Peruvian Food Insecurity in The Face of Recurrent Natural Disasters: A Two-Step Adoption Analysis for Improved Potato Varieties

Catherine E. O'Donnell

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Catherine Larochelle, Chair
Jeffrey Alwang, Co-chair
Guy Hareau

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ACADEMIC ABSTRACT

The International Potato Center (CIP) and Peruvian National Agricultural Research Institute (INIA) have invested a substantial amount of resources towards the development of improved potato varieties in Peru. These varieties are adaptable to the agro-ecologies of the Andes and have specific biotic and abiotic attributes. These efforts have led to the release of several prominent varieties including Canchan-INIA, Amarilis, Unica, Serranita and others. A 2013 household survey conducted by CIP was used to describe the diffusion of improved potato varieties in Peru. These data were also used to identify specific constraints to their adoption and dis-adoption. The assessment focused on a two-step adoption model, adoption and dis-adoption, by utilizing a Heckman Probit model to demonstrate two-steps of the adoption process. The Heckman Probit model was used to analyze variables affecting adoption and dis-adoption of improved varieties. Results suggest that adoption is region specific, time dependent, and in some cases relies on informal transmission methods. Risk to food insecurity and recurrent natural phenomena affect adoption and sometimes dis-adoption. Additionally, factors affecting a farmer's exposure to risk, such as information constraints and household head age, wealth, and social network were found to affect the adoption and dis-adoption of improved varieties.

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GENERAL ABSTRACT

Improved potato varieties, engineered by the International Potato Center (CIP) and Peruvian National Agricultural Research Institute (INIA), are adapted to the agro-ecologies of the Andes and have specific biotic and abiotic attributes, such as late blight resistance. There are a number of prominent engineered varieties produced by CIP and INIA including Canchan-INIA, Amarilis, Unica, Serranita and others, which have the potential to increase the yields and incomes of highland potato farmers. A 2013 household survey conducted by CIP was used to describe the diffusion of improved potato varieties in Peru. These data were also used to identify specific constraints to their adoption and dis-adoption. The assessment focused on a two-step adoption model, adoption and dis-adoption, by utilizing a Heckman Probit model to demonstrate two-steps of the adoption process. The model was used to analyze variables affecting adoption and dis-adoption of improved varieties. Results suggest that adoption is region specific, time dependent, and in some cases relies on informal transmission methods. Farmers living in areas more prone to food insecurity and natural phenomena are less likely to adopt certain improved varieties and more likely to continue to adopt these varieties after initial adoption. Additionally, factors affecting a farmer's exposure to risk, such as information constraints and household head age, wealth, and social network were found to affect the adoption and dis-adoption of improved varieties.

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Chapter 1: Introduction

Peru has experienced strong economic growth rates since the beginning of the 1990's (United Nations: World Bank Group, 2011), and the World Bank now classifies Peru as an upper-middle-income country. Nevertheless, the country's growth has been uneven, disproportionally favoring the urban areas along the western coast. Rural poverty and climatic shocks threaten food security for one of Peru's most vulnerable populations-highland potato farmers. Roughly 38 percent of the Peruvian population does not meet the daily-recommended caloric intake (2,100Kcal) (WFP, 2016). In rural areas, extreme poverty is more than double that of the national average and as much as 80 percent of children under five years old in the Peruvian highlands are undernourished (WFP, 2016).

Food availability, climatic shocks, volatile international commodity markets, and inadequate purchasing power are inter-related and all contribute to poverty and food insecurity among Peru's rural poor (WFP, 2016). Climate shocks, specifically floods, droughts, emerging pests and diseases threaten staple crop yields. Lower crop yields cause not only food shortages but also probable increases in domestic food prices. Both factors can harm the nutritional status of the poor, most of whom are dependent on agriculture for income.

1.1 Problem statement

Potatoes are a great low-fat carbohydrate food source. A serving size of potatoes delivers 10percent of the recommended daily fiber. Cooked potatoes have more protein and twice the amount of calcium than maize. Some Peruvian potato varieties have anti-cancer, immune-boosting, and cholesterol-reducing properties (CIP, 2016).

Peru's per capita annual consumption of potatoes (around 80 kg) is significantly higher than other Latin American countries (51kg in Chile, 44kg in Argentina, and 25 kg in Ecuador) (FAO, 2008). The potato is also a major employment source for farmer in Peru. It employs more than 597000 farmers, 25 percent from Puno, 9 percent from Junin, 12 percent from Cusco, 8 percent from Huanuco, 8 percent from Cjamarca, 8 percent from Ancash, and 8 percent for La Libertad (Stencel, 2013). The increase in per capita incomes paired with the fact that the potato is a normal good (as incomes grow, the consumption of potatoes increase) reveals the potato market can be a good source of future income for potato farmers (Trading Economics, 2015; andina.com.pe, 2015). This paired with the fact that 90 percent of Peruvian potato production takes place in the highlands (Buijs, Martinet, Ghislain, & Mendiburu, 2005, p. 179), demonstrates that potato production and marketing can be a vital component in alleviating rural poverty and food insecurity. Increased potato production in the Andes could result in substantial benefits for the rural poor, such as improved nutrition (via increased consumption and income), health, and overall community welfare (via increased farm profit).

The Peruvian National Agricultural Research Institute (known as INIA from its Spanish acronym) and the International Potato Center (known as CIP from its Spanish acronym) have collaborated in breeding and releasing improved potato varieties with the potential to increase productivity and lower production costs. Breeding efforts resulted in improved varieties that are late blight[1] resistant and require less fungicide. It is estimated that 15 percent of Peruvian potato production is lost due to late blight and adoption of late-blight resistant varieties can dramatically improve yields. In addition late-blight resistance can increase returns to farmers; the estimated

[1] Late blight is a major potato disease caused by microorganisms. The microorganism, *Phytophthora infestans,* causes accumulated lesions in the tissue of the potato. A few days following the first lesion, the entire potato can be destroyed (Schumann & D'Arcy, 2000).

[2] Diffusion of improved varieties refers to the proportion of improved potato seed currently planted or the

average cost of fungicide to manage late blight (~$150 USD per hectare) accounts for roughly 10 to 15 percent of total production costs (Ortiz O. , et al., 1998, p. 106), so resistance, which lowers fungicide applications, is a viable option.

Improved potatoes have attributes that can result in cost savings and increased yields, but the diffusion[2] of these varieties across Peru has been lower than CIP has expected. Newer improved varieties such as Canchán and Amarilis have not been as broadly adopted by farmers and do not appear to be significantly replacing Yungay, an older and still widely adopted improved variety. For this study, and according to CIP's request, we use Yungay, and older improved variety, to compare Canchán and Amarilis, a set of newer varieties, against. In doing so we can understand the factors which aid adoption and dis-adoption of a highly adopted improved variety, Yungay, in comparison to factors affecting the adoption and dis-adoption of other newer improved varieties which are less adopted, Canchán and Amarilis

The decision to adopt an improved technology has distinct phases. As outlined by Van Den Ban and Hawkins (1996), there are five distinct phases, (i) Awareness; the farmer becomes aware of the new technology (ii) Interest; the farmer seeks more information about the new variety (iii) Evaluation; the farmer weighs the pros and cons of adopting the new technology (iv) Trial; the farmer tests the new technology on a small scale having decided that the technology is worth trying and (v) Adoption; the farmer continues to use the technology (Van Den Ban & Hawkins, 1996). Our study focuses on steps four and five by identifying the determinants that lead a farmer to enter into a trial adoption period and the determinants that explain whether a farmer decides to continue planting the variety after the trial period. Once a farmer engages in a trial adoption period it is not guaranteed she will continue to plant the improved variety. A

[2] Diffusion of improved varieties refers to the proportion of improved potato seed currently planted or the percentage of farmers who have ever planted improved varieties nationally, or by specific region.

farmer may experiment with the new variety then stop planting the new variety. Dis-adoption of newer improved varieties may be one of the reasons why current adoption is lower than anticipated and why Yungay is still the most widely adopted improved variety.

Imperfect access to informal seed systems and agro-ecological heterogeneity may contribute to lower than expected levels of adoption. Formal potato seed systems in Peru are poorly developed; consequently, the diffusion of improved varieties is largely informal. Under these conditions, it is unlikely that a variety is available across all areas of the Peruvian highlands. In this study, the informal seed system includes any seed source where a farmer is most likely to receive uncertified seed. These sources include trading or receiving as gifts potato seeds from other farmers, and purchasing of potato seeds from local seed producers. Formal sources of improved potato seeds include any seed source where a farmer is most likely to receive certified/quality declared seed. The formal seed sources for this study include, NGOs, government (such as INIA experiment stations), field experiments, plot demonstrations, farmer groups, local merchants, and agro-veterinarians.

Seeds of particular varieties may not be available to even entire districts, the second largest political unit in Peru. The spread of improved varieties also depends on their suitability to specific agro-ecologies. Certain areas may be more susceptible to recurring natural phenomena that affect crop yields and the level of food insecurity. Farmers in differing ecologies thus face different levels of risk and ability to bear risks. Certain potato varieties may perform better than others under these extreme weather conditions, influencing farmers' decisions to dis-adopt varieties that perform poorly and continue to adopt varieties that perform well.

Some studies have analyzed the determinants of adoption for improved varieties in Peru (Brush, Taylor, & Bellon, 1991; Buijs, Martinet, Ghislain, & Mendiburu, 2005; Pradel, Hareau, Quitanilla, & Suarez, 2013). However, no known study considers factors affecting adoption, dis-adoption, and the role of food-insecure areas (FIAs) in the adoption and dis-adoption of improved potato varieties across agro-ecologies. Likewise, previous research did not compare the diffusion of specific varieties nor the determinants of adoption and dis-adoption by variety. This analysis focuses on eight varieties jointly released by CIP and national partners: Canchán, Amarilis, Unica, Andina, Chaska, Perricholi, Serranita, Roja Ayacuchana, and Yungay. The study assesses factors influencing sustainable adoption rates by examining the similarities and differences in the determinants of adoption and dis-adoption between Yungay, Canchan and Amarilis.

Knowledge about dis-adoption is particularly important because many resources have been dedicated to the research and extension of these technologies (Mbanaso, 2011, p. 23). To our knowledge no study has assessed factors influencing dis-adoption of improved potato varieties in the Andes. However, the determinants of improved sweet potato variety dis-adoption have been studied in Southern Nigeria. The author found that an increase in the number of problems with processing and cultivating sweet potato increased the probability of a farmer dis-adopting (Mbanaso, 2011). Information on why farmers dis-adopt, where dis-adoption occurs, and how dis-adoption can be quelled may help increase the impact of the next generation of improved potato varieties and effectively use the limited time, money, and expertise used to engineer these varieties.

1.2 Objectives and Hypotheses

The objectives of this study are to:

1. Describe the diffusion of the improved potato varieties by region and in Peru as a whole.
2. Evaluate how food insecurity and reccurent natural phenomena relate to adoption and dis-adoption.
3. Identify constraints to adoption and determinants of dis-adoption.

This thesis will aid in understanding reasons for improved variety adoption, location-specific factors that induce adoption, and factors affecting dis-adoption. In turn, breeders and seed specialists can use this information to improve variety development and seed dissemination methods to achieve lower levels of food insecurity and improve welfare for Peruvian potato farmers. The following hypotheses will be tested:

Hypothesis 1: Adoption of improved varieties is regionally dependent and time dependent.

Comparing the probability of adoption and dis-adoption per variety by region (northern, central, and southern highlands) will be used to test hypothesis one. Describing how long the improved varieties have been available in the area will explain time dependency. In the temporal analysis, we test whether the longer a farmer learns about the improved variety, the more likely he will be to adopt and continue to grow the variety.

Hypothesis 2: Natual phenomena and food insecurity influence adoption and dis-adoption decisions. More precisely, living in areas highly vulnerable to climatic phenomena and food insecurity is expected to decrease adoption and dis-adoption.

To capture both natural phenomena and food insecurity, we use an index developed by World Food Programme (WFP). This index represents food insecurity in the face of climatic phenomena. Using the WFP index, we test whether the probability of adoption and dis-adoption differs between farmers facing different levels of food insecurity in the face of climatic phenomena.

Hypothesis 3: Access to informal seed systems will increase the likelihood of adoption.

We create a measure of access to the informal seed system and include this measure as covariate in the adoption models to test our hypothesis. Access to informal seed systems is defined as whether or not a farmer has at one point in time obtained improved potato seed from the informal seed system. The significance and the sign of the coefficient capturing access to the informal seed system will inform on the role of informal seed systems in the decision to adopt improved varieties.

Hypothesis 4: Access to information about the variety will increase the likelihood of adoption and continued adoption.

Access to information includes information about the improved variety obtained through proximity to an INIA experiment station, or market practices. The hypothesis will be tested by using two variables: distance the farm household is from an agricultural experiment station and whether a farmer sells potatoes on the market.

Hypothesis 5: Ability to mitigate risk will increase the likelihood of adoption and continued adoption.

Factors, such as wealth and land size, that increase ability to bear risk when adopting a new technology will increase the likelihood of adoption and continued adoption.

1.3 Thesis structure

This thesis is comprised of five chapters. Chapter 2 provides a framework for interpreting variety dissemination, adoption, and dis-adoption results. This includes an overview of the nine varieties' attributes such as adaptation levels, year released, testing locations, and locations formally sold. The second chapter also describes how seeds are disseminated through the informal seed system. Chapter 3 describes the methods and data used to achieve the thesis objectives. The chapter outlines a conceptual framework in order to explain the hypotheses used to accomplish the objectives of this study. Data collection, including the sample selection method and the survey instrument, are also described in this chapter. Furthermore, a descriptive analysis of the data is provided to better understand dissemination, adoption, and dis-adoption of potato varieties. Chapter 3's final section outlines the empirical models' variables used per matrix and provides an explanation for variables chosen. Chapter 4 analyzes and critiques our model's findings and Chapter 5 discusses the implications of the study's findings.

Chapter 2: Background

In order to identify factors influencing adoption of improved potato varieties, it is important to understand factors affecting seed availability. It is also necessary to compare characteristics of each improved potato variety, and factors affecting productivity. We provide information on seed availability and productivity factors in this chapter, which help us better interpret our study's findings.

2.1 The Nine Improved Varieties- Availability, Pests, and Diseases

2.1.1 Availability

Table 1 contains the names and attributes of the nine improved varieties evaluated in this study, with special attention given to Yungay, Canchan, and Amarilis. We consider each each variety's release date because we are interested in the timing and spatial dynamics of adoption. We make the distinction between formal and informal release year and consider where the variety evaluations took place, and where its respective certified seed is sold.

Table 1 Potato Variety Release Dates, Location, Sale Locations, and Ambit Suitability

Potato Variety (*Institutions involved in the release and development*)	**Year Formally Released** ***(Testing Locations)***	**Year Informally Released**	**Departments with Certified Seed Available at the Time of the Study**	**Ambit** (***Adaptation in meters above sea level (MASL)***)
Canchán *(CIP and INIA)*	1990 *(Ayacucho*, Cajamarca, Cusco, *Huánuco)*	1979	Cajamarca, Cusco, Huánuco, Junín	Highlands and Coast *(2,000 to 2,700)*
Amarilis *(CIP and INIA)*	1993 *(Ancash, Ayacucho, Cajamarca, Cusco, Junín, Huánuco, Huancayo)*	1986	Ayacucho, Cajamarca, Huánuco, Huancayo, Junín , Lima	Northern and Central Highlands Central Coast *(2,700 to 3,200)*
Unica *(Universidad de Ica)*	1998 *(Ica)*	1992	Cusco, Junín	Central Highlands: Ancash, Huánuco, Junín Southern Highlands: Ayacucho The Coast: La Libertad *(Altitudes up to 3,700)*
Andina *(CIP-DGI-MINAG)*	1984 *(Puno)*	N/A	N/A	Highlands *(Not available)*
Chaska *(CIP and INIA)*	1981 *(Cusco)*	N/A	N/A	Central and Southern Highlands: Cusco, Puno, Apurímac *(Not available)*
Perricholi *(CIP and INIA)*	1984 *(Huánuco)*	N/A	Junín	Highlands and Coast *(Up to 3,500)*
Serranita *(CIP and INIA)*	2005 *(Junín, Huánuco, Cusco, Ayacucho, Cajamarca)*	1995	Apurímac, Ayacucho, Cajamarca, Cusco, Huánuco, Huancavelica, Junín	High Altitude Andes: Huancavelica, Junín Other Departments: Pasco, Huánuco *(2,400 to 3,800)*
Roja Ayacuchana *(CIP and INIA)*	2010 *(Ayacucho)*	N/A	Ayacucho, Huancavelica, Huánuco, Junín	N/A *(2,100 to 3,900)*
Yungay *(INIA)*	1971 *(Lima)*	N/A	Cajamarca, Junín	Central Highlands *(3,700)*

Sources: (INIA, Ministerio de Agricultura, CIP, Red Latinpapa, 2012) (Cunya , 2008) (CIP) (Mendoza, Gastelo, Flores, Blas, & Roncal, 1993) (Gastelo, Roncal, & Figueroa, Canchan-INIAA: Nueva Variedad de Papa, 1990) (INIA) (INIA) (Espino, Escate, Espinoza, Fonseca, & Mendoza) (CIP , 1970s) (INIA, 2009) (Basurto, 2000)

After varieties are engineered, they are evaluated by farmer field schools, plot experiments, and/or by INIA experiment stations in the highlands. We consider the first year the evaluation started as the informal release year because farmers through testing mechanisms, such as farmer field schools, can obtain improved seed before it is formally released. Of the nine improved varieties, we found informal release information for Amarilis, Unica, Serranita, and Canchán. Canchán was formally released in 1990, but the variety was created by CIP and its evaluation started in 1980. During the ten-year period farmers could informally distribute uncertified Canchán seed (Fonseca, Labarta, Mendoza, Landeo, & Walker, 1996). We use the informal release year to analyze the speed of adoption per variety of interest in Peru and the northern, central, and southern regions. Understanding when the variety became informally available to the public allows us to more accurately access the dynamics of dispersion and when a farmer could have realistically adopted the variety. We use formal release years for varieties where informal release years cannot be found. The formal release date is the year the variety was formally certified after thorough testing and evaluation. After formal certification, certified seed for the new variety become available to farmers. Formal release is used as release dates for all varieties for which an informal release year could not be found (Yungay, Andina, Chaska, Perricholi, and Roja Ayacuchana).

