Acad Sci U S A*. 2014;111: 889–3894.
25. Sherwood SG, Paredes M. Dynamics of perpetuation: the politics of keeping highly toxic pesticides on the market in Ecuador. *Nat Cult*. 2014;9:21–44.
26. Sorby K, Fleischer G, Pehu E. *Integrated Pest Management in Development Review of Trends and Implementation Strategies*. Agriculture & Rural Development Working Paper 5. Washington, DC: World Bank; 2003.
27. Mariyono J. Integrated pest management training in Indonesia: does the performance level of farmer training matter? *J Rural Commun Dev*. 2009;4:93–105.
28. Bentley JW, Barea O, Priou S, Equise H, Thicle G. Comparing farmers field schools, community workshops, and radio: teaching Bolivian farmers about bacterial wilt of potato. *J Int Agr Ext Educ*. 2004;14:45–61.
29. Huan NH, Mai V, Escalada MM, Heong KL. Changes in rice farmers' pest management in the Mekong Delta, Vietnam. *Crop Prot*. 1999;18:557–563.
30. Williamson S, Ball A, Pretty J. Trends in pesticide use and drivers for safer pest management in four African countries. *Crop Prot*. 2008;27:1327–1334.
31. Ramirez OA, Mumford JD. The role of public policy in implementing IPM. *Crop Prot*. 1995;14:565–572.
32. Food and Agriculture Organization of the United Nations. Pesticides use. http://faostat3.fao.org/browse/R/RP/E.
33. Hameleers A, Antezana S, Paz B. *Agriculture Human Investment Strategies: Towards Strengthening the Farmers Innovation Capacity (FIC) Study Case: Bolivia*. La Paz, Bolivia: Centro de Estudios y Proyectos; 2012.
34. Aramayo A, Condarco G, Huici O, Jørs E. *Informe de Evaluacion—Sistematizacion del Proyecto: Los Plaguicidas, la Salud y el Medio Ambiente en Bolivia*. La Paz, Bolivia: Fundacion Plagbol; 2013.
35. Jors E, Morant RC, Aguilar GC, et al. Occupational pesticide intoxications among farmers in Bolivia: a cross-sectional study. *Environ Health*. 2006;5:10.
36. Thiele G, Nelson R, Ortiz O, Sherwood SG. Participatory research and training: ten lessons from the Farmer Field Schools (FFS) in the Andes. *Currents* 2001;27:4–11.
37. Rogers EM. *Diffusion of Innovation*. New York, NY: Simon & Schuster; 1995.
38. Velasquez M. *IPM contra tratamiento conventional en Repollo*. La Paz, Bolivia: Universidad mayor de San Andres; 2005.
39. Lagnaoui A, Santi E, Santucci F. Strategic Communication for Integrated Pest Management. Annual Conference of International Association for Impact Assessment, Vancouver, Canada, 2004. *Agric Hum Values*, vol 15.
40. Konradsen F, van der Hoek W, Cole DC, et al. Reducing acute poisoning in developing countries—options for restricting the availability of pesticides. *Toxicology*. 2003;192:249–261.
41. Jeger MJ. Bottlenecks in IPM. *Crop Prot*. 2000;19:787–792.

Appendix 1. Focus groups' ratings and arguments on the IPM innovation.

