The Impact of Text Messages on Adoption and Knowledge of Integrated Pest Management Practices: A Randomized Control Trial Study of Potato Farmers in Carchi, Ecuador

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Thesis submitted to the faculty of Virginia Polytechnic Institute and State University in partial fulfillment for the degree of:

Master of Science
In
Agricultural and Applied Economics

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August 13, 2015
Blacksburg, Virginia

Keywords: Adoption, integrated pest management, randomized control trial, agricultural extension, uncertainty, dynamic programming.

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ABSTRACT

Farmers' adoption of new agricultural technologies in developing countries is sometimes limited, despite the benefits. Potato farmers in Carchi, Ecuador rely heavily on pesticides to limit pest and disease damage, rather than adopting a more sustainable and economically viable alternative: Integrated Pest Management (IPM). Uncertainty about the benefits of IPM is one limitation to adoption. Information that reduces uncertainty can therefore promote adoption. Competing farming activities also limit IPM adoption by farmers, who may forget or delay using the practices. One way to simultaneously transfer information and remind farmers to adopt IPM is through text messages.

To evaluate the impact of text messages on IPM adoption, we conducted a Randomized Control Trial (RCT) among potato farmers in Carchi, Ecuador. The RCT allowed us to identify the causal impact of text messages by comparing adoption rates and knowledge scores between farmers who received text messages (treatment), and farmers who did not (control). After attending a one-day training, the treatment received tailored IPM text messages. After the trial, farmers reported their adoption and knowledge of IPM practices

Treatment farmers adopted IPM practices at higher rates than the control. Treatment farmers also exhibited more knowledge about IPM than control, which is evidence of the text messages' knowledge-building effect. Text messages are therefore shown to be a positive supplement to an in-person training program because they build knowledge and can remind farmers, both of which encourage the adoption of IPM, which benefits the farmer, his community, and the environment.

Acknowledgements

First, I would like to acknowledge my committee co-chairs, Dr. Jeffrey Alwang and Dr. Catherine LaRochelle for their support during my program at Virginia Tech. I appreciate their guidance and patience as I navigated the design, implementation, and evaluation of the program that formed the basis of my research. I would also like to acknowledge Dr. George Norton for his encouragement and introducing me to the idea of technological change as an integral tool of economic development.

I would like to also thank the dedicated INIAP team in Carchi, Ecuador, without whom this research would not be possible. I am especially appreciative to Dr. Victor Barrera for his coordination of the entire effort including the first field days, text message system, and data collection; Moazir Celleri for leading the data collection and driving us all over Ecuador for surveying; Jovanny Suquillo for his tireless work to promote IPM among potato farmers; and Fernando Solis for his friendship, technical potato production knowledge, and assistance in creating the final questionnaire.

I am especially indebted to my fellow graduate students, especially Vanessa Carrion, whose prior work on potato IPM in Carchi and general guidance on research and academics was invaluable. I would also like to thank Gwendolyn Rees for helping me translate English into math; Ed Ekpoudom for teaching me Bayes Rule and dynamic programming; Jared Farris for his patient econometric explanations; and Frances Dowd for all of her proofreading help. I would also like to thank our graduate coordinator, Joanna Lewis, whose kindness and expert direction helped me immensely.

Finally, I'd like to acknowledge the entire Virginia Tech community. Your embodiment of, and commitment to, *Ut Prosim*, continually reminded that I came here to conduct research that would make a difference in the world, and it was an honor to work among those who feel the same.

This research was supported by the United States Agency for International Development Integrated Pest Management Innovation Lab.

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Chapter 1: Introduction

Adoption of new agricultural technologies, such as new crop varieties, machinery, and crop management techniques, can stimulate economic growth and contribute to poverty alleviation by raising productivity, reducing production costs, and fostering health and environmental stewardship. To achieve these positive outcomes, new agricultural technologies must be adopted by farmers. However, several factors might constrain adoption of certain technologies in many developing countries. Farmers adopt technologies when the benefits outweigh the costs. For new technologies, however, benefits might not be well understood by the farmer, and this uncertainty limits adoption. Reductions in uncertainty through knowledge transfer can lead to the adoption of beneficial technologies.

In many countries, agricultural extension services are the primary agents of knowledge transfer. Two popular methods of extension training in developing countries are Farmer Field Schools (FFS), and Farmer Field Days (FFD). Both are participatory training methods, with FFS taking place over a period of several weeks or months, and FFDs generally consisting of a single day of training. FFDs train interested farmers by using demonstration plots to introduce new varieties or specific pest and crop management techniques. FFDs can be effective in introducing new technologies, and strengthening farmer's knowledge of their use. However the lack of periodic reinforcement as a farmer experiments with a new technology could limit the reduction of uncertainty, preventing adoption.

The structure of FFSs includes this follow-up by training farmers regularly over a period of weeks or months. Participation in FFS is generally more limited than in FFD, as attendance is often restricted to those who have been identified as leaders in a community. This selectivity is due to the training capacity component of FFS, where, after learning how to disseminate the information and techniques, attendees are asked to teach others in their communities. There are several motivations for asking participants to train others: further developing the leadership potential of attendees; increasing the reach of the program; and reducing per-farmer training costs (Ali & Sharif, 2012). FFS have been found to increase productivity, decrease pesticide use, and increase agricultural knowledge (Godtland, Sadoulet, Janvry, Murgai, & Ortiz, 2004; Guo, Jia, Huang, Kumar, & Burger, 2015; Mauceri, Alwang, Norton, & Barrera, 2007). Participation in FFS is also tied to ontological shifts in the perspectives of participants. In rural Kenya, for example, FFS participants developed a stronger work ethic and increased confidence in their farming abilities as a result of their training. Productivity increases resulting from these ontological shifts can lead to economic development and poverty alleviation. (Duveskog, Friis-Hansen, & Taylor, 2011). Despite the popularity of FFS, they are expensive to implement. Furthermore, cost effectiveness depends on whether participants transmit knowledge to others (Mauceri et al., 2007).

FFS were first introduced in Asia in the 1980s as a way to train farmers in Integrated Pest Management (IPM). IPM is a system of practices and processes that form a holistic approach to preventing pest and disease damage while minimizing the use of harmful chemicals. Methods include biological controls such as introduction of natural predators, breeding for resistance, cultural controls such as crop rotation, mechanical and physical controls like the use of hilling or placement or bait plants, and chemical controls, which are used only selectively in ways that limit environmental damage ("What is Integrated Pest Management?," 2015). Adoption of IPM promotes the long-term sustainability of the agricultural system.

Despite the positive benefits associated with IPM adoption, its use is limited, especially in developing countries. One reason for limited adoption is the inherent complexity of some components of IPM, which necessitates comprehensive training. IPM as a system is complex because it requires farmers to monitor and identify pests and also determine when environmental factors and pest presence indicate action should be taken. This complexity necessitates ongoing training during which a farmer is able to experiment with IPM practices and receive regular advice from IPM experts. While this type of training and follow up is present in FFS, the one-off nature of the less expensive FFDs does not allow for it. Another cause of limited adoption is due to the prevalence of pesticides, which can be effective at combatting pests and disease. Furthermore, their use is encouraged by pesticide salesman who have incentives to promote pesticide use. Despite the positive benefits associated with the adoption of IPM, extension organizations with limited budgets face a challenge of encouraging the adoption of this complex set of techniques.

Potato farmers in Carchi, Ecuador could benefit from decreased reliance on pesticides and increased adoption of viable IPM alternatives. Carchi Province is in northern Ecuador on the Columbian border. Its stable year-round temperature and regular precipitation makes it favorable to year-round crop cultivation. Approximately half of the labor force in Carchi is engaged in agricultural production, which includes the cultivation of potatoes, corn and wheat. While the sale of dairy products is also an important source of income, Carchi is the most productive potato area of Ecuador (MAGAP 2010). Average potato yields in Carchi are 26 metric tons per hectare, while the national average is just 8 metric tons (INEC 2010). In addition to favorable climatic conditions, high yields are the result of extensive use of chemicals, including pesticides (Carrion, 2013). Pesticides represent between 12% and 20% of total production costs of potato farmers in Carchi (Barrera, 2003.).

The pesticides used by Carchi potato farmers combat three insect pests and two diseases: Central American tuber moth *(Tecia solanivora);* leaf miner *(Liriomyza huidobrensis)*; Andean potato weevil *(Premnotrypes Vorax)*; late blight *(Phytophthora infestans)*; and Rhizoctonia *(Rhizoctonia Solani).*[1] While pesticides are effective in reducing damage, increasing yields, and increasing farm profits (Feder, 1979), their overuse can be detrimental. Overuse can reduce the number of beneficial insects, which increases the population of previously unproblematic insect pests. The proliferation of the leaf miner is one example of the consequences of pesticide overuse in Carchi, as this insect pest generally causes only small amounts of damage, unless its natural predator has been chemically eradicated. Another problem with pesticide overuse is resistance to key pesticide ingredients, resulting in the use of higher concentrations and more toxic pesticides. Finally, pesticide overuse can lead to poisoning, which affects both the person who sprays the pesticides, those in the vicinity, and individuals who eat heavily sprayed produce.

Though potato farmers in Carchi rely heavily on pesticides to control these insect pests and diseases, IPM awareness and use is prevalent in the area. A survey conducted in 2013 showed that 93% of potato farmers in Carchi reported having heard of IPM and most used one or more IPM technique (Carrion, 2013). Scientists at the National Autonomous Institute of Agricultural and Livestock Research (INIAP) have conducted IPM research focused on Carchi potato production since the mid 1990's. They developed techniques to combat and control each of the major pests in the area.[2] Though IPM as a system is complex, each technique ranges in implementation difficulty. For example, to prevent damage from the Andean potato weevil, IPM advocates the use of traps made of cardboard, applied with a recommended insecticide, and

[1] A detailed description of each of these are included in Appendix A Table A.1.
[2] A detailed list of techniques specific to each pest or disease that have been tailored by INIAP for potato farmers in Carchi is included in Table A.2 Appendix A.

spaced every 10 meters throughout the plot. The multiple steps required to build and set traps makes it a relatively complex practice, and one that requires more detailed knowledge. To prevent the tuber moth, however, farmers should simply hill around each plant to create a barrier between the tuber and the pest.

Since 1998, INIAP has partnered with the United States Agency for International Development's (USAID) IPM Collaborative Research Support Program (IPM CRSP), now called Innovation Lab, managed by Virginia Tech, to assist in developing IPM techniques, and evaluating IPM adoption and its impact. In field trials conducted between 1998 and 2003, researchers found that when comparing plots where conventional pest control was used with those where IPM was employed, yields were at least equal, and production costs were lower on IPM plots (Mauceri et al., 2007). The lower production costs combined with lower reliance on pesticides thus increase environmental and health benefits to make IPM an economically viable and sustainable pest control option.

Despite the documented benefits, IPM adoption has not spread significantly. Limited spread is in part caused by a lack of public extension. Though INIAP has a technology transfer unit responsible for diffusing IPM information, limited funds prevent the types of training required to properly encourage adoption of complex IPM technologies. The majority of potato IPM information diffusion takes place through INIAP's small regional office in Carchi. The office is staffed by three technicians who answer farmer questions about their potato crop, develop and market a bioinsecticide to prevent Rhizoctonia (Bacu-Turin), and conduct site-specific research on the presence of pests and efficacy of certain IPM methods. Technicians hold periodic FFDs, however the long-term trainings most effective for teaching complex technologies like IPM, have not been held since 2003 (Carrion 2013).

A need exists for a low-cost method that provides farmers with periodic follow-up information about IPM that reduces uncertainty about the efficacy of the techniques. One way of providing this follow-up is through text messages. Though text messages can have many applications in development programming, and may be used in some cases to supplement in-person programs, here we are interested in testing the function of the text messages after techniques have been introduced by a technician or extension agent. In a similar fashion to FFS, which encourage IPM adoption by regularly reinforcing the proper use of the technology, detailed informational text messages could increase the use of these practices. These text messages could serve two purposes, either individually or in combination: (1) provide information on the technique itself, and (2) remind farmers to employ the technique. Regular informational text messages may serve to build farmer's understanding of and knowledge about the technique. The more information a farmer receives, the more uncertainty about IPM benefits can be reduced. This reduction in uncertainty may stimulate adoption of beneficial practices.

The reminder component of text messages is also important, because farmers engaged in other farming activities may not remember to conduct IPM practices learned in previous trainings, and, in response to pest pressure and damage, use the chemical controls they know are effective. For farmers who spray in a cycle according to a calendar, a properly timed message could break the spraying cycle with a reminder to first determine pest presence, and spray only when a threshold level of pest presence has been detected.

Several factors make Carchi, Ecuador an ideal place to evaluate the efficacy of text messages on the adoption and knowledge of IPM. In Ecuador, the mobile phone penetration rate, is 104%,[3] and text messages are free to receive. Furthermore, the literacy rate in Ecuador is 92% (Barrera, 2003.), an indication that farmers are able to read and process the information provided in text messages. Most potato farmers in Carchi, therefore, have mobile phones and the ability to receive and read text messages. Furthermore, these individuals are aware of, and have been trained in IPM, yet continue to use highly toxic pesticides as their primary method of controlling pests and diseases, despite the documented benefits of IPM (Carrion, 2013). For these reasons, potato farmers in Carchi are an ideal population on which to test the effectiveness of regular text messages in promoting IPM knowledge and adoption.

To assess the effectiveness of the text message program, a randomized control trial (RCT) is used. Program participants are randomly divided into two groups: one group is "treated" with an intervention for a period of time, while the other, control group, is not. Provided the groups are balanced, meaning that randomization was successful and that, on average, key socio-economic characteristics between the treatment and control groups are not statistically different, differences in observed outcomes can be attributed to the intervention. The use of RCTs in program evaluation has grown dramatically as the demand for evidence-based-programming has increased. This is because RCTs can be effective in identifying a treatment effect of an intervention without some of the problematic assumptions of econometric techniques. RCTs therefore allow researchers to identify a causal link between a treatment and an outcome (Duflo, Glennerster, & Kremer, 2006a).

[3] Cell phone penetration rate refers to the number of mobile phone subscriptions in a given area. According to the World Bank, between 2013-2014, Ecuador has 104 mobile cellular subscriptions per 100 people, indicating that some individuals have more than one mobile phone subscription. Source: http://data.worldbank.org/indicator/IT.CEL.SETS.P2. This number varies depending on source, but remains between 100 and 113.

The specific **objectives** of this study are to:

1. Assess the impact of text messages on IPM adoption;
2. Assess the impact of text messages on knowledge of IPM practices;
3. Determine the pathways by which text messages encourage adoption – via reminders and/or information provision; and
4. Identify the types of IPM practices (simple or complex) for which text messages are most effective.

The thesis is organized as follows. Chapter 2 provides an overview of interventions that used mobile phones to encourage individuals to adopt positive behaviors and actions, or implement a new technology. Chapter 3 provides a conceptual framework under which a dynamic programming model illustrates the technology adoption process under uncertainty, and the potential benefits of regular text messages. It also presents the research methodology. Chapter 4 describes the survey, presents summary statistics, and develops the empirical estimation model. Chapter 5 includes results, and Chapter 6 concludes the paper with a discussion of limitations and applications for future research.

Chapter 2: Literature Review

As the use of mobile phones proliferates throughout the world, development practitioners have increasingly considered using mobile phone technology to reach their target audience. It is important to evaluate the effectiveness of these programs in complementing or substituting for alternative training programs. It is also important to determine the types of programs for which the text messages are most effective. Interventions via mobile phones lend themselves well to randomized evaluation, as it is relatively simple to cleanly divide and administer an intervention by simply sending text messages to the treatment group and preserving the status quo in the control group. Problems present in other RCTs such as contamination, or non-compliance are less likely with a text message intervention. If the experiment is well designed, differences in the outcomes of recipients and non-recipients provide an unbiased measure of the effectiveness of the programs. There are two main bodies of literature that evaluate the effectiveness of text messages in encouraging behavior changes and increasing knowledge: those that evaluate health and wellness programs, often called mHealth, and studies that evaluate the effectiveness of programs that provide simple and complex agricultural information.

mHealth programs primarily use text messages as reminders for patients, though some also provide information. Programs include those for diabetes management, smoking cessation and increasing physical activity (Fjeldsoe, Marshall, & Miller, 2009; Hurling, 2007; Rodgers, 2006). Overall, text messaging programs have been found to be effective in improving health outcomes and increasing the adherence to drug regimens (Costa et al., 2012; Lin et al., 2012; Ulla, Simon Francis, & Vibeke, 2010). The credibility of these assessments is furthered through the use of RCTs to cleanly identify the treatment effect of the text messages. While the majority of research has been conducted in developed countries, there is no implication that similar programs would be ineffective in a developing-country context – just that the demand for such programs is higher in countries with a stronger for-profit health and wellness marketplace. Furthermore, though this IPM adoption study seeks to encourage farmers to adopt agricultural practices, rather than healthy behaviors, the idea that reminders can lead to action can be applied across disciplines.

RCTs have allowed researchers to establish a causal link between short-term positive behavioral outcomes and the receipt of text messages in the areas of smoking cessation, physical activity and diabetes treatment (Fjeldsoe et al., 2009). An RCT involving smokers in New Zealand used daily tailored text messages to encourage smoking cessation. Messages included advice, support and distractions. The messages proved effective in the short-term, with 28% of recipients reporting not smoking after 6 weeks, compared to 13% of individuals in the control. However there was no significant difference in the cessation rates of participants at the conclusion of the study at 26 weeks (Rodgers, 2006).

In the UK, text messages that provided a reminder to exercise and solutions for perceived activity barriers (such as finding exercise difficult, lack of confidence, fear of being injured, or not having access to sidewalks or walking paths) increased the amount of moderate-intensity physical activity among recipients. Researchers found that individuals in the treatment group accessed supplementary online materials more than those in the control group, indicating that the text messages influenced overall involvement in the program and interest in exercise (Hurling, 2007). Of the RCT trials that evaluated the effectiveness of diabetes management programs, later compiled and summarized by Fjeldsoe et. al. (2009), it was found that treated individuals exhibited statistically significant positive outcomes as a result of receipt of text messages. These positive outcomes included improved metabolic control and improved adherence to insulin regimens. In general, programs that provided tailored advice were found to be more effective and had lower attrition rates than those that provided general information (Fjeldsoe et al., 2009).

Adherence to drug regimens is also positively influenced by the receipt of reminder text messages. In Brazil, HIV positive women randomly assigned to receive weekly text messages reminding them to take anti-retroviral medication reported that these messages were helpful in adhering to a drug regimen, however due to the small sample size, differences between the treatment and control were not statistically significant (Costa et al., 2012). An RCT in Denmark showed that daily text messages significantly improved adherence to an anti-asthmatic drug regimen (Ulla et al., 2010).

In China, recipients of appointment reminders visited the doctor more frequently, received more comprehensive treatment, and had better health outcomes than non-recipients. In a large study involving treatment of children for cataracts, randomly assigned parents who received text messages reminding them of scheduled appointments had a 47.2% higher attendance rate than those who did not. Results show that the difference in attendance rates between the treatment and control group increases over time, suggesting that reminders are more effective the farther the initial intervention and follow-up appointment are. While the treatment and control groups had a 10.8% difference attendance rates for the first follow up appointment; that difference rose dramatically to 54.5% for the fourth appointment. As follow-up appointments are crucial for the correct diagnosis and treatment of cataracts, children of parents who received these text messages received more additional surgeries, laser treatments, and prescriptions for new glasses (Lin et al., 2012).

Several studies provide evidence of the effectiveness of text message reminder programs in agriculture. The first assess programs that provide market price or weather information, while the second evaluate initiatives that transmit more advanced agricultural knowledge in order to improve farming methods (Fafchamps & Minten, 2012; Fu & Akter, 2012; Nakasone, 2013). In general, with some exceptions, researchers find that the receipt of text messages influences a farmer's decision of where to sell his crops, though differences in the prices received between control and treatment groups is not always statistically significant (Fafchamps & Minten, 2012). In Peru, farmers randomly selected to receive text messages with market price information following harvest received higher prices for some crops. Statistically significant differences in prices received for treatment vs. control were found mainly for perishable crops, highlighting the importance of timely information (Nakasone, 2013).

In India, researchers used an RCT to determine the benefits of weather and market price information delivered through a system called "Reuters Market Light" among members of 100 villages. While the treated reported choosing a market based on market price information, the realized difference in the price received by treatment and control farmers for their crops was not statistically significant. Furthermore, there were no statistically significant differences in crop value-added, crop losses resulting from rainstorms, or likelihood of changing cultivation practices between the treatment and control groups (Fafchamps & Minten, 2012).