In addition to the year the variety became available, where the variety was tested, where the variety is available for formal sale, and where the variety is geographically best suited are also important factors in the diffusion of improved varieties. Junín, Cusco, and Huánuco are the departments with the most improved varieties available from previous testing or through formal sale sites (i.e. where certified seed is available) (INIA, Ministerio de Agricultura, CIP, Red Latinpapa, 2012). Canchán, Amarilis, and Serranita have the widest formal outreach throughout

Peru. These varieties were informally available through experiment stations during their testing and are formally available for sale in more departments than any of the other improved varieties as shown in Table 1 column four by the number of departments that have tested and formally sell certified seed. Varieties with “N/A” values for “department with certified seed available” may have formal sale locations, but our research did not find any locations.

For geographic suitability (found in column five of Table 1) Amarilis is best suited for the northern highlands. Amarilis is also suitable for the central highlands, along with Unica, Serranita, and Yungay. Departments found in the central highlands include Ancash, Huánuco, and Junín. Chaska is suitable for both the central and southern highlands in departments such as Apurímac, Cusco, and Puno. Serranita is specified to be best suited for higher altitudes areas in the highlands, whereas Canchán, Unica, and Perricholi are adapted for less specific areas, such as the highlands and the coast.

The availability of improved seed by time and environmental suitability of the varieties are important when evaluating the diffusion of improved varieties. The information helps provide explanations for statistics on adoption and dis-adoption and econometrics analysis findings. The next section will expand on the reasons why these varieties may be well suited for the specified locations. We acknowledge that the information compiled in Table 1 could have missing information, such as formal sales locations and where the variety is well suited. For example, there may be more information available for Canchán, Amarilis, and Serranita, making the varieties appear to have a larger formal outreach than other varieties. This is a weakness of this section and is recognized when conducting the analysis and interpreting the results.

2.1.2 Pests and Diseases

Table 2 shows the variety characteristics such as pest and disease resistance. By understanding variability in attributes, we will be able to better understand why farmers adopt and dis-adopt specific varieties in certain locations over others.

Table 2 Potato Variety Attributes

Potato Variety	Attributes
Canchán	Resistant to late blight Medium susceptibility to Rhizoctonia and Erwinia
Amarilis	Moderately resistant to late blight Found in Cajamarca to be resistant to nematodes
Unica	Resistant to PVY and PVX virus Tolerant to PLRV and nematodes RKN Adaptable to arid and warm climates Susceptible to nematodes, Rhizoctonia, and Erwinia
Andina	Not Available
Chaska	Not Available
Perricholi	Resistant to late blight Resistant to warts (Synchytrium endobioticum) Moderately tolerant to frost
Serranita	Resistant to late blight Tolerant to Cyst nematode
Roja Ayacuchana	Resistant to late blight Resistance to decay (Phytophthora erytropseptica) Resistant to PVY and PVX Frost and drought tolerance
Yungay	Moderately resistant to late blight Susceptible to PLRV, PVY, and PVX

Sources: (INIA, Ministerio de Agricultura, CIP, Red Latinpapa, 2012) (Cunya , 2008) (CIP) (Mendoza, Gastelo, Flores, Blas, & Roncal, 1993) (Gastelo, Roncal, & Figueroa, Canchan-INIAA: Nueva Variedad de Papa, 1990) (INIA) (INIA) (Espino, Escate, Espinoza, Fonseca, & Mendoza, UNICA: Variedad de Papa con Tolerancia al Calor)

Improved potato varieties are bred to address pests, diseases and climate shocks most detrimental to yields. The main biotic constraints are late blight (*Phytophthora infestans),* potato viruses (*potato leafroll virus (PLRV), potato virus Y (PVY), and potato virus X (PVX)),* cyst nematodes (*Globodera pallida and G. rostochiensis*), bacterial illnesses (*Erwinia)*, and other fungal illnesses (*Rhizoctonia*). Abiotic constraints include frost and drought. These constraints are unevenly present around potato-producing areas and improved varieties are targeted to areas where their attributes best address the area production constraints.

Viruses (PVY, PVX, and PLRV) and late blight exist in most regions of the Andes (CIP, 1996). Viruses are present in all environmental conditions, while late blight occurs where heavy rains are present and when temperatures range between 10 and 25°C (CIP, 1996, p. 15). These temperatures are prevalent in most areas of the Andes except in higher altitudes where it is consistently colder. Yungay and Roja Ayacuchana are the only two varieties with simultaneous resistant to late blight, PVY, and PVX. Even though Serranita is engineered for higher altitude areas where late blight should be less of a problem it still has late blight resistant properties. Canchán, Amarilis, Yungay, Perricholi, Serranita, and Roja Ayacuchana varieties are all resistant to late blight. Unica is resistant to PVY, PVX, and tolerant to PLRV, but not resistant to late blight.

Cyst nematodes are a prevalent problem in main potato growing areas (CIP, 1996, p. 73). Cyst nematodes are spread through the soil. Cyst-ridden soil often gets stuck to farm tools, making it challenging to control. These nematodes persist in temperate zones and high altitude tropics (CIP, 1996, p. 73). High altitude tropics are located on the eastern side of the Andes as well as between the highlands and the eastern Andean forests.

Bacterial illness, such as Erwinia, is located in warm climates where moisture is excessive (CIP, 1996, p. 5). This means Erwina can be a problem in areas where cyst nematodes are a problem such as the eastern side of the Andes where there is high moisture and low altitude. Amarilis, Unica, and Serranita varieties are resistant to nematodes. Even though Unica is adapted to lower altitude areas, such as the coast, it is susceptible to Erwinia. Canchán, which is also adapted to lower altitude areas, is also susceptible to Erwinia.

Frost risk among the regions is the highest in the eastern high plains where temperatures drop to as low as two degrees below zero Celsius between December and March (CIP, 1999, pp. 373-377). Frost can damage potato leaf area reducing the plant's ability to photosynthesize and grow; it can also lead to tuber seed storage problems (CIP, 1999, p. 375). Varieties released to address frost are Perricholi, and Roja Ayauchana. Unlike frost, droughts are not location specific and may occur throughout the Andes. Droughts generally occur during El Niño years when all areas of Peru are susceptible to both droughts and floods. Roja Ayauchana, the newest improved variety, is the only drought tolerant listed variety.

After reviewing improved seed availability and locations where potato varieties are best suited given a set of engineered attributes, the next section provides information on how seeds are disseminated. Understanding ways improved varieties are multiplied and transported across the Andes allows the study to further understand how certain dissemination methods may induce adoption.

2.2 Potato Seed Systems in Peru

Potato seeds are regenerated using clonal propagation to ensure the next potato is a genetic replica of the previous potato. In clonal propagation, potato tubers, instead of sexual seeds, are used to produce the next generation of potatoes. Potato tubers are heavier than sexual seeds, making them more difficult to transport and more susceptible to damage. Due to these characteristics, and the lack of formal seed systems (which includes seed certification, certified seed distribution and certified seed sale) in the highlands, spreading improved potato seed is a challenge in many developing countries" (FAO, 2017; Thiele G. , 1998; Tripp, 1995).

A seed system is "an interrelated set of components including breeding, management, replacement and distribution of seed" (Thiele G. , 1998, p. 84). In formal systems, certified seed is available through public and private institutions and industries (Wattnem, 2016). Farmers can purchase certified potato seeds through certified sellers in a formal seed system, such as INIA's experiment stations[3] found throughout Peru. An informal seed system distributes unregulated seed (i.e. uncertified seed), which comes from farmers who multiply seeds over several generations, often beginning with certified seed (Wattnem, 2016). The distinction between formal and informal seed systems is that the latter have uncertified seed. In Peru, farmers rely heavily on informal seed systems because poor infrastructure and thin markets mean that formal suppliers are rare in remote areas (Thiele G. , 1998).

Potato seeds can suffer from degeneration, the infection by viruses, pathogens and pests that occur after continuous cropping cycles (Douglas, 1980). Degeneration decreases the quality of the potato and its yield. In higher altitude areas (above 2800 meters) seed degeneration is slow because cooler temperatures at higher altitudes reduce "multiplication of vector and/or pathogens" that may limit the spread of disease (Thomas-Sharma, et al., 2015). Due to low pest and disease pressure at high elevation, Peruvian potato seeds are informally certified in the higher regions where potato seeds of higher quality exist. Communities and certain households are known for their seed quality and are used as certification points in the informal flow of seeds from highlands to lowlands (Scheidegger, 1989).

The informal multiplication scheme, through the informal seed market, provides a lower cost "neighborhood certification", where good quality potatoes are purchased based on their past performance with other neighborhoods or farmers (Scheidegger, 1989, p. 9). This type of seed

[3] A list of locations where formally certified seed is sold is available from page 85 to 88 in "*Catálogo De Nuevas Variedades De Papa: Sabores y Colores Para El Gusto Peruano*" (INIA, Ministerio de Agricultura, CIP, Red Latinpapa, 2012)

market provides a decentralized way of providing seeds with lower transaction costs. Knowledge regarding which community or farmer informally multiplied the seed also lowers the risk of obtaining poor quality seed (Prain G., 1988, p. 192). Farmers with acces to the informal seed system receive improved seed or information about improved varieties by a trusted friend, community or family member. The risks associated with adoption decrease as farmers become more informed about the origin of the seed and its attributes (such as less pesticide use, resistances, planting altitude, vegetation period, and more) through a trusted friend, community or family member. The low costs and reduced risks associated with obtaining seeds in the informal system underlie how information and trust may induce adoption. The literature finds mixed results on the differences in the quality of seed, and its affect on yield, obtained from the informal seed system compared to the formal seed system (Douglas, 1980; Monares, 1988, p.4; Recharte, 1993, p.279). Therefore, obtaining an improved variety seed, assuming its negligible affects on yield, from the informal seed system may be a more effective system to induce adoption and spread improved potato seed across Peru.

Chapter 3: Methods and Data

3.1 Conceptual Framework

Many studies have modeled technology adoption using a binary variable-farmers either adopt or do not. Other studies have gone further and modeled adoption as a multi-step process (Kijima, Otsuka, & Sserunkuuma, 2011; Van Den Ban & Hawkins, 1996; Lambrecht, Vanlauwe, Merckx, & Maertens, 2014; Hamzakaza, et al., 2014; Mbanaso, 2011). This study views adoption as a multi-step process. A farmer's current adoption status is a snapshot of the dynamic process of adoption where farmers are continually learning, testing, adopting, and dis-adopting varieties. For this analysis, we focus on two stages of the adoption process--adoption and dis-adoption. The conceptual framework addresses specific factors affecting the decision to adopt and the decision to dis-adopt after a trial period. First, we underscore the importance of risk in a farmer's decision to adopt and dis-adopt. Then, we discuss how information and social learning can reduce risk and improve technology management- increasing the likelihood of adoption and decreasing the likelihood of dis-adoption. We conclude this section by mentioning how other factors such as food insecurity and farmer characteristics affect adoption and dis-adoption.

3.1.1 Risk Aversion and Expected Utility

Having never planted the variety before, the farmer first tries out the variety. This experimentation is called the trial period. The farmer will adopt the new technology for a trial period only if increased yields, or losses avoided, result in increased profit greater than zero (Mills, 1997). Due to variability in production, there is risk embedded in expected yield gains. Risk in production is expressed by the variance in yield over harvesting seasons. Both the mean and the variance of expected yield are important in a farmer's decision to adopt a new technology. If expected yield and variance are the same as the status quo mean yield and variance, the farmer should draw the same utility from the two technologies, meaning the farmer should be indifferent in chosing between the two technologies.

We assume farmers are risk averse, meaning they have a concave utility function with respect to wealth. In a mean preserving spread, risk-averse farmers draw higher utility from technologies with lower yield variances because they are less risky. Therefore, in a mean preserving spread, risk-averse farmers will choose the new technology if the variance is less than the status quo technology's variance (ECO 317 – Economics of Uncertainty – Fall Term 2007 Notes for lectures 4. Stochastic Dominance), given identical means.

Once the farmer adopts the new technology she enters the trial period. During the trial period, farmer gains information about the variety's performance under farmer specific agro-ecological conditions and management practices. After the trial period, the farmer decides whether to continue to plant (this includes expanding or lessening production) or dis-adopt the variety. Continued adoption largely depends on experiences during the trial period (Lambrecht, Vanlauwe, Merckx, & Maertens, 2014). Farmer characteristics influence the outcome of the trial, consequently influencing dis-adoption. If the actual yield gain from adoption is significantly below expected yield gain of the new technology, the farmer may abandon the technology, even if the gain is positive (Lambrecht, Vanlauwe, Merckx, & Maertens, 2014).

3.1.2 Information and Risk

A farmer needs information on technology attributes, including labor, input costs, yield and variability of the technologies, market prices and more (Lambrecht, Vanlauwe, Merckx, & Maertens, 2014). Lack of information about attributes increases the risk of adoption, in turn reducing the expected utility drawn from planting the variety and lowering the likelihood of adoption. A farmer may be more likely to obtain accurate information about the new technology due to her proximity to experiment stations and access to potato markets. For example, closer proximity to an INIA experiment station may increase the farmer's access to technology information and the technology itself, lowering uncertainty associated with technology adoption, thus increasing the likelihood of adoption.

Increased access to information also affects continued adoption. Increased knowledge about the improved technology allows farmers to have expectations more in line with realized outcomes (Ghadim and Pannell, 1999; Marra, Pannell and Ghadim, 2003). Therefore, the knowledgeable farmer will be less likely to be disappointed after the trial period and dis-adopt. Also, increased knowledge gained from access to information allows better management and, possibly, higher returns from trial adoption (Lambrecht, Vanlauwe, Merckx, & Maertens, 2014), increasing the likelihood of continued adoption.

Social learning by observing the experiences of others is one way farmers can increase knowledge about the variety. This increases the probability of adoption and obtaining higher yields, which in turn decreases the likelihood of dis-adoption. A study conducted in India on high-yielding seed varieties (HYVs) showed that imperfect knowledge is a significant barrier to continued adoption. However, this can be diminished as a farmer observes her neighbors' experience with HYVs (Foster & Rosenzweig, 1995). The study also found that improved knowledge about HYV management through observing neighbors' experiences increased crop profitability. Non-adopting farmers surrounded by community members who adopt can collect more information increase their learning and the probability of continued adoption. Farmers can observe how to manage the new technology under differing agro-ecological and household constraints, and management practices. The longer the farmer spends learning about the new technology, the lower the knowledge barrier the farmer faces (Foster & Rosenzweig, 1995). This finding underscores a time dependence with adoption. The longer a farmer can learn about the variety the more likely she will have acquired good knowledge about the variety. The knowledge gained through observing other farmers over time will reduce uncertainty and increase crop profitability (or net yield gains) and consequently the probability of continued adoption.

Other findings suggest that although more information in a nearby social network reduces costs of learning, it also presents a free rider problem (Wollni & Andersson, 2014). When farmers learn about a new technology and decide to adopt it, they assume the risk. The knowledge a farmer obtains from adopting and experimenting helps neighbors learn, presenting a positive information externality. Some argue this could be detrimental to adoption. Farmers are not able to fully internalize the positive effects of technology adoption, leading to lower than optimal levels of adoption (Blackman & Naranjo, 2012; Bolwig, Gibbon, & Jones, 2009; Knowler & Bradshaw, 2007). A study conducted in Honduras found that a farmer's utility from planting a new technology diminishes due to perceived free-riding, delaying adoption until more farmers in the community adopted (Wollni & Andersson, 2014). The finding underscored, again, a time component in adoption. A time lag can exist in adoption if farmers gain dis-utility from perceived free-riding. However, if a farmer is more altruistic there may be an incentive to adopt quicker and an increase in adoption due to the utility gained from helping others (Wollni & Andersson, 2014).

3.1.2 Food Insecurity and Farmer Characteristics

A farmer's exposure to risk may be contingent upon her risk to food insecurity in the face of recurrent natural phenomena and farmer characteristics. Both factors affect a farmer's decision to adopt and continue to adopt improved varieties. Increased risk exposure should deter initial adoption of improved varieties. The continued adoption decision should be largely influenced by the variety's performance during the trial adoption, which is influenced by agro-ecological conditions and natural phenomena. Previous studies found that exposure to natural phenomena, such as climatic shocks, can have different effects on adoption of improved technologies. A study conducted in Kenya found that farmers who experienced recurrent climatic shocks used higher rates of hybrid seed (Martina, Di Falco, Smale, & Swanson, 2016). However, a study conducted in Ethiopia found that farmers use modern varieties to lessen exposure to natural disaster risks, while farmers who have been severely exposed to weather events were less likely to use modern varieties (Narloch, Lipper, & Cavatassi, 2011). No study has examined the impact of exposure to climatic shocks on dis-adoption decisions.

Farmer characteristics affecting the decision to evaluate a new technology will differ from factors affecting continued or dis-adoption (Lambrecht, Vanlauwe, Merckx, & Maertens, 2014). Farmers with lower levels of wealth, such as fewer productive assets, smaller landholdings, and lower savings are more risk averse (Parvan, 2011), decreasing the likelihood of adoption. Although risk aversion with respect to continued adoption decisions has not been thoroughly studied, a study conducted in Indonesia on the determinants of post-adoption behavior found that resource endowment had little effect on continued adoption (Mappigau, Musa, & Amraeni, 2016). This finding helps demonstrate that risk aversion, such as farmers with lower levels of wealth, may not play as much of a role in continued adoption decisions as it does in deciding whether or not to adopt.