COMPONENTS EVALUATED	FARMERS, N=3 (COFFEE-COCA), CARANAVI	FARMERS, N=3 (VEGETABLES-FRUITS), CARANAVI	FARMERS, N=5 (STRAWBERRY), COMARAPA	PROFESSORS AT THE FACULTY OF AGRONOMY – UMSA, N=2, LA PAZ	PROFESSORS AT THE TECHNICAL INSTITUTE OF AGRICULTURE ISTAIC, N=3, CARANAVI
	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS
Comparative advantage					
Production costs compared to conventional agriculture	*Lower* *Many inputs are local. Most of what is needed is nearby.*	*Higher* *Preparation of inputs is expensive in time.* *Cannot be obtained in the market.*	*Lower* *Own preparation of inputs. It is prepared with local products.*	*Lower* *Local cost-free inputs are used.* *Less quantity of product is applied in an efficient way, lowering costs.*	*Lower* *Local products are used* *The IPM reduces the environmental cost and maintains the soil preserving its characteristics and fertility.* *It watches out for the consumer's health.*
Use of labor force compared to conventional agriculture	*Higher* *Products should be collected and this takes time.* *Care should be given to the preparation and wait some time until it is ready for use.*	*Higher* *Because of the application of several techniques that are generally manual.* *The production of bioinputs takes time (collection, preparation, maturing).*	*Higher* *Manual work is required more frequently.* *Agrochemical products that reduce the use of manpower cannot be used as weed-killers.*	*Higher* *Some activities that require more work are carried out.* *As local inputs are used, they should be collected, prepared and applied, in the case of chemicals, they only should be bought and applied.*	*Higher* *The products should be prepared, because they cannot be bought in the market.* *The products should be looked for in the field, time is allocated to the preparation until the input is ready.*
Yields compared to conventional agriculture	*Equal* *At the beginning, it is hard to produce and the yield is lower, but it becomes equal in time.* *The yield is higher regarding vegetables.*	*Lower* *It is difficult to produce in large quantity, there are many problems for the cultivation and the pests persist in the area.* *Cultivation in small farms, the yield is not so important. The main thing is that the product is healthy and does not harm the health like before.*	*Lower* *The size of the fruit is smaller than the conventional one.* *The useful life of the plant is longer with IPM.*	*Equal* *The quantity may be the same but the quality of the product is higher, which is why it gets better price in the market.* *The IPM is not basically aimed at increasing the yield, but at getting a cleaner production with the exact amount of pesticide, generating safe conditions in the use of pesticides for the farmers and avoiding environmental damage.*	*Higher* *The good fertility of the soil is a consequence of the IPM, which is why the harvests are more regular regarding yields and more sustainable.* *It is important to carry out a proper and opportune management of the crop, for which purpose the well applied chemical control helps.*
Value of the crop compared to conventional agriculture	*Higher* *Middlemen start to pay more for the product.* *Consumers pay for the quality of organic coffee and coca, they even look for them at the small farms.*	*Equal* *The value of the efforts made by the producer is not recognized.* *The quality is not appreciated.*	*Higher* *Consumers start to look for organic strawberry at better price, although the qualities of this product are not recognized yet in the market in general.* *The organic certification gets complicated because of the pollution originated in the neighboring areas.*	*Higher* *The quantity may be the same but the quality of the product is higher, which is why it gets better price in the market.* *Organic production is more and more demanded in the market, the prices it gets are higher than the prices of the conventional product.*	*Equal* *The market does not recognize the quality, it pays the same as per the conventional product, which is why they get mixed in the market.* *There is no certification that guarantees the quality of the product, which is why the consumers do not feel confident to pay more.*

(Continued)

Appendix 1. (Conitnued)