IPM is a complex technology, and this complexity could contribute to uncertainty about its benefits, limiting adoption. For this reason, it is important to identify RCT studies that measure the impact of text messages in transmitting information about systems similar in complexity to IPM. Several interactive mobile phone programs that use a combination of information delivery, and provision of tailored request-based extension through mobile phone networks have been analyzed using an RCT. An RCT framework combined with double difference and reflexive comparison found that extension service delivery in India improved significantly in terms of speed, amount, and quality due to the mobile phone component (Fu & Akter, 2012). Also in India, farmers randomly selected to participate in a mobile-based agricultural consulting service were more likely to use appropriate pesticides and fewer hazardous ones. Furthermore, members of the treatment group reported relying less on advice from input sellers. Researchers found, however, that the while participating in the program promoting adoption of better agricultural practices, farmer's knowledge of these practices did not increase, suggesting that the farmers accepted the agricultural advice without understanding the evidence that substantiated it (Cole, 2012).

The literature on the use of RCTs to evaluate the effectiveness of text messages in changing behavior and improving recipient outcomes supports the notion that text messages could increase IPM among potato farmers in Carchi. It shows that text messages can serve as both reminders, and providers of information. While Rogers (2009) indicated that the effectiveness of text messages diminished over time, Lin et. al. (2012) showed bigger differences in appointment attendance the further away patients were from the experiment start date. We expect that text messages that promote the use of practices where benefits can be immediately realized (whereas benefits from smoking cessation are often longer term) will not have diminished effectiveness over time. The conclusion that tailored advice was more readily followed than general advice (Fjeldsoe et al., 2009) will also be incorporated into the program design.

A gap exists in the literature on the effect of text messages on encouraging the adoption of complex agricultural practices, and more specifically, on using text messages as a supplement to in-person agricultural training. This research therefore adds to the literature by providing empirical evidence to the theoretical concepts that adoption can be encouraged via information provision, which reduces uncertainty about a technology's benefits, and via reminder to apply a practice.

Chapter 3: Concepts and Methods

3.1.Conceptual Framework

A farmer's decision to adopt a new agricultural technology can be modeled using a dynamic programming framework. Here, we investigate the potential impact of free informational text messages on the farmer's decision to adopt IPM. Farmers are assumed to maximize expected profit, which is a function of production costs, yield and output price. Pest management activities incur both labor and material costs, and output is also dependent on pest management, as pest damage can decrease yields. Farmers compare the expected cost of pest management techniques with their expected returns.

For each pest or combination of pests, and at each level of existing or predicted damage, there exists a probability distribution associated with the effectiveness of IPM in limiting damage, and protecting yields. A farmer can make a decision based on both existing and predicted damage, as some practices must be employed after damage has been detected, and other practices when damage has not occurred, but must be prevented. Similarly, there exists a probability distribution associated with the effectiveness of non-IPM chemical controls. As with any new technology, the probability distribution of benefits associated with adoption of IPM is not well known to farmers. The probability distribution of benefits associated with the use of a known technology, such as chemical controls, holds less uncertainty. The relatively higher levels of uncertainty about IPM benefits can induce farmers to choose chemical controls over IPM, even when IPM would lead to greater benefits, as the expectation of IPM success may not match the actual probability distribution. Over time, farmers can receive signals, or pieces of information, that update their belief of the probability distribution associated with the success of each technique at each level of pest pressure. Our hypothesis is that when farmers have less uncertainty about IPM, and update their understanding of IPM benefits, they will adopt IPM over conventional pest control for those techniques that it is optimal to do so.

To explain this more formally, we adapt the model first presented by Ulu & Smith (2009), who considered the process through which a consumer adopts a single new technology under uncertainty. As IPM is not just one technology, but rather a series of techniques, which may or may not be used in combination, a farmer must consider many adoption decisions. Furthermore, a number of external factors, including damage levels and the presence of other pests, affect the objective probability distribution of IPM adoption benefits.

Within each problem, in each period, farmers have a choice to adopt or reject a particular IPM technique all together, or wait and gather more information. The benefits of adopting a technique are: $\theta \in \Theta \subseteq \mathfrak{R}$, where θ is the net present value of benefits from adopting the new technique, with $\mathfrak{R}$ denoting the set of benefits from all IPM techniques. Beliefs about the benefits of the IPM technique, given each level of damage and the presence of any other pest or disease, follow a probability distribution assumed to be continuous, with a density of π over Θ. These respective distributions form the state variables for each dynamic programming model. θ is assumed to be π-integrable in that $\int_\theta |\theta| \; \pi(\theta) d\theta$ is finite. In each period, the farmer makes a decision to adopt, reject, or wait for more information. If he decides to adopt the IPM technique, a fixed adoption cost of K must be paid. This cost varies by technique, and in many cases is zero. The farmer receives a net expected benefit from adoption of $\int_\theta |\theta| \; \pi(\theta) d\theta - K$. If he gathers more information, the cost of c must be paid. During this time, a farmer can observe a signal, $x \in X$, drawn with likelihood function $L(x|\theta)$. A Likelihood Ratio (LR) improvement happens when the likelihood of receiving a signal increases. Here, an assumption is made that signals always properly inform the farmer. Then, π is updated using Bayes' rule to find posterior $\Pi\ (\theta;\ \pi, x)$ given by

$$\Pi\ (\theta;\ \pi, x) = \frac{L(x|\ \theta)\ \pi\ (\theta)}{f\ (x; \pi)}$$

The farmer continues to the next period, where the new prior distribution is the posterior distribution from previous stage. The optimal value function with *k* periods remaining is:

$$v_0^*(\pi) = 0$$

$$v_k^*(\pi) = max\{0, \int_\theta\ \theta\pi(\theta)d\theta - K, -c + \delta E[v_{k-1}^*(\Pi(\pi,\ \tilde{x}))]\},$$

Where $\delta\ (0 \leq \delta \leq 1)$*:* is a discount factor and expectation of next period's value function is taken over all possible signals $\tilde{x}$.[4] For text message recipients, the cost of gathering information is zero, as they receive the message free of charge. Furthermore, the likelihood ratio, $L(x|\ \theta)$, for text message recipients is extremely high, as he regularly receives messages that correctly inform him of the benefits of the technology, which update his preferences using Bayes' rule. For these reasons, farmers who receive text messages are more likely to adopt IPM techniques because 1) they have a lower information gathering cost, K, than non-recipients; and 2) they receive more signals to adopt.

From the proofs provided by Ulu & Smith from their model of technology adoption under uncertainty, we can make several other inferences that explain the value of both free information and regular messages, and also a theoretical basis for understanding which practices might have higher adoption rates than others, given equal benefits. If LR-improvements, or increases in the likelihood that a farmer will receive signals, properly inform the farmer of the objective

[4] This presentation borrows heavily from "Uncertainty, information acquisition, and technology adoption" (Ulu & Smith, 2009)

distribution of a technique's benefits, a farmer will adopt personally beneficial technologies. In relation to regular text messages, as a farmer receives more signals, he will move from rejection to adoption, if adoption is in fact optimal. More signals will lead to LR-improved posterior distributions. Therefore the promotion of IPM technology through increased signals, like text messages, that lead to farmers to have an LR-improved prior distribution of the benefit of the technique, increase the probability of adoption and lead to earlier adoptions. Finally, if costs of gathering information and adoption are low, then benefits are likely to be greater than costs, which will lead to adoption.

Although the model shows that free, regular, quality information that allows a farmer to update his understanding of the probability distribution of benefits will eventually lead him to adopt all beneficial practices, it is also possible from this framework to hypothesize about the types of practices that are more likely to be adopted first. In addition to uncertainty, cost also factors into the adoption decision. Practices that have a lower adoption cost, such those for which no separate inputs are required, will be adopted more quickly than practices where a separate input is required. Next, holding the objective probability distribution of the benefit of two techniques constant, complex techniques take longer to be adopted than simple techniques, as there is more uncertainty regarding their benefits, and farmers may choose to wait and gather more information, rather than adopting.

Another explanation of the value of text messages in encouraging adoption is that text messages simply remind farmers to use IPM. In general, farmers are busy with their on-farm work, and may forget to, or put off, using a new practice, such as IPM. There is evidence that while people in general are prone to failing to follow through on an intended action (Datta & Mullainathan, 2012), individuals in developing countries lack the types of prompts and social cues that may remind them to do so (Bertrand, Mullainathan, & Shafir, 2006). As was shown in the mHealth portion of the literature review, text messages that remind recipients to engage in a particular behavior or action are effective. IPM text messages have the potential to promote adoption through the knowledge building and uncertainty reduction, and also the simple reminder to adopt.

An application of the dynamic programming model to a farmer's adoption decision process suggests that recipients of text messages possess more knowledge than those who did not. If learning reduces farmer's uncertainty about the probability distribution of IPM benefits, the text message recipient will have more knowledge about IPM, and thus a higher probability of adopting than a non-recipient. The treatment group would therefore have higher levels of both adoption and knowledge than the control group. There are three alternative hypotheses: The first is that there is no significant difference in the adoption rates and knowledge levels of the treatment and control. This would imply that that farmers 1) do not learn from the text messages, and/or 2) text messages do not serve as reminders to adopt IPM practices. The second is that while farmers who receive text messages adopt at higher rates than non-recipients, they possess similar knowledge to non-recipients. This would imply that text messages serve as reminders, rather than knowledge builders. Under the third scenario, treatment farmers have more knowledge than the control but the same adoption rates, which suggests that while text messages build knowledge, they do not promote adoption.

3.2.Experimental Design

To examine the impact of using text messages to complement a one-day IPM training program on adoption, we conduct an RCT involving potato farmers from Carchi, Ecuador. Three potato IPM field days were held by INIAP in Carchi during April and May 2014. During the field day, farmers visited various demonstration plots and were trained in proper IPM techniques by agricultural technicians. These field days were open to the public, and were promoted locally via radio, newspaper, and through INIAP-Carchi's extension networks. Costs to attend the field day, borne by farmers, included an all-day time commitment and transportation to the event. Benefits beyond training included lunch and the opportunity to network with farmers from neighboring regions. In total, approximately 450 potato farmers attended the field days. At the conclusion of the field day, each farmer received a take-home brochure that reinforced IPM methods (Appendix F).

A short survey was conducted during the field day to gather information on farmer's name, residence, cell phone number, relationship to household head, ability to receive messages, and the current production stage of their most important potato crops (later dubbed "reference plot"). Phone numbers were subsequently used to transmit texts to the treatment group. Potato production stage determined the order in which text messages would be received. Name and location were used to find participants for follow-up interviews at the conclusion of the trial.

Knowing a farmer's potato production stage was crucial for the intervention as IPM techniques vary based on the stage of production of the crop. Potatoes are grown year-round in Carchi. The stages of potato production are: 1) Period between planting and emergence of the plant's foliage; 2) Period from emergence until the formation of the tubers; and 3) Period between the formation of tubers until harvest. It was important to divide farmers by production stage so that messages were received during a time when the contents were most relevant.

Farmers were eligible to participate in the trial if they provided a unique cell phone number (meaning that they were the only ones at the field day who gave that cell phone number, as some family members share a phone) and had the ability to receive text messages. If more than one individual reported the same cell phone number, the household head was enrolled. Of 450 attendees, 435 met the inclusion criteria and agreed to participate in the trial, and thus were enrolled in the experiment. These farmers are located in six cantons, 22 parishes, and 103 villages. The number of farmers eligible to participate in the experiment exceeded the estimated minimum sample size to ensure statistical power of the trial, which was 330. This was calculated based on the probability of adoption using a sample size calculator in JMP[5], a computer-based statistical software tool administered by SAS[6], where the following parameters were entered: Probability of Type 1 error: 0.10; probability of Type 2 error: 0.80; minimum detectable difference in mean adoption score (percent of practices adopted): 5; standard deviation: 18.2. Though the probability of a Type 1 error used in sample size calculations is generally .05, the high costs of surveying the larger sample led to the decision to use .10 instead (Duflo, Glennerster, & Kremer, 2006b). The standard deviation of the adoption score was taken from Carrion's 2013 study of IPM adoption among Carchi potato farmers. Statistical collaborators from the Virginia Tech Laboratory for Interdisciplinary Statistical Analysis confirmed that 330 farmers would be more than sufficient, given the rigorous nature of the RCT design. To control for potential attrition, each of the 435 farmers was enrolled in the trial.

[5] When created, JMP originally stood for "John's Macintosh Program", but now only the acronym is used officially.

[6] JMP uses the following equation to calculate the minimum sample size:

$$n = \frac{2(z_{1-\frac{\alpha}{2}} + z_{1-\beta})^2}{(\frac{\mu_0 - \mu_1}{\sigma})^2}$$

Where: α refers to the probability of a Type 1 error; β is the probability of a Type II error; $\mu_0 - \mu_1$ is the minimum detectable difference in means; and σ is the standard deviation of the variable of interest. z_1 is the value from the standard normal distribution.

Villages were randomly assigned between control and treatment groups. Randomization was done at the village, rather than at the farmer level to minimize the potential for spillover. Spillover in this context would occur if individuals in the control receive information provided to those in the treatment group, which would cause the effect of the intervention to be attenuated. All Eligible farmers in treatment villages were assigned to receive text messages.

The trial lasted six months--the approximate length of a potato production cycle. From June to October, 2014, farmers in treatment villages received three weekly text messages reinforcing techniques learned at the field day. Messages were sent by researchers through Ecuadoran text messaging software "ContactoSMS". Each message was constrained by the allowable character limit for texts, and began with "MIP" (Spanish for "IPM") to properly identify the text to the recipient. The first message was introductory in nature, welcoming participants to the program, and informing them that they would begin receiving regular free messages with tips about managing their potato crop. Subsequent messages were staggered to correspond to a farmers' stated potato production cycle. A list of the messages is included in Appendix E.

3.3. Data Collection

Data collection began in October 2014, just after the intervention finished, and took place over a period of approximately 2 months, ending in mid-December. Of the 435 farmers included in the intervention, a total of 354 were interviewed. The fact that not all farmers were interviewed was due to survey staff time constraints and we assume that it does affect the analysis of the differences in IPM adoption and knowledge rates between treatment and control groups.

The survey was developed in conjunction with program staff and scientists at INIAP. It was tested several times in June and September with potential enumerators and text message recipients to ensure questions were clear. The survey included 112 questions divided into 7 modules. Module 1 included basic information about the farmer. Module 2 contained questions about household characteristics. Module 3 elicited potato production information including potato planting and harvesting timing, and was used to determine a “parcel of reference”. Farmers were directed to detail their pest management techniques specific to this parcel of reference in the latter half of the survey. Module 4 covered the information sources used to learn about IPM and other pest management techniques. Module 6 contained a single question about the number of pesticide applications in the parcel. Module 6 covered IPM knowledge and adoption questions and was divided into 5 sections, one for each insect pest or disease. Each section of module 6 began with a question about perceived pest pressure and damage experienced during the current cycle in the potato parcel of reference. That was followed by a general question about ways farmers control insect pest and disease. Then farmers reported whether or not they used each of the IPM techniques demonstrated during the field day and reinforced in the take-home brochure and text messages. Farmers were tested on their knowledge of the proper IPM controls, regardless of whether or not they reported using the technique. Finally, at the end of module 6, farmers were asked about asset ownership. Module 7 elicited feedback from recipients regarding their perceptions of the messages to inform future programming efforts[7].

[7] The survey is included in the appendix in both Spanish and English.

Chapter 4: Data and Empirical Model

The socio-economic characteristics of the farmers in the treatment and control groups were examined to determine that balance existed in the study, meaning that on average, the treatment and control groups do not differ significantly. Balance implies that mean differences in adoption and knowledge rates can be causally linked to the treatment. Imbalance in covariates that impact the outcome could bias the effect if not adjusted for. After balance is established, a comparison of the adoption rates of particular IPM techniques, and differences in IPM knowledge between the two groups provide the impact of text messages. An empirical model is used to analyze the impact of text messages on adoption to test our hypothesis that farmers gained knowledge through the text messages, which led to IPM adoption.

4.1.Data & Summary Statistics

Table 1: Household and Farm Characteristics of Sampled Potato Farmers in Carchi, Ecuador, 2014

Characteristic	Overall	Treatment	Control	p-value
Age of the farmer (in years)	41.71	40.45	43.18	0.022
Education of the farmer (in years)	8.14	8.33	7.93	0.173
Reference Plot: Size of potato plot in most recent production (in Hectares)	2.73	2.67	2.79	0.682
Farm Size per agricultural worker (hectares of land owned per family member over 14 engaged in on-farm work)	2.21	2.14	2.29	0.103
Time from home to potato plot (In minutes)	29.10	29.09	29.12	0.991
Total farm size (in hectares)	5.11	4.87	5.39	0.211

Notes: Each p-value results from a t-test of the statistical significance of difference in means between treatment and control groups.

The average farmer is about 42 years old and has an 8^{th} grade education (Table 1). His reference plot is located within 30 minutes of his home, by his usual method of transport, which could be walking, bus, or driving, and is just under 3 hectares. To test the balance of these covariates, a t-test was used. Results show that the treatment and control are balanced for each of variables except for age. Farmers in the treatment group are slightly younger than those in the control group. However this difference is small and will be controlled for in subsequent econometric analysis. This implies that a causal link can be established between receipt of text messages and increases in adoption and knowledge.

If farmers change their pest management techniques in response to observing a pest, pest pressure would be endogenous to the adoption decision. Any differences in pest pressure between treatment and control groups must therefore be assessed. Two measures of pest pressure are examined: 1) Observation of the pest or disease in the reference plot; and 2) The amount of damage, measured in percentage points, in the reference plot due to a particular disease or pest, if the pest is observed (Table 2).

Table 2: Pest Pressure Experienced by Potato Farmers in their Most Recent Cycle of Production, by Pest or Disease, Carchi 2014

	Percent of Farmers Who Observed Each Pest/Disease				Average Reported Damage, Measured as Percent of crop affected or damaged (contingent on observation of pest)			
Pest	Overall (%)	Treatment (%)	Control (%)	p-value*	Overall (%)	Treatment (%)	Control (%)	p-value
Andean potato weevil	85	87	83	0.268	15	15	14	0.372
Tuber moth	80	82	79	0.461	17	17	16	0.658
Leaf miner	85	87	82	0.208	16	17	16	0.249
Late blight	89	90	87	0.268	17	17	18	0.607
Rhizoctonia	50	54	45	0.097	14	13	14	0.285

Notes: Reported p-value the result of t-test for significance of difference in means between Treatment and Control Groups. A p-value above .10 signifies that the difference between the treatment and control is not statistically significant.

Results show that there is no statistically significant difference between the observation of each pest and related damage levels between control and treatment farmers. Over 80% of the sample observed the Andean potato weevil, tuber moth, leaf miner and late blight in their plot of reference. Farmers who observed pests in the reference plot, reported on average low damage levels. As differences are not statistically significant between the treatment and control groups, we can conclude that pest pressure is similar between groups.

Table 3: Adoption of Integrated Pest Management (IPM) Practices, By Practice, Carchi Potato Farmers 2014

IPM Practice	Percentage of Respondents Adopting			
	Total (%)	Control (%)	Treatment (%)	p-value
Use of traps for Andean potato weevil	17	13	20	0.11
Use of bait plants for Andean potato weevil	18	9	25	0.00
Use of IPM chemical control for Andean potato weevil (contingent on observation)*	56	62	52	0.08
Solarize seeds to prevent tuber moth	62	53	70	0.00
Application of Bacu-Turin to prevent tuber moth	11	8	13	0.10
Hilling to prevent tuber moth	87	82	91	0.01
Use of IPM chemical control for tuber moth (contingent on observation)*	81	80	82	0.60
Use of fixed traps for leaf miner	8	10	7	0.45
Use of mobile traps for leaf miner	6	7	6	0.75
Disinfect seeds to prevent Rhizoctonia	61	56	66	0.04
Use of IPM chemical control for Rhizoctonia (contingent on observation)	54	50	57	0.40

Notes: Each row represents a different IPM practice and the percentage of respondents claiming to use that practice. P-value is the result of a t-test for statistical significant difference in mean adoption rates between the treatment and control.
*The use of chemical controls for Andean potato weevil and tuber moth is only consistent with IPM if the farmer first observes the pest before spraying. For this reason, farmers are considered to have adopted these IPM practices only if they also report observing the Andean potato weevil or tuber moth respectively.

Adoption of each IPM practice in a farmer's reference parcel during their most recent potato production cycle is shown in Table 3. The adoption rate for four of the 11 practices is statistically higher among treatment than the control group. These IPM practices are bait plants for the Andean potato weevil, solarization for the tuber moth, hilling for the tuber moth, and disinfecting seeds to prevent Rhizoctonia. The largest differences are in the use of bait plants to control for the Andean potato weevil and solarization for the tuber moth.