Household head age and experience should affect adoption and dis-adoption decisions. Higher levels of education increase the ability to process information and use that information more effectively in managing technology. With older age and higher levels of education comes knowledge, which reduces uncertainty and a farmer's aversion to risk, thus increasing adoption. Lower levels of risk through older age and higher levels of education allows for more efficient production and technology use (Feder & Umali, 1993), decreasing the likelihood of dis-adoption. However, empirical results for age show mix results for the directional effect age has on adoption (Uaiene, Arndt, & Masters, 2009; Admassie & Gezahegn, 2010). Older farmers may be more experienced and have more access to needed resources which can reduce the uncertainty and risk which comes with adopting a new technology. Younger farmers may be more prone to taking risks, and thus more likely to adopt and continue to adopt improved technology. Therefore, the directional effect age has on adoption and continued adoption is indeterminate.

3.2 Data

CIP conducted a nationally representative household survey[4] from November 2012 to July 2013 (CIP, 2013). The survey used a two-stage cluster sampling method. The first stage involved determining the number of households to interview in each department, the largest political unit in Peru, based on the proportion of land each department dedicated to potato production. Due to financial limitations, not all departments that have land dedicated to potato production were considered in this first stage. Instead, ten departments, representing 86percent of

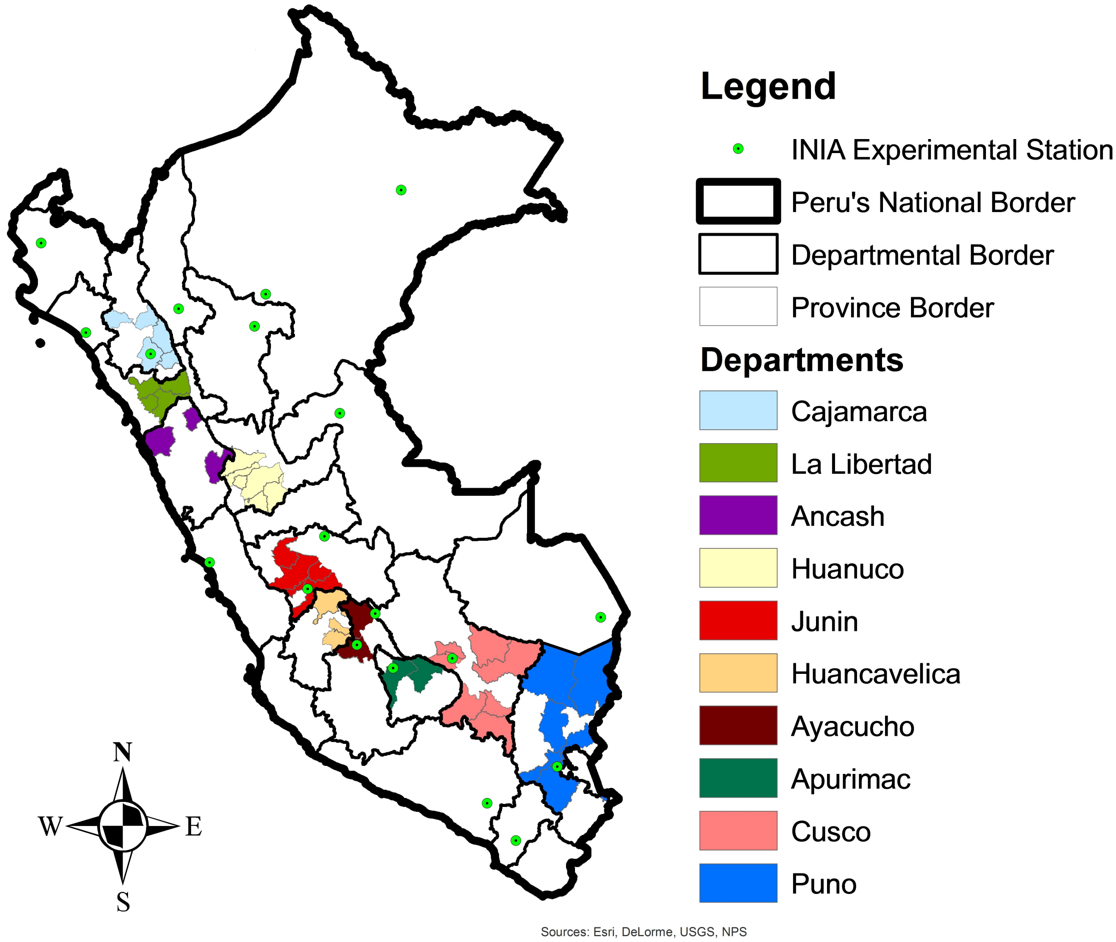
[4] The full questionnaire can be found in Appendix A. The survey contains eight modules: household demographics, social capital and networks, land cultivation and tenure, potato production, market access and participation, housing characteristics, assets, and access to agricultural capital, financial inputs, and institutions.

the total land area in Peru dedicated to potato production, were included in this first stage (Pradel, Hareau, Quintanilla, & Suarez, 2013).

In the second stage, districts (the lowest political unit in Peru) were selected, where the probability of a district being selected was proportional to the total land dedicated to potato production. A sample cluster of 115 communities in all preselected districts was then identified by convenience, and reliable community informants helped randomly select households within each community. The number of households surveyed per community is not uniform across the 115 communities but varies between three and twenty[5]. In total, 1,078 households in 115 communities, 81 districts, 42 provinces, and 10 departments were interviewed. Figure 1 provides a map of the sampled areas and the locations of each INIA experiment station.

[5] Appendix Table A2 provides a list of each community and the number of households surveyed in each community.

Figure 1 CIP Survey Province Locations Color Coded by Department



Each province where potato farmers were interviewed is color-coded based on department.
Source: (Pradel, Hareau, Quintanilla, & Suarez, 2013)

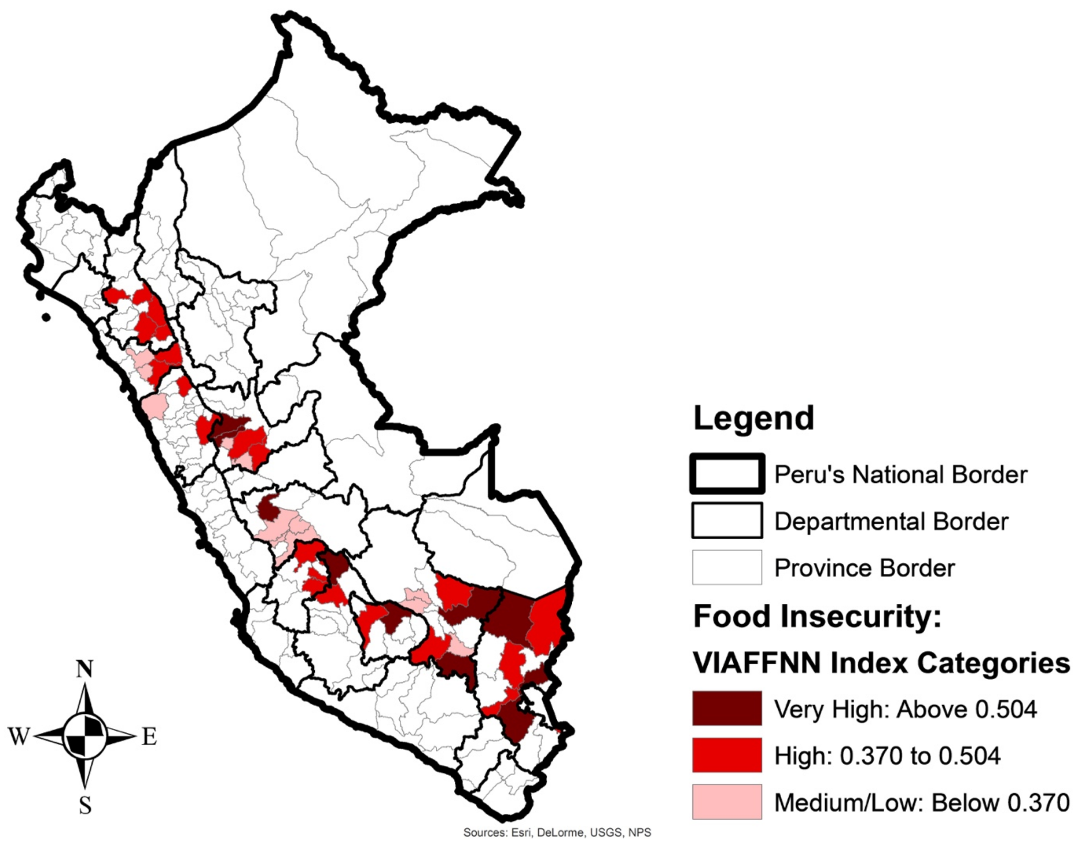
To test hypothesis two, i.e. that living in areas highly vulnerable to climatic phenomena and food insecurity decreases adoption and increase dis-adoption, household survey data are supplemented with an analysis by the WFP on vulnerability to food insecurity relative to recurrent natural phenomena or VIAFFNN (Spanish acronym for vulnerability to food insecurity in the face of recurrent natural phenomena index). The data are taken from a 2015 WFP Report on climatic phenomena in relation to food insecurity in the Andean region (WFP, 2015). The WFP accomplishes food insecurity analysis for four Andean countries, Bolivia, Peru, Ecuador, and Colombia. By using Vulnerability Analysis and Mapping (VAM), the WFP report projects food insecurity in relation to climatic phenomena index for the lowest political unit of each respective country. One hundred and ninety districts were analyzed for Peru. The district-level analysis involved the creation of an index combining two measures: the recurrence of natural phenomena and food insecurity. The index is calculated by using the joint probability of a natural phenomenon that may threaten food insecurity, as well as the probability of food insecurity. The food insecurity measure includes four components: food availability, access to food, food use, and institutionalization. The recurrence of natural phenomena measure has one component, stability[6], which is measured by the reaccurence of natural phenomena.

Using the WFP data and classification metrics, each selected district in the CIP household survey data is classified as very high, high, medium, and low vulnerability to food insecurity given recurrent natural phenomena. Only 1percent of the household data was classified in the WFP's low vulnerability category. Too few observations in one category can affect the power of the tests. To mitigate this problem, we simplify the WFP classification scheme in to three classification groups -very high, high, and medium/low FIAs. Very high FIAs are districts classified as having an index above 0.504 (color coded as maroon in Figure 2), high FIAs range from 0.370 to 0.504 (color coded as red in Figure 2), and medium/low FIAs (color coded as pink in Figure 2) have indices lower than 0.370. The average district elevation for very high FIAs is 3490.98 meters, 3395.25 meters for high districts, and 3387.91 meters for medium/low vulnerability districts. Based on the three classifications, 31 percent of households reside in very high FIAs, 48 percent in high FIAs, and 21 percent in medium/low FIAs. Figure 2 displays the

[6] Appendix B provides a list of the variables entering each component, and data sources.

VIAFFNN index for very high, high, and medium/low FIAs across provinces[7] within each respective department. Very high, high, and medium/low FIAs are scattered across the central and southern regions of the country. Very high and medium/low FIAs may boarder one another, underscoring the variability in agro-ecologies and food insecurity across departments. Less food insecure areas characterize the most northern provinces surveyed; with only high and medium/low classifications found.

Figure 2 Food Insecurity Given Climatic Phenomena in Sampled Areas of the Peruvian Highlands



VIAFFNN index across CIP surveyed areas.
Source: (WFP, 2015)

[7] We map this data at the province level to better visually demonstrate the differences in risk indices across Peru. The province level data uses the average of the district indices.

The data were further supplemented based on household coordinates[8] to obtain household elevations (meters above sea level) and distances to the nearest experiment station. We used ArcMap v.3.1 (ESRI) to obtain household elevation from a Digital Elevation Model (DEM) for Peru (The CGIAR Consortium for Spatial Information (CGIAR-CSI), 2017). The DEM resolution is 1km by 1km; therefore, an elevation value is represented per square kilometer. For distance to nearest experiment station the “Near” tool in ArcMap is used to calculate the distance from each household or experiment station to the nearest road feature. After this value is found, the network analysis tool uses the Peruvian road system shapefile to calculate the distance (km) from the household road feature intersect to the nearest experiment station road feature intersect. By summing these values, the study calculates a realistic distance from each household to the nearest experiment station. There are shortcomings in the method used to calculate proximity to nearest experiment station. First, there may be connecting roads, which are missing from the road network data set leading to errors in the calculated value. Second, many times farmers avoid roads that have to circumvent rivers and mountains and instead walk shorter distances to their desired location. Despite these weaknesses, the study still uses the calculated distance because it is the best estimated distance the study was able to render.

3.3 Summary Statistics

Summary statistics about adoption and farmer characteristics are presented in this section. Adoption statistics are presented for the nine improved varieties for Peru and by department. Statistics are presented by farmers who are currently adopting, farmers who have ever adopted, and farmers who have dis-adopted Yungay, Canchan, and Amarilis. Adopting farmers are those

[8] For the 155 households, which had missing coordinates we used the center of the community coordinate, the lowest sampled unit, as an estimate for household location. If a community coordinate was not found, we used the center of the district the household resides in as the household coordinate.

who planted one of the improved varieties during the 2011 to 2012 farming season. Dis-adopters are those who have planted the variety before but did not plant the variety during the 2011 to 2012 harvesting season. Farmers who have ever planted the variety include both current adopters and those who dis-adopted.

3.3.1 Highland Potato Farming Statistics

Table 3 represents the total land area in hectares under potato production during the 2011-12 harvest season by department and for Peru.

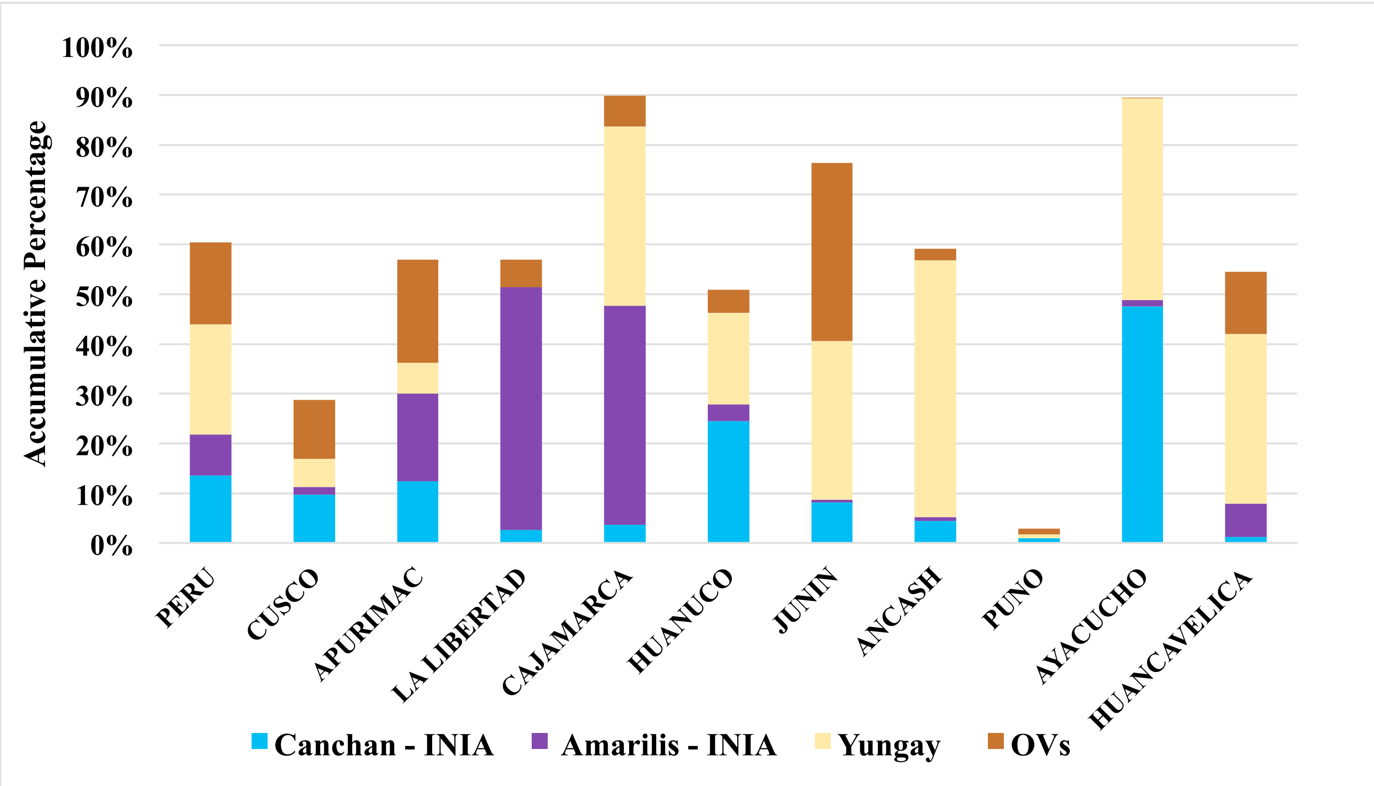
Table 3 Area of Land (ha) dedicated to Potato Production in Peru and per Department

Department	Area (Ha.)
Cusco (South)	33,619
Apurimac (South)	16,968
Puno (South)	52,312
Huánuco (Central)	35,635
Ayacucho (Central)	21,471
Huancavelica (Central)	20,899
La Libertad (North)	24,730
Cajamarca (North)	29,706
Junín (Central)	24, 012
Ancash (Central)	12,456
Peru	275,706

This data was obtained from the Peruvian Ministry of Agriculture.
Source: (Pradel, Hareau, Quintanilla, & Suarez, 2013)

The departments of Puno, Huánuco, and Cusco have the largest land area dedicated to potato production. Ancash, Apurimac, and Huancavelica have the smallest land area dedicated to potato production. Figure 3 represents the proportion of the land area, stated in Table 3, dedicated to potato production by potato variety during the 2011 to 2012 harvesting season. In order to clearly compare all nine varieties and focus specifically on the proportion of land dedicated to the three main varieites (Yungay, Canchan, and Amarilis), Unica, Andina, Chaska, Perricholi, Serranita, and Roja Ayacuchana are grouped together in one group called OVs (other varieties). The proportion of land represented in Figure 3 for OVs demonstrate the proportion of potato production land dedicated to any combination of Unica, Andina, Chaska, Perricholi, Serranita, and Roja Ayacuchana, within that department and nationally. In Peru, around 60 percent of potato production land is dedicated to the nine specified varieties of interest. Despite Puno, Huánuco, and Cusco having the largest share of land dedicated to potato production, they have the smallest shares of land dedicated to improved potato variety and the largest shares of land dedicated to native potato varieity. Departments with the smallest amount of land dedicated to potato production have over 50 percent of their potato land area dedicated to the studied improved varieties.