COMPONENTS EVALUATED	FARMERS, N=3 (COFFEE-COCA), CARANAVI	FARMERS, N=3 (VEGETABLES-FRUITS), CARANAVI	FARMERS, N=5 (STRAWBERRY), COMARAPA	PROFESSORS AT THE FACULTY OF AGRONOMY – UMSA, N=2, LA PAZ	PROFESSORS AT THE TECHNICAL INSTITUTE OF AGRICULTURE ISTAIC, N=3, CARANAVI
	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS
Compatibility					
Compatibility with local culture compared to conventional agriculture	*Higher* *Because of the recognition it makes of ancient practices of respect to the Pachamama, which are present among the families of the communities.* *It supports the protection of the environment.* *It takes care of the people's health.*	*Higher* *In the past we used to take care of the soil and the environment, then we started to produce only with chemicals. We realized that this was not good, that it was damaging everything. Now we are looking for recovering the environment, not damaging it.* *With the cultural values, there is recovery and exchange of ancient knowledge of the communities, which is good for the new generations.*	*Higher* *The environment is not contaminated with agrochemical product residues or containers.* *It is renewed, the offerings to the Pachamama are again practiced.* *The observation of the lunar phase is practiced to sow.*	*Higher* *Direct contribution is made for the conservation of the environment and natural resources that sustain the agriculture, such as soil and water.* *Many traditional practices that are being forgotten are recovered with the cultural values.*	*Higher* *It incorporates the cultural control, which adopts ancient practices.* *There is high compatibility with the environment and the conservation of soil and water.* *The ethical nature of agricultural production becomes important with the IPM in that nature-producer-consumer relationship.*
Compatibility with national production regulations (CENAPE, organic production)	*High* *Regulations for the certification as organic coffee are observed to export the product with AOPEB and other organizations.* *The regulations of the CENAPE, which is organizing the Municipal Committee of Ecological Production, are not applied yet.*	*High* *The Municipal Committee of Ecological Production was organized based on the promoters to implement the regulations of ecological production.* *There are 180 producer families and 95% of them qualify to become organic producers.*	*Low* *The current regulations are not observed, nobody controls how the product is obtained. Controls should be implemented.* *The recommendation of the label is not read (conventional producer).*	*High* *In general, it is compatible with the regulations regarding the innocuousness of foods, which are recovered by the Act 3525 that will regulate and promote the ecological production in Bolivia.* *With several regulations and with the New Political Constitution of the State, as well as with the regulations and good agricultural practices that the FAO and other international organizations try to disseminate among the farmers.*	*Low* *The institutions in charge of the control are not fulfilling their obligations (e.g. Nobody controls the introduction of citrus plants carrying canker and the disease is spreading).* *There are no laboratories to define situations. Currently the work is carried out intuitively or in many cases as a political favor.*
Compatibility of IPM with known agricultural practices	*High* *Many practices already known and practiced by the old people are carried out.* *More time and dedication are required, in a few words, it is necessary to be decided.*	*Medium* *The grounds are the same, but the IPM requires more knowledge on the roots of the problems and how these can be overcome. Study, experimentation and test are required to be sure of its usefulness.* *Almost everything of the conventional agriculture is useful, but the IPM improves a lot the agriculture, although it is not so easy to put into practice, it is necessary to learn a lot of things and make the decision to do things well.*	*Medium* *It is an improved agriculture, but the grounds are the same.*	*Medium* *In general, producers try to get the highest volume of harvest and make use of all the alternatives available, mainly the most effective, immediate and cheap, such as the use of pesticides. For that reason, sometimes the IPM is not completely compatible with conventional agriculture.*	*High* *Local products used by the producers, such as plant extracts, are adopted within the IPM.* *It incorporates the cultural control, which adopts ancient practices.*

Appendix 1. (Conitnued)

COMPONENTS EVALUATED	FARMERS, N=3 (COFFEE-COCA), CARANAVI	FARMERS, N=3 (VEGETABLES-FRUITS), CARANAVI	FARMERS, N=5 (STRAWBERRY), COMARAPA	PROFESSORS AT THE FACULTY OF AGRONOMY – UMSA, N=2, LA PAZ	PROFESSORS AT THE TECHNICAL INSTITUTE OF AGRICULTURE ISTAIC, N=3, CARANAVI
	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS
Complexity					
Complexity of understanding IPM practices	*Medium* *Changing from the conventional is hard, especially when it was practiced for a long time.* *It is not easy to identify pests, diagnose, know how to control them and dose pesticides.* *Because of our low educational level it is hard for us to memorize, we don't read much, that is why practice helps.*	*Medium* *It is not complicated but knowing and managing new techniques, such as light and color traps, is required.* *It is not complex when there is willingness to learn and study, it is necessary to make the decision of adopting the IPM in a responsible way.*	*Medium* *Too much technical language is used, there are many words that are not understood well in the beginning.* *Paying attention and asking facilitates the understanding.*	*Easy* *It is easy to understand when the trainers make efforts to reach the farmers with simple and appropriate language explaining the causes behind the high presence of pests, the considerable losses they cause and how this situation can be reverted working on the causes.* *It is easy when theory is accompanied by practice and joint reflection with the farmers.*	*Easy* *It is not complicated but first awareness raising should be carried out among producers using appropriate educational material.* *There is more awareness on the problems it prevents, such as environmental and health problems, and this has influence for a better understanding.*
Complexity to use IPM compared to the common practices	*Medium* *The quick response that the producers want and the little information they have on the IPM, results in their choosing the use of agrochemical products.*	*Medium* *The IPM activities take time, new complementary techniques are required. One thing gives continuity to the other, an isolated practice does not work.* *It is not complex but you should be dedicated, it is necessary to do things well and in due time.*	*Medium* *Asking questions has helped.* *The manuals have been very useful in the field.*	*Medium* *Because it requires the previous preparation of inputs and other practices that are mainly preventive.* *It is very easy to use chemical products, producers frequently use to do it.*	*Medium* *The farmers have knowledge base, availability of time and patience.* *There is environmental and health awareness among producers, which motivates them to practice the IPM.*