Table 4: Knowledge of Integrated Pest Management (IPM) Techniques to Control for the Andean Potato Weevil, tuber moth, leaf miner, Late Blight, and Rhizoctonia for Potato Farmers in Carchi, Ecuador 2014

Knowledge Tested	Correct Response	Treatment (%)	Control (%)	p-value
Andean Potato Weevil				
IPM Andean potato weevil control techniques (Marked correct if one or more listed. Two or more if insecticides mentioned)	Insecticides, traps, volunteer plants, rotation	50	35	0.00
Recommended distance between Andean potato weevil traps	10 meters X 10 meters	66	29	0.00
Insecticide used in Andean potato weevil	Acefato, Profenofos, Fipronil	71	42	0.00
Insecticide used for bait plants	Acefato	63	26	0.00
Recommended distance between bait plants	5 meters	50	16	0.00
IPM Recommended Insecticide for Andean potato weevil	Profenofos, Acefato	55	39	0.00
Timing of first chemical control	When presence detected	37	48	0.03
Timing of second chemical control	Only if presence persists	41	52	0.05
Number of subsequent chemical controls needed if Andean potato weevil present after first control	Three	17	9	0.03
Tuber moth				
IPM tuber moth Control Techniques (Marked correct if one or more listed. Two or more if insecticides mentioned)	Bacu-Turin, solarization, hilling, sprinkler irrigation, use of insecticides	52	25	0.00
Solarization time to prevent tuber moth infestation	25 – 60 days	51	29	0.00
Type of hilling to prevent the tuber moth	High and crossed	69	43	0.00
Importance of hilling	To create a barrier between the tuber and pest	85	79	0.21
Fumigation time in relation to hilling	Concurrently	62	46	0.00
Purpose of fumigating while hilling	To kill any pests present between the top of the soil and the tuber	80	78	0.62
IPM recommended insecticide for tuber moth	Profenofos, Acefato	59	32	0.00
Leaf miner				
IPM leaf miner Control Techniques (Marked correct if one or more listed)	Chemical controls, yellow traps	63	30	0.00
Timing of fixed trap installation	After weeding	37	24	0.01
Timing of mobile trap passing	When measured presence high	39	21	0.00
Timing of leaf miner chemical control for adult leaf miners	When measured population is high, between emergence and flowering	70	33	0.00
Timing of leaf miner chemical control for larva	When measured population is high, between flowering and harvesting	57	30	0.00

Knowledge Tested	Correct Response	Treatment (%)	Control (%)	p-value
Late blight				
IPM Late Blight Prevention and Control Techniques (one or more)	Plant resistant varieties, use fungicides with low toxicity, rotate fungicides	38	33	0.39
Importance of using chemicals with different active ingredients in controlling late blight (one or more)	To rotate; to reduce likelihood of resistant strains developing	98	97	0.59
Rhizoctonia				
IPM Rhizoctonia Prevention and Control Techniques (Marked correct if one or more listed. Two or more if insecticides mentioned)	Disinfect seeds, use chemical control after planting, use high quality seeds	57	32	0.00
Seed disinfecting process	Submerge seed potatoes in a tank with disinfecting products, then dry and leave in the sun	38	20	0.00
IPM recommended chemical for disinfecting seed potatoes	Azoxistrobina (Quantis)	25	15	0.01
IPM recommended chemical for Rhizoctonia control	PCNB, Tabendazol	28	18	0.02
Recommended seed quality maintenance techniques	Use new, high quality seed potatoes every three years, remove yellow plants	57	52	0.31

Notes: The treatment group refers to those who were randomly selected to receive text messages about IPM for a period of 6 months. The control group did not receive messages. Statistically significant differences indicate the impact of messages.

Out of the 28 IPM-specific knowledge questions, farmers in the treatment group correctly answered 22 questions at a higher rate than those in the control group (Table 4). Differences were large, and statistically significant. While farmers in the treatment group demonstrated more knowledge about IPM for the tuber moth, leaf miner, Andean potato weevil, and Rhizoctonia, there was no statistically significant difference in the knowledge of IPM late blight prevention and control techniques. This is not surprising, given the long history of late blight presence in Carchi coupled with the lack of commercially viable alternatives to chemicals strong enough to prevent late blight from spreading, once present.

Statistical test to assess equality in mean socio-economic characteristics and pest pressure showed that the control and treatment groups were balanced. Statistically significant differences in the adoption of four of 11 practices can therefore be attributed to the receipt of text messages. Furthermore, text messages likely contribute heavily to knowledge building, as a larger percentage of treatment than control farmers correctly answered the majority of IPM knowledge questions.

4.2.Empirical Model

Descriptive statistics indicate that text messages are effective in encouraging the adoption of some IPM practices, but not others. To understand the types of practices for which text messages are effective, techniques are categorized in two different ways; first, according to simplicity, i.e. whether a technique is simple or complex[8]; and second, whether the technique requires an input purchase or not. The number of practices a farmer adopts per category is divided by the total number of practices within the category to form a "Degree of Adoption" for simple, complex, no input, and input reliant practices. To determine whether the adoption of these practices is due to the knowledge building, reminder effect, or both, a "Knowledge Score" is created that measures the percent of correctly answered knowledge questions. A detailed explanation of how these scores were calculated is included in Appendix B. If text messages have a positive impact on the knowledge score, this implies a knowledge building effect. If text messages have no impact on the knowledge score, but do impact the degree of adoption, we can infer that messages likely only serve to remind farmers to engage in IPM practices. If text messages positively impact both knowledge and adoption, have an impact on knowledge and increase the degree of adoption, text messages likely encourage adoption through a knowledge building and/or reminder effect.

[8] Categorizations of practices according to complexity and purchase requirement are in Table B.1

4.2.1. Dependent Variable: Adoption

There are four dependent variables - degree of adoption of: simple practices, complex practices, practices where separate purchase is required, and practices where no separate purchase is required. Each of these categorizations provides insight into the importance of information, cost, and the value of text messages in encouraging adoption.

Table 5: Adoption of Integrated Pest Management (IPM) Techniques by Type, Carchi Potato Farmers, 2014

Type of IPM Practice Adopted	Average Degree of Adoption			
	Overall (%)	Treatment (%)	Control (%)	P-Value
Simple Practices	61	63	59	0.06
Complex Practices	20	23	17	0.00
Practices Where Separate Purchase Required	33	34	32	0.33
Practices Where No Separate Purchase Required	46	52	39	0.00

Notes: Reported p-value corresponds to the statistical significance of differences in average knowledge scores between the treatment and control groups. Statistically significant differences can be attributed to the receipt of text messages.

The degree of adoption of simple practices adoption measures the number of simple practices adopted out of five total simple practices (Table B.1). These practices are categorized as simple because they require little knowledge, and no additional effort outside of what is typical for potato producers. Farmers in Carchi regularly spray pesticides, with respondents reportedly spraying between eight and 22 times on one plot during a typical six-month production cycle. Using an IPM recommended synthetic pesticide is therefore assumed to not require additional work. For this reason, the use of an IPM chemical for the Andean potato weevil, tuber moth, and Rhizoctonia are all categorized as simple. Hilling to prevent the tuber moth is also classified as simple, as walking the fields and tidying the rows regularly is standard practice. The solarization of seeds to prevent the tuber moth is similarly categorized as simple, given that this technique only requires placing seed potatoes in the sun before planting.

The degree of adoption of complex practices is the percentage of complex practices adopted out of a possible total of 6 practices (Table B.1). These practices are categorized as complex as their adoption involves a number of precise steps outside of what is typically accomplished by potato farmers in the area, and requires more knowledge about the technique. The use of traps and bait plants to capture Andean potato weevils is considered complex, due to multiple steps required for their preparation and use. Mobile and fixed traps for the leaf miner similarly require multiple steps to both prepare, and employ. Furthermore leaf miner traps require the purchase of sticky yellow plastic sheeting. Bacu-Turin has only been recently introduced and is not sold in every agrochemical retail outlet. Therefore farmers interested in using Bacu-Turin must engage in a search to obtain it. Once obtained, farmers must take an extra step after solarizing to apply it. Disinfecting seeds to prevent Rhizoctonia is categorized as complex as well, as a separate purchase and several steps are required to employ this technique.

Results show that text messages are effective in encouraging the adoption of practices that are simple, complex, and for which no separate purchase is required (table 5). This is demonstrated with a t-test comparing differences in mean adoption rates. Text messages are slightly more effective in encouraging the adoption of complex practices than simple ones as shown by a comparatively larger difference between treatment and control adoption rates for complex practices, a potential indication of the value of knowledge. The finding that out of the four "degrees of adoption" the difference between the treatment and control is greatest for practices that do not require an input purchase. This could suggest that the reminder effect is stronger than the knowledge effect. It also supports the hypothesis that cost, availability, and accessibility of inputs factors into the adoption decision. It also provides evidence that text messages have a reminder effect, as a farmer may immediately try a technique that is not reliant on a separate purchase.

4.2.2. Dependent Variable: Knowledge

To determine the extent to which text messages have a knowledge building effect, we measure both overall, and pest-specific IPM knowledge.

Table 6: Knowledge of Integrated Pest Management (IPM) Techniques by Practice Type, Carchi Potato Farmers, 2014

Type of Knowledge Measured	Average Knowledge Score			
	Overall (%)	Treatment (%)	Control (%)	P-Value
Overall	51	57	42	0.00
IPM Controls for Andean potato weevil	42	50	33	0.00
IPM Controls for tuber moth	60	68	51	0.00
IPM Controls for leaf miner	49	58	39	0.00
IPM Controls for Rhizoctonia	32	37	26	0.00

Notes: Score is out of 100 possible points. Reported p-value correspond to the statistical significance of differences in average knowledge scores between the treatment and control groups. Statistically significant differences can be attributed to the receipt of text messages.

The overall knowledge score is based on a total of 24 knowledge questions[9] and reflects the number of correctly answered knowledge questions, measured as a percentage. Text messages contribute to a 15 percentage-point difference in the overall knowledge score, providing strong evidence that texts have a knowledge-building effect. This difference is consistent across each pest and disease[10].

[9] Of 28 total knowledge questions in the survey, 4 were general questions designed to get farmers to think about their pest management practices and were not included when calculating the score. The remaining 24 were specific to the IPM techniques and are included.

[10] No score is included for created for Late Blight, as only one IPM specific Late Blight knowledge question was included in the survey.

A comparison of differences in adoption and knowledge scores between the treatment and control group support the hypothesis that text messages are effective because they increase a farmer's knowledge, thereby reducing his uncertainty about the distribution of benefits, and leading him to adopt certain IPM techniques (table 6). Furthermore, a large statistically significant difference between treatment and control groups for the adoption of practices for which no separate purchase is required is evidence of the reminder effect of the text messages. Use of the degree of adoption and knowledge score as dependent variables in an econometric model, together with explanatory variables controlling for within group differences, will further provide evidence of the effectiveness of text messages in encouraging adoption and knowledge of IPM practices and also illustrate the relative importance of knowledge and reminder effects.

4.2.3. Explanatory Variables

It is possible that different population sub-groups react differently to the receipt of text messages. It is also possible that a farmer's characteristics, independent of his participation in the treatment and control group, influence his overall knowledge and adoption of IPM. For these reasons, the following explanatory variables are included: farmer's age, farmer's education, the size of his reference plot, farmer's wealth, labor availability on the farmer's farm, and time from a farmer's home to his plot of reference. To determine whether text message benefits are confined to a certain subset of the population, inclusion in the treatment group is interacted with age, education, and time from the home to plot of reference to form three interaction terms.

When tested empirically throughout the literature, the impact of farmer's age on adoption has mixed results. Theories that model the adoption decision using risk, contend that age is negatively correlated with adoption as risk tolerance decreases when a farmer grows older (Mauceri et al., 2007). In the conceptual framework in Chapter 3, we showed that limited adoption is a result of uncertainty about the probability distribution of benefits. The more correct signals a farmer receives, the more he will adopt IPM. If we assume that, before this intervention, the number of per-year signals was the same for each farmer per year, we might expect that older farmers will adopt more than younger farmers, as they have received more signals in their lifetime. However the idea that LR improvements lead to adoption rely on the assumption that each signal lets a farmer updates his preferences according to Bayes rule. If the signals he received were incorrect, or conflicting, they would not, in fact have reduced his uncertainty over time. As we cannot determine the accuracy of the signals farmers received prior to the intervention, it is difficult to hypothesize as to whether or not older farmers adopt and possess more IPM knowledge than younger farmers. Text messages however could have a greater effect on younger farmers than older farmers, as younger farmers could be more open to learning new information. Younger farmers could also be able to better make use of cell phone and access information provided in text messages. For this reason, we expect to see that the coefficient referring to the interaction of age and the treatment is positive for adoption. Finally, the squared age term is also included in the adoption regression as it is possible that a non-linear relationship exists between age and adoption. The squared age term is expected to be negative, as the impact of age on adoption is expected to increase at a decreasing rate, and might become negative when age reaches a certain value.

Theoretically, education can positively influence adoption and knowledge. Better-educated farmers have an increased ability to acquire knowledge and understand complex techniques, which lead to higher levels of adoption (Feder & Umali, 1993). We expect farmers with a higher level of education to adopt more IPM practices, and possess more IPM knowledge. Furthermore, it follows from the conceptual framework that better educated farmers might understand message content more easily, and therefore be able to more readily update their perceptions about the benefits from IPM. If text messages increase knowledge, which in turn reduces uncertainty and leads to adoption, the interaction term of possessing a secondary education and receiving the treatment should be positive both for knowledge and adoption.

The size of the reference plot is hypothesized to negatively affect adoption, as a larger plot necessitates more inputs, including labor. A farmer is therefore able to more easily implement the IPM practice, and observe its effectiveness with greater certainty. A relatively larger reference plot could have greater variability within it than a smaller plot, which could influence the relative effectiveness of a particular technique.

Wealth can affect adoption in several ways, some of which may counteract each other. Empirically, depending on the context, wealth has been shown to have positive, negative, and insignificant effects on the adoption of conservation agriculture practices, labor-based low-cost practices (Knowler & Bradshaw, 2007). In this model we expect wealthier farmers to adopt more of the practices for which a separate input is required, as they are less likely to be cash and credit constrained than poorer farmers. Wealthier farmers are also more able to bear risk than poorer farmers. If we take two farmers, one rich and one poor, and assume that text messages reduce both farmers' uncertainty about the probability of IPM benefits to the point where no uncertainty exists at all, the wealthier farmer will adopt more than the poor farmer, because he will accept a greater risk that benefits will not be realized. Overall, it is likely that the impact of wealth on adoption and knowledge, holding all else constant, may be insignificant or even negative as wealthier households likely use more chemical-intensive practices, which are often counter to the adoption of IPM (Mauceri et al., 2007). Relative wealth is captured using a Principal

Component Analysis (PCA) index to compare asset ownership, with steps detailed in (Fry K., 2014). A Stata file detailing the construction is included in Appendix D.

Labor availability is measured as the amount of farm land per family member over the age of 14 engaged in on-farm work. As many IPM techniques are more labor intensive than conventional controls, greater labor availability could decrease the per person costs of adoption. For this reason, we hypothesize that increased labor availability will increase adoption.

The time it takes for a farmer to travel from his home to his plot is hypothesized to have a negative effect on IPM adoption. The closer in proximity a farmer is to his plot, the more likely he is to observe the effectiveness of a particular IPM technique. Therefore, the farther away he is from his plot, the more uncertain he will be about the benefits of a technique. Furthermore, the opportunity cost of time to travel to a plot is higher for plots that are far away. This makes it difficult to observe pest pressure, and reduces the adoption of IPM techniques for which pest observation is a necessary first step. Additionally, a farmer who lives closer to his potato plot can more quickly act on the information included in a text message. Therefore the reminder effect of text messages should be greater for those who live in close proximity to his plot.

4.2.4. Econometric Model Specification

The relationship between adoption and the explanatory variables is expressed as:

$$Y_i^j = aTREAT_i + bS_i + cF_i + dG_i * TREAT + \varepsilon_i \qquad (1)$$

Where Y_i^j is the Adoption Score for farmer *i*, and:

$$j = \begin{cases} S\ for\ Simple\ Practices \\ C\ for\ Complex\ Practices \\ P\ for\ Purchase\ Reliant\ Practices \\ N\ for\ Non-Purchase\ Reliant \end{cases}$$

And:

- $TREAT = \begin{cases} 1\ if\ Treatment \\ 0\ if\ Control \end{cases}$;

- *S* is a vector of farmer-specific socio-economic characteristics: Age, age squared, education, and wealth;
- *F* is a vector of farm characteristics: size of potato reference plot, labor availability (measured in land per worker), and time from home to reference plot;
- *G* is a vector of characteristics that are interacted with the treatment (age, education, and time from the home to plot)
- ε_i is the idiosyncratic error term, which is assumed to be clustered at the village level (heteroscedasticity), has no seral correlation, and normally distributed.

The coefficient *a* will be positive if the text messages had a positive impact on adoption; coefficients *b* and *c* will reflect the influence of those socio-economic or farm characteristics on adoption; and the sign of coefficient *d* will show whether receiving the treatment impacts differently those who are older, have a secondary education, and live farther from the reference plot.

To estimate the impact of text messages on knowledge, a similar econometric specification is proposed:

$$Z_i = aTREAT + bS_i + cP_i\ educ\_8 * TREAT + \varepsilon_i \qquad (2)$$

Where

- Z_i is the overall knowledge score of farmer *i;*
- $TREAT = \begin{cases} 1\ if\ Treatment \\ 0\ if\ Control \end{cases}$;
- *S* is a vector of farmer-specific socio-economic characteristics: age, education, and wealth;

- *educ_8 * TREAT* is the interaction term of being in the treatment group and having a secondary education;
- ε_i is the idiosyncratic error term, which is assumed to be clustered at the village level (heteroscedasticity), has no seral correlation, and normally distributed.

The coefficient *a* will be positive if the text messages had a positive impact on knowledge; coefficients *b* will reflect the influence of those socio-economic on knowledge; and the sign of coefficient *c* will show whether receiving the treatment impacts differently who have a secondary education.

Chapter 5: Results

Econometric results confirm that text message recipients adopt IPM at higher rates than non-recipients (table 7). Large increases in knowledge among farmers in the treatment relative to those in the control group show that messages do have a knowledge building effect. Furthermore, the fact that practices for which no separate purchase is required are adopted more by the treatment than the control group is strong evidence that texts do not just build knowledge, but have a reminder effect as well.

As randomization was conducted at the village level standard errors are clustered at the village level. For this reason, a robust variance estimate was obtained that relaxes the usual assumption that observations are independent across each farmer. Observations are instead assumed to be independent across villages, but not necessarily within them. While this affects the standard errors and variance, it does not affect the coefficient estimates (StataCorp, 2013).

Table 7: Impact of Text Messages on the Adoption of Integrated Pest Management (IPM) by Simple and Complex Practice Type, Carchi Potato Farmers 2014

	Simple Practice Adoption (Scale: 0-1)	Complex Practice Adoption (Scale: 0-1)
Treatment	.058* (.058)	.059** (.017)
Age of Farmer in Years	.002 (0.110)	-.001 (.538)
Age Squared	0.00 (0.963)	-.000 (.899)
Farmer has >8 years of Formal Education	.026 (0.426)	.040 (.272)
Wealth	-.006 (0.427)	-.010*** (.010)
Size of potato reference plot	-.005 (0.293)	-.001 (.653)
Labor Availability (land per worker)	-.001 (0.752)	.003 (.417)
Time (in minutes) that it takes from home to the potato plot	.001 (0.118)	-.000 (.660)

Notes: Treatment indicates farmer was randomly selected to receive text messages. Columns represent regression results where the rate of adoption of simple practices and complex practices are the dependent variables. Scale is from 0-1, where a coefficient of .058 translates to a 5.8% point difference in the rate of adoption.
***, **, * means significant at the 1%, 5%, and 10% level respectively.
Interaction dummies were not included in the regression, as each was found to be statistically insignificant.

Being part of the treatment is significant and the most important predictor of adoption of simple and complex IPM practices, indicating that the receipt of text messages positively influences the adoption of both types of practices. The only other statistically significant covariate is wealth in the case of the adoption of complex practices – an increase in wealth is associated with a decrease in the adoption of complex practices. This could be related to the idea that richer farmers have a higher opportunity cost of time, and therefore do not choose to adopt time intensive practices.

Next, we analyze the impact of the treatment on the adoption of purchase reliant and non-purchase reliant IPM practices. If we assume that the knowledge requirement for these two sets of practices is the same, we would expect the reminder effect to be larger for non-purchase reliant practices. This is because farmers may immediately use practices that don't require them first to leave home and purchase inputs.