Figure 3 Distribution of Varieties Nationally and Per Department Based on Quantity (kg) of Seed Used in the 2011 to 2012 Harvest Season



Source: (International Potato Center, 2011-2012)

Cajamarca, Ayacucho, and Junín have the largest proportion of potato land area dedicated to improved varieties. In Cajamarca, most land area for the nine improved varieties is dedicated to Yungay and Amarilis, where in Ayacucho more land is dedicated to Canchan and Yungay. In Junín, most of the land under improved potato production is dedicated to Yungay and OVs. The lowest proportion land dedicated to the nine improved varieties is found in Puno and Cusco. In Puno, most land for improved variety production is dedicated to Canchan, OVs, and then Yungay, but area under improved variety production is less than 8 percent. In Cusco, of the land areas dedicated to improved variety production most of which is dedicated to OVs, Canchan, and then Yungay.

Nationally, 39 percent of potato producing households are planting Yungay, 31 percent are planting Canchan, 23 percent are planting Amarilis, and 21 percent are planting OVs. The average potato farming household head is male and 46 years old with six years of formal education. The average household has four members, cultivate 2.4 hectares, and 1.4 hectares are dedicated for potato production (Table 4). Average household elevation is 3,423 meters above sea level and 57.4 percent of the households sell potatoes on the market. Although there are differences in current adoption rates across Peru, there are only few household characteristics that are statistically different between farmers who are currently adopting Yungay, and those adopting Canchan, and Amarilis.

Table 4 Household Characteristics for Farmers in Peru and Farmers Planting Yungay, Canchan, Amarilis, and/or OVs

Variables	**Peru**	**Household Plants Yungay**	**Household Plants Canchan *(Test1)***	**Household Plants Amarilis *(Test2)***
Number of Observations	1078	416	338	246
Household Head Age (years)	45.8	45.1	44.8	44.5
Male Headed Households (%)	89.3	89.4	91.4	93.1
Education of Household Head (years)	6.3	6.4	6.7	5.8*
Household size (number of people)	4.2	4.3	4.3	4.3
Land Area Farmer is Responsible for (ha)	2.4	3.0	3.0	3.0
Land Area Dedicated to Potato Production (ha)	1.4	1.7	1.7	1.3*
Household Elevation (m)	3423.2	3242.9	3433.7***	3256.3
Household Sells Potatoes on the Market, (1=Yes, 0=No (%)	57.4	67.8	60.7**	61.4*

*Notes: (*) indicates significance at the 10% level, ** at 5%, and *** at 1%.*
***Test1** refers to farmers who are planting Yungay versus farmers who are planting Canchan*
***Test2** refers to farmers who are planting Yungay versus farmers who are planting Amarilis*
***Test3** refers to farmers who are planting Yungay versus farmers who are planting OVs*

Source: (International Potato Center, 2011-2012)

Households who are planting Yungay during the 2011 to 2012 farming season are more educated than farmers planting Amarilis. On average, these farmers have more land than the average highland potato farmer. Farmers planting Yungay have more land dedicated to potato production than the average highland potato farmer and farmers planting Amarilis. A larger share of farmers who are planting Yungay sell their potatoes on the market than the average potato farmer and farmers planting Amarilis or Canchan. Households who plant Yungay are located at lower elevations than the average potato farmer, and farmers planting Canchan. The statistics show that, on average, farmers who are planting Yungay have more land they are responsible for, more land dedicated to potato production, are more market oriented, and are located at lower elevations. The results indicate that Yungay potato farmers have more commercial potato farmering characteristics (i.e. market oriented larger land for potato production), than farmers planting Canchan and Amarilis.

3.3.2 Comparison of Farmers Ever Adopting Multiple Varieties and Adoption by Department

Previous statistics only explain current adoption, during the 2011 to 2012 harvesting season, and do not account for farmers who have ever adopted an improved variety. In this section, we show the proportion of farmers adopting one variety while also adopting and dis-adopting another variety and the patterns of adoption and dis-adoption per variety and across farmers. This is described as “cross-adoption and dis-adoption statistics” because each household can adopt and dis-adopt multiple varieties across time. We then compare the adoption of Yungay with other varieties based on which department the farmer resides in.

3.3.2.1 Cross-adoption and Dis-adoption Statistics

Table 5 and Table 6 demonstrate the proportion of farmers who adopt one variety while adopting and dis-adopting another variety. For example, 66 percent of farmers who have ever adopted Yungay also adopted Canchan. Farmers who adopt Amarilis also have a high proportion (around 60 percent) of farmers who adopt Canchan as well. These statistics demonstrate that Canchan is highly adopted, with 57 percent of households ever adopting the variety.

Despite Canchan having high adoption rates, we also find high dis-adoption. Canchan dis-adoption rates are near 50 percent regardless of farmers adopting other varieties. Dis-adoption of Yungay and Amarilis is lower than Canchan dis-adoption rates, with around 30 percent dis-adopting the two varieties. Unchanging dis-adoption rates across farmers ever adopting Yungay, Canchan, and Amarilis demonstrate that farmers having adopted one variety or another have little effect on whether the farmer dis-adopts the variety of interest.

Table 5 Adoption of Multiple Varieties-Yungay, Canchan, and Amarilis

	Farmers Ever Adopted		
Farmers Also Adopted	**Yungay**	**Canchan**	**Amarilis**
Number of Observations (1078)	587	618	330
Farners Ever Adopted Yungay	100%	62%	60%
Farners Ever Adopted Canchan	66%	100%	60%
Farners Ever Adopted Amarilis	33%	32%	100%

Source: (International Potato Center, 2011-2012)

Table 6 Adoption and Dis-adoption of Yungay, Canchan, and Amarilis

	Farmers Ever Adopted		
Farmers Also Dis-adopted	**Yungay**	**Canchan**	**Amarilis**
Number of Observations (1078)	587	618	330
Farners Dis-adopted Yungay	29%	33%	36%
Farners Dis-adopted Canchan	52%	45%	52%
Farners Dis-adopted Amarilis	29%	32%	25%

Source: (International Potato Center, 2011-2012)

The statistics reveal that certain varieties such as Canchan with high dis-adoption rates are less desirable than Yungay and Amarilis, which have lower dis-adoption rates. Half of farmers who dis-adopted Canchan report reasons for dis-adopting the variety. Of the half of the dis-adopters who do report reasons, 25 percent state that dis-adoption is attributed to Canchan's susceptibility to disease/plagues. Another 15 percent attribute dis-adoption to low yields, and around 14 percent attribute dis-adoption to lack of seed availablility and poor potato prices. Forty-four percent of farmers who dis-adopted Canchan are planting Yungay during the 2011 to 2012 harvest season and 23 percent are planting Amarilis.

Those who report reasons for dis-adopting Amarilis attribute dis-adoption of Amarilis to lack of seed availability. Likewise farmers dis-adopting Yungay attribute dis-adoption to lack of seed availability or low yields. 45 percent of farmers who dis-adopted Amarilis are planting Yungay, and 29 percent are planting Canchan. Of the farmers who dis-adopted Yungay, 30 percent are planting Canchan and Amarilis.

The statistics demonstrate why farmers are dis-adopting Canchan, Amarilis, and Yungay. They also underscore that a large portion of farmers who dis-adopt Canchan or Amarilis are planting Yungay, proving that Yungay may be more desireable than both Canchan and Amarilis. We find that farmers who dis-adopt Yungay do not show strong replacement preference for

Canchan or Amarilis, but both varieties are equally planted among farmers who dis-adopt Yungay.

3.3.2.2 Departmental Comparison

To understand the differences in adoption patterns by department we compare three exclusive groups. The first group contains farmers who have only adopted Yungay and have not adopted another improved variety (Canchan or Amarilis). The second group includes farmers who have adopted an improved variety (Canchan or Amarilis), but have never adopted Yungay. The third group involves farmers who have adopted Canchan or Amarilis and have at one point in time adopted Yungay.

First, we compare farmers ever adopting Yungay (and never adopting Canchan) with farmers ever adopting Canchan (and never adopting Yungay), and farmers adopting both Yungay and Canchan (Table 7).

Table 7 Percentage of Adopters Adopting Yungay, Canchan, or Yungay and Canchan by Department

Variable	Sample	Ever Adopted Yungay *(Test1)*	Ever Adopted Canchan *(Test2)*	Ever Adopted Yungay and Canchan *(Test3)*
Department	819	201	232	386
Cusco (South)	87	6.97***	19.83***	6.99
Apurimac (South)	58	4.48***	16.38***	2.85
Puno (South)	90	5.47***	31.90***	1.30***
Huánuco (Central)	151	7.96	11.64***	27.98***
Ayacucho (Central)	70	1.49	0.86***	16.84***
Huancavelica (Central)	65	13.93***	0.43***	9.33*
La Libertad (North)	86	12.44	13.36**	7.77**
Cajamarca (North)	80	21.39***	6.99	4.31***
Junín (Central)	94	17.91***	1.29***	14.25
Ancash (Central)	38	7.96***	0.00***	5.70

*Notes: (*) indicates significance at the 10% level, ** at 5%, and *** at 1%.*
Test1 *refers to farmers who have ever planted Yungay and not Canchan versus farmers who have ever planted Canchan, but not Yungay.*
Test2 *refers to farmers who have ever planted Canchan and not Yungay versus farmers who have planted both Canchan and Yungay.*
Test3 *refers to farmers who have ever planted Yungay and not Canchan versus farmers who have planted both Canchan and Yungay*

Source: (International Potato Center, 2011-2012)

We find there are a statistically significant lower proportion of farmers ever adopting Yungay than farmers ever adopting Canchan in the south (Cusco, Apurimac, and Puno). In Puno, however, there is a statistically higher proportion of farmers adopting Yungay compared to farmers adopting both Yungay and Canchan. This is most likely due to the fact that Puno has different production systems, which rely more on traditional (such as Yungay) and native varieties. In two central departments (Huanuco and Ayacucho), there are higher proportions of farmers adopting Canchan than farmers adopting Yungay and not Canchan. In the remaining central departments (Huancavelica, Ancash, and Junín) we find a higher portion of farmers adopting Yungay rather than Canchan. Likewise in Cajamarca more farmers adopt Yungay compared to just Canchan. In La Libertad a higher share of farmers adopt Canchan (and do not adopt Yungay) than farmers who adopt Yungay and have never adopted Canchan.

The proportion of farmers adopting Yungay compared to farmers adopting Amarilis or Yungay and Amarilis is higher in all-southern departments except Apurimac (Table 8). A higher proportion of farmers in Apurimac adopt Amarilis than Yungay, or Amarilis and Yungay. In the central departments, a higher proportion of farmers adopt Yungay than Amarilis, and not Yungay. In the north (La Libertad and Cajamarca) a higher share of farmers adopts Amarilis or Amarilis and Yungay than only Yungay. This makes sense as Amarilis was released in the North so more farmers were more likely to hear about Amarilis and obtain Amarilis seed.

Table 8 Percentage of Adopters Adopting Yungay, Amarilis, or Yungay and Amarilis by Department

Variable	**Sample**	**Ever Adopted Yungay *(Test1)***	**Ever Adopted Amarilis *(Test2)***	**Ever Adopted Yungay and Amarilis *(Test3)***
Department	722	392	135	195
Cusco (South)	49	10.20	5.93***	0.51***
Apurimac (South)	55	3.06***	25.93***	4.10
Puno (South)	17	4.08*	0.74	0.00***
Huánuco (Central)	135	20.15***	8.15 ***	23.08
Ayacucho (Central)	68	16.33**	0.00*	2.05***
Huancavelica (Central)	67	12.24***	2.22**	8.21
La Libertad (North)	96	3.83***	30.37**	20.51***
Cajamarca (North)	105	1.79***	25.93	32.31***
Junín (Central)	92	20.41***	0.74**	5.64***
Ancash (Central)	38	7.91***	0.000***	3.59**

*Notes: (*) indicates significance at the 10% level, ** at 5%, and *** at 1%.*
***Test1** refers to farmers who have ever planted Yungay and not Amarilis versus farmers who have ever planted Amarilis, but not Yungay.*
***Test2** refers to farmers who have ever planted Amarilis and not Yungay versus farmers who have planted both Amarilis and Yungay.*
***Test3** refers to farmers who have ever planted Yungay and not Amarilis versus farmers who have planted both Amarilis and Yungay*

Source: (International Potato Center, 2011-2012)

3.4 Empirical Specification

This section outlines the empirical model used to explain adoption and dis-adoption and test our four hypotheses. Further explanation is provided by describing why variables were chosen and how they were measured.

3.4.1 Model

We estimate a Heckman Probit model to explain trial period adoption and continued use of improved potato varieties, represented by Equation 1 and Equation 2 respectively.

(1) $\mathrm{Y}_{ij1} = \mathrm{f}(\mathrm{X}_i,\ \mathrm{Z}_k, \varepsilon_i)$

$$\text{Where,}\ \ \mathrm{Y}_{ij1} = \begin{cases} \mathrm{Y}_{ij1} \ = 1 \text{ if household has ever planted variety } j \\ \mathrm{Y}_{ij1} \ = 0 \text{ if household has never planted variety } j \end{cases}$$

(2) $\left(\mathrm{Y}_{ij2} \middle| \mathrm{Y}_{ij1} = 1\right) = \mathrm{f}(\mathrm{X}_i, \mathrm{Z}_k, \omega i)$

$$\text{Where,}\ \ \mathrm{Y_{ij2}} = \begin{cases} \mathrm{Y}_{ij2} \ = 1 \text{ if household currently plants variety j} \\ \qquad \mathrm{Y}_{ij2} \ = 0 \ \text{ if household has dis} - \text{adopted variety j} \end{cases}$$

- Y_{ij1} is the binary variable for a trial period (1) that is equal to 1 if household i^{th} has ever adopted variety j^{th} (Yungay, Canchan, Amarilis) at any point in time, and zero otherwise
- Y_{ij2} is the binary variable for the post-trial period (2) for whether the i^{th} household dis-adopted or continues to plant the j^{th} variety (Yungay, Canchan, Amarilis). Dis-adoption decision is contingent upon the farmer having adopted the variety in the trail period $\left(\mathrm{Y}_{ij2} \middle| \mathrm{Y}_{ij1} = 1\right)$.

- The exogenous explanatory variables reflect household, and district level characteristics:
  - X_i is a vector of variables of household characteristics;
  - Z_k is a vector of variables of district-level characteristics;
  - ε_i and w_i are idiosyncratic errors which vary over households and are correlated with each other;

The continued adoption stage only includes households who have at one point in time adopted the improved variety (Y_{ij1} =1). As such, there is a non-random selection of households. This leads to selection bias; farmers who did not adopt in the first stage are not represented in the second stage adoption analysis, and first-stage adopters and non-adopters might be different in unobservables, such as the ability to bear risk. The Heckman approach treats the non-random sample selection problem as an omitted variable problem and uses the Inverse Mills Ratio (IMR) to control for such bias. The Heckman Probit model assumes that the error terms of the two stages are correlated (Heckman , 1979). Also, a variable that explains the outcome of the selection equation (adoption) but does not explain the outcome of the dis-adoption equation except through its effect on adoption, is included in the selection equation. This variable is excluded from the second stage and this exclusion allows us to identify the effect of adoption on the second-stage outcome.

3.4.2 Explanatory Variables

Explanatory variables are arranged by household and district-level and are used to test hypotheses 1 through 5. Other explanatory variables, such as elevation are used as control variables. Table 9 provides variable definitions.