(Continued)

Appendix 1. (Conitnued)

COMPONENTS EVALUATED	FARMERS, N=3 (COFFEE-COCA), CARANAVI	FARMERS, N=3 (VEGETABLES-FRUITS), CARANAVI	FARMERS, N=5 (STRAWBERRY), COMARAPA	PROFESSORS AT THE FACULTY OF AGRONOMY – UMSA, N=2, LA PAZ	PROFESSORS AT THE TECHNICAL INSTITUTE OF AGRICULTURE ISTAIC, N=3, CARANAVI
	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS
Trialability					
Costs of testing	*Low* *The inputs collected in the field or at home are cost-free.* *The preparation should be applied on time, otherwise it might be lost (most of them evaporate).*	*Medium* *The costs are low considering that all the required material is near (in the community), but it takes time and is laborious.* *Testing is cheap, because almost everything you need can be found in the field, but you should be strict, do things well and on time to see results.*	*Low* *The low cost motivates to try, because everything you need is in the community.*	*Low* *Many local inputs are used, which facilitates to test almost without cost.* *Much depends on the efforts made by the farmers and the proposals of the technicians.*	*Low* *Mainly because of the use of own inputs available in the area.*
Simplicity of testing	*Easy* *A good education base is required to facilitate the practice.* *It is necessary to arouse the curiosity of farmers and then they continue practicing.*	*Easy* *Almost all the techniques can be practiced because there are the means in the community and only the knowledge to apply them is required.* *Many techniques can be demonstrated in a practical way and give results.*	*Easy* *At the beginning it is difficult because there is no confidence, until it is tested and there are results.* *Then there is interest to reproduce the experience for others to see and get convinced.*	*Easy* *There is a high number of practices very easy to test in a practical way. The technicians use these to demonstrate the virtues of the IPM (for example, different traps).*	*Medium* *Sometimes, making a necessary product takes 3 months, that is why the producers should anticipate the situations and be prepared.*
Visibility of results in tests	*Easy* *When proper work is carried out regarding prevention, the results are evident.* *The waiting period of the chemical product is at least 20 days, of the organic product 5 days.*	*Medium* *There are quick results in some cases (traps).* *But the final result is only known when the harvest is obtained, and that takes time.* *(We have discontinued the use of pesticides, although the rest of the producers still know the basics about them).*	*Medium* *Sometimes the results are quick, quicker than those of the conventional agriculture.*	*Easy* *In cases such as the light and color traps, the results are immediate.* *However, the results take place based on the sum of the actions or techniques applied.*	*Medium* *It takes time, farmers want to see quick results, but with the IPM they are a consequence of the time spent.* *The farmers have to take care of many things, which might explain their desire to see immediate results. However, this attitude is changing little by little.*

Appendix 1. (Conitnued)