Table 8: Impact of Text Messages on the Adoption of Integrated Pest Management (IPM) by Purchase-Reliant and Non-Purchase Reliant Practice Type, Carchi Potato Farmers 2014

	Purchase Reliant Practice Adoption (Scale: 0-1)	Non-Purchase Reliant Practice Adoption (Scale: 0-1)
Treatment	.024 (.257)	.128*** (.000)
Age of Farmer in Years	.000 (.656)	0.000 (.970)
Age Squared	-.000 (.498)	.000 (.544)
Farmer has >8 years of Formal Education	.032 (.379)	.039 (.292)
Wealth	-.013** (.033)	-.007 (.184)
Size of potato reference plot	-.006 (.093)	.003 (.559))
Labor Availability (land per worker)	.002 (.425)	-.001 (.790)
Time (in minutes) that it takes from home to the potato plot	-.000 (.660)	.001* (.071)

Notes: Treatment indicates farmer was randomly selected to receive text messages. Columns represent OLS regression results where Purchase Reliant Practice Score and Non Purchase-Reliant Score are the dependent variables.
***, **, * means significant at the 1%, 5%, and 10% level respectively.
Interaction dummies were not included in the regression, as each was found to be statistically insignificant.

Results provide strong evidence of the reminder effect of text messages. The treatment contributes to a 13 percentage point higher adoption of non-purchase reliant practices. Each of the other coefficients are extremely small, or statistically insignificant, indicating that the receipt of text messages is likely the only factor that influences adoption.

These results show that adoption of both complex and simple IPM practices can be encouraged through text messages, and that the adoption of non-purchase reliant practices significantly increases by text messages. To obtain better understanding about the pathway of influence (whether the text message serves only as a reminder or increases knowledge), we examine differences in IPM knowledge between treatment and control groups. If knowledge differences are significant, texts have a knowledge building effect. If no differences are present, we reject the hypothesis that text messages promote adoption through knowledge building, and can conclude that messages serve only to remind farmers to adopt. In table 9, the results of the econometric model showing the impact of the treatment on the knowledge score are provided.

Table 9: Impact of Text Messages on the Knowledge of Integrated Pest Management (IPM), Carchi Potato Farmers, 2014

	Overall Knowledge Score
Treatment	0.152*** (0.000)
Age	0.001 (0.877)
Farmer has >8 Years of Formal Education	.070** (.044)
Wealth	-.009 (.233)
Education X Treatment	.045 (0.338)

Notes: P-values correspond to standard errors clustered at the village level.
***, **, * means significant at the 1%, 5%, and 10% level respectively.

Results show that text messages have a significant knowledge building effect, as evidenced by a large (15 point) statistically significant coefficient on the treatment dummy variable. Having a secondary education leads to a statistically significant 7 percentage point increase in the knowledge score. However individuals with a secondary education receive no greater returns to text messages than those without a secondary education. While this is contrary to our expectation, and counter to the results of Cole (2012), who found that text messages increased knowledge only among those with a secondary education, it is positive news for practitioners, as benefits of these text messages are not confined to those with higher levels of education.

Chapter 6: Conclusion and Discussion

Once IPM techniques have been introduced to farmers via a field day, text messages are shown to be an effective supplementary tool in encouraging their adoption. Text messages are effective because they simultaneously decrease a farmer's information search costs, and increase the number of signals he receives about a technique. The conceptual framework demonstrated that, theoretically, a farmer can update his beliefs about the probability distribution of a technique's benefits through the receipt of regular informational messages, and subsequently adopt those practices that maximize profits. This is consistent with the empirical comparison of the mean adoption rates of those randomly assigned to receive text messages and control groups. The impact of these messages is further verified through an econometric analysis, where the dummy variable for treatment was the most significant predictor of the adoption of both simple and complex practices.

The knowledge-building effect of text messages was demonstrated through the 15 percentage point difference in knowledge between the treatment and control groups, holding all other factors constant. Given differences in knowledge scores were nearly three times the difference in adoption rates of simple and complex practices, it is possible that although farmers are learning, they fail to adopt certain practices either because they are not beneficial, because of cost, or because they do not have immediate access to the needed inputs. The idea that cost is a deterrent to adoption can be shown by comparing differences in the adoption of purchase reliant, and non-purchase reliant practices. However these differences could also be attributed to access, availability, and timing. While text messages appear ineffective in encouraging the adoption of purchase reliant practices, they are very effective in encouraging the adoption of practices for which no separate purchase is required. This could also be evidence of the reminder effect of messages, as techniques that are not purchase reliant can immediately be implemented, once a reminder messages is received.

This study supports the idea that increased signals can reduce a farmer's uncertainty about the benefits of a new technology, thereby increasing its adoption. It also supports the behaviorist idea that nudges, or reminders to act, can encourage the adoption of low-cost, or easily implementable practices in an agricultural setting. For practitioners, the findings of this study indicate that supplementing an in-person training program with regular informational messages can increase a farmer's knowledge, and lead to the adoption of both simple and complex techniques. Furthermore, the benefits of this intervention are uniform across ages, educational attainment, and wealth.

It is important however to note that, as with other RCTs, the results of this study are dependent on the characteristics of the farmers in attendance at the field day, which may or may not represent the entire population of potato producers in Carchi. Additionally, results might not be replicable across survey areas. It is also crucial to reiterate that the effectiveness of text messages demonstrated in this study was contingent on their content being first delivered via an in-person demonstration session. However, given that the costs of message transmission are low, adding a text message supplement to an already existing in-person training program could be an attractive option for practitioners engaged in agricultural extension work. Regular informational messages have the ability to influence a farmer's adoption of beneficial agricultural technologies, impacting economic growth and poverty alleviation by raising productivity, reducing production costs, and fostering health and environmental stewardship.

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Appendix A: Pests, Diseases, and Management Techniques

Table A.1: Description of Potato Pests and Diseases Present in Carchi, Ecuador for which Integrated Pest Management (IPM) Techniques are Taught

Pest/Disease	Description
Andean Potato Weevil *Premnotrypes Vorax* Gusano Blanco	• Common pest with potatoes grown at high altitudes, with damage characterized by circular holes in potatoes. • Larva live in and feed on tubers, reducing salable yields and use of potatoes as seeds. If life cycle is completed before potatoes mature, damage could be present at time of harvest. Otherwise, damage presents itself in storage. • Adults nibble on leaves, which indicate presence of the Andean potato weevil, but does not cause significant damage on its own.[11] • Extremely long life cycle (424-499 days) https://research.cip.cgiar.org/confluence/display/icmtoolbox/Andean+Potato+Weevil
Central American tuber moth *Tecia solanivora* Polilla	• An insect that reduces the quality and quantity of potatoes produced, and affected potatoes become susceptible to pathogen infection. • The tuber moth affects potatoes in the field, and in storage, as infected potatoes contaminate uninfected ones in storage leaving the entire harvest unsalable[12] • Sometimes at harvest, no damage is visible, but eggs that have been laid under the surface can cause further damage in storage and lead to a secondary infestation of a different pathogen [13] • The tuber moth can survive year to year, especially when infested tubers are used as seed potatoes • Damage levels up to 45% are reported in the fields, and 100% in storage
Late Blight *Phytophthora infestans* Lancha	• A fungus which caused the Irish Potato Famine and is extremely widespread among potato cultivation. Resistant varieties exist, though in Carchi, few are commercially viable. • Leaves: Dark blotches on leaves and stems. Produces sporangia which looks like white mold under leaves. Entire plant can be destroyed and collapse within a few days. • Tubers: Sporangium washed from leaves onto the soil. • Affected tubers end up rotting • Blight spread in wet weather and wind. • In the last 25 years has resurged as a problem as resistance to fungicides has quickly developed. This is the result of a second mating type being introduced that allows quicker development of resistance. • Potatoes from a previous harvest including volunteer potatoes affected by blight are biggest cause of spreading disease from one year to the next

[11] https://research.cip.cgiar.org/confluence/display/icmtoolbox/Andean+Potato+Weevil
[12] http://entnemdept.ufl.edu/creatures/VEG/POTATO/potato_tuberworm.htm
[13] https://research.cip.cgiar.org/confluence/display/icmtoolbox/Potato+tuber+moth

Pest/Disease	Description
Leaf Miner *Liriomyza huidobrensis* Mosca Minadora	• Leaf miners damage the leaves of the potato, limiting the plant's growth through a reduction in photosynthesis capabilities • A large increase in leaf miner presence and damage throughout South America is caused by destruction of natural enemies of the leaf miner through pesticide over-spraying • Heavy infestation causes leaves to senesce prematurely[14], so fields with significant damage look burned[15]
Rhizoctonia *Rhizoctonia Solani* Spanish: Rhizoctonia	• A fungus that root rot. While relatively new to Carchi, Rhizoctonia has been present in other areas for over 100 years. • Damage characterized by the formation of black masses (fungus bodies) on the tuber[16] These formations do not damage the tuber itself, but transmit the disease and prohibit new growth. • Fungus attacks sprouts before they emerge, causing delayed emergence, and weakened and uneven plants.

14
http://keys.lucidcentral.org/keys/v3/leafminers/key/Polyphagous%20Agromyzid%20Leafminers/Media/Html/Liriomyza_huidobrensis.htm
15 https://research.cip.cgiar.org/confluence/display/icmtoolbox/Leaf+Miner+Fly
16 http://www.potatodiseases.org/rhizoctonia.html

Table A.2: Potato Integrated Pest Management (IPM) Techniques developed for Carchi, Ecuador Per Pest/Pathogen

Pest/Disease	**Recommended IPM Controls** 1: Planting → Emergence; 2: Emergence → Tuber Formation; 3: Tuber formation → Harvest
Andean Potato Weevil	1: Traps, bait plants made from volunteer plants* treated with Acefato 2: Application of Acefato or Profenofos on the base of the plant *if* presence detected 3: Repeat pesticide application if it rains right after application
Potato tuber moth	1: Solarization for at least 25 days prior to planting; application of bio insecticide "Bacu-Turin" 2: Hilling and simultaneous fumigation with Profenofos or Acefato 3: Sprinkler system; application of low toxicity pesticides *if* presence detected
Leaf Miner	1: Fixed yellow traps installed after weeding 2: Mobile yellow traps; application of low-toxicity pesticide if presence detected 3: Application of insecticide if leaf miner worms appear during this stage
Late Blight	All: Fungicide rotation; removal of plants near affected ones; use of resistant varieties
Rhizoctonia	1: Disinfect seeds by submerging potatoes in water tank treated with Azoxistrobina 2: Application of PCNB and Tiabendazol to the stem and soil 65 days after planting 3: Removal of yellow plants to maintain seed quality

*Volunteer plants are potato plants that emerge from potato plants that were left in the field after harvest. In IPM, they are transplanted to the borders and used as bait plants. However volunteer plants can often hold late blight sporangia from a previous season. These plants should not be used if late blight was present in the previous planting cycle.

Appendix B: Dependent Variables for Adoption

Table B.1: Integrated Pest Management (IPM) Practices Included in Each Adoption Score

IPM Practice	IPM Adoption Scores			
	Simple	**Complex**	**Purchase-Reliant**	**Non-Purchase Reliant**
Use of traps for Andean potato weevil		×		×
Use of bait plants for Andean potato weevil		×		×
Use of IPM chemical control for Andean potato weevil (contingent on observation)	×		×	
Solarize seeds to prevent tuber moth	×			×
Application of Bacu-Turin to prevent tuber moth		×	×	
Hilling to prevent tuber moth	×			×
Use of IPM chemical control for tuber moth (contingent on observation)	×		×	
Use of fixed traps for leaf miner		×	×	
Use of mobile traps for leaf miner		×	×	
Disinfect seeds to prevent Rhizoctonia		×	×	
Use of IPM chemical control for Rhizoctonia (contingent on observation)	×		×	

To create the adoption rates for each adoption category (simple, complex, no input, and input required), the following framework was used. Table B.2 presents a list of practices and a corresponding abbreviation used in the subsequent equations.

Table B.2: Adoption of Integrated Pest Management (IPM) Practices, and corresponding field codes

IPM Practice	Code for Equation
Use of traps for Andean potato weevil	WEEVIL_TRAPS
Use of bait plants for Andean potato weevil	WEEVIL_BAIT
Use of IPM chemical control for Andean potato weevil (contingent on observation)*	WEEVIL_CHEM
Solarize seeds to prevent tuber moth	TUBERMOTH_SOLARIZATION
Application of Bacu-Turin to prevent tuber moth	TUBERMOTH_BACUTURIN
Hilling to prevent tuber moth	TUBERMOTH_HILLING
Use of IPM chemical control for tuber moth (contingent on observation)*	TUBERMOTH_CHEM
Use of fixed traps for leaf miner	LEAF_FTRAPS
Use of mobile traps for leaf miner	LEAF_MTRAPS
Disinfect seeds to prevent Rhizoctonia	RHIZ_DISINFECT
Use of IPM chemical control for Rhizoctonia (contingent on observation)	RHIZ_CHEM

To create the Simple Practice Score, simple practices are divided into preventative and reactive subsets, as the correct adoption of the reactive practices is contingent on the observation of the pest or pathogen:

$$Preventative\ Practices\ (P) = \{TUBERMOTH\_HILLING, TUBERMOTH\_SOLARIZATION\}$$

$$Reactive\ Practices (R) = \{WEEVIL\_CHEM, TUBERMOTH\_CHEM, RHIZ\_CHEM\}$$

Where each of the preventative practices and reactive practices in brackets correspond to IPM practices listed in table

Then, the *Simple Practice Score* is defined by equation (B.1):

$$Simple\ Practice\ Score\ (\%)_i = \frac{\sum_R adopt_R^i + \sum_P adopt_P^i}{\sum_R observe_R^i + 2} \tag{B.1}$$

Where:

- $adopt_R = \begin{cases} 1 & if\ related\ pest\ is\ observed\ AND\ the\ practice\ is\ adopted \\ 0 & otherwise \end{cases}$;
- $adopt_P = \begin{cases} 1 & if\ the\ practice\ is\ adopted \\ 0 & otherwise \end{cases}$;
- $observe_R = \begin{cases} 0 & if\ related\ pest\ unobserved\ AND\ practice\ not\ adopted \\ 1 & otherwise \end{cases}$; and
- '2' in the denominator corresponds to the number of preventative practices.

Equation (1) calculates the proportion of correctly adopted simple practices and is generally of the form (*No. Correct adoption actions taken* / *No. Cases where 'adopt' is the correct action*). However, there is a need to distinguish between *reactive* and *preventative* adoption actions taken, since adoption of a *preventative* practice is always desirable but adoption of *reactive* practice is only 'correct' if it occurs after the pest has been observed; i.e. if a pest is *not* observed then the correct action is to *not* adopt the reactive practice. This is taken into account in equation (B.1) as follows: The numerator measures the number of correct adoption actions taken, and thus varies between 0 and 5. The denominator ranges from 2 to 5 and measures the number of cases where 'adopt' is the correct action, that is, when the relevant pest *is* observed for a reactive practice and always for a preventative practice. Thus, $observe_R$ is defined such that an individual is not penalized for the correct action of *not* adopting a reactive practice when the relevant pest was *not* observed, but *is* penalized for incorrectly adopting a reactive practice when the relevant pest was not observed.

For the Complex Practice score (Equation (B.2)), the 6 practices are all preventative, and correct adoption is therefore not contingent on observation of the associated pest. The *Complex Practice Score* is defined by equation (B.2):

$$Complex\ Practice\ Score\ (\%)_i = \frac{\sum_P adopt_P^i}{6} \tag{B.2}$$

Where $adopt_P$ is defined analogously as in equation (B.1), and 6 refers to the number of practices.

Components of the Separate Purchase Score are categorized as preventative and reactive, as was the case with Simple Practices as follows:

$$Preventative\ (P) = \{TUBERMOTH\_BACUTURIN, LEAF\_FTRAPS, LEAF\_MTRAPS, RHIZ\_DISINFECT\}$$

$$Reactive(R)\ = \{WEEVIL\_CHEM,\ TUBERMOTH\_CHEM, RHIZ\_CHEM\}B$$

Then the *Separate Purchase Score* is defined by equation (3):

$$Seperate\ Purchase\ Score\ (\%)_i = \frac{\sum_R adopt_R^i + \sum_P adopt_P^i}{\sum_R observe_R^i + 4} \tag{B.3}$$

Where $adopt_R, adopt_P$ and $observe_R$ are defined analogously as in (B.1) and "4" corresponds to the number of preventative practices for which a separate purchase is required.

The four practices included in the No Separate Purchase Score are all preventative, and the *No Separate Purchase Score* is defined by Equation (B.4):

$$No\ Separate\ Purchase\ Score\ (\%)_i = \frac{\sum_P adopt_P^i}{4} \tag{B.4}$$

Where $adopt_P$ is defined analogously as in equation (1) and "4" corresponds to the number of practices.

Pest related variables (Table 8) include both preventative and reactive practices, classified as follows:

$$Preventative\ (P) = [WEEVIL\_TRAPS, WEEVIL\_BAIT, TUBERMOTH\_SOLARIZE, TUBERMOTH\_BACUTURIN, TUBERMOTH\_HILLING, LEAF\_FTRAPS, LEAF\_MTRAPS; RHIZ\_DISINFECT]$$

$$Reactive(R) = [WEEVIL_{CHEM}, TUBERMOTH_{CHEM}, RHIZ_{CHEM}]$$

Then, for each pest, a related score is created:

$$Weevil\ Adoption\ Score\ (\%)_i = \frac{\sum_R adopt_R^i + \sum_P adopt_P^i}{\sum_R observe_R^i + 2} \tag{B.5}$$

$$Tubermoth\ Adoption\ Score\ (\%)_i = \frac{\sum_R adopt_R^i + \sum_P adopt_P^i}{\sum_R observe_R^i + 3} \tag{B.6}$$

$$Leafminer\ Adoption\ Score\ (\%)_i = \frac{\sum_P adopt_P^i}{2} \tag{B.7}$$

$$Rhizoctonia\ Adoption\ Score\ (\%)_i = \frac{\sum_R adopt_R^i + \sum_P adopt_P^i}{\sum_R observe_R^i + 1} \tag{B.8}$$

Where $adopt_R, adopt_P$ and $observe_R$ are defined analogously as in Equation (1).