Table 9 Heckman Probit Variable Definitions used to Test Hypotheses

Variables	Definition	Presence of Explanatory Variable in Selection and Dis-adoption Equations
Dependent Variables		
EverPlantedVariety	The dependent variable in the adoption model: 1 if household had cultivated the improved variety or variety group at some time prior to the survey date, 0 otherwise	Selection
DisadoptionVariety	The dependent variable in the dis-adoption model: 1 if household abandoned cultivating the improved variety or variety groups as of the survey date, 0 otherwise	Dis-adoption
Household Level Variables (Xi)		
HHHeadAge	Head of household age (0=18-24, 1=25-54, 2=55-64, 3=65 and older)	Both
HHHeadEducation	Household head education (0=No Education, 1=Primary, 2=Secondary, 3=Above Secondary)	Both
SocialNetwork	The number of people the household can count on in times of need. (Calculated using the CIP household survey)	Both
TotalLand	Total land per household which is used for farming and other practices (ha)	Both
AssetIndex	Index of household assets	Both
HHHeadGender	Household head gender (0=Male, 1=Female)	Both
HHSellPotatoMarket	Whether household sells potatoes at local, district or main market (1=Yes, 0=No)	Both
DistancetoES	The distance a household is from an experiment station (km)	Both
Region	Household regional location (1=Southern Departments: Cusco, Apurimac, and Puno, 2= Central Departments: Huánuco, Ancash, Ayacucho, Junin, and Huancavelica, 3=Northern Departments: La Libertad and Cajamarca)	Both
Elevation	Household elevation (MASL)	Both
PlantedImproveseedFromInformal	Whether a farmer has at one point in time obtained any improved potato seed from the informal seed system. (1=Yes, 0=No)	Selection
District Level Variables (Zk)		
AvailabilityDistrictVariety	Number of years since variety was first planted in the district until present (2013) (Yrs.)	Both
VIAFFNN	World Food Programme: Food insecurity given recurrent natural disasters index (1=Medium/Low, 2=High, 3=Very High)	Both

3.4.3 Hypothesis 1: Adoption of varieties is regionally dependent and time dependent

3.4.3.1 Spatial Clustering

We further test spatial clustering of adoption by including a regional variable (Region) with three regions-northern highlands, central highlands, and southern highlands. From this regional categorical variable, we test the significance of household's regional location with a farmer's decision to adopt and dis-adopt. Using this variable, we can observe whether farmers are more likely to adopt and/or dis-adopt a variety or variety group based on their regional location. We compare the spatial clustering of adoption for our set of improved varieties with that of Yungay.

3.4.2.2 Time Dependence

We capture time dependence by the number of years since the variety was first planted in the district until present (2012) (reflected by our AvailabilityDistrictVariety variable). As outlined in the conceptual framework, the longer a variety is available in a farmer's community and planted by a neighbor, the more knowledge a farmer will attain by observing her neighbor. One limitation to our data set is that we do not have information on the year the variety stopped being planted in the district (i.e. the year the entire district dis-adopted the variety). Therefore, we cannot obtain the exact length of time the variety is available per district. Instead we assume that since the variety was first planted in the district until present is the length of time the variety was available in the district. We further test time dependence nationally and by region by graphing the rate of adoption over time per variety since each variety's release year. This analysis will be explained further in the next chapter.

3.4.4 Hypothesis 2: Living in areas highly vulnerable to climatic phenomena and food insecurity is expected to decrease adoption and decrease dis-adoption

3.4.4.1 VIAFFNN Index

To account for food insecurity and the occurrence of climate shocks, we use the food insecurity index in the face of recurrent natural disasters data from the WFP. By using this categorical variable (VIAFFNN), we can test whether farmers in high risk areas are less likely to adopt and dis-adopt.

3.4.5 Hypothesis 3: Access to informal seed systems will increase the likelihood of adoption

3.4.5.1 Access to Informal Seed Systems

We use whether a farmer has at one point in time obtained any improved potato seed for the first time from the informal seed system, as measuring a farmer's access to improved varieties from the informal seed system (PlantedImproveseedFromInformal). The low costs of obtaining improved seeds from the informal seed system is expected induce adoption. Since we assume that this variable only affects the decision to adopt, and not dis-adoption, we include it as an exclusion variable in our model.

3.4.6 Hypothesis 4: Access to information about the variety will increase the likelihood of adoption and continued adoption

Measuring access to information can be challenging given that each community and household have different constraints which limit their access to information about improved potato varieties and potato farming practices. We attempt to control for these factors by including the distance a household is from an experiment station (DistancetoES), and whether a farmer is market oriented (HHSellPotatoMarket).

3.4.6.1 Distance from Experiment Station

INIA Experiment stations are agricultural research centers that test improved potato varieties, produce high quality potato seed, transfer improved potato seed to the public, and provide additional information needed to manage the new technology (INIA). These stations are located throughout Peru (as shown in Figure 1). Farmers close to experiment stations are more likely to obtain rich information and the support needed for improved variety use. A study conducted in 2012 on agricultural experiment productivity spillovers found that communities closer to experiment station had increased and sustained local agriculture productivity. The study also found that productivity even grew over time (Kantor & Whalley, 2012). Therefore, we predict farmers located closer to an experiment station are more likely to adopt improved technology and less likely to dis-adopt.

3.4.6.2 Market Oriented

To account for access to information we use whether a farmer sells potatoes on the market. The market is a place where farmers can learn about improved varieties and their associated attributes at a relatively low cost. We assume that if a farmer sells potatoes on the market, that the benefits of selling potatoes and exchanging information outweigh the costs of going to the market. The benefits of going to the market include profit gained from selling the potatoes and information gained from the exchange of non-market goods, such as ideas and information. We postulate that if a potato farmer is market oriented, she will be more likely to obtain accurate information about new potato varieties at low cost compared to farmers who are not market oriented, increasing the probability of adoption and decreasing the probability of dis-adoption.

3.4.7 Hypothesis 5: Ability to mitigate risk will increase the likelihood of adoption and continued adoption

We predict that the ability for a farmer to mitigate risk will increase the probability of adoption and decrease the probability of dis-adoption. Age (HHHeadAge) and education (HHHeadEducation) of the household head, a farmer's social network (SocialNetwork), wealth (AssetIndex), and total land (TotalLand) are used to capture a farmer's ability to mitigate risk.

3.4.7.1 Age and Education

In this study, we assume that the head of the household makes most decisions about adopting new varieties. We use the household head's age and education to represent the age and education of the person in the household who makes the decisions on improved variety use. Age is represented as a quadratic relationship because as household head gets older we believe the effect age has on adoption and dis-adoption diminishes. We categorize education into three categories. Education's categories are no education, primary education, and secondary education and above secondary education.

3.4.7.2 Social Network

Households with stronger social networks should be in a better position to mitigate risk and obtain information. We measure[9] social networks as the number of people a farmer can count on in times of critical need (i.e. financial need). This number represents the number of links a farmer has within his or her social network. The more links a farmer has to individuals for support, the more likely she will be able to quickly recuperate from economic shocks.

[9] The data used to measure social network comes from the CIP household survey in section 2.B.

3.4.7.3 Wealth

The wealthier a farmer is, the more likely she can cope with risks. In developing countries' agricultural sectors, incomes can be highly volatile from year to year. Rather than dealing with the ambiguities of how to collect and measure household income, we use an asset index to capture long-term wealth. Assets reflect long-term accumulated wealth (including monetary and non-monetary wealth) and are considered a better reflection of household living standards than income (Moser & Felton, 2007).

The wealth index is created using polychoric principal component analysis (Polychoric PCA). The main assumption of this method "is that there is a latent variable assumed to represent long-term well-being, which can be observed through ownership of different assets" (Larochelle, Alwang, & Taruvinga, 2014, p. 86). Using Equation 3, we compute an asset index score for the ith household by including the presence and absence of asset ownership and estimated asset weights across households.

$$(3)\ \mathrm{AI}_i = \sum_{j=1}^{n} \mathrm{w}_j \mathrm{a}_{ij}$$

- AI_i represents an asset index score for the i^{th} household.
- a_{ij} represents the ownership status of the j^{th} asset for the i^{th} household.
- w_j is the estimated weight using polychoric PCA.

Before the estimation of polychoric PCA, assets[10] are first ordered (Larochelle, Alwang, & Taruvinga, 2014). For example, a straw roof is ranked lower than a tile roof, because tile is more durable and undoubtedly more expensive. Using the set of categorical asset values from the CIP household survey, weights are then estimated using a polychoric matrix. The polychoric PCA calculates weights for both ownership of assets and lack of ownership. The weights ($\boldsymbol{w_j}$)

[10] Assets used include roof, walls, water source, bathroom type, and regular cooking fuel. As well as sound equipment, TV, telephone, computer, stove, refrigerator, bicycle, car, and motorcycle.

and presence or absence of ownership (a_{ij}) are then used to derive an asset index[11] for each household.

3.4.7.4 Total Land

A household's ability to bear risk is reflected not only by their personal wealth, but also by land they own or access. Total land farmed is used instead of total land owned because highland farmers typically work on land held by the community (CIP, 2009). Farmers with larger plots of land are able dedicate a proportion of their land for experimentation. Potato farmers with larger land holdings have more opportunities to diversify the type of varieties they harvest, softening the potential financial burden of risk taking (i.e. planting a new potato variety). Likewise, farmers with larger land holdings are able to dedicate a larger portion of their land for experimentation, observing a larger sample size of the potato variety. This can lead to more realistic expectation, decreasing the likelihood of dis-adoption.

3.4.8 Method Weaknesses

In many adoption studies, current characteristics are used to describe past decisions. Many variables in this study have this innate flaw. Some variables are static and are solely descriptive for the 2011 to 2012 cultivation season. They do not explain other pertinent and continuing factors which affect trial period adoption and dis-adoption throughout time. We attempt to overcome this disconnect by including variables that capture decisions and actions which occurred before 2011. The informal seed system, for example, represents access to other improved varieties before the 2011 to 2012 harvesting season. The length the variety has been available in the district, in some cases, represents actions taken place before 2011, assuming farmers in the district started planting before 2011. Food insecurity, given recurrent natural

[11] The asset index range is from -1.937 to 6.67.

phenomena, also includes variables that are affected by past decisions. It explains past constraints that might have affected a farmer's trial period and post-trial period adoption decisions.

Chapter 4: Findings

4.1 Descriptive Analysis

First, we compare household and district level characteristics by farmers who have planted an improved variety (all eight improved varieties not including Yungay) versus farmers who have never planted an improved variety. We also compare statistics of farmers who have adopted Yungay with those who have not adopted Yungay. Then we depict the temporal dimension of adoption showing that some varieties over time are adopted quicker than others.

In Table 10 we compare household characteristics between farmers who adopt improved varieties and farmers who do not adopt improved varieties. Farmers who adopt improved varieties are more educated, and more market oriented. A higher portion of adopters of improved varieties are male compared to non-adopters. On average, farmers who adopt improved varieties have more land than farmers who do not adopt. Farmers who adopt improved varieties are located at lower elevations and are closer to an experiment station. Due to the definition of our informal seed system source, a higher percentage of farmers use the informal seed system and plant improved varieties than farmers who do not plant improved varieties. A lower portion of farmers who live in very high FIAs adopts improved varieties than the portion of farmers who do not adopt improved varieties. A higher portion of farmers who live in medium/low FIAs adopt improved varieties.

Table 10 Household Characteristics for Farmers Who Adopt and Do Not Adopt Improved Varieties

Variable	Sample	Ever Adopted Improved Variety *(Test1)*	Never Adopted Improved Variety
Number of Observations	1078	836	242
Household Head Age	1078	45.31	47.69
Household Head Education			
No formal education	105	8.73**	13.22
Some primary	324	30.14	29.75
Secondary and above	649	61.12	57.02
Household Elevation	1078	3373.02***	3596.76
Total Land	1078	2.67***	1.65
Asset Index			
1	227	20.10	22.20
2	205	17.72	20.57
3	215	19.25	20.77
4	217	21.64	18.33
5	214	21.29	18.13
Household Head Gender			
Male	963	90.67***	84.71
Female	115	9.33***	15.29
Household Sells Potatoes on the Market			
No	459	36.84 ***	62.40
Yes	619	63.16***	37.60
Household Distance from the Nearest Experiment Station	1078	137.79*	151.91
VIAFFNN			
Medium/Low Vulnerability	231	23.68***	13.64
High Vulnerability	514	47.61	47.93
Very High Vulnerability	333	28.71***	38.43
Planted Improved Seed from Informal Seed System			
No	610	47.19***	67.82
Yes	468	52.81***	32.18

*Notes: (*) indicates significance at the 10% level, ** at 5%, and *** at 1%.*
***Test1** refers to farmers who have ever planted improved variety (besides Yungay) versus farmers who have never planted an improved variety (besides Yungay)*

Source: (International Potato Center, 2011-2012)

There is no statistically significant difference in household head age, gender, education, or wealth between farmers who adopt Yungay and farmers who do not adopt Yungay (see Table 10). Farmers who adopt Yungay are more market oriented. On average farmers who adopt Yungay have 3.12 hectares of land and farmers who have never planted Yungay are responsible for 1.64 hectares of land. Farmers who adopt Yungay are on average, farther from an experiment station and live in lower elevated areas than farmers who do not adopt Yungay. Higher portions of farmers who have adopted Yungay have used the informal seed system than the portion of farmers who have never adopted Yungay. Also, in medium/low FIAs a higher portion of farmers adopts Yungay than the portion of farmes that does not adopt Yungay.

Table 11 Household Characteristics for Farmers Who Adopt and Do Not Adopt Yungay

Variable	**Sample**	**Ever Adopted Yungay *(Test1)***	**Never Adopted Yungay**
Number of Observations	1078	587	491
Household Head Age	1078	45.61	46.11
Household Head Education			
No formal education	105	8.69	11.00
Some primary	324	29.98	30.14
Secondary and above	649	61.33	58.85
Household Elevation	1078	3271.71***	3604.42
Total Land	1078	3.12***	1.64
Asset Index			
1	227	20.10	22.20
2	205	17.72	20.57
3	215	19.25	20.77
4	217	21.64	18.33
5	214	21.29	18.13
Household Head Gender			
Male	963	89.61	89.00
Female	115	11.00	10.39
Household Sells Potatoes on the Market			
No	459	33.39***	53.56
Yes	619	66.61***	46.44
Household Distance from the Nearest Experiment Station	1078	147.41**	133.24
VIAFFNN			
Medium/Low Vulnerability	231	24.19**	18.13
High Vulnerability	514	46.17	49.49
Very High Vulnerability	333	32.38	29.64
Planted Improved Seed from Informal Seed System			
No	610	47.19***	67.82
Yes	468	52.81***	32.18

*Notes: (*) indicates significance at the 10% level, ** at 5%, and *** at 1%.*
***Test1** refers to farmers who have ever planted improved variety (besides Yungay) versus farmers who have never planted an improved variety (besides Yungay)*

Source: (International Potato Center, 2011-2012) (WFP, 2015)

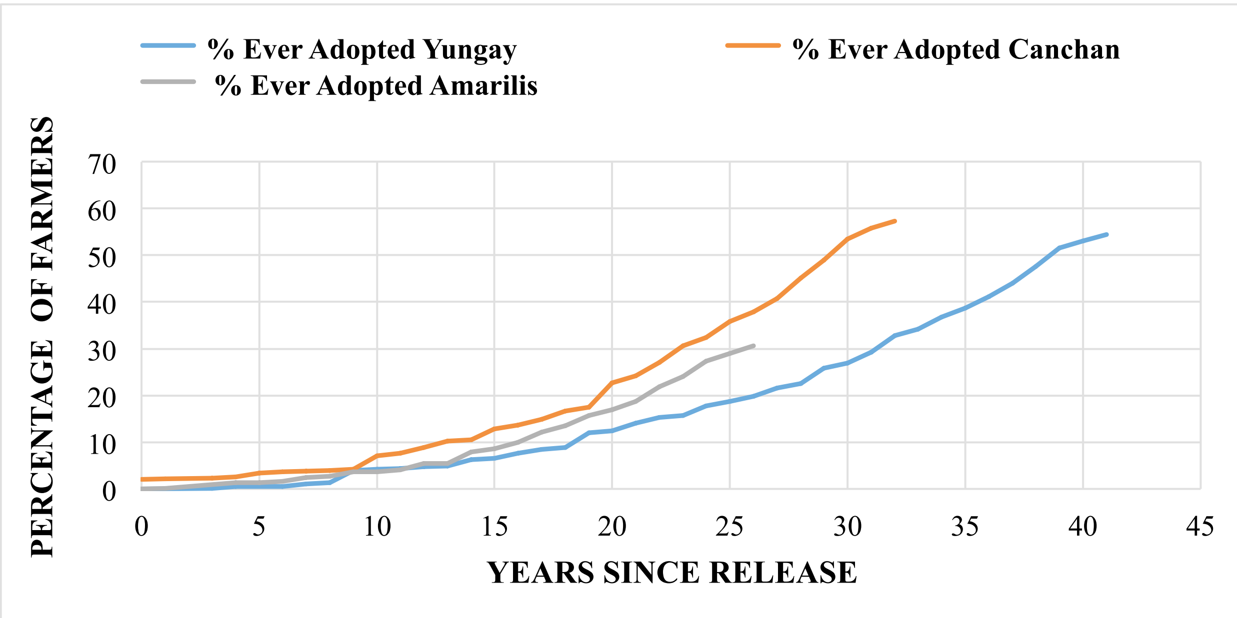
The statistics underscore key findings and their potential implications, some of which will be tested by the Heckman Probit models. Younger and more market oriented farmers appear to be adopting improved varieties (including Yungay). Likewise farmers who adopt improved varieties (including Yungay) are on average responsible for more land. More land equates to a larger area for experimentation and better ability to bear more risk. As a result it may be that households who have more land are more likely to plant newer improved varieties. Distance from an experiment station may also induce adoption. Farmers who adopt improved varieties and/or Yungay are on average closer to an experiment station.

Household elevation and food insecurity may also influence adoption of improved varieties and Yungay. Farmers adoptiong improved varieties, including Yungay, adopt at lower elevated areas. Despite Yungay's recommend planting elevation of 3,700 MASL (found in Table 1), farmers, on average, adopt Yungay at much lower elevations than other varieties. Potatoes adopted at lower elevations are more susceptible to pests and diseases. The findings indicate that improved varieties and Yungay are more resistant to pest and diseases than other variety options. Lower food insecurity may also influence the adoption of improved varieties and Yungay. Farmers living in medium/low FIAs seem to have a stronger preference for improved varieties and/or Yungay than other potato varieties. In higher risk areas farmers appear to gain less utility from adopting improved varieties than other varieties.