COMPONENTS EVALUATED	FARMERS, N=3 (COFFEE-COCA), CARANAVI	FARMERS, N=3 (VEGETABLES-FRUITS), CARANAVI	FARMERS, N=5 (STRAWBERRY), COMARAPA	PROFESSORS AT THE FACULTY OF AGRONOMY – UMSA, N=2, LA PAZ	PROFESSORS AT THE TECHNICAL INSTITUTE OF AGRICULTURE ISTAIC, N=3, CARANAVI
	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS
Observability					
Observable changes in the yield	*Difficult* *There are no noticeable changes in the quantity produced per hectare.*	*Difficult* *It takes time and work to apply the IPM and the yield is not always higher.* *Although the yield is important, it is more important for us that the product is healthy and that we don't get poisoned when producing or eating it.*	*Difficult* *The yield is lower but it can be compensated with the longer useful life of the plants.*	*Medium* *The yield is not a priority, but the quality of the product.* *Reaching the expected yield levels takes some time.*	*Medium* *An interesting yield is achieved if there are good conditions, that is, if there is a good start having soil with good characteristics.*
Observable changes in the quality of the product	*Easy* *The taste of coca is sweeter, that can be quickly perceived.* *Tomatoes are more delicious.* *One more point is paid for coffee and one more Boliviano for a pound of coca.* *The market does not recognize the quality of citrus fruits or vegetables.*	*Easy* *The product is comparably of better quality, this is highly appreciated by the families.* *It is of high quality (taste, shelf life), but it is not yet recognized in the market.*	*Easy* *Taste and shelf life (in good conditions it lasts up to 3 days more than the conventional strawberry)* *The size of the fruit is smaller than the conventional one.*	*Easy* *The smell and taste are indicators that allow to detect the quality.* *However, the visual quality of the product is not always the best, as it happens with conventional agriculture.*	*Easy* *Its good smell and taste are easily perceived.* *However, the difference will only be told through analysis in laboratory.*

(Continued)

Appendix 1. (Conitnued)

COMPONENTS EVALUATED	FARMERS, N=3 (COFFEE-COCA), CARANAVI	FARMERS, N=3 (VEGETABLES-FRUITS), CARANAVI	FARMERS, N=5 (STRAWBERRY), COMARAPA	PROFESSORS AT THE FACULTY OF AGRONOMY – UMSA, N=2, LA PAZ	PROFESSORS AT THE TECHNICAL INSTITUTE OF AGRICULTURE ISTAIC, N=3, CARANAVI
	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS	RATINGS AND ARGUMENTS
Re-invention					
Possibility to incorporate new ideas and improving IPM elements based on own experience	*Easy* *Trying different dosages of bio-inputs the results were incorporated with the practice.* *We are always looking for new alternatives to tackle the problems or to improve what we already know.*	*Easy* *Many techniques have been modified by the promoters, for example, the way of preparing insecticides or the dosages for the different crops, which they disseminated later together with the results.* *New experiences are incorporated and made available for technicians and farmers, they test them and are disseminated in this way.*	*Easy* *We are always testing something new, the good results are discussed with the rest of farmers and the knowledge is available for everyone.*	*Easy* *It is known that the producers incorporate elements that arise from the practice; they do that for new crops in which they test the techniques.* *Several adaptation experiences are divulged by the producers.*	*Easy* *The farmers are constantly testing and incorporating new elements, such as the use of plant extracts, which they dose for each crop in a different way.*
Alliances					
Possibility to find allies to disseminate IPM	*Medium* *It is not that easy, sometimes the alliances don't materialize. Unión PROAGRO wants its 200 member producers to be trained.* *Development Program of World Vision wants to adopt the promoters as trainers in the communities.* *The municipality was going to fund trainings in three cantons but it didn't work.*	*Difficult* *It has been difficult to find good allies. The mayor's office, which is supposed to care more about these subjects, has not done much in the last two years, and now it's worse because it is not working for two months already.* *Good alliances are being constructed with ISTAIC and AOPEB.*	*Difficult* *The mayor's office contributes almost exclusively to the training of farmers.* *It does not provide enough support to the strengthening of the association of organic producers.* *There are no other support institutions.*	*Medium* *There were difficulties at the university itself to find allies among the authorities and the professors.* *It's easier outside the university, among the professionals carrying out rural extension activities.* *There is a favorable institutional context and generalized awareness for the dissemination of the IPM.*	*Difficult* *A work group on the subject is being strengthened. ISTAIC, organizations of producers, AOPEB, Unión PROAGRO and support institutions participate in the group. The intention is to generate a publication with the systematization of the experiences developed in the area.* *The problems in the municipality hinder all coordination relations.*