Appendix C: Wealth Index

To measure farmers' wealth, the questionnaire asked farmers to report their ownership of certain assets, including televisions, refrigerators and potable water. From this data, a wealth index was created that provided a composite measure of a farmer's relative living standard. To do this, a statistical procedure called "principal components analysis" (PCA) was employed in Stata using guidelines from "Measuring Equity with Nationally Representative Wealth Quintiles, published by PSI.[17] Following is the Stata .do file used to create the index:

```
//Create Wealth Index//

//run PCA components analysis using Stata command pca where each variable is an observation
of the number of each item a farmer claims to own//
pca W_TELEVISIONS W_REFRIGERATORS W_MICROWAVES W_TELEPHONE
W_CELLPHONES W_MOTORCYCLE W_VEHICLES W_PUMPS W_CLOTHES
W_WATER W_TOILET W_COMPUTER W_COWS, means

//assign wealth index scores to each respondent//
predict wealthscore

//determine range of wealth index scores for each quintile//
xtile quintile=wealthscore, nq(5)

summ wealthscore if quintile ==1
summ wealthscore if quintile ==2
summ wealthscore if quintile ==3
summ wealthscore if quintile ==4
summ wealthscore if quintile ==5

//standardize survey variables by mean and standard deviations to account for binary and
continuous variables//
//subtract the mean of the variable from each value and then divide by standard deviation//
gen W_TELEVISIONS_2 = (W_TELEVISIONS - 1.237)/0.564
gen W_REFRIGERATORS_2 = (W_REFRIGERATORS - 0.677)/.525
gen W_MICROWAVES_2 = (W_MICROWAVES - 0.295)/.504
gen W_TELEPHONE_2 = (W_TELEPHONE -0.433)/.561
gen W_CELLPHONES_2 = (W_CELLPHONES - 1.473)/.873
gen W_MOTORCYCLE_2 = (W_MOTORCYCLE  - 0.425)/0.569
gen W_VEHICLES_2 = (W_VEHICLES - 0.371)/0.579
```

[17] http://www.psi.org/wp-content/uploads/2014/10/Wealth-Quintile-Guide.pdf

```
gen W_PUMPS_2 = (W_PUMPS - 0.252)/0.49
gen W_CLOTHES_2 = (W_CLOTHES - 0.32)/0.519
gen W_WATER_2 = (W_WATER - 0.907)/0.292
gen W_TOILET_2 = (W_TOILET - 0.819)/0.386
gen W_COMPUTER_2 = (W_COMPUTER - 0.513)/0.617
gen W_COWS_2 = (W_COWS - 5) /7.05

//apply factor weights: multiply standardized variable by factor weights, then add values together//
gen W_TELEVISIONS_3 = W_TELEVISIONS_2*.1739
gen W_REFRIGERATORS_3 = W_REFRIGERATORS_2*.3379
gen W_MICROWAVES_3 = W_MICROWAVES_2*.3828
gen W_TELEPHONE_3 = W_TELEPHONE_2*.3406
gen W_CELLPHONES_3 = W_CELLPHONES_2*.0942
gen W_MOTORCYCLE_3 = W_MOTORCYCLE_2*.0882
gen W_VEHICLES_3 = W_VEHICLES_2*.3577
gen W_PUMPS_3 = W_PUMPS_2*.2608
gen W_CLOTHES_3 = W_CLOTHES_2*.4019
gen W_WATER_3 = W_WATER_2*.1784
gen W_TOILET_3 = W_TOILET_2*.1718
gen W_COMPUTER_3 = W_COMPUTER_2*.3527
gen W_COWS_3 = W_COWS_2*.1821

//add values together to create wealthscore//
gen WEALTHI =
W_TELEVISIONS_3+W_REFRIGERATORS_3+W_MICROWAVES_3+W_TELEPHONE_3
+W_CELLPHONES_3+W_MOTORCYCLE_3+W_VEHICLES_3+W_PUMPS_3+W_CLOTH
ES_3+W_WATER_3+W_TOILET_3+W_COMPUTER_3+W_COWS_3

label var WEALTHI "Wealth Index created using PCA for assets"
```

Appendix D: Regression Results – Stata log file

```
.  **simple adoption regression**
.  reg simple_adopt_s i.TREAT c.AGE##c.AGE i.EDUC_8 WEALTHI POT_NOW FARM_PER_WORKER TIME, vce(cluster comunidad)

Linear regression                                      Number of obs =      344
                                                       F(  8,    60) =     2.47
                                                       Prob > F      =   0.0218
                                                       R-squared     =   0.0360
                                                       Root MSE      =   .21828

                                 (Std. Err. adjusted for 61 clusters in comunidad)
```

simple_adopt_s	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
1.TREAT	.0547061	.0282979	1.93	0.058	-.0018982	.1113103
AGE	.0022423	.0068089	0.33	0.743	-.0113775	.0158621
c.AGE#c.AGE	3.38e-06	.000072	0.05	0.963	-.0001406	.0001473
1.EDUC_8	.0261921	.0327006	0.80	0.426	-.0392188	.0916031
WEALTHI	-.0064867	.0081042	-0.80	0.427	-.0226975	.0097242
POT_NOW	-.0048795	.0046022	-1.06	0.293	-.0140852	.0043262
FARM_PER_WORKER	-.000865	.0027247	-0.32	0.752	-.0063153	.0045853
TIME	.0007867	.0004956	1.59	0.118	-.0002046	.001778
_cons	.4655042	.1691873	2.75	0.008	.1270793	.8039291

```
.  margins, dydx(*) post

Average marginal effects                          Number of obs   =        344
Model VCE    : Robust

Expression   : Linear prediction, predict()
dy/dx w.r.t. : 1.TREAT AGE 1.EDUC_8 WEALTHI POT_NOW FARM_PER_WORKER TIME
```

	dy/dx	Delta-method Std. Err.	t	P>|t|	[95% Conf.	Interval]
1.TREAT	.0547061	.0282979	1.93	0.058	-.0018982	.1113103
AGE	.0025246	.0015566	1.62	0.110	-.0005892	.0056383
1.EDUC_8	.0261921	.0327006	0.80	0.426	-.0392188	.0916031
WEALTHI	-.0064867	.0081042	-0.80	0.427	-.0226975	.0097242
POT_NOW	-.0048795	.0046022	-1.06	0.293	-.0140852	.0043262
FARM_PER_WORKER	-.000865	.0027247	-0.32	0.752	-.0063153	.0045853
TIME	.0007867	.0004956	1.59	0.118	-.0002046	.001778

Note: dy/dx for factor levels is the discrete change from the base level.

```
.  **complex adoption regression**
.  reg complex_adopt_s TREAT c.AGE##c.AGE EDUC_8 WEALTHI POT_NOW FARM_PER_WORKER TIME, vce(cluster comunidad)

Linear regression                                      Number of obs =     344
                                                       F(  8,    60) =    4.41
                                                       Prob > F      =  0.0003
                                                       R-squared     =  0.0519
                                                       Root MSE      =  .20474

                                (Std. Err. adjusted for 61 clusters in comunidad)
------------------------------------------------------------------------------
                |               Robust
complex_adopt_s |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
----------------+-------------------------------------------------------------
          TREAT |   .0588483    .024063     2.45   0.017     .0107151    .1069814
            AGE |  -.0000995   .0082342    -0.01   0.990    -.0165703    .0163713
                |
    c.AGE#c.AGE |   -.000011   .0000863    -0.13   0.899    -.0001836    .0001615
                |
         EDUC_8 |   .0404942   .0365572     1.11   0.272    -.0326311    .1136194
        WEALTHI |  -.0144133   .0053967    -2.67   0.010    -.0252084   -.0036182
        POT_NOW |  -.0018537    .004104    -0.45   0.653     -.010063    .0063556
FARM_PER_WORKER |   .0026336   .0032217     0.82   0.417    -.0038108    .0090779
           TIME |  -.0001584   .0003582    -0.44   0.660     -.000875    .0005582
          _cons |   .1772935   .1937705     0.91   0.364    -.2103051    .5648921
------------------------------------------------------------------------------

.  margins, dydx(*) post

Average marginal effects                          Number of obs   =        344
Model VCE    : Robust

Expression   : Linear prediction, predict()
dy/dx w.r.t. : TREAT AGE EDUC_8 WEALTHI POT_NOW FARM_PER_WORKER TIME

------------------------------------------------------------------------------
                |            Delta-method
                |      dy/dx   Std. Err.      t    P>|t|     [95% Conf. Interval]
----------------+-------------------------------------------------------------
          TREAT |   .0588483    .024063     2.45   0.017     .0107151    .1069814
            AGE |  -.0010188   .0016452    -0.62   0.538    -.0043096     .002272
         EDUC_8 |   .0404942   .0365572     1.11   0.272    -.0326311    .1136194
        WEALTHI |  -.0144133   .0053967    -2.67   0.010    -.0252084   -.0036182
        POT_NOW |  -.0018537    .004104    -0.45   0.653     -.010063    .0063556
FARM_PER_WORKER |   .0026336   .0032217     0.82   0.417    -.0038108    .0090779
           TIME |  -.0001584   .0003582    -0.44   0.660     -.000875    .0005582
------------------------------------------------------------------------------

.
end of do-file

. log close
```

```
. do "/var/folders/b6/6g41x4vx267gxxrnpdp68skw0000gn/T//SD00202.000000"

.  **no purchase adoption regression**
.  reg nopurchase_adopt_s TREAT c.AGE##c.AGE EDUC_8 WEALTHI POT_NOW FARM_PER_WORKER TIME, vce(cluster comunidad)

Linear regression                                      Number of obs =     344
                                                       F(  8,    60) =    4.89
                                                       Prob > F      =  0.0001
                                                       R-squared     =  0.0853
                                                       Root MSE      =  .24025

                                (Std. Err. adjusted for 61 clusters in comunidad)
---------------------------------------------------------------------------------
                |               Robust
nopurchase_ad~s |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
----------------+----------------------------------------------------------------
          TREAT |   .1284397   .0313428     4.10   0.000     .0657449    .1911346
            AGE |  -.0049707   .0094705    -0.52   0.602    -.0239145    .0139731
                |
    c.AGE#c.AGE |   .0000605   .0000992     0.61   0.544     -.000138     .000259
                |
         EDUC_8 |    .038518   .0362533     1.06   0.292    -.0339995    .1110354
        WEALTHI |  -.0076702   .0057028    -1.34   0.184    -.0190776    .0037371
        POT_NOW |   .0026779   .0045581     0.59   0.559    -.0064397    .0117955
FARM_PER_WORKER |   -.000866   .0032416    -0.27   0.790    -.0073501    .0056181
           TIME |   .0010444   .0005684     1.84   0.071    -.0000926    .0021814
          _cons |   .4353022   .2175566     2.00   0.050     .0001243    .8704801
---------------------------------------------------------------------------------

.  margins, dydx(*) post

Average marginal effects                          Number of obs   =        344
Model VCE    : Robust

Expression   : Linear prediction, predict()
dy/dx w.r.t. : TREAT AGE EDUC_8 WEALTHI POT_NOW FARM_PER_WORKER TIME

---------------------------------------------------------------------------------
                |            Delta-method
                |      dy/dx   Std. Err.      t    P>|t|     [95% Conf. Interval]
----------------+----------------------------------------------------------------
          TREAT |   .1284397   .0313428     4.10   0.000     .0657449    .1911346
            AGE |   .0000806   .0021558     0.04   0.970    -.0042316    .0043929
         EDUC_8 |    .038518   .0362533     1.06   0.292    -.0339995    .1110354
        WEALTHI |  -.0076702   .0057028    -1.34   0.184    -.0190776    .0037371
        POT_NOW |   .0026779   .0045581     0.59   0.559    -.0064397    .0117955
FARM_PER_WORKER |   -.000866   .0032416    -0.27   0.790    -.0073501    .0056181
           TIME |   .0010444   .0005684     1.84   0.071    -.0000926    .0021814
---------------------------------------------------------------------------------

.
end of do-file

. log close
```

```
.  **purchase adoption regression**
.  reg purchase_adopt_s TREAT c.AGE##c.AGE EDUC_8 WEALTHI POT_NOW FARM_PER_WORKER TIME, vce(cluster comunidad)

Linear regression                                      Number of obs =     344
                                                       F(  8,    60) =    2.14
                                                       Prob > F      =  0.0460
                                                       R-squared     =  0.0295
                                                       Root MSE      =   .1944

                                (Std. Err. adjusted for 61 clusters in comunidad)
---------------------------------------------------------------------------------
                |               Robust
purchase_adop~s |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
----------------+----------------------------------------------------------------
          TREAT |   .0243252   .0212334     1.15   0.257    -.0181478    .0667982
            AGE |    .004989   .0071309     0.70   0.487     -.009275    .0192529
                |
    c.AGE#c.AGE |  -.0000525   .0000771    -0.68   0.498    -.0002067    .0001017
                |
         EDUC_8 |      .0316   .0356428     0.89   0.379    -.0396963    .1028963
        WEALTHI |  -.0134002   .0061223    -2.19   0.033    -.0256467   -.0011537
        POT_NOW |  -.0063433   .0037165    -1.71   0.093    -.0137774    .0010908
FARM_PER_WORKER |   .0022292   .0027745     0.80   0.425    -.0033207    .0077791
           TIME |  -.0001827   .0004133    -0.44   0.660    -.0010095    .0006441
          _cons |   .2055402    .172275     1.19   0.238    -.1390611    .5501415
---------------------------------------------------------------------------------

.  margins, dydx(*) post

Average marginal effects                          Number of obs   =        344
Model VCE    : Robust

Expression   : Linear prediction, predict()
dy/dx w.r.t. : TREAT AGE EDUC_8 WEALTHI POT_NOW FARM_PER_WORKER TIME

---------------------------------------------------------------------------------
                |            Delta-method
                |      dy/dx   Std. Err.      t    P>|t|     [95% Conf. Interval]
----------------+----------------------------------------------------------------
          TREAT |   .0243252   .0212334     1.15   0.257    -.0181478    .0667982
            AGE |   .0006072   .0013565     0.45   0.656    -.0021062    .0033205
         EDUC_8 |      .0316   .0356428     0.89   0.379    -.0396963    .1028963
        WEALTHI |  -.0134002   .0061223    -2.19   0.033    -.0256467   -.0011537
        POT_NOW |  -.0063433   .0037165    -1.71   0.093    -.0137774    .0010908
FARM_PER_WORKER |   .0022292   .0027745     0.80   0.425    -.0033207    .0077791
           TIME |  -.0001827   .0004133    -0.44   0.660    -.0010095    .0006441
---------------------------------------------------------------------------------

.
end of do-file

. log close
```

```
.  **knowledge score regression**
.  reg knowledge_s i.TREAT c.AGE##c.AGE i.EDUC_8##i.TREAT WEALTHI, vce(cluster comunidad)

Linear regression                                      Number of obs =      345
                                                       F(  6,    61) =     6.64
                                                       Prob > F      =   0.0000
                                                       R-squared     =   0.1446
                                                       Root MSE      =   .20978

                               (Std. Err. adjusted for 62 clusters in comunidad)
------------------------------------------------------------------------------
             |               Robust
 knowledge_s |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     1.TREAT |   .1379075   .0393385     3.51   0.001     .0592452    .2165698
         AGE |  -.0090834   .0084045    -1.08   0.284    -.0258893    .0077225
             |
 c.AGE#c.AGE |   .0001112   .0000966     1.15   0.254     -.000082    .0003044
             |
    1.EDUC_8 |   .0485176   .0505905     0.96   0.341    -.0526443    .1496796
             |
EDUC_8#TREAT |
        1 1  |   .0392047   .0570211     0.69   0.494    -.0748162    .1532255
             |
     WEALTHI |  -.0077344   .0064187    -1.20   0.233    -.0205694    .0051006
       _cons |   .5816297   .1888477     3.08   0.003     .2040053     .959254
------------------------------------------------------------------------------

.  margins, dydx(*) post

Average marginal effects                          Number of obs   =        345
Model VCE    : Robust

Expression   : Linear prediction, predict()
dy/dx w.r.t. : 1.TREAT AGE 1.EDUC_8 WEALTHI

------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     1.TREAT |   .1525666   .0297226     5.13   0.000     .0931327    .2120006
         AGE |   .0001921   .0012361     0.16   0.877    -.0022797    .0026638
    1.EDUC_8 |   .0696541   .0339287     2.05   0.044     .0018094    .1374987
     WEALTHI |  -.0077344   .0064187    -1.20   0.233    -.0205694    .0051006
------------------------------------------------------------------------------
Note: dy/dx for factor levels is the discrete change from the base level.

.
end of do-file

. log close
```

Appendix E: Messages

Following is a list of the messages that were sent to farmers in the treatment group. A translation into English is provided immediately below each message. Each message is divided by pest, and then by potato production stage.

MENSAJES AGRICULTORES PRODUCTORES DE PAPA EN CARCHI

Mensaje de bienvenida: Estimado Agricultor: Bienvenido/a al sistema de mensajes del MIP. Usted recibirá periódicamente consejos técnicos para el manejo de su cultivo de papa.

Welcome message: Dear Farmer: Welcome to the system of IPM messages. You will periodically receive technical advice for the management of your potato crop.

GUSANO BLANCO

Período desde antes de la siembra hasta la emergencia

1. MIP: Recuerde preparar correctamente el suelo para disminuir la población de gusano blanco.

   Remember to prepare the soil correctly to reduce the white worm population

2. MIP: Construya trampas con cartón, costales o pajas de páramo, dentro coloque ramas de papa con insecticida (2cc de Acefato por lt de agua)

   Build traps out of cardboard, or straw, place within the branches of the potato plant with insecticide (2cc acetate per one liter of water)

3. MIP: Coloque trampas en el lote distribuidas a una distancia de 10m x 10m (100 trampas/hectárea).

   Place traps on the lot distributed every 10m x 10m (100 traps per hectar)

4. MIP: Coloque plantas cebo (plantas renacidas) con insecticida (2 cc de Acefato por lt de agua) en los bordes del lote cada 5 metros.

   Place bait plants with insecticide (2cc Acefato per 1 lit. water) along the border of the plot every 5 meters.

5. MIP: No gaste su dinero fumigando en la siembra y retape, porque así no se controla a la plaga del gusano blanco.

Don't spend your money spraying during planting (and covering) because it doesn't control the White Worm.

Período desde la emergencia hasta la formación de tubérculos

6. MIP: No gaste su dinero fumigando después de la floración, porque así no se controla al gunsano blanco.

   Don't spend your money spraying after flowering, because it doesn't control the White Worm.

7. MIP: Si existe presencia de la plaga realice un control químico (parte baja de la planta), (2.5cc de profenofos o 2cc de Acefato por lt de agua).

   If the pest is present, apply chemical control (on the lower part of the plant) 2.5 cc Profonofos or Acephate 2cc per lt of water)

8. MIP: Recuerde que los gusanos blancos adultos se alimentan de las hojas bajeras, por lo tanto, fumigue en la base de la mata.

   Remember that adult white worms feed on lower leaves, therefore spray at the bottom of the bush.

9. MIP: Continúe evaluando la población de gusano blanco, si persiste realice dos controles más a los 60 y 80 días después de la siembra.

   Continue to evaluate the population of white worm, if it persists, perform two controls more at 60 and 80 days after planting.

Período desde la tuberización hasta después de la cosecha

10. MIP: Si llueve el día que fumigó o el día siguiente, es mejor que vuelva a fumigar.

    If it rains the day of fumigation or the day after, it is better to spray again.

11. MIP: Coloque plantas cebo (plantas renacidas) con insecticida (2 cc de Acefato por lt de agua) en los bordes del lote cada 5 metros.

    Place plant baits with insecticide (2cc Acefato / 1 liter water) along the edges of the plot, every 5 meters.

POLILLA DE LA PAPA

Período desde antes de la siembra hasta la emergencia

1. MIP: Recuerde que para controlar la polilla debe asolar la semilla por al menos 25 días.
   Remember to control the moth, [ravage] the seed for at least 25 days.

2. MIP: Aplique Bacu-Turín en una dosis de 0.2 kg por 45 kg de semilla y luego guarde la papa donde no le dé directamente el sol.

   Apply Bacu-Turin at a dose of 0.2 kg per 45 kg of potato seeds and place out of direct sunlight.

   Período desde la emergencia hasta la formación de tubérculos

3. MIP: Coloque dos trampas por hectárea con feromona sexual para determinar la presencia de polilla en el lote.
   Place two traps per hectare with sex pheremone to determine the presence of the moth in the plot.

4. MIP: Recuerde que las trampas de feromona se deben cambiar cada 8 días.

   The placement of the pheremone traps should be changed every 8 days.

5. MIP: Si encuentra 50 adultos por trampa y por semana es necesario realizar control químico

   If you find more than 50 adult moths per trap in a week, it is necessary to apply chemical control.

6. MIP: El control químico se debe realizar cada 60, 75 y 90 días utilizando Profenofos o Acefato (2 cc por lt de agua).

   Chemical control should be applied every 60, 75, and 90 days by using Profenofos or Acefato (2cc Acefato / liter of water)

7. MIP: Recuerde que con aporques altos y cruzados se evita que la polilla dañe los tuberculos.

   Remember that high and crossed hilling prevents moth damage to the tubers.

8. MIP: Cuando realice las labores de aporque, primero fumigue la base de la planta y luego aumente más tierra (huacho cruzado).
   When hilling the soil, first fumigate the base of the plant, and then increase to more land (using a cross pattern)

9. MIP: En zonas con altas cantidades de polilla realice el control químico y enseguida realice el medio aporque y aporque altos.
   In areas with a lot of moths, perform chemical controls and then do the middle hilling and the high hilling.

10. MIP: Recuerde aporcar por ambos lados cuidando de no dejar espacios vacíos entre los tallos.

Remember to ridge on both sides and be careful not to leave empty spaces between the stems.

Período desde la tuberización hasta después de la cosecha

11. MIP: Recuerde que en verano puede bajar las poblaciones de polilla utilizando riego por aspersión.

    Remember that in summer you can reduce the populations of the moth using sprinkler irrigation.

12. MIP: Si la población de polilla persiste aplique moderadamente insecticidas de baja toxicidad (Profenofos o Acefato 2cc por lt de agua).

    If the moth population persists, apply moderatly low toxicity insecticides (profonofos or Acephate 2cc per liter of water)

MOSCA MINADORA DE LA PAPA

Período desde antes de la siembra hasta la emergencia

1. MIP: Recuerde colocar trampas amarillas fijas o móviles de plástico impregnadas de Agrotack (pegante) para combatir la mosca minadora.
   Remember to place fixed or mobile yellow traps with Agrotack (glue) to compat the leafminer.

2. MIP: Elabore trampas fijas utilizando plástico amarillo de 40cm largo x 30cm de ancho con estacas de madera de 80cm, que se entierran en el suelo.
   Develop fixed traps using yellow plastic 40 cm long and 30cm wide with 80 cm wooden stakes, which are burried in the ground.