4.1.1 Temporal Analysis

In Figure 4 we graph the percentage of farmers who have ever planted the variety over time since the variety's release date. The origin of the graph represents each variety's release year. For varieties with informal release years, Yungay and Canchan, we use the informal release date as the year the variety first became available. The first year farmers planted the variety of interest is summed over time across farmers. From this yearly sum, we find the percentage of farmers who have at one point in time adopted the variety until that year. The last data point over time represents the total percentage of farmers by 2012 that have ever planted the variety.

Figure 4 Percentage of Farmers Ever Adopting Yungay, Canchan, and Amarilis Over Time



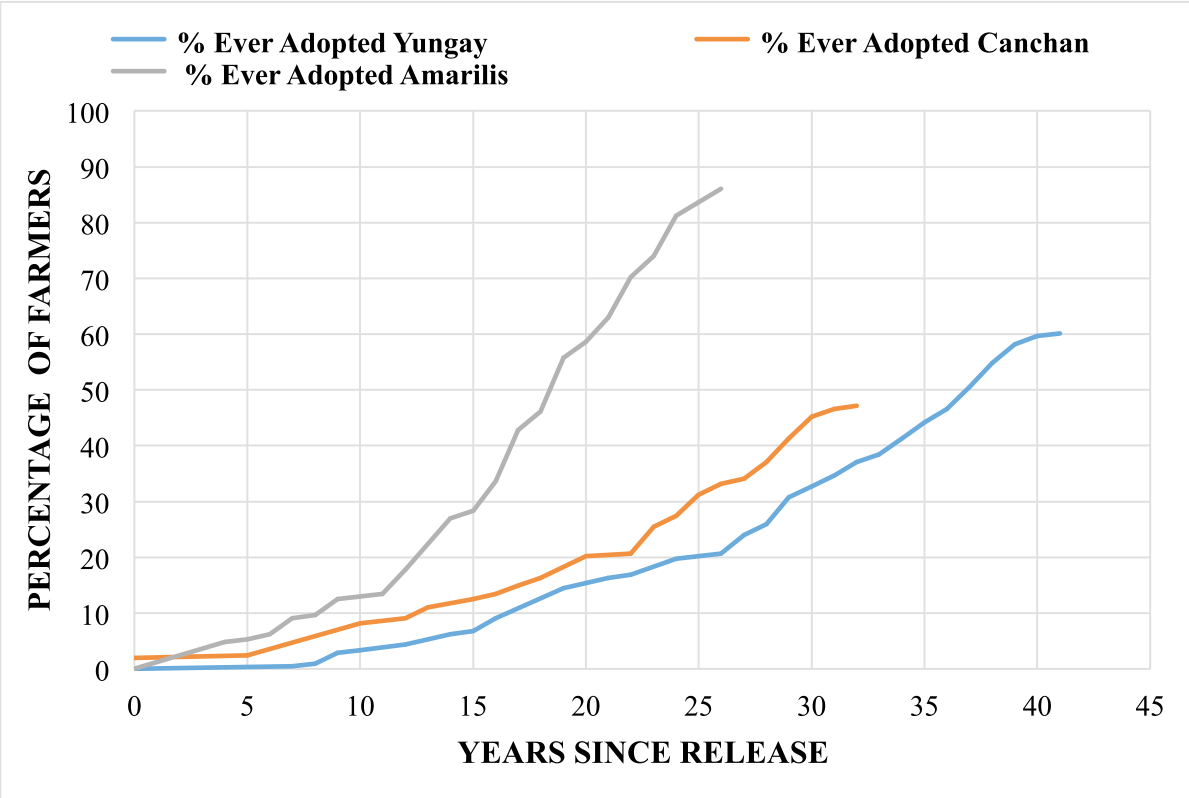
Source: (International Potato Center, 2011-2012)

Figure 4 demonstrates that the percentage of farmers who have ever adopted Yungay, Canchan, and Amarilis increases at an increasing rate and then the percentage decreases. Ten years after each variety's release 7.1 percent of highland farmers adopted Canchan, 3.7 percent adopted Yungay, and 3.7 adopted Amarilis. The rate of adoption 20 years after each variety is released is again highest for Canchan, with 22.6 percent of farmers ever adopting the variety, then Amarilis and Yungay, with 17.0 percent adopting Amarilis and 12.4 adopting Yungay. The differing rates demonstrate that diffusion over time is quickest for Canchan, the variety with the highest percentage of farmers ever planting the variety. Amarilis is the second quickest variety followed by Yungay. The projection of the three varieties predicts that adoption of Canchan and

Amarilis in Peru is surpassing that of Yungay and will surpass that of Yungay 35 to 40 years after each respective variety's release.

The rate of adoption over time changes according to region. In the north adoption of Amarilis over time is quickest and adoption of Canchan and Yungay are slower and follow a similar projection path over time (Figure 5). The rate of adoption is higher and quicker for Amarilis, and Yungay in the north than their national adoption rates over time. Twenty years after the varieties' releases 58.6 percent of farmers adopted Amarilis and 15.4 adopted Yungay in the north. Currently over 80 percent of farmers in the north have adopted Amarilis, and over 50 percent have adopted Yungay. However, the rate of adoption for Canchan over time is very similar to its national adoption rates, with 8.2 percent of highland farmers ever adopting Canchan ten years after its release and 20.2 adopting twenty years after its release.

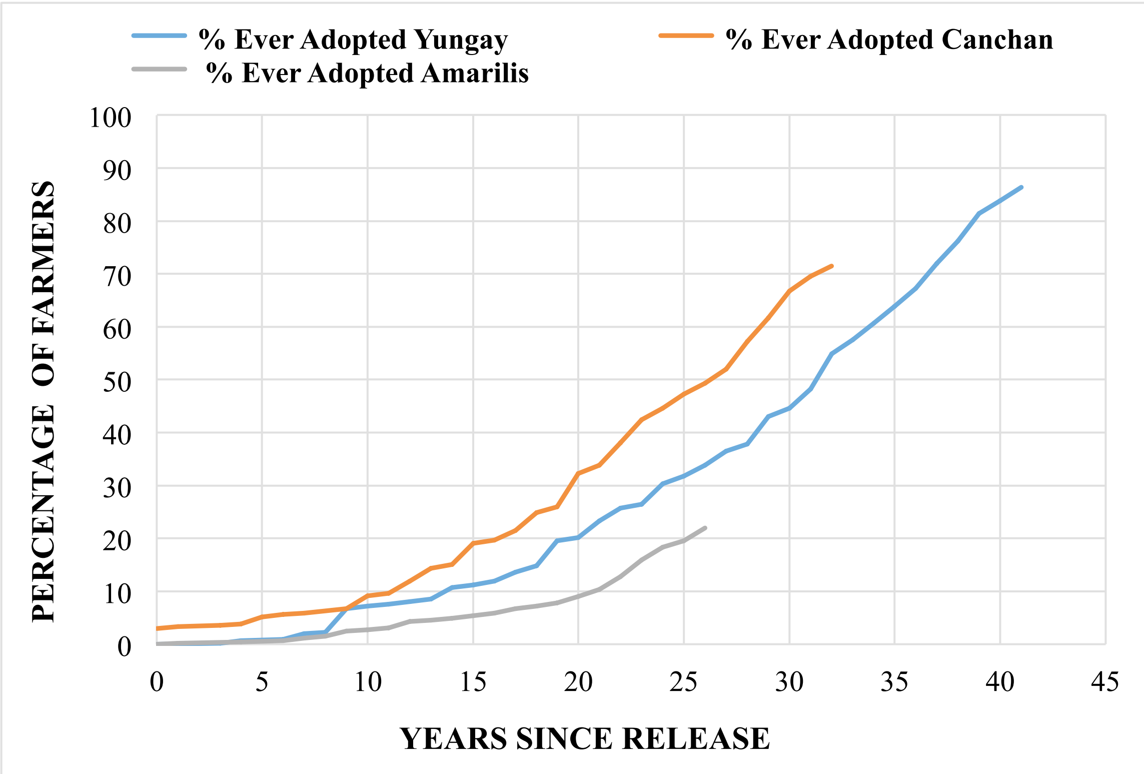
Figure 5 Percentages of Farmers Ever Adopting Yungay, Canchan, and Amarilis Over Time in the North



Source: (International Potato Center, 2011-2012)

In the central highlands adoption of Amarilis over time is low and slow. Ten years after the variety was released only 2.7 percent of farmers adopted Amarilis (Figure 6). Although adoption of Amarilis is much lower and slower than its national adoption rates, adoption of Yungay and Canchan is higher and quicker. Ten and twenty years after Canchan's release 9.2 and 32.3 percent of farmers adopted Canchan in the central highlands. Ten and twenty years after Yungay's release 9.2 and 20.2 percent of highlanders adopted Yungay.

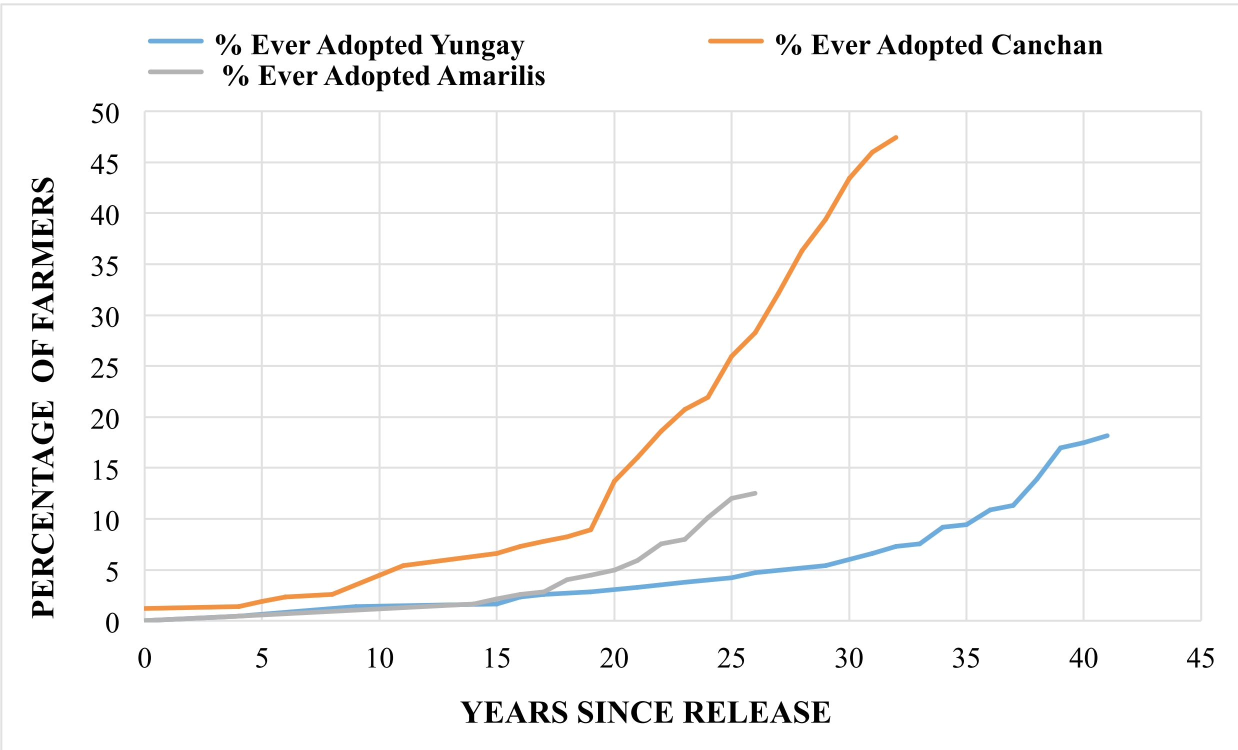
Figure 6 Percentages of Farmers Ever Adopting Yungay, Canchan, and Amarilis Over Time in the Central Highlands



Source: (International Potato Center, 2011-2012)

In the southern highlands adoption is lower and much slower for all three varieties compared to national adoption rates over time (Figure 7). Yungay has the slowest adoption rate over time. Ten and twenty years after Yungay's release only 1.6 and 3.3 percent of farmers adopted Yungay in the south. Amarilis has a slightly higher adoption rate over time than Yungay. Ten and twenty years after the variety's release 1.6 and 5.0 percent of farmers in the south adopted Amarilis. Although adoption of Canchan is slower than its national adoption rates, Canchan has the quickest adoption rate in the south compared to all three varieties. Almost fifty percent of farmers have adopted Canchan in the south and twenty years after its release 13.7 percent of farmers adopted Canchan. Adoption is lower and slower for the south because departments like Puno, which favor traditional and native varieties, have low improved variety adoption rates.

Figure 7 Percentages of Farmers Ever Adopting Yungay, Canchan, and Amarilis Over Time in the South



Source: (International Potato Center, 2011-2012)

There are several weakness and missing data that hinder the study's temporal analysis. First, some farmers who adopted each variety had to recall actions which could have taken place twenty years prior. Since Yungay is the oldest variety, its projection is most likely to have the most errors because farmers had to remember actions taking place further back in time than farmers who adopted earlier released varieties. Due to errors in human memory, the slope of Yungay's adoption projection is more likely to contain the most errors. Second, the projections only show adoption throughout time and do not include dis-adoption.

4.2 Heckman Probit Results

In this section, we first describe the Heckman Probit results for all improved varieties except Yungay, and then we describe models' results for Yungay, Canchan, and Amarilis. The uncensored observations per model (located on the top left of each table) represent the number of households who have adopted the variety of interest. Censored observations are the number of farmers who have not planted the variety of interest, and are not a part of the dis-adoption analysis. The higher number of uncensored observations improves the dis-adoption analysis, as a large sample size yields more reliable results due to a narrower margin of error, a higher confidence level, and a greater power (Select Statistics Services, 2017).

The Wald test (located on the top right of each model) fails to reject the null hypothesis that all coefficients except the intercept are equal to zero. The Wald tests of independent equations (located on the bottom of each model) for improved varieties, Yungay, and Amarilis show that we fail to reject the null hypothesis, providing evidence that the two probit equations are independent. For Canchan we reject the null hypothesis, demonstrating dependence between the two equation's error terms.

4.2.1 Improved Variety Heckman Probit Results

Improved variety adoption is defined as a farmer adopting one or more of the eight specified improved varieties (not including Yungay). Improved variety dis-adoption is defined as a farmer having planted one or more of the eight varieties, but not currently planting any of the improved varieties during the 2011 to 2012 harvesting season. The study finds that reduced risk via increased wealth increases the likelihood of a farmer adopting one or more improved varieties. Farmers in the third wealth quintile are 6.65 percentage points more likely to adopt an improved variety than are those in the lowest quintile (Table 12). Increased information also increases the likelihood of a farmer adopting an improved variety. Farmers who sell potatoes on the market have a statistically significant increase in the likelihood of adoption by 10.40 percentage points. Farmers located one kilometer farther from the nearest experiment station have a reduced probability of adopting an improved variety.

Household's regional location and the length of time an improved variety is available in a farmer's district affects adoption. There is a higher likelihood of a farmer adopting an improved variety if she resides in a central or northern department. Farmers residing in a central department are 20.47 percentage points more likely to adopt than farmers residing in a southern department. Farmers residing in a northern department are 27.64 percentage points more likely to adopt one or more improved varieties than a farmer in a southern department. Likewise a year increase in the number of years an improved variety is available in the district increases the probability of a farmer adopting an improved variety, but only by 0.74 percentage points.

A farmer's decision to dis-adopt an improved variety is affected by the household's ability to mitigate risk, its proximity to an experiment station, regional location, and the the level of food insecurity a farmer faces based on her district of residence (Table 13). Farmers in the fifth wealth quintile are 11.11 percentage points less likely to dis-adopt an improved variety than are those in the lowest quintile. A one-kilometer increase in distance from an experiment station increases the likelihood of dis-adoption by 0.07 percentage points. Farmers residing in the north are 14.20 percentage points less likely to dis-adopt an improved variety than if they are located in a southern department. Farmers located in higher FIAs are less likely to dis-adopt an improved variety than farmers located in areas with lower risk to food insecurity and recurrent natural disasters. Farmers in very high FIAs are 13.78 percentage points less likely to dis-adopt.

Table 12 Heckman Probit Results: Probability of Adoption of Improved Varieties

Number of obs.=1078 Censored obs.=242 Uncensored obs.= 836 Log pseudolikelihood = -893.8047	Wald chi2(19) = 52.21 Prob>chi2= 0.0001	**Adopts Improved Variety**		
Variables		**dy/dx**	**Std. Err.**	**P>|z|**
HHHeadAge		-0.0009	0.0010	0.339
HHHeadEducation				
Some primary		0.0173	0.0472	0.715
Secondary and above		0.0098	0.0500	0.845
SocialNetwork		0.0086	0.0055	0.121
TotalLand (ha)		-0.0004	0.0030	0.894
AssetIndex				
2		-0.0249	0.0398	0.531
3		0.0665*	0.0354	0.060
4		0.0548	0.0426	0.198
5		0.0289	0.0431	0.503
HHHeadGender (1=Male, 2=Female)		-0.0355	0.0385	0.357
HHSellPotatoMarket (0=No, 1=Yes)		0.1040***	0.0319	0.001
DistancetoES (km)		-0.0003*	0.0002	0.063
Region				
Central		0.2047***	0.0499	0.000
Northern		0.2764***	0.0447	0.000
Elevation (m)		0.00004	0.00004	0.299
PlantedImproveseedFromInformal (0=No, 1=Yes)		0.0518*	0.0266	0.051
AvailabilityDistrictImproved		0.0074***	0.0018	0.000
VIAFFNN				
High		-.00001	0.0431	0.999
Very High		-0.0067	0.0480	0.889
Wald test of indep. Eqns. (rho=0): chi2(1) = Prob> chi2= 0.743				
*Notes: A star (*) indicates significance at the 10% level, ** at 5%, and *** at 1%.*				

Table 13 Heckman Probit Results: Probability of Dis-adoption of Improved Varieties

	Dis-adopts Improved Variety (Conditional on having adopted at some time)		
Variables	dy/dx	Std. Err.	P>|z|
HHHeadAge	-0.0011	0.0013	0.415
HHHeadEducation			
Some primary	-0.0656	0.0639	0.305
Secondary and above	-0.0519	0.0648	0.423
SocialNetwork	-0.0019	0.0064	0.765
TotalLand (ha)	-0.002	0.0033	0.531
AssetIndex			
2	-0.0607	0.0470	0.197
3	-0.0530	0.0502	0.291
4	-0.0546	0.0550	0.321
5	-0.1111**	0.0541	0.040
HHHeadGender (1=Male, 2=Female)	-0.0312	0.0489	0.524
HHSellPotatoMarket (0=No, 1=Yes)	-0.0175	0.0401	0.662
DistancetoES (km)	0.0007***	0.0002	0.001
Region			
Central	0.0417	0.082	0.609
Northern	-0.1420*	0.0737	0.054
Elevation (m)	0.00002	0.0001	0.695
PlantedImproveseedFromInformal (0=No, 1=Yes)	0.0004	0.0037	0.908
AvailabilityDistrictImproved			
VIAFFNN			
High	-0.0912	0.0655	0.164
Very High	-0.1378**	0.0642	0.032
*Notes: A star (*) indicates significance at the 10% level, ** at 5%, and *** at 1%.*			

4.2.2 Yungay Heckman Probit Results

The dependent variable for the selection equation equals one if the farmer has at one point in time adopted Yungay. Farmers have dis-adopted Yungay if at one point in time they adopted the variety but are not currently planting the variety. The decision to adopt Yungay is affected by five variables: (1) household wealth, (2) the number of people in the social network, (3) regional household location, (4) household distance from an experiment station, (5) the number of years Yungay was first planted in the district until present. Increased wealth from the lowest wealth quintile to the third wealth quintile increases the probability of adoption by 6.65 percentage points (Table 14). An increase of one person in a farmer's social network increases the probability of a farmer adopting Yungay by 0.51 percentage points, holding all else constant. There is a higher likelihood of a farmer adopting Yungay if she resides in a central (by 37.36 percentage points) or a northern department (by 21.67 percentage points) than if she lives in a southern department. Living one kilometer farther from an experiment station reduces the likelihood of adopting Yungay. Also, a one-year increase in the number of years Yungay is available in the district increases the probability of a farmer adopting Yungay by 1.12 percentage points.

The decision to dis-adopt Yungay is affected by elevation, distance to the nearest experiment station, regional location, availability of the variety in the district, and FIA (Table 15). A one kilometer increase in the distance a household is from the nearest experiment station increases the probability of a farmer dis-adopting Yungay by 0.08 percentage points. Also, a one-meter increase in household elevation increases the probability of dis-adoption by 0.02 percentage points. Households from central departments are 25.72 percentage points less likely to dis-adopt Yungay compared to farmers residing in southern departments. Yungay seed being available an additional year in the district increases the probability of dis-adoption by 0.75 percentage points. Lastly, farmers living in high FIAs are more likely to dis-adopt by 11.72 percentage points than farmers residing in low/medium FIAs. This demonstrates that farmers in lower risk areas gain more utility from continuing to plant Yungay than farmers in higher risk areas.

Table 14 Heckman Probit Results: Probability of Adoption of Yungay

Number of obs.=1078 Censored obs.= 491 Uncensored obs.=587 Log pseudolikelihood = -744.9303	Wald chi2(19)= 48.60 Prob>chi2= 0.0002	**Adopts Yungay Variety**		
Variables		**dy/dx**	**Std. Err.**	**P>|z|**
HHHeadAge		-0.0007	0.0009	0.416
HHHeadEducation				
Some primary		0.0241	0.0403	0.550
Secondary and above		0.0129	0.0457	0.777
SocialNetwork		0.0051*	0.0029	0.082
TotalLand (ha)		0.0027	0.0019	0.153
AssetIndex				
2		-0.0629*	0.0376	0.094
3		-0.0597*	0.0331	0.072
4		0.0236	0.0355	0.506
5		0.0037	0.0386	0.924
HHHeadGender (1=Male, 2=Female)		0.0405	0.0407	0.320
HHSellPotatoMarket (0=No, 1=Yes)		0.0326	0.0301	0.278
DistancetoES (km)		-0.0003*	0.0001	0.061
Region				
Central		0.3736***	0.0731	0.000
Northern		0.2167***	0.0701	0.002
Elevation (m)		-0.0001	0.00004	0.163
PlantedImproveseedFromInformal (0=No, 1=Yes)		0.0171	0.0219	0.435
AvailabilityDistrictYungay		0.0112***	0.0014	0.000
VIAFFNN				
High		-0.0080	0.0362	0.824
Very High		-0.0324	0.0425	0.446
Wald test of indep. Eqns. (rho=0): chi2(1)=0.01 Prob> chi2= 0.9426				
*Notes: A star (*) indicates significance at the 10% level, ** at 5%, and *** at 1%.*				

Table 15 Heckman Probit Results: Probability of Dis-adoption of Yungay

	Dis-adopts Yungay (Conditional on having adopted at some time)		
Variables	**dy/dx**	**Std. Err.**	**P>|z|**
HHHeadAge	0.0022	0.0015	0.134
HHHeadEducation			
Some primary	-0.0237	0.0678	0.727
Secondary and above	0.0224	0.0745	0.763
SocialNetwork	0.0035	0.0055	0.523
TotalLand (ha)	0.0013	0.0036	0.728
AssetIndex			
2	0.0065	0.0559	0.908
3	0.0953	0.0658	0.147
4	-0.0704	0.0589	0.232
5	-0.0367	0.0667	0.582
HHHeadGender (1=Male, 2=Female)	0.0082	0.0648	0.900
HHSellPotatoMarket (0=No, 1=Yes)	-0.0408	0.0554	0.462
DistancetoES (km)	0.0008***	0.0002	0.000
Region			
Central	-0.2572***	0.0778	0.001
Northern	-0.1094	0.0986	0.267
Elevation (m)	0.0002**	0.0001	0.027
PlantedImproveseedFromInformal (0=No, 1=Yes)	0.0075***	0.0029	0.009
AvailabilityDistrictYungay			
VIAFFNN	0.1172**	0.0530	0.027
High	0.1172**	0.0530	0.027
Very High	0.0446	0.0574	0.438
*Notes: A star (*) indicates significance at the 10% level, ** at 5%, and *** at 1%.*			

4.2.3 Canchan Heckman Probit Results

The dependent variable for the selection equation equals one if the farmer has at one point in time adopted Canchan. Dis-adoption is defined as farmers ever planting Canchan, but currently are not planting Canchan during the 2011 to 2012 harvesting season. A household's ability to mitigate risk, access to information, regional location, access to the informal seed system, and availability of the variety in district all affect the decision to adopt Canchan (Table 16). As with improved variety adoption, increased wealth from the lowest wealth quintile to the third wealth quintile increases a farmer's likelihood of adoption by 8.36 percentage points. Increased wealth from the lowest wealth quintile to the fourth quintile increases a farmer's likelihood of adoption by 10.35 percentage points. An additional hectare of land owned increases the likelihood to adopt Canchan by 0.52 percentage points.

Farmers who sell potatoes on the market have an increased likelihood of adopting Canchan of 11.79 percentage points, with a significance level of one percent. Farmers with access to the informal seed system are 6.47 percentage points more likely to adopt Canchan than farmers who have not had access to improved seed via the informal seed system. An additional year of Canchan being available in the farmer's district increases the probability of adoption by 6.47 percentage points. Lastly, specific regions affect adoption of Canchan. Farmers located in the central highlands have a higher probability of adopting Canchan (by 17.54 percentage points) than farmers in the southern highlands.

A farmer's decision to dis-adopt Canchan is not affected by household head characteristics, but is affected by household's access to information, regional location, and risk to food insecurity (Table 17). Farmers who sell potatoes on the market are more likely to dis-adopt Canchan by 12.05 percentage points than farmers who do not sell potatoes on the market. Farmers in the north are also more likely to dis-adopt Canchan by 13.27 percentage points than if they live in the south. Farmers who live in high FIAs are less likely to dis-adopt Canchan by 10.95 percentage points compared to those who live in a lower FIAs.

Table 16 Heckman Probit Results: Probability of Adoption of Canchan

Number of obs.=1078 Censored obs.=460 Uncensored obs.= 618 Log pseudolikelihood = -1064.812	Wald chi2(19) = 53.50 Prob>chi2= 0.0000	**Adopts Canchan Variety**		
Variables		**dy/dx**	**Std. Err.**	**P>|z|**
HHHeadAge		-0.0011	0.0012	0.347
HHHeadEducation				
Some primary		-0.0423	0.0628	0.501
Secondary and above		0.0064	0.0660	0.922
SocialNetwork		0.0044	0.0057	0.438
TotalLand (ha)		0.0052*	0.0029	0.078
AssetIndex				
2		0.0133	0.0458	0.772
3		0.0836*	0.0456	0.067
4		0.1035**	0.0480	0.031
5		0.0629	0.0471	0.182
HHHeadGender (1=Male, 2=Female)		-0.0564	0.0444	0.204
HHSellPotatoMarket (0=No, 1=Yes)		0.1179***	0.0392	0.003
DistancetoES (km)		0.0001	0.0002	0.666
Region				
Central		0.1754***	0.0550	0.001
Northern		-0.0551	0.0740	0.457
Elevation (m)		0.0001	0.0001	0.215
PlantedImproveseedFromInformal (0=No, 1=Yes)		0.0647***	0.0232	0.005
AvailabilityDistrictCanchan		0.0055*	0.0030	0.063
VIAFFNN				
High		-0.0813	0.0551	0.140
Very High		-0.0751	0.0646	0.245
Wald test of indep. Eqns. (rho=0): chi2(1) = 230.48 Prob> chi2= 0.0000				
*Notes: A star (*) indicates significance at the 10% level, ** at 5%, and *** at 1%.*				

Table 17 Heckman Probit Results: Probability of Dis-adoption of Canchan

	Dis-adopts Canchan (Conditional on having adopted at some time)		
Variables	**dy/dx**	**Std. Err.**	**P>|z|**
HHHeadAge	-0.0002	0.0321	0.995
HHHeadEducation			
Some primary	-0.0814	0.0764	0.287
Secondary and above	-0.0590	0.0742	0.426
SocialNetwork	0.0079	0.0123	0.521
TotalLand (ha)	-0.0048	0.0356	0.892
AssetIndex			
2	-0.0168	0.0711	0.813
3	0.0454	0.0750	0.545
4	0.0740	0.0713	0.299
5	-0.1159	0.0712	0.103
HHHeadGender (1=Male, 2=Female)	0.0622	0.4129	0.880
HHSellPotatoMarket (0=No, 1=Yes)	0.1205**	0.0500	0.016
DistancetoES (km)	0.0006	0.0006	0.322
Region			
Central	0.0300	0.0640	0.639
Northern	0.1327*	0.0757	0.080
Elevation (m)	-0.0001	0.0006	0.843
PlantedImproveseedFromInformal (0=No, 1=Yes)	-0.0030	0.0331	0.929
AvailabilityDistrictCanchan			
VIAFFNN	-0.1095*	0.0655	0.094
High	-0.0370	0.0750	0.622
Very High	-0.0370	0.0750	0.622
*Notes: A star (*) indicates significance at the 10% level, ** at 5%, and *** at 1%.*			

4.2.4 Amarilis Heckman Probit Results

The dependent variable for the selection equation equals one if the farmer has at one point in time adopted Amarilis. Farmers have dis-adopted Amarilis if at one point in time they adopted the variety but are not currently planting the variety. Older household heads are slightly less likely to adopt Amarilis than younger household heads (see Table 18). Farmers a year older are 0.15 percentage points less likely to adopt Amarilis. As with improved varieties, farmers in the third wealth quintile are 7.64 percentage points more likely to adopt Amarilis than farmers in lower wealth indices. Also, farmers located in northern departments are more likely to adopt Amarilis than farmers in southern departments. Length of the variety availability in the district also affects a farmer's decision to adopt. A one-year increase in the amount of time Amarilis was available in the district increases the likelihood of a farmer adopting Amarilis by 1.66 percentage points, holding all else constant.

Distance to an experiment station and food insecurity given recurrent natural phenomena are the only variables that affect a farmer's probability of dis-adoption (Table 19). Being one kilometer farther away from an experiment station increases in the probability of dis-adopting Amarilis by 0.10 percentage point. This signifies that information from an experiment station may have no affect on initial adoption, but the quality of information attained from an experiment station positively affects a farmer's decision to continue planting Amarilis. Farmers located in very high FIAs are 25.26 percentage points less likely to dis-adopt Amarilis compared to those who live in a medium/low FIA. This demonstrates that farmers in very high FIAs draw utility from planting Amarilis and therefore continue to plant Amarilis.

Table 18 Heckman Probit Results: Probability of Adoption of Amarilis

Number of obs.=1078 Censored obs.=748 Uncensored obs.= 330 Log pseudolikelihood = -548.214	Wald chi2(19) = 75.78 Prob>chi2= 0.0000	**Adopts Amarilis Variety**		
Variables		**dy/dx**	**Std. Err.**	**P>|z|**
HHHeadAge		-0.0015*	0.0009	0.082
HHHeadEducation				
Some primary		0.0176	0.0430	0.683
Secondary and above		-0.0106	0.0419	0.800
SocialNetwork		0.0008	0.0034	0.812
TotalLand (ha)		-0.0001	0.0018	0.940
AssetIndex				
2		-0.0208	0 .0322	0.519
3		0.0764**	0.0338	0.024
4		0.0202	0.0314	0.520
5		0.0553	0.0344	0.108
HHHeadGender (1=Male, 2=Female)		-0.0001	0.0311	0.996
HHSellPotatoMarket (0=No, 1=Yes)		-0.0155	0.0281	0.581
DistancetoES (km)		0.0001	0.0002	0.513
Region				
Central		-0.0681	0.0487	0.162
Northern		0.3413***	0.0947	0.000
Elevation (m)		-0.00003	0.00003	0.395
PlantedImproveseedFromInformal (0=No, 1=Yes)		0.0157	0.0235	0.502
AvailabilityDistrictAmarilis		0.0166***	0.0023	0.000
VIAFFNN				
High		0.0245	0.0432	0.570
Very High		-0.0021	0.0531	0.969
Wald test of indep. Eqns. (rho=0): chi2(1) = 0.60 Prob> chi2=0.4385				
*Notes: A star (*) indicates significance at the 10% level, ** at 5%, and *** at 1%.*				

Table 19 Heckman Probit Results: Probability of Dis-adoption of Amarilis

	Dis-adopts Amarilis (Conditional on having adopted at some time)		
Variables	**dy/dx**	**Std. Err.**	**P>|z|**
HHHeadAge	-0.0005	0.0019	0.791
HHHeadEducation			
Some primary	-0.0561	0.0997	0.573
Secondary and above	-0.0113	0.1074	0.916
SocialNetwork	-0.0017	.011698	0.887
TotalLand (ha)	0.0024	0.0032	0.463
AssetIndex			
2	-0.0924	0.1030	0.370
3	0.0617	0.0741	0.405
4	-0.0656	0.0809	0.418
5	0.0447	0.0832	0.591
HHHeadGender (1=Male, 2=Female)	-0.0030	0.0985	0.976
HHSellPotatoMarket (0=No, 1=Yes)	0.0554	0.0713	0.437
DistancetoES (km)	0.0010**	0.0004	0.020
Region			
Central	-0.0093	0.1443	0.949
Northern	-0.1568	0.1283	0.222
Elevation (m)	0.0001	0.0001	0.428
PlantedImproveseedFromInformal (0=No, 1=Yes)	-0.0008	0.0066	0.906
AvailabilityDistrictAmarilis			
VIAFFNN			
High	-0.0544	0.1034	0.599
Very High	-0.2526**	0.1195	0.035
*Notes: A star (*) indicates significance at the 10% level, ** at 5%, and *** at 1%.*			

4.3 Conclusion and Limitations

In the case of improved varieties (including Yungay), there is evidence that adoption is time dependent and spatially gathered in certain highland regions. The study also finds that adoption is influenced by household exposure to food insecurity from given recurrent natural phenomena, access to the informal seed system, household characteristics that mitigate risk, and access to information. Evidence exists in support of and against each hypothesis, depending on which variety is analyzed.

There is consistent evidence that an additional year of the variety being available increases the likelihood of a household adopting an improved variety, demonstrating that adoption of improved varieties is time dependent. In the northern and central highlands farmers are more likely to adopt and less likely to dis-adopt an improved variety than if they live in the south. There are exceptions to this generalization, such as Canchan; farmers are more likely to dis-adopt Canchan if they live in the northern highlands than if they live in the southern highlands. For northern and central highlands, adoption rates are higher and diffusion is quicker throughout time as well.

There is no evidence that higher FIAs negatively influence adoption of improved potato varieties. FIAs do affect a farmer's decision to dis-adopt improved varieties, Yungay, Canchan, and Amarilis. In support of the study's hypothesis farmers facing higher risk to food insecurity are less likely to dis-adopt (i.e. more likely to continue planting) improved varieties, Canchan, and Amarilis. Yungay is the exception in this case, as farmers in higher FIAs are more likely to dis-adopt Yungay. The statistics may underscore that Yungay is less suitable for farmers' tastes and preferences in higher FIAs than Canchan and Amarilis, two varieties that highly replace Yungay after farmers dis-adopt Yungay.

There is evidence in the case of Canchan that access to the informal seed system promotes adoption. The informal seed system does not appear to play a role in the adoption of other improved varieties. Factors that represent household ability to bear risk, i.e. household head age, education, wealth, and social network, have differing effects on adoption and dis-adoption depending of the improved varieties. Farmers with larger social networks are more likely to adopt Yungay. We also find that poorer farmers are more likely to adopt Yungay, while wealthier farmers are more likely to adopt and less likely to dis-adopt Canchan and Amarilis.