3. MIP: Las trampas amarilla móviles se colocan después de la deshierba, se deben colocar en el lote en zig-zag (45 por hectárea).
   Mobile yellow traps are placed after the weeding and should be placed on the plot in a zig-zag (45 per hectare)

4. MIP: La trampa móvil se elabora utilizando plástico amarillo de 2 m. de largo por 0.90 m. de ancho con soportes de madera en los dos extremos.
   Mobile traps are made by using yellow plastic 2m long by 0.9 m wide with wooden supports on both ends.

5. MIP: Pase Las trampas móviles por encima de los surcos de papa, para atrapar a las moscas minadoras adultas que están en el cultivo.
   Place the mobile traps above the furrows of potatoes to cath adult leafminers present in the cultivated plot.

Período desde la emergencia hasta la formación de tubérculos

6. MIP: Realice control de mosca minadora utilizando la trampa móvil pasándola varias veces sobre el cultivo.

   Perform leafminer control using mobile traps passing several times over the crop.

7. MIP: Si la población de moscas adultos persiste haga un control químico con productos específicos desde la emergencia hasta la floración.
   If the population of adult leafminers persists, make a specific chemical control from emergence until flowering.

Período desde la tuberización hasta después de la cosecha

8. MIP: Las minas de mosca minadora en las hojas se ven desde la floración hasta la cosecha; se controla para los gusanos que están en las minas.

   The [minas] of the leafminer are from flowering until harvest, and can be controled when the worms are on the [minas]

9. MIP: Si la población en minas persiste aplique insecticidas específicos para gusanos desde la floración hasta antes de la cosecha.
   If the population continues mining, apply specific insecticides to the worms from flowering to harvest.

LANCHA DE LA PAPA

Período desde antes de la siembra hasta la emergencia

1. MIP: Recuerde que las esporas del hongo de la lancha germinan en condiciones de humedad y temperaturas altas.

   Remember that Late Blight spores germinate in high humidity and temperature.

2. MIP: Recuerde utilizar variedades resistentes para prevenir el daño de lancha.

   Remember to use resistent varieties to prevent Late Blight damage.

3. MIP: Para prevención de lancha realice un primer control (cuando todas las plantas hayan salido del suelo) use Dimetomorf 500g en 200 lt de agua.

   To prevent late blight perform a first check when all plants have been removed from the soil (Dimetomorf 500 g in 200 liters of water)

4. MIP: Realice un segundo control para lancha a los 8 días del primero (Clorotalonil 500cc en 200 lt de agua o Mancozeb 500g en 200 lt de agua).

Perform a second control of late blight 8 days after the first (Clorotalonil 500 cc in 200 liters water or Mancozeb 500g in 200 liters of water)

Período desde la emergencia hasta la formación de tubérculos

5. MIP: Realice una evaluación al azar de la presencia de lancha después de la emergencia (tome varias plantas por surco en espacios de 10 metros).

   Perform a random assessment of the presence of late blight after emergence (take several plants per row every 10 meters)

6. MIP: Revise bien las hojas para determinar la presencia de lancha, repita por lo menos cada semana, si existe lancha realice un control químico.

   Inspect the stem to determine the presence of late blight, repeat at least every week and use chemical controls in the presence of late blight.

7. MIP: Como control quimico aplicar Fosfitos 400 cc en 200 lt de agua, además de controlar lancha es un fertilizante foliar.

   To control chemically apply Fosfitos 400 cc to 200 lt water, fertilized foliage is also late blight control.

8. MIP: Recuerde que el uso continuo de fungicidas con el mismo principio activo puede generar resistencia de la lancha a estos productos.
   Remember that continuous use of fungicides with the same active ingredients may lead to resistance of late blight to these products.

9. MIP: Recuerde utilizar fungicidas con diferentes principios activos.
   Remember to use different fungicides with different active ingredients.

Período desde la tuberización hasta después de la cosecha

10. MIP: Las rotaciones de fungicidas se realizarán entre sistémicos y protectantes tomando en cuenta la fase del cultivo.

    Fungicide rotations will be between systemic and protectant taking into account the stage of cultivation.

11. MIP: El intervalo de aplicaciones para lancha se realizará dependiendo de las condiciones climáticas.

    The range of applications for late blight take place depending on weather conditions.

12. MIP: Recuerde que en época muy lluviosa las aplicaciones para la lancha se deben realizar cada 8 días.

    Remember that during rainy season late blight control methods should be performed every 8 days.

13. MIP: Recuerde que en época seca las aplicaciones para la lancha se deben realizar cada 12 o 15 días.

    Remember that in the dry season late blight control methods should be performed every 12 to 15 days.

14. MIP: Un ejemplo de una rotación de fungicidas para lancha se detalla en el folleto que se le entregó en el día de campo.

    An example of fungicide rotation for late blight is detailed in the brochure given at the field day.

RHIZOCTONIA DE LA PAPA

Período antes de la siembra hasta la emergencia

1. MIP: Para prevenir Rhizoctonia recuerde desinfectar su semilla un día antes de la siembra con Azoxistrobina (200g en 200 lt de agua).

   To prevent Rhizoctonia remember to disinfect your seeds one day before planting with Azoxistrobina (200 g in 200 liters of water)

2. MIP: A 65 dias de la siembra desinfecte al tallo y suelo en forma de chorro, (PCNB 600g en200 lt de agua + Tiabendazol 200g en 200 lt de agua).

   65 days after planting, disinfect the stem and the soil in a stream (PCNB 600g/200 liter water and Tiabendazol 200 g in 200 liter water)

3. MIP: Recuerde que para mantener la calidad de su semilla, si en su cultivo existen plantas amarillas, hay que eliminarlas por completo.
   Remember to maintin the quality of the seed, if there are yellow plants among the cultivated, they must be eliminated completely

TOXICIDAD DE LOS PESTICIDAS

1. MIP: Recuerde que los pesticidas en el borde inferior de la etiqueta llevan impresa una franja de color que indica su categoría toxicológica.
   Remember that pesticide bottles have a band on the lower border that indicates toxicity levels

2. MIP: El color verde en la etiqueta de un pesticida indica que el producto normalmente no ofrecen peligro.
   Green on the bottom of the pesticide package indicates that the product normally causes no harm.

3. MIP: El color azul en la etiqueta de un pesticida indica que son poco peligrosos, pero se debe tener cuidado en su uso.
   Blue on the bottom of the pesticide package indicates that it is not very dangerous, but that care must be taken in its use.

4. MIP: El color amarillo en la etiqueta de un pesticida indica que son nocivos y moderadamente peligrosos.

   Yellow on the bottom of the pesticide package indicates that it is harmful and moderately dangerous.

5. MIP: El color rojo en la etiqueta de un pesticida indica que son productos sumamente peligrosos y tóxicos
   Red on the bottom of the pesticide package indicates that it is a toxic product and extremely dangerous.

Appendix F: Survey

Adopción de Manejo Integrado de Plagas en el cultivo de papa en la provincia de Carchi
Cuestionario de entrevista No. _______

[Leer la introducción] *Gracias por tomarse el tiempo para responder a las preguntas de la encuesta. Las repuestas únicamente se utilizarán para ayudar a diseñar mejores proyectos que permitan controlar las plagas de la papa en su finca. Los resultados serán analizados por una universidad de los Estados Unidos y por lo tanto las respuestas no serán reportadas al gobierno ni utilizadas para determinar su acceso a los servicios sociales.*

MÓDULO 1. INFORMACIÓN BASICA

1. ¿Ud. asistió al Día de Campo?
   1 = Si _____
   2 = No_____ **(Si no asistió, no continuar con la encuesta)**

2. Nombre del entrevistado: ______________________________________

3. Nombre del entrevistador: ______________________________________

4. Fecha de la entrevista: Día ____ Mes ____ Año 2014

5. Cantón: _______________________________

6. Parroquia: _____________________________

7. Comunidad: ____________________________

8. Número de celular: _______________________

9. ¿Quién es el usuario principal del teléfono?
   1 = Entrevistado_____
   2 = Esposa_____
   3 = Hijos_____
   4 = Otra persona que no viven en casa con Ud.______

10. ¿Recibió mensajes de texto con consejos técnicos para el Manejo Integrado de Plagas (MIP) en el cultivo de papa?
    1=Si ________
    2=No ________

11. Geo-referenciación del hogar:
Latitud: ___________ Longitud: ___________ Altitud: __________

12. ¿Cuántos años de edad tiene? _____

13. ¿Cuántos años de educación formal posee? _______

MÓDULO 2. CONDICIONES SOCIO-ECONÓMICAS

14. ¿Cuántos miembros conforman su familia y viven en su hogar con Ud.? _____

15. ¿Cuántos miembros de su familia son mayores de 14 años? ______
¿Cuántos miembros trabajan dentro de la finca (mayores de 14 años)?_______
¿Cuántos miembros trabajan afuera de la finca (mayores de 14 años)?_______

16. En su hogar, ¿Cuál es la actividad que le da mayores ingresos al año?
1= Papa____
2= Leche/venta de productos lácteos____
3= Otros cultivos ____
4= Otros ingresos ____

17. ¿Cuántas hectáreas de terreno tiene en total?________

MÓDULO 3: PRODUCCIÓN DEL CULTIVO DE PAPA

18. ¿Cuántas hectáreas tiene con papa?_________

19. Fecha de la última siembra de papa: Mes _____ Año _____

20. ¿Qué variedad sembró en la última siembra? _______________

21. ¿Cuál es la superficie de la parcela de papa que sembró recientemente?:_______

22. Fecha de la última cosecha de papa: Mes _____ Año _____

23. ¿Cuál es la superficie de la parcela de papa que cosechó últimamente?:_______

(La parcela en referencia es la ultima sembrada hasta el 30 de agosto 2014)

24. ¿Tiempo que le toma en ir de la casa a su parcela principal de papa? ______

MÓDULO 4. FUENTE DE INFORMACION

25. ¿Dónde aprendió sobre el Manejo Integrado de Plagas (MIP)? **(Indíquele al encuestado toda las opciones y anote con 1=si, 2=no)**

Código	Fuente	¿De qué fuente aprendió sobre el MIP? **(1 = Si, 2 = No)**	¿Cuáles fueron las <u>tres</u> fuentes más importantes? (**Señale con una X)**
1	Días de campo		
2	Escuelas de campo		
3	Cursos		
4	Talleres		
5	Visitas de extensionistas		
6	Giras de observación		
7	Folletos / Boletines		
8	Medio de comunicación (Radio, televisión o periódico)		
9	Casas comerciales		
10	Vecinos/Otros agricultores		
11	Mensajes de texto		
12	Otros		

26. ¿Cada qué tiempo visitan los vendedores de agroquímicos a su finca o comunidad?_______
¿Cuándo fue la última visita? (mes/año) ________

27. ¿Trabaja en fincas de otros agricultores con la producción de papa?
1 = Si ______
2 = No _____

28. ¿De quién ha recibido información sobre productos químicos para papa desde mayo 2014?
1 = No ha recibido información nueva desde mayo 2014______
2 = De los vendedores de las casas comerciales _______
3 = De los extensionistas _______
4 = De anuncios comerciales _______
5 = De vecinos/otros agricultores_______
6 = Otros_______

MÓDULO 5. APLICACIÓN DE PESTICIDAS

(La parcela en referencia es la ultima sembrada hasta el 30 de agosto 2014)

29. ¿Cuántas aplicaciones de pesticidas realizó en este ciclo en la parcela en referencia? ________

MÓDULO 6: CONOCIMIENTO Y USO DEL MIP EN PAPA

***[Leer]* Algunas personas recomiendan utilizar trampas y plantas cebo para el control del MIP.**

30. ¿Para cuál insecto o enfermedad se usa trampas? **(No leer las respuestas)**
1 = Gusano Blanco ______
2 = Polilla ______
3 = Mosca Minadora ______
4 = Lancha ______
5 = Rhizoctonia ______
6 = Otro ______

31. ¿Para cuál insecto o enfermedad se usa plantas cebo? **(No leer las respuestas)**
1 = Gusano Blanco ______
2 = Polilla ______
3 = Mosca Minadora ______
4 = Lancha ______
5 = Rhizoctonia ______
6 = Otro ______

Gusano Blanco

32. ¿Qué importante ha sido la presencia y daño del gusano blanco en los últimos tres ciclos de la producción de papa? **(Indique 1= No importante, 2 = Medio Importante, 3 = Muy importante)** _____

33. ¿Observó/a al gusano blanco en su cultivo en este ciclo en la parcela en referencia?
1 = Si _____
2 = No ______ **(Si es NO pase a la pregunta 36)**

34. ¿En qué estado del ciclo de vida observó/a al gusano blanco?
1 = Adulto _____
2 = Larva ______

35. ¿Qué porcentaje de daño del gusano blanco observó/a en el cultivo? ______

36. ¿Cómo se puede controlar el gusano blanco? **(No leer las respuestas)**
1 = Usando insecticidas (control químico) ______
2 = Usando trampas _____
3 = Usando plantas cebo ______
4 = Rotando cultivos ______

5 = Otro _____
6 = No sabe ______

37. ¿Qué recomienda el MIP para el control del gusano blanco? **(No leer las respuestas)**
1 = Usando insecticidas (control químico) ______
2 = Usando trampas _____
3 = Usando plantas cebo ______
4 = Rotando cultivos ______
5 = Otro _____
6 = No sabe ______

38. Si utiliza trampas para controlar el gusano blanco, ¿Cuántas pone por hectárea? ______ **(técnico calculo si necesario)**
No utiliza______

39. ¿A qué distancia recomienda el **MIP** que se distribuyan las trampas?
1 = ____m X ____m
2 = No sabe ____

40. Si utiliza trampas para el gusano blanco, ¿Cómo prepara la trampa? **(No leer las respuestas)**
1 = Pedazo de cartón de 30 cm x 40 cm_____
2 = Ramas frescas de papa______
3 = Uso de insecticidas _______
4 = Otro ______
5 = No utiliza_____ **(Si NO utiliza pasar a la pregunta 42)**

41. ¿Qué insecticidas utiliza para preparar la trampa para el gusano blanco? **(No leer las respuestas)**
1 = Acefato (Ortisec, Orthene, Oftran, Ortril, Chevron RE, Asataf, Pillarthene, Kitron, Aimthane) _____
2 = Profenofos______
3 = Fipronil (Fiprex, Ligero)_____
4 = Otro _____
5 = No utiliza ninguna insecticida _____

42. ¿Qué insecticidas recomienda el **MIP** para preparar la trampa para el gusano blanco? **(No leer las respuestas)**
1 = Acefato (Ortisec, Orthene, Oftran, Ortril, Chevron RE, Asataf, Pillarthene, Kitron, Aimthane) _____
2 = Profenofos______
3 = Fipronil (Fiprex, Ligero)_____
4 = Otro _____
5 = No sabe _____

43. Si utiliza plantas cebo para el gusano blanco, ¿Cómo las prepara? **(No leer las respuestas)**

*1 = Plantas de papa renacientes*______

*2 = Plantas renacientes puestas al borde*_____

*3 = Uso de insecticidas*_____

4 = Otro ______

*5 = No utiliza*______ **(Si NO utiliza pasar a la pregunta 45)**

44. ¿Con qué insecticida prepara las plantas cebo? **(No leer las respuestas)**

1 = Acefato (Ortisec, Orthene, Oftran, Ortril, Chevron RE, Asataf, Pillarthene, Kitron, Aimthane) _____

*2 = Curacron*______

*3 = Otro*_______

4 = No utiliza ninguna insecticida ______

45. ¿Con qué insecticida recomienda el **MIP** preparar las plantas cebo? **(No leer las respuestas)**

1 = Acefato (Ortisec, Orthene, Oftran, Ortril, Chevron RE, Asataf, Pillarthene, Kitron, Aimthane) _____

*2 = Curacron*______

*3 = Otro*_______

4 = No sabe ______

46. Si utiliza plantas cebo ¿A qué distancia las coloca?

1 = Cada _____ metros

2 = No utiliza______

47. ¿A qué distancia recomienda el **MIP** para colocar las plantas cebo?

1 = Cada _______metros

2 = No sabe_______

48. ¿Cuál insecticida aplica para controlar el gusano blanco en el cultivo? **(No leer las respuestas)**

*1 = Profenofos (Curacron, Selecron, Polycron)*______

2 = Acefato (Ortisec, Orthene, Oftran, Ortril, Chevron RE, Asataf, Pillarthene, Kitron, Aimthane)

*3 = Otro*_____

4= No utiliza ninguna insecticida ________

49. ¿Cuál insecticida recomienda el **MIP** utilizar para controlar el gusano blanco en el cultivo? **(No leer las respuestas)**

*1 = Profenofos (Curacron, Selecron, Polycron)*______

2 = Acefato (Ortisec, Orthene, Oftran, Ortril, Chevron RE, Asataf, Pillarthene, Kitron, Aimthane) ______
3 = Otro ______
*4 = No sabe*_____

50. ¿Cuándo realiza el primer control químico para controlar el gusano blanco en el cultivo? **(No leer las respuestas)**
*1 = Cuando existe presencia de la plaga*_____
*2 = Otro*_____
3 = No sabe _______

51. Después del primer control químico ¿Cuándo necesita volver a controlar? **(No leer las respuestas)**
*1 = Cuando persiste la plaga*_____
2 = Otro ______
3 = No sabe _____

52. Si persiste la plaga después del primer control químico ¿Cuántos controles más realiza después del primero? _______
No sabe_______

Polilla

53. ¿Qué importante ha sido la presencia y daño de la polilla en los últimos tres ciclos de la producción de papa? **(Indique: 1= No importante, 2 = Medio Importante, 3 = Muy importante)** _____

54. ¿Observó/a la polilla en el cultivo de papa en este ciclo en la parcela en referencia?
1 = Si _____
2 = No_____ **(Si es NO pase a la pregunta 56)**

55. Si observó/a ¿Qué porcentaje de daño de la polilla observó/a? _______

56. ¿Cómo se puede prevenir y controlar la polilla? **(No leer las respuestas)**
*1 = Aplica Bacu-Turin (insecticida)*______
2 = Asolea la semilla _______
3 = Realiza el aporque _______
4 = Proporciona riego por aspersión _______
5 = Utiliza productos químicos ______
*6 = Otro*______
7 = No sabe ______

57. ¿Qué recomienda el **MIP** para prevenir y controlar la polilla? **(No leer las respuestas)**
*1 = Aplica Bacu-Turin (insecticida)*______
2 = Asolea la semilla _______
3 = Realiza el aporque _______
4 = Proporciona riego por aspersión _______

5 = Utiliza productos químicos ______
*6 = Otro*______
7 = No sabe ______

58. ¿Qué tratamiento realiza en la semilla para prevenir la polilla? **(No leer las respuestas)**
*1 = Aplica Bacu-Turin (insecticida)*______
2 = Asolea la semilla _______
*3 = Otro*______
4 = No realiza nada a la semilla _____

59. Si asolea su semilla ¿Cuantos días deja en el sol? _____; No asolea_____

60. ¿Cuantos días recomienda el **MIP** dejar en el sol la semilla?
1 = ____ días
2 = No sabe _____

61. Si utiliza Bacu-Turin ¿Cuándo aplica? **(No leer las respuestas)**
1 = Después de asolear ______
*2 = Antes de guardar*_____
*3 = Otro*_____
*4 = No utiliza*_____ **(Si NO utiliza pase a la pregunta 64)**

62. Si utiliza Bacu-Turin ¿Qué cantidad utiliza?
1 = ______kg Bacu-Turin por _____kg de semilla
2 = No sabe _____

63. ¿Dónde guarda la semilla después de aplicar el Bacu-Turin? **(No leer la respuesta)**
*1= Un lugar que no le dé directamente los rayos solares*_____
2 = Otro _____
*3 = No guarda la semilla*_____

64. ¿Qué cantidad de Bacu-Turin recomienda el **MIP** poner en la semilla?
1= ______kg Bacu-Turin por _____kg de semilla
2= No sabe _____

65. ¿Qué lugar para guardar la semilla recomienda el **MIP** después de aplicar el Bacu-Turin? **(No leer la respuesta)**
*1= Un lugar que no le dé directamente los rayos solares*_____
2 = Otro _____
*3 = No sabe*_____

66. Si hace el aporque para controlar la polilla ¿Como lo hace? **(No leer la respuesta)**
1 = Alto y cruzado por ambos lados _____
*2 = Otro*______

*3 = No hace*_____

67. ¿Qué recomienda el **MIP** sobre el aporque para controlar la polilla? **(No leer la respuesta)**
*1= Hacer aporque alto y cruzado por ambos lados*_____
2= Otro _____
*3= No sabe*_____

68. ¿Por qué es importante para controlar la polilla realizar el aporque? **(No leer las respuestas)**
1= Actúa como una barrera física entre la plaga y las papas _____
2= Otro _____
3= No sabe ____

69. ¿Fumiga cuando realiza el aporque?
1 = Si _____
2 = No ____

70. De acuerdo con el **MIP** ¿En la época del aporque cuándo se debe fumigar? **(Puede leer)**
1 = Al momento del aporque_____
2 = Antes del aporque _____
3 = Después del aporque______
4 = Otro_____
5 = No sabe_____

71. ¿Por qué debe fumigar en ese momento? **(No leer las respuestas)**
*1 = Para evitar que los gusanos de las polillas entren en las papas*_____
*2 = Otro*_____
3 = No sabe ______

72. ¿Qué productos químicos utiliza para controlar la polilla? **(No leer las respuestas)**
*1 = Profenofos (Curacron, Corage)*______
2 = Acefato (Ortisec, Orthene, Oftran, Ortril, Chevron RE, Asataf, Pillarthene, Kitron, Aimthane) _____
*3= Otro*____
*4 = Ninguno*____

73. ¿Qué productos químicos recomienda el **MIP** utilizar para controlar la polilla? **(No leer las respuestas)**
*1 = Profenofos (Curacron, Corage)*______
2 = Acefato (Ortisec, Orthene, Oftran, Ortril, Chevron RE, Asataf, Pillarthene, Kitron, Aimthane) _____
*3= Otro*____
4=No sabe ______

Mosca Minadora

74. ¿Qué importante ha sido la presencia y daño de la mosca minadora en los últimos tres ciclos de la producción de papa? **(Indique: 1= No importante, 2 = Medio Importante, 3 = Muy importante) ________**

75. ¿Observó/a la mosca minadora en su cultivo en este ciclo en la parcela en referencia?
1 = Si _____
2 = No ______ **(Si es NO pase a la pregunta 77)**

76. ¿Qué porcentaje de daño de la mosca minadora observó/a? _______

77. ¿Cómo se puede controla la mosca minadora? **(No leer las respuestas)**
1 = Utiliza trampas amarillas ______
2 = Utiliza el control químico ______
3 = Otro _______
*4 = No sabe*________

78. ¿Qué recomienda el MIP para controlar la mosca minadora? **(No leer las respuestas)**
1 = Utiliza trampas amarillas ______
2 = Utiliza el control químico ______
3 = Otro _______
*4 = No sabe*________

79. ¿Qué tipo de trampas amarillas utiliza? **(No leer las respuestas)**
*1 = Móvil*____
*2 = Fija*____
*3 = Móvil y fija*____
*4 = No utiliza*_____ **(Si no, pase a la pregunta 81)**

80. Si usa <u>trampas fijas</u> ¿Cuándo las instala en su cultivo? **(No leer las respuestas)**
*1 = Después de la deshierba*____
*2 = Otro*____

81. ¿Cuándo recomienda el **MIP** instalar las trampas fijas? **(No leer las respuestas)**
*1 = Después de la deshierba*____
2 = Otro ____
*3 = No sabe*____

82. Si utiliza <u>trampa móvil</u> ¿Cuándo pasa la trampa? **(No leer las respuestas)**
*1 = Cuando exista alta población*____
*2 = Otro*____
3 = No realiza _____

83. De acuerdo con el **MIP** ¿Cuándo se debe pasar la trampa móvil? **(No leer las respuestas)**
*1 = Cuando exista alta población*____
*2 = Otro*____

3 = No sabe____

84. ¿A qué parte de la planta ataca la mosca minadora? **(No leer las respuestas)**
1 = A las hojas____
2 = Otro____
3 = No sabe____

85. Si realiza control químico para los adultos de la mosca minadora ¿Cuándo efectúa ese control? **(No leer las respuestas)**
1 = Cuando exista alto población _____
2 = Desde la emergencia hasta la floración_____
3 = Otro_____ Explica ______________
4 = No realiza_____

86. De acuerdo con el MIP ¿Cuándo se debe realizar el control químico para los adultos de la mosca minadora? **(No leer las respuestas)**
1 = Cuando exista alto población _____
2 = Desde la emergencia hasta la floración_____
3 = Otro _____ Explica ______________
4 = No sabe_____

87. Si realiza un control químico para los gusanos de la mosca minadora ¿Cuándo lo realiza? **(No leer las respuestas)**
1=Cuando exista alto población _____
2= Desde la floración hasta antes de la cosecha____
3= Otro____ Explica ______________
4 = No realiza_____

88. ¿Cuándo recomienda el MIP realizar un control químico para los gusanos de la mosca minadora? **(No leer las respuestas)**
1 = Cuando exista alto población _____
2= Desde la floración hasta antes de la cosecha____
3 = Otro _____ Explica ______________
4 = No sabe____

Lancha

89. ¿Observó/a la lancha en su cultivo en este ciclo en la parcela en referencia?
1 = Si _____
2 = No ______ **(Si es NO pase a la pregunta 91)**

90. ¿Qué porcentaje de daño de la lancha observó/a? _______

91. ¿Qué puede hacer para controlar la lancha? **(No leer las respuestas)**
1 = Utiliza el control químico ______
2 = Sembrar variedades resistentes____

*3 = Rotaciones de fungicidas*____
4 = Otro ____

92. ¿Qué recomienda el MIP para controlar la lancha de la papa ? **(No leer las respuestas)**
*1 = Sembrar variedades resistentes*____
2 = Usar fungicidas de baja toxicidad _____
*3 = Rotaciones de fungicidas*____
4 = No sabe ____

93. ¿Cuántas aplicaciones realizó/a para controlar la lancha de la papa en este ciclo en la parcela en referencia?________

94. ¿Cuántos fungicidas (número de productos) utilizó/a para controlar la lancha de la papa en este ciclo en la parcela en referencia?________
(Nota por favor confirmar la confiabilidad de la respuesta: Alta ___ Baja___)

95. ¿Para qué utiliza diferentes químicos? **(No leer las respuestas)**
*1 = Para hacer rotaciones*________
*2 = Para disminuir resistencia*________
3 = Otro _______

Rhizoctonia

96. ¿Observó/a la Rhizoctonia en su cultivo en este ciclo en la parcela en referencia?
1 = Si_______
2 = No_______ **(Si NO, pase a pregunta 98)**

97. ¿Qué porcentaje de daño de la Rhizoctonia observó/a? _______

98. ¿Qué puede hacer para controlar el ataque de la Rhizoctonia? **(No leer las respuestas)**
1 = Desinfecta la semilla ______
2 = Utiliza el control químico (después de la siembra) ______
3 = Utiliza semillas de calidad _____
4 = No sabe _______

99. ¿Qué recomienda el **MIP** para controlar el ataque de la Rhizoctonia? **(No leer las respuestas)**
1 = Desinfecta la semilla ______
2 = Utiliza el control químico (después de la siembra) ______
3 = Utiliza semillas de calidad _____
4 = No sabe _______

100. Si desinfecta su semilla para prevenir la Rhizoctonia ¿Qué productos utiliza? **(No leer las respuestas)**
*1 = Azoxistrobina (Quantis)*____

2 = Otro____
3 = No desinfecta ____

101. De acuerdo con el **MIP**, ¿Cómo desinfecta la semilla para prevenir Rhizoctonia? **(No leer las respuestas)**
1 = Sumergiendo los tubérculos en un tanque con el producto y luego dejando secar a la sombra____
2 = Otro____
3 = No sabe ______

102. ¿Qué productos recomienda el **MIP** para desinfectar su semilla y prevenir la Rhizoctonia? **(No leer las respuestas)**
1 = Azoxistrobina (Quantis)____
2 = Otro ____
3 = No sabe____

103. Si realiza control químico de la Rhizoctonia ¿Qué productos utiliza? **(No leer las respuestas)**
1 = PCNB (Terraclor), Tiabendazol (Mintezol, Tresaderm, Arbotect) ____
2 = Otro____
3 = No realiza ____

104. ¿Qué productos recomienda el MIP para el control de la Rhizoctonia? **(No leer las respuestas)**
1 = PCNB (Terraclor), Tiabendazol (Mintezol, Tresaderm, Arbotect ____
2 = Otro____
3 = No sabe ____

105. ¿Qué hace usted para mantener la calidad de las semillas? **(No leer las respuestas)**
1 = Renovar las semillas de calidad cada 3 anos.
2 = Eliminar las plantas amarillas ______
3 = Otro _____
4 = No hace nada ____

106. ¿Qué recomienda el MIP para mantener la calidad de las semillas? **(No leer las respuestas)**
1 = Renovar las semillas de calidad cada 3 anos_______
2 = Eliminar las plantas amarillas ______
3 = Otro _____
4 = No sabe ____

107. ¿Cuántas aplicaciones de los siguientes productos realizó en este ciclo en la parcela en referencia?

Nombre del producto	Número de aplicaciones

Carbosulfan (Eltra 48 FC)	
Metomyl (Lannate)	
Mancozeb (Dithane M-45 NT, Fungis-Khan, Moncozeb 80, Titan 80 WP, Triziman D)	
Cymoxanil + Mancozeb	
Profenofos (Curacron, Courage)	
Clorpirifos (Latigo)	
Fipronil (Halcon, Fiprex)	
Cipermetrina	

108. ¿Qué bienes y servicios posee su familia en su casa? *[No importa si es viejo, dañado, o de sus hijos, etc. Las respuestas no serán reportadas al gobierno ni utilizadas para determinar su acceso a los servicios sociales]*

Bien/Servicio	Número (0=ninguno, 1=uno, 2=dos, etc.)
Televisor	
Refrigeradora	
Microondas	
Teléfono fijo	
Teléfono celular	
Motocicleta	
Vehículos	
Bombas estacionarias	
Lavadora de ropa	
Agua potable dentro de la casa	
Baño dentro de la casa	
Computadora	
Ganado (Bovino)	

MÓDULO 6. MENSAJES DE TEXTO

[Pregúntele SOLO si recibió mensajes de texto]

Usted ha recibido mensajes de texto sobre las prácticas de MIP. Respuestas veraces a estas preguntas nos ayudarán a mejorar el proyecto y no afectarán el empleo de cualquier persona involucrada en el programa.

109. ¿Fueron los mensajes fáciles de entender?
1 = Si_____
2 = No______

110. Los mensajes fueron enviados tres veces por semana. ¿Fue la frecuencia apropiada?
1 = Si_____
2 = No____

111. Si respondió “No”, piensa que los mensajes deben ser enviados:
1 = Con más frecuencia______
2 = Con menos frecuencia _______
3 = Prefiere no recibir los mensajes de texto _______
4 = Otro _______ Describe ______________

112. ¿Con qué frecuencia ha usado las recomendaciones de los mensajes?
1= 0% ____
2 = 25% ___
3 = 50% ___
4 = 75% ___
5 = 100% ____

Adoption of Integrated Pest Management in Potato in the Carchi Province
Question No. _______

[Read the Introduction] *Thank you for taking the time to respond to the questions in this survey. The questions will only be used to help design better programs that allow you to control pests and disease on your land. The results will be analyzed by a university in the United States, and responses will not be reported to the government or used to determine eligibility for social services.*

MODULE 1. BASIC INFORMATION

1. Did you attend the Field day in May?
   1 = Yes _____
   2 = No_____ **(If they didn't attend, don't continue)**

2. Name of Interviewee: ______________________________________

3. Name of Interviewer ______________________________________

4. Day of Interview: Day ____ Month ____ Year 2014

5. Cantón (administrative unit, similar to county) _______________________________

6. Parroquia (administrative unit, smaller than county) _____________________________

7. Comunidad (community/ town): ____________________________

8. Cell Phone Number: _______________________

9. Who is the principal user of the cell phone?
   1 = Interviewee_____
   2 = Spouse_____
   3 = Children_____
   4 = Other person living outside the home______

10. Have you received text messages with technical advice about IPM for potatoes?
    1=Yes ________
    2=No ________

11. GPS of Home:
    Latitude: ___________ Longitude: ___________ Altitude: __________

12. How old are you?_____

13. How many years of formal education do you have? _______

MODULE 2. SOCIO-ECONOMIC CONDITIONS

14. How many people comprise your family who live in the home with you? _____

15. How many members of your family are older than 14?_______
    How many members work on the farm (older than 14)_______
    How many members work outside of the farm (older than 14)______

16. On your farm, what is the activity from which you receive the most income in a year?
    1= Potatoes____
    2= Milk/ Sale of dairy products____
    3= Other crops____
    4= Other income ____

17. How many hectares do you have in total? ______

MODULE 3: POTATO CULTIVATION

18. How many hectares of potato do you have?_________

19. Date of last potato planting: Month _____ Year _____

20. What variety of potatoes did you plant most recently? _______________

21. What is the size of the plot that you planted with potatoes most recently?_______

22. Date of last potato harvest: Month _____ Year _____

23. What is the size of the plot of potatoes that you harvested most recently?_______

    (The "reference parcel" is the last planting before August 30th)

24. How long does it take you to go from your house to your potato plot? ______

MODULE 4. INFORMATION SOURCES

25. Where did you hear about IPM? **(read the interviewee all of the options and note with 1=yes, 2=no)**

Code	Source	Where did you hear about IPM? **(1 = Si, 2 = No)**	What are the three most important information sources (**Mark with an X)**
1	Field Days		
2	Field Schools		
3	Courses		
4	Talleres (not sure the translation, farmers know what this is)		
5	Extension Visits		
6	Observational Tours		
7	Brochures		
8	Media (Radio, television, newspapers)		
9	Commercial Vendors		
10	Neighbors/Other farmers		
11	Text Messages		
12	Other		

26. How frequently do vendors of agrochemicals visit your house or community? _____
When was the last visit?________

27. Do you work in the farms of other farmers in their production of potato?
1 = Yes ______
2 = No _____

28. From whom have you received information about the products you buy for potatoes since May 2014?
1 = I haven't received new information since May 2014 ______
2 = From vendors in commercial houses_______
3 = From extension agents_______
4 = From advertisements/commercials _______
5 = From neighbors/other farmers_______
6 = Other_______

MODULE 5. APPLICATION OF PESTICIDES

(The reference parcel is the ultimate planting before August 30, 2014)

29. How many applications of pesticides did you use in the reference parcel in this cycle of production? ________

MODULE 6: KNOWLEDGE AND USE OF IPM

***[READ]* Some people recommend using traps and trap crops in using IPM.**

30. For which insect or disease do you use traps? **(Don't read the answers)**
    1 = Gusano Blanco ______
    2 = Polilla ______
    3 = Mosca Minadora ______
    4 = Lancha ______
    5 = Rhizoctonia ______
    6 = Other ______

31. For which insect or disease do you use trap plants? **(Don't read the answers)**
    1 = Gusano Blanco ______
    2 = Polilla ______
    3 = Mosca Minadora ______
    4 = Lancha ______
    5 = Rhizoctonia ______
    6 = Other ______

Gusano Blanco (White Worm)

32. How important has the presence and damage of the gusano blanco been in your last three cycles of potato production? **(Indicate 1= Not important, 2 = Of medium importance, 3 = Very important)** _____

33. ¿Have you observed gusano blanco in your plot in this cycle in the plot of reference?
    1 = Yes _____
    2 = No ______ **(If no, go to question 36)**

34. En what stage of life where the gusano blanco that you observed?
    1 = Adults _____
    2 = Larva ______

35. What percent of damage did you observe due to gusano blanco? ______

36. How can you control against gusano blanco? **(Don't read the answers)**
    1 = Using insecticides (chemical control) ______
    2 = Using traps _____
    3 = Using trap plants ______
    4 = Rotating crops ______
    5 = Other _____

6 = Don't know ______

37. What are the IPM recommended techniques for controlling gusano blanco? **(Don't read the answers)**
   1 = Using insecticides (chemical control) ______
   2 = Using traps _____
   3 = Using trap plants ______
   4 = Rotating crops ______
   5 = Other _____
   6 = Don't know ______

38. If you use traps to control gusano blanco, how many do you put per hectare? Si utiliza trampas para controlar el gusano blanco, ______ **(interviewer calculates if necessary)**
   Does not use______

39. What is the IPM recommended distance to distribute traps?
   1 = ____m X ____m
   2 = Don't know ____

40. If you use traps to control gusano blanco, how do you prepare it? **(Don't read the answers)**
   *1 = Make a box out of cardboard that is 30 cm x 40 cm*_____
   *2 = Use fresh potato stalks*______
   3 = Use insecticide _______
   4 = Other ______
   *5 = Doesn't use*_____ **(If don't use, go to question 42)**

41. Which insecticides do you use to prapre the trap?
   1 = Acefato (Ortisec, Orthene, Oftran, Ortril, Chevron RE, Asataf, Pillarthene, Kitron, Aimthane) _____
   *2 = Profenofos*______
   *3 = Fipronil (Fiprex, Ligero)*_____
   4 = Other _____
   5 = Doesn't use any insecticides in the trap _____

42. What are the IPM recommended insecticides for use in traps to control against gusano blanco?
   1 = Acefato (Ortisec, Orthene, Oftran, Ortril, Chevron RE, Asataf, Pillarthene, Kitron, Aimthane) _____
   *2 = Profenofos*______
   *3 = Fipronil (Fiprex, Ligero)*_____
   4 = Other _____
   5 = Don't know _____

43. If you use trap plants (plantas cebo) to control against gusano blanco, how do you prepare them?
1 = Leftover potato plants ______
*2 = Place plants along the borders of the field*_____
*3 = Use insecticides*_____
4 = Other ______
*5 = Doesn't use trap plants*______ **(If don't use go to question 45)**

44. Which insecticide do you use for the trap plants?
1 = Acefato (Ortisec, Orthene, Oftran, Ortril, Chevron RE, Asataf, Pillarthene, Kitron, Aimthane) _____
*2 = Curacron*______
*3 = Other*_______
*4 = Doesn't use insecticides*______

45. What is the IPM recommended insecticide for use in the trap plants?
1 = Acefato (Ortisec, Orthene, Oftran, Ortril, Chevron RE, Asataf, Pillarthene, Kitron, Aimthane) _____
*2 = Curacron*______
*3 = Other*_______
4 = Doesn't know ______

46. If you use trap plants, what distance do you place them apart?
1 = Every _____ meters
2 = Doesn't use______

47. What is the IPM recommended distance to place trap plants?
1 = Every _______meters
2 = Doesn't know_______

48. What insecticide do you use to control gusano blanco in your potato plot?
*1 = Profenofos (Curacron, Selecron, Polycron)*______
2 = Acefato (Ortisec, Orthene, Oftran, Ortril, Chevron RE, Asataf, Pillarthene, Kitron, Aimthane)
*3 = Other*_____
4= Don't use any insecticides ________

49. What is the IPM recommended insecticide to control gusano blanco?
*1 = Profenofos (Curacron, Selecron, Polycron)*______
2 = Acefato (Ortisec, Orthene, Oftran, Ortril, Chevron RE, Asataf, Pillarthene, Kitron, Aimthane) ______
3 = Other ______
*4 = Doesn't know*_____

50. When does one use the first chemical control to control for gusano blanco?

1 = When the pest is present_____
2 = Other_____
3 = Doesn't know _______

51. After the first control, when is it necessary to control again?
1 = If the pest persists_____
2 = Other ______
3 = Doesn't know _____

52. If the pest persists after the first control, how many additional controls are necessary?
____
Don't know_______

Polilla

53. How important has the presence and damage of the polilla been in your last three potato production cycles? **(Indicate: 1= Not important, 2 = Of medium importance, 3 = Very important)** _____

54. ¿Have you observed polilla in your field in this cycle in the reference plot?
1 = Yes _____
2 = No_____ **(If no, go to question 56)**

55. If you've observed polilla, what percent of damage have you observed? _______

56. How can you prevent and control polilla?
1 = Apply Bacu-Turin (insecticide)______
2 = Solarize the seeds _______
3 = Hilling _______
4 = Use sprinker irrigation _______
5 = Use chemicals ______
6 = Other______
7 = Don't know ______

57. What is the IPM recommendation for controlling polilla?
1 = Apply Bacu-Turin (insecticide)______
2 = Solarize the seeds _______
3 = Hilling _______
4 = Use sprinker irrigation _______
5 = Use chemicals ______
6 = Other______
7 = Don't know ______

58. What treatment do you apply to the seeds to prevent polilla?
1 = Apply Bacu-Turin______
2 = Solarize the seeds _______
3 = Other______

*4 = Don't do anything to the seeds*_____

59. If you solarize, how many days do you leave the seeds in the sun? _____; Don't solarize_____

60. What is the IPM recommendation for number of days to solarize?
1 = ____ days
2 = Don't know____

61. If you use Bacu-Turin, when do you apply it?
1 = Before solarizing ______
*2 = After storing*_____
*3 = Other*_____
*4 = Don't use*_____ **(If don't use, go to question 64)**

62. If you use Bacu-Turin, how much do you use?
1 = ______kg Bacu-Turin per _____kg of seeds
2 = Don't know _____

63. Where do you store seeds after applying Bacu-Turin?
1= A place with no direct sunlight _____
2 = Other _____
*3 = Don't store seeds*_____

64. What amount of Bacu-Turin does IPM recommend??
1= ______kg Bacu-Turin per _____kg of seeds
2= Don't know _____

65. Where does IPM recommend storing seeds after applying Bacu-Turin?
*1= A place with no direct sunlight*_____
2 = Other _____
*3 = Don't know*_____

66. If you use hilling to control for polilla, how do you hill?
1 = Tall and crossed on both sides _____
*2 = Other*______
*3 = Don't hill*_____

67. What is the IPM recommended hilling technique to control for polilla?
1= Make a hill that is tall and crossed, on both sides
2= Other _____
*3= Don't know*_____

68. Why is it important to hill when controlling for polilla?

1= To create a physical barrier between the pest and the potatoes _____
2= Other _____
3= Don't know ____

69. Do you fumigate when you hill?
1 = Si _____
2 = No ____

70. According to IPM, at what stage of hilling do you fumigate? **(Can read)**
1 = At the moment of hilling_____
2 = Before hilling _____
3 = After hilling______
4 = Other_____
5 = Don't know_____

71. Why does one fumigate in this moment?
*1 = To prevent polilla worms from entering the potatoes*_____
*2 = Other*_____
3 = Don't know ______

72. What chemicals do you use to control for polilla?
*1 = Profenofos (Curacron, Corage)*______
2 = Acefato (Ortisec, Orthene, Oftran, Ortril, Chevron RE, Asataf, Pillarthene, Kitron, Aimthane) _____
*3= Other*____
*4 = None*____

73. What are the IPM recommended products to control polilla?
*1 = Profenofos (Curacron, Corage)*______
2 = Acefato (Ortisec, Orthene, Oftran, Ortril, Chevron RE, Asataf, Pillarthene, Kitron, Aimthane) _____
*3= Other*____
4=Don't know ______

Mosca Minadora (Leaf Miner

74. How important has the presence and damage of the leaf miner been do your last three potato production cycles? **(Indicate: 1= Not important, 2 = Of medium importance, 3 = Very important** ________

75. Have you observed the mosca minadora in your cultivation in the cycle of reference?
1 = Yes _____
2 = No ______ **(If no, go to question 77)**

76. What percent damage from the leaf miner have you observed? _______

77. How can you control the leaf miner?

1 = Using yellow traps ______
2 = Using chemical controls ______
3 = Other _______
*4 = Don't know*________

78. What is the IPM recommendation for controlling the leaf miner?

1 = Use of yellow traps ______
2 = Use of chemical controls ______
3 = Other _______
*4 = Don't know*________

79. What type of yellow traps do you use?

*1 = Mobile*____
*2 = Fixed*____
*3 = Mobile and fixed*____
*4 = Don't use*_____ **(If no, go to question 81)**

80. If you use fixed yellow traps, when do you install them?

*1 = After weeding*____
*2 = Other*____

81. What is the IPM recommendation about when to install fixed yellow traps?

*1 = After weeding*____
2 = Other ____
*3 = Don't know*____

82. If you use mobile traps, when do you pass them in your field?

*1 = When the population of leaf miners is high*____
*2 = Other*____
3 = Don't use _____

83. What is the IPM recommendation for when to pass mobile traps?

*1 = When the population of leaf miners is high*____
*2 = Other*____
*3 = Don't know*____

84. What part of the plant does the leaf miner attack?

*1 = The leaves*____
*2 = Other*____
*3 = Don't know*____

85. If you use chemical controls against the leaf miner adults, when do you employ these controls?

1 = When the population is high _____
*2 = After emergence before flowering*_____
*3 = Other*_____ *Explain* ______________

*4 = Don't use*_____

86. According to IPM, when should you use chemical controls to prevent adult leaf miners?
1 = When the population is high _____
*2 = After emergence before flowering*_____
*3 = Other*_____ *Explain* _______________
*4 = Don't use*_____

87. If you use chemical controls against the leaf miner worms, when do you employ these controls?
1=When the population is hig _____
*2= From flowering until before harvest*____
*3= Other*____ *Explain* _______________
*4 = Don't use chemical controls*_____

88. What is the IPM recommendation for when to use chemical controls for the leaf miner worms?
1 = When the population is high _____
*2= From flowering until before harvest*____
3 = Other _____ *Explain* _______________
*4 = Don't know*____

Lancha (Blight)

89. Have you observed blight in the parcel of reference?
1 = Yes _____
2 = No ______ **(If no, go to question 91)**

90. What percent damage have your observed? _______

91. What can you do to control blight?
1 = Use chemical controls ______
*2 = Plant resistant varieties*____
*3 = Rotate fungicides*____
4 = Other ____

92. What does IPM recommend to control potato blight?
*1 = Plant resistant varieties*____
2 = Use fungicides with low toxicity levels _____
*3 = Fungicide rotation*____
4 = Don't know ____

93. How many applications of fungicide do you use to control blight in the cycle in the reference parcel?________

94. How many fungicides (number of products) do you use to control blight in the cycle in the reference parcel?________
(Please note the confidence with which the farmer answers High ___ Low___)

95. Why do you use different chemicals?
*1 = In order to use crop rotation*________
*2 = In order to diminish resistance*________
3 = Other _______

Rhizoctonia

96. Have you observed Rhizoctonia in the cycle in the parcel of reference?
1 = Yes_______
2 = No_______ **(If NO, go to question 98)**

97. What percentage of damage from Rhizoctonia did you observe? _______

98. What can you do to control the attack of Rhizoctonia?
1 = Disinfect the seeds ______
2 = Use chemical controls ______
3 = Use high quality seeds _____
4 = Don't know _______

99. What does IPM recommend to control the attack of Rhizoctonia?
1 = Disinfect the seeds ______
2 = Use chemical controls (after planting) ______
3 = Use high quality seeds _____
4 = Don't know _______

100. If you disinfect the seeds to prevent Rhizoctonia what do you disinfect with?
*1 = Azoxistrobina (Quantis)*____
*2 = Other*____
3 = No desinfecta ____

101. According to IPM, how can you disinfect the seeds to prevent Rhizoctonia?
1 = Submerge the potatoes in a tank with a chemical product and allow to dry in the sun ____
*2 = Other*____
3 = Don't know ______

102. What products does IPM recommend to disinfect the seeds to prevent Rhizoctonia?
*1 = Azoxistrobina (Quantis)*____
2 = Other ____
*3 = Don't know*____

103. If you use chemical controls for Rhizoctonia, what products do you use?

1 = PCNB (Terraclor), Tiabendazol (Mintezol, Tresaderm, Arbotect) ____
*2 = Other*____
3 = Don't use ____

104. What products does IPM recommend to control Rhizoctonia?
1 = PCNB (Terraclor), Tiabendazol (Mintezol, Tresaderm, Arbotect ____
*2 = Other*____
3 = Don't know ____

105. What do you do to maintain the quality of the seeds?
*1 = Renew quality seeds every three years*______
2 = Eliminate yellow plants ______
3 = Other _____
4 = Don't do anything ____

106. What does IPM recommend to maintain seed quality?
1 = Renew quality seeds every three years _______
2 = Eliminate yellow plants ______
3 = Other _____
4 = Don't know ____

107. How many applications of the following products do you use in the cycle and parcel of reference?

Product Name	Number of Applications
Carbosulfan (Eltra 48 FC)	
Metomyl (Lannate)	
Mancozeb (Dithane M-45 NT, Fungis-Khan, Moncozeb 80, Titan 80 WP, Triziman D)	
Cymoxanil + Mancozeb	
Profenofos (Curacron, Courage)	
Clorpirifos (Latigo)	
Fipronil (Halcon, Fiprex)	
Cipermetrina	

108. Which of the following does your family have in your house? *[It's unimportant if the good is old, damaged, your children's, etc. The answers will not be reported to the government or used to determine your access to social services.]*

Service/ Good	Number
Television	
Refrigerator	
Microwave	
Fixed telephone	
Cell phone	
Motorcycle	
Car/ Truck	
Stationary pump	
Washing machine	
Potable water in the house	
Bathroom in the house	
Computer	
Cows	

MODULE 6. TEXT MESSAGE

[Ask only if the respondent received text messages]

You have received messages about IPM practices. The answers to these questions will help us improve the program and do not affect the employment of any of the persons involved in the program

109. Were the messages easy to understant?
1 = Yes_____
2 = No______

110. Messages were sent three times a week. Was the frequency appropriate?
1 = Yes_____
2 = No____

111. If you responded "No", do you believe the messages should be sent:
1 = More frequently______
2 = Less frequently _______
3 = Not at all _______
4 = Other_______ Describe ______________

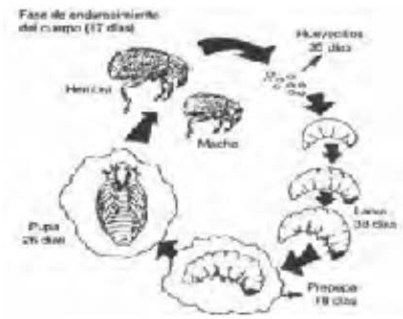
112. How frequently did you use the recommendations in the text messages?
1= 0% ____
2 = 25% ___
3 = 50% ___
4 = 75% ___
5 = 100% ____

Appendix G: IPM Brochure

GUSANO BLANCO DE LA PAPA

Período desde antes de la siembra hasta la emergencia

1. El gusano blanco de la papa tiene cuatro estados: 1) huevo, 2) larva, 3) pupa y 4) adulto. El estado de larva es el que pica y daña los tubérculos de la papa.



2. El adulto del gusano blanco en el día se esconde en sitios obscuros y con humedad, y en la noche salen sólo para comer las hojas bajeras de papa y malezas.

3. Los jóvenes adultos de gusano blanco, están dentro del suelo y salen a la superficie cuando se prepara el suelo. Los adultos en el terreno preparado caminan hasta 30 metros, medidos en línea recta, en un mes.

La mayor cantidad de adultos de gusano blanco aparece desde la preparación del suelo hasta 45 días después de la siembra y desde los 30 hasta los 60 días después de la cosecha. El daño principal lo causa la larva que hace huecos en la papa, disminuyendo su calidad, precio, y si el daño es grande, se puede perder hasta la mitad de la cosecha. Mientras que el daño que causa el adulto en las hojas bajeras no afecta el rendimiento.

4. Una buena preparación del suelo, permite disminuir la población de gusano blanco. Este es el momento para colocar las trampas en el lote distribuidas a una distancia de 10 m x 10 m (100 trampas/hectárea).

5. Las trampas se construyen con cartón (40 cm x 40 cm), costales viejos o pajas de páramo, dentro de las cuales se pone ramas de papa a las cuales se les aplica insecticida (2 cc de Acefato por litro de agua) para matar a los adultos que llegan a comer las hojas.

6. Después de la preparación del terreno se debe poner plantas cebo (plantas renacidas) en los bordes del lote cada 5 metros, a las que se les aplica insecticida (2 cc de Acefato por litro de agua) para matar a los adultos que llegan, de otros lotes, para alimentarse.

7. No gaste su dinero fumigando, a la siembra y al retape, porque así no se controla a la plaga del gusano blanco.

Período desde la emergencia hasta la formación de tubérculos

8. No gaste su dinero fumigando después de la floración, porque así no se controla la plaga.
9. Solo si existe presencia de la plaga realice un control químico dirigido a la parte baja de la planta, con Profenofos o Acefato con 2.5 y 2.0 cc/l de agua, respectivamente.
10. Recuerde que los adultos se alimentan de las hojas bajeras; por lo tanto, fumigue en la base de la mata.
11. Continúe evaluando la población de gusano blanco, si persiste realice dos controles más a los 60 y 80 días después de la siembra.

Período desde la tuberización hasta después de la cosecha

12. Si llueve el día que fumigó o el siguiente día, es mejor que vuelva a fumigar.
13. Para evitar que los adultos de gusano blanco, lleguen desde las parcelas cosechadas o desde los terrenos removidos hasta las nuevas siembras, ponga plantas renacidas en los bordes de la parcela cosechada.

POLILLA DE LA PAPA

Periodo desde antes de la siembra hasta la emergencia

1. El ciclo de vida de la polilla de la papa pasa por cuatro etapas: 1). adulto, 2) huevo, 3) larva, y 4) pupa. El daño principal lo causa la larva que hace huecos en la papa y le daña parcial o totalmente.

2. Para controlar la polilla que está en la semilla se recomienda la asolación por al menos 25 días, lo que hace que salgan los gusanos de las papas.

La asolación de la semilla es una medida ecológica que ayudará a los agricultores para defenderse de esta nueva plaga. La superficie usada para la asolación debe ser de tierra, con una cierta inclinación para evitar el encharcamiento del agua y pudrición del tubérculo. El tiempo de asolación puede llegar a 25 días, sin embargo el tubérculo puede soportar hasta 60 días. La papa debe ser colocada en una sola capa, y cada cierto tiempo debe cambiarse de lado para conseguir un mejor efecto del sol.

3. Después de que asoleó la semilla aplique Bacu-Turín en una dosis de 0.2 kg por 45 kg de semilla y luego guarde la papa en un lugar que no le dé directamente los rayos solares.

Período desde la emergencia hasta la formación de tubérculos

4. La mayor población de polillas peligrosas ocurre desde antes de la floración hasta la maduración de la planta.

   El daño principal lo causa la larva que hace huecos en la papa y le daña parcial o totalmente. Si el daño es grave se puede perder hasta una tercera parte de la producción en el campo y la totalidad de la semilla almacenada.

5. Coloque dos trampas por hectárea con feromona sexual para determinar la presencia de la plaga en el lote.

Como preparar y utilizar la trampa:

- Corte los lados de un envase de plástico formando una ventana
- Coloque la feromona atada a un alambre en la parte superior del envase y ponga en la parte inferior agua jabonosa.
- El agua jabonosa sirve para retener a los adultos que han caído en la trampa.
- La trampa se debe cambiar de cada 8 días.

6. Si existen 50 adultos por trampa y por semana, realice control químico al cultivo para polilla a los 60, 75 y 90 utilizando Profenofos o Acefato en dosis de 2 cc/l de agua, preferentemente.

7. Para evitar que los gusanos de las polillas entren a las papas después del

medio aporque o aporque, primero fumigue a la base de la planta y luego aumente más tierra (huacho cruzado).

En zonas con altas cantidades de polilla realice el control químico y enseguida realice el medio aporque y aporque altos. Este actúa como una barrera física entre la plaga y las papas. Es ideal aporcar por ambos lados cuidando de no dejar espacios vacíos entre los tallos.

8. Se evita el daño de la polilla a los tubérculos haciendo aporques altos y cruzados.

Período desde la tuberización hasta después de la cosecha

9. En época de verano puede bajar las poblaciones de polilla utilizando riego por aspersión, ya que este elimina las polillas que están volando junto a las matas de papas.
10. Si la población de polilla persiste aplique insecticidas de baja toxicidad y de manera moderada como Profenofos o Acefato en dosis de 2 cc/l de agua.

MOSCA MINADORA DE LA PAPA

Periodo desde antes de la siembra hasta la emergencia

1. El ciclo de vida de la mosca minadora pasa por cuatro etapas: 1) **adulto**, 2) **huevo**, 3) **larva**, y 4) **pupa**.

2. Baje poblaciones de adultos de mosca minadora con trampas fijas o móviles de plástico de color amarillo e impregnado de Agrotack (pegante).

   La mayor cantidad de adultos de mosca minadora aparece durante la floración del cultivo. El daño principal se produce en las hojas, causando la pérdida del follaje. La caída temprana de las hojas impide el engrosamiento de las papa. Las papas salen delgadas, por lo que se pierde calidad y precio.

3. Las trampas fijas se elaboran utilizando plástico amarillo de 40 cm. largo por 30 cm. de ancho con estacas de madera de 80 cm de largo, las cuales se entierran al suelo.

4. Después de la deshierba instale las trampas amarillas fijas para eliminar adultos de mosca minadora.

5. Coloque las trampas fijas en el lote en zig-zag en la cantidad de 45 por hectárea.

6. La trampa móvil se elabora utilizando plástico amarillo de 2 m. de largo por 0.90 m. de ancho con soportes de madera en los dos extremos.

7. Las trampas móviles se pasan por encima de los surcos de papa y de esta manera atrapa a los adultos que están en el cultivo.

Período desde la emergencia hasta la formación de tubérculos

8. La población de adultos o moscas minadoras se presentan desde la emergencia de la planta hasta la floración; entonces el control se hace para adultos.

   Realice control de mosca minadora utilizando la trampa móvil pasándola varias veces sobre el cultivo y si la población de adultos persiste haga un control químico con productos específicos.

9. Si las poblaciones de adultos persisten aplique insecticidas específicos para adultos desde la emergencia hasta la floración.

Período desde la tuberización hasta después de la cosecha

10. La presencia de minas de mosca minadora en las hojas se observa desde la floración hasta la cosecha; entonces el control se hace para los gusanos que están en las minas.

11. Si la población dentro de las minas persiste aplique insecticidas específicos para los gusanos y aplique desde la floración hasta antes de la cosecha.

LANCHA DE LA PAPA

Período desde antes de la siembra hasta la emergencia

1. Las esporas del hongo de la lancha se transmiten de una planta enferma a una planta sana a través del viento.

2. Las esporas del hongo germinan en condiciones de humedad y temperaturas altas.

3. El mayor daño de la lancha se presenta en variedades de papa con poca resistencia a esta enfermedad, en época lluviosa, y cuando no se hace un control oportuno de la enfermedad.

4. El daño aparece en las hojas jóvenes y tallos, pero si la enfermedad avanza, puede afectar a las papas.

5. Para prevenir el daño de lancha se recomienda utilizar variedades resistentes, de acuerdo a la zona, seleccione las variedades más resistentes a enfermedades.

6. Recuerde, para prevención de lancha, aplique en el primer control, cuando todas las plantas hayan salido del suelo, Dimetomorf (500 g/200 l de agua).

7. Recuerde, para control de lancha a los 8 días del primer control, aplique Clorotalonil (500 cc/200 l de agua) o Mancozeb (500 g/200 l de agua).

Período desde la emergencia hasta la formación de tubérculos

8. Inicie la evaluación de la presencia de lancha después de la emergencia del cultivo al azar, tomando varias plantas o por surco en espacios de 10 metros.

9. Revise bien las hojas para determinar la presencia de la enfermedad y repita la evaluación por lo menos cada semana y si existe lancha realice el control químico.

10. Aplicar Fosfitos (400 cc/200 l de agua), que además de controlar lancha es un fertilizante foliar.

11. Aplicar Mandipropamida (400 cc/200 l de agua) para controlar lancha.

12. Aplicar Clorotalonil (500 cc/200 l de agua) o Mancozeb (500 cc/200 l de agua) para controlar lancha.

Período desde la tuberización hasta después de la cosecha

13. Aplicar para control de lancha y roya, Azoxistrobina, o en ausencia de roya Dimetomorf (500 g/200 l de agua).

14. Aplicar Clorotalonil (500 cc/200 l de agua) o Mancozeb (500 cc/200 l de agua) para controlar lancha.

15. Como el tiempo ha sido muy lluvioso, aplicar para lancha Dimetomorf (500 g/200 l de agua).

16. Aplicar un fungicida protectante, puede ser Clorotalonil (500 cc/200 l de agua) o Mancozeb (500 g/200 l de agua).

17. Aplicar Fosfitos (400 cc/200 l de agua) para controlar lancha y favorecer la tuberización.

18. Aplicar Mandipropamida (400 cc/200 l de agua) para controlar lancha.

19. Recuerde, para controlar lancha y ayudar al engrosamiento de tubérculos, aplicar Fosfitos (400 cc/200 l de agua).

20. Aplicar Clorotalonil (500 cc/200 l de agua) o Mancozeb (500 cc/200 l de agua) para controlar lancha.

RHIZOCTONIA DE LA PAPA

Período antes de la siembra hasta la emergencia

1. No se olvide de desinfectar su semilla un día antes de la siembra con Azoxistrobina, para prevenir daño por Rhizoctonia (200g/200 litros de agua), sumergiendo los tubérculos en un tanque con el producto por 5 minutos y luego dejar secar a la sombra.

2. En el medio aporque (65 días de la siembra) es momento de una nueva desinfección para prevenir Rhizoctonia, la cual será dirigida al tallo y suelo en forma de chorro, aplicando PCNB (600g/200 litros de agua) + Tiabendazol (200g/200 litros de agua).

3. Para mantener la calidad de su semilla, si en su cultivo existen plantas amarillas hay que eliminarlas por completo.