Similarly, access to information has mixed effects on the adoption and dis-adoption of improved varieties. There is only consistent evidence for one variable that represents access to information—distance from an experiment station, which is negatively associated with adoption and positively associated with disadoption (for all improved varieties, Yungay, and Amarilis). Farmers who sell potatoes on the market are more likely to adopt an imporved variety, but the variable has no effect on a farmer's decision to dis-adopt improved varieties (see Table 12 and 13). Whether a farmer sells potatoes on the market has no affect on a farmer's decision to adopt or dis-adopt Yungay or Amarilis. Canchan is the only specific variety affected by whether a farmer sells potatoes on the market. Farmers who sell potatoes on the market are more likely to adopt Canchan, but also more likely to dis-adopt Canchan. Farmers who sell potatoes on the market and have dis-adopted Canchan attribute dis-adoption to low price of the potato and its susceptibility to pest and diseases. The reasons for dis-adoption demonstrate that Canchan is no longer highly valued in the highland markets due to its low market prices and susceptibility to pest and diseases.

Several weaknesses limit this study. First, the results are based upon survey respondent's memory. The questionnaire asked farmers to remember if and when they planted each improved variety. In some cases, farmers needed to recall actions from more than fifteen years prior. These responses were used to formulate our dependent adoption and dis-adoption variables, test our hypothesis, and test whether adoption is time dependent. Farmers did not report the year they dis-adopted the variety. Therefore, time dependence could not be shown for dis-adoption. Due to data restrictions, the definition of access to the informal seed system is not sufficiently strict. The informal seed system includes any seed source where a farmer is most likely to receive uncertified seed (i.e. receiving, as gifts, potato seeds from other farmers and purchasing of potato seeds from local seed producers). There are no data on whether the seed was certified or uncertified. To control for the weak definition and potential recall bias, we run regressions with the informal seed system variable being in both the selection and dis-adoption equations and without the informal seed system variable in either equation; we find that its inclusion and exclusion does not affect the study's results. Differences in results are small when the informal seed system variable is only included the selection equation compared to when the variable is included in both equations and excluded from both equations.

The study's weaknesses outline the need to include more specific questions in future technology adoption and dis-adoption surveys. First, the farmer should, per variety, specify the timing of dis-adoption to conduct more in-depth time analyses. Information on the year farmers dis-adopted each variety is critical to understanding the success or failure of a variety in a region throughout time. Future household adoption and dis-adoption surveys should therefore include the year a farmer adopted the variety, dis-adopted the variety, and if they ever re-planted the variety again. With such information future analysis can more accurately assess the dynamics of adoption and dis-adoption since the variety's release. Second, to improve our understanding of the informal seed system and its effects on adoption and dis-adoption, farmers should be asked whether the first improved seed obtained was certified or not. Farmers should also be asked where they originally obtained their certified or uncertified seed. This information could potentially open up new and improved research on informal versus formal seed transmission methods and could even lead to studies underscoring the differing effects of certified and uncertified seed on yield and dis-adoption. Third, the elevation should be measured at each plot the farmer planted the variety. Peruvian plots can be far removed from household locations leading to different elevation for household plots. Doing this will improve the accuracy effects of elevation on adoption and dis-adoption. Lastly, farmers should be asked to more specific about why they dis-adopted each variety. For example, some farmers dis-adopted Canchan because of its susceptibility to pests and diseases. It would be relevant to ask a follow-up question to know which pests and diseases harmed Canchan's output and resulted in farmer dis-adoption. With such information, organizations, such as CIP and INIA, can more accurately understand why varieties are being dis-adopted and if their attributes, such as late blight resistance, are still working in the field.

Chapter 5: Discussion

This study demonstrates that improved variety adoption is a dynamic process with several factors hindering and influencing adoption. The focus of this study is adoption and dis-adoption given food insecurity, information constraints, and socioeconomic factors. Using a recent household survey conducted by CIP from 2011 to 2012 together with supplemented data from the World Food Programme and Consortium for Spatial Information, we use a two-step adoption model to understand the effects of FIAs, information, constraints, and households risk factors on adoption and dis-adoption of improved Peruvian potato varieties. The findings demonstrate that regional location, FIAs, the informal seed system, access to information, and socioeconomic factors all affect adoption and in some cases, dis-adoption. The study also underscores the need for specific questions and information to improve future adoption and dis-adoption studies. Information on the year the farmer dis-adopted the variety, whether the farmer first seed was certified, plot elevation, and which pests and diseases caused dis-adoption all can contribute to improving future adoption and dis-adoption analyses.

Despite Yugnay's high adoption rates, when observing the projection of adoption over time in comparison to two other highly adopted varieties, Canchan and Amarilis, we find that Yungay's adoption levels may be surpassed by Canchan and Amarilis. Specifically Amarilis's equally low dis-adoption rates and likelihood of continued adoption in very high FIAs further indicates Amarilis will surpass Yungay's national adoption rates in time, assuming adoption behavior continues to be the same. Regional preferences and FIAs may underscore improved variety adoption and dis-adoption patterns. Household's ability to mitigate risk, such as household head age and education, and wealth affect a farmer's decision to adopt and dis-adopt improved vareities. Information acquired through differing sources have contrasting effects on the adoption and dis-adoption of certain improved vareities. These effects have implications for each variety. For instance, the information acquired by the market promotes the adoption of all improved varieties and specifically Canchan. It also influences the dis-adoption of Canchan. The results indicate that the market is a good place to promote the adoption of newer varieties. It is also pertinent to consider the reasons why Canchan is not fitting for the market. The contradicting adoption and dis-adoption results for Canchan may indicate that the variety was highly promoted throughout the market, but it is now becoming less desirable.

Findings of this study can aid future improved variety dissemination efforts, hopefully increasing the impact of improved varieties. First, dissemination efforts can target specific regions and agro-ecologies where specific varieties are best suited, leading to increased adoption and decreased dis-adoption of the improved variety in the area. We find that Yungay should be promoted in lower FIAs where the variety is more likely to be retained. Improved varieties (all eight improved varieties, not including Yungay) should be promoted in higher FIAs where farmers are less likely to dis-adopt. Second, an increase in length of time a variety is present in the district increases adoption of improved varieties. Therefore, experts can focus on the dissemination of these varieties in districts where the variety has yet to be planted. This would increase the likelihood of improved variety adoption within these districts. Third, information regarding variety characteristics and dissemination efforts need to be more widely spread. As previously described, increased knowledge through experiment stations would improve variety adoption and decrease dis-adoption. Also, information via markets increases the probability of adoption, further helping improved varieties diffuse to market oriented farmers. Markets may be a more impactful and cheaper option to diffuse improved variety information and seed throughout the Peruvian highlands than other traditional methods. Necessary improvements in appropriate allocation of dissemination efforts and improvements in knowledge transfer may make the resources towards engineering improved varieties more impactful on the wellbeing of highland potato farmers.

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CODE | | | | | | |

Appendices

Appendix A: Survey Questionnaire

INTERNATIONAL POTATO CENTER: HOME SURVEY:

"IMPACTS ON THE ADOPTION OF IMPROVED POTATOES IN PERU"

PROJECT FINANCED THROUGH STC-CGIAR **CONTACT**: W.PRADEL@CGIAR.ORG (WILLY PRADEL, CIP, LIMA)

SURVEY CODE: See annex for the codes

DEPARTMENT		PROVINCE	DISTRICT	COMMUNITY	INTERVIEWER	HOME

NOTES FOR THE INTERVIEWER

A. Only farmers who cultivate/have cultivated potato in the last campaign (2011-2012). Before the interview ask if the farmer:
"In the last potato campaign that you harvested during 2012, have you cultivated potato at least in one of your Plots?
(Owned or rented Plots). YES ☐ ⇨ go to B
NO end the visit and thank the person

B. *Only the people of the household, man or woman, will be interviewed. They must have enough information about topics related to the potato production in his/her household, not necessarily the head of household. If the person is not available, find out if there is another time you can find that person, arrange time and day to return home to the respective interview.*

C. *Before you start, introduce yourself (give your name) and explain the propose of the visit. Please note that the survey is being done by the International Potato Center in cooperation with the INIA and Agricultural Agencies in the context of a project measuring the adoption and impact of improved potato varieties. The purpose of the survey is to understand better the living conditions of farmers and potato production.*

NOTE: For the entire interview use the Code 99 to indicate that the respondent answered "do not know" or "do not remember" or does not want or cannot comment. The answers "I do not have" (0) and "not applicable" (N.A.) if you differ from the others.

CODE | | | | | | |

PART 0. GENERAL INFORMATION OF THE INTERVIEW AND IDENTIFICATION OF THE SELECTED HOUSEHOLD

DATE OF THE INTERVIEW		LATITUDE (S)	
TIME THE INTERVIEW BEGAN:		LONGITUDE (E)	
NUMBER OF GPS:		ALTITUDE (masl):	

1. Name and last name of the head of household		**2.** Name and last name of the interviewee	

PART 1: COMPOSITION AND CHARACTERISTICS OF HOUSEHOLD

1. Code of the person (CP)	2. Name of the members of the household living during the potato campaign of 2012. *(Begin with the interviewee followed by their spouse)*	3. Sex **Code A** 1. Male 2. Female	4. Relationship with the head of household **Code B** 1. Head of Household 2. Spouse 3. Son/Daughter 4. Parents 5. Siblings 6. Stepson/Stepdaughter 7. Grandson/Granddaughter 8. Other relative other, specify	5. Marital Status **Code C** 1. Married living with spouse 2. Married but spouse lives outside the household 3. Divorced / separated 4. Widowed 5. Single Other, specify	6. Age (Years) Babies of <1 year, In months	7. Formal Education **Code D** 0. None 1.Primary 2. Secondary 3. Superior, but not university 4.University	7. Formal Education **Years**	8. Yes, column **7=0** Do you know how to read/write? **Code E** 0. No 1. Just read 2. Read and write	9. Occupation **Code F** 1. Agriculture (crops + cattle) 2. Wage-earner 3. Self employed 4. Casual laborer in farms 5. Casual laborer outside of farms 6. Student 7. Pastor 8. Housewife Other, specify First	9. Occupation Second
01										
02										
03										
04										
05										
06										
07										
08										

CODE ☐☐☐ ☐☐☐

09										
10. Number of the members who live outside of the household										
11. Number of the members who had joined this household in the past 12 months										

CODE ☐☐☐ ☐☐☐

PART 2: SOCIAL CAPITAL AND NETWORK

Section 2.A: Membership (belonging) to formal or informal farming organizations in the past three years (One member per line.)

Any household member has been involved in farmer organizations formal and / or informal in the past three years? ☐ (1.Yes; 0. No)

If the answer is "YES", please, ask the information of the next table and if the answer is "NO", go to Section 2.B.

1. Name of the person *(See Part 1)*		2. Type of group belonging or household member used to belong: **Code A** 1. Input suppliers / union / cooperatives 2. A group of producers and/or marketers of potatoes/seed 3. Local government 4. Farmers association 5. Women association 6. Church related association 7. Water users association 8. Other, specify	3. Two most important roles of the group: **Code B** 1. Marketing of production 2. Marketing/access to inputs 3. Seed production. 4. Group of farming researchers 5. Savings and Loans 6. Nursery Garden 7. Water and soil conservation 8. Credit to inputs 9. Other, specify		4. Years which joined the group (AAAA)	5. Role of the group **Code C** 1. Board member (specify) 2. Ordinary members	6. Do you have to pay for the membership? **Code D** 1. Yes 0. No	7. Are you a current member? **Code D** 1. Yes 0. No	8. If No in column 7, reason why you left the group **Code E** 1. Left because the organization was not useful/profitable 2. Left because of poor management 3. Couldn't pay the membership fee 4. Group stopped existing 5. Other, specify
			1st.	2nd.					
CP	Name								

Section 2.B. Social relationships

1. Number of years the interviewee has lived in the community ☐

2. Number of people you can trust in a critical moment (e.g. borrow money) in your community **(Family out of home?)**

a) Relatives ☐ b) Non-relatives (Neighbors) ☐

3. Number of people you can trust in a critical moment (e.g. borrow money) outside of your community

4. a) Relatives ☐ b) Non Relatives. ☐

CODE

PART 3: LAND OWNERSHIP AND FARMING PRODUCTION (per plot, campaign that ends in 2012)

Section 3.A. Sir/Miss, now we will talk about the plot that the household owns, we ask not to give estimations of the area and distance. How many plots the household owns including the pasturage are and rest lands?

1.Register of the plot *Register the Plots that the household owns, start with the largest with potato crops*		**2.What is the plot area?** Measurements: Conversion of the unity given to square meters			**3.Ownership situation of the plot** Code: 1. Registered property 2. Titled property (deed) 3. Untitled property 4. Rented 5. Rented to others 6. Communal 7. Communal, collective	**4.Distance from home to plot** (in minutes)	**5.Use of the plot** Code: 1= Agricultural use, crops 2= Livestock, pasturage 3= Rest Other, specify
Plot	**Name of the plot o place of its location**	**Quantity**	**Unit**	**Length**	**Code**	**Minutes**	**Code**
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

CODE ☐☐☐☐☐☐☐

Section 3.B. Sir/Miss, following our conversation of the use you give to the plot that belongs to the household, during the campaign being harvested or will be harvest in 2012, we ask now to give us harvest estimations

1.Plots Registry *Register the household Plots, start with the largest potato crop.* Plot (it has to coincide with the Section 5A)		**2.What crops did you harvest in each plot?** *If the plots are harvested with more than one crop, write one crop per line, repeating the plot number and "Name" of the respective plot.*	**3.How much did you harvest on these crops during the last campaign?** Measurements: Conversion of the unity given to square meters			**4.When was the plot harvested?**	**5.What % of each crop did you sell in the market?**
Plot	**Name**	**Crop name**	**Quantity**	**Unit**	**Measure**	**Month**	**%**

CODE ☐☐☐☐☐☐☐

Section 3.C: Knowledge and Information sources of the seed and adoption of improved potato variety.

Ask the farmer to talk about all the varieties of potato he has heard about.

1.Name of the type improved potatoes you know about	**2. Year you were introduced to this variety**	2.**Type information source** **Code A** 1. Agriculture Ministry 2. Agriculture Cooperative 3. Farmers Association 4. NGO 5. Investigation Institutions (CIP, INIA) (experiments/demonstrations/days in the field) 6. Other farmer who is a relative 7. Other farmer who is neighbor 8. Radio/newspaper/TV Other, specify	4. Have you ever planted? **Code B** 0. No 1. Yes	4. If "**Yes" in question 4,** first year of harvest	If they responded "**Yes" in question 4**, **Primary source of the first seeds**		8. Would you plant this variety in the future? **Code B** 0. No 1. I don't know 2. Yes	9. If "**No" in question 4 or 8,** Why? **Code C** 1. Seeds not available 2. Lack of money to buy seed (credit) 3. Susceptible to disease/plagues 4. Poor flavor 5. Variety of low performance 6. Low price 7. There is not a Market 8. Lack of land to experiment 9. Requires too many skills 10. Prefer other variety Other, specify **RESON FOR DISADOPTIN***
					6. Primary Source **Code D** 1. Field experiments 2. Demonstration Plots 3. Group of farmers 4. Local producers of the seed 5. Local business 6. Agro-vets 7. Exchange between farmers 8. Given away by NGO/government Other, specify	7. Quantity **(Kg)**		
Name	**AAAA**	**Code**	**Code**	**AAAA**	**Code**	**Kg.**	**Code**	**Code**

CODE ☐☐☐☐☐☐☐

PART 4. Potato Production (Agricultural campaign 2011-2012)

Section 4.A. Varieties cultivated by plot and potato harvest for the agricultural campaign 2011-2012:

If potatoes are grown as mixed varieties, register each variety in a different row.

1. Register of plot Code number of the plot (see Section 3A)		2. Type of potato	3. Seed (kg) used in each kind *Measurements: Conversion of the unity given to square meters*			4. Seed source in 2011 for each variety **Code D** 1. Own 2. Local Market 3. Commercial House 4. Group of seed growers 5. Friends/neighbors/relatives 6.MINAG, INIA, SENASA 7. NGO 8. CIP Other (specify)	5. Potato yield for each variety			6. The total harvest, how much is intended for sale and others uses? *This quantity in relation to the total quantity harvested*				7. Buy potatoes of this variety for consumption?	
							Total harvest			Sale after harvest	Donations or trades, others	Seed used in planting 2012(kg)	Household consumption to date	Purchase for household consumption	
Plot	Name	Name	Quantity	Unit	Measurement	Code	Quantity	Unit	Measurement	Quantity	Quantity	Quantity	Quantity	Quantity	Month

CODE ☐☐☐☐☐☐☐

Section 4.B: Characteristics of the improved and local potatoes main varieties during the last campaign

Ask the farmer the three main local and improved varieties are farming now. Then ask the farmer to value the potato varieties according to their characteristics based on Code A.

	1. Five main **potato varieties** *The term "main" depends on what the farmer defines by main, it can be by the quantity cultivated or another consideration*	**Code of characteristics [Can use weighted Method Here??]** 1. Very Bad 2. Bad 3. Regular 4. Good 5. Very Good 6. I don't know/No opinion								2. **Other reason to value this variety**
		Agronomic Characteristics				**Economic Characteristics**		**Use Value**		
		3. Tuber yield	4. Frost tolerance	5. Late blight resistance	6. High content of dry material	7. Demand for potatoes on the market	8. Potato price	9. Flavor	10. Cooking time	
	Improved Potatoes									
1st.										
2nd										
3rd										
4tt										
5th										
	Native Potatoes									
1st .										
2nd										
3rd										
4tt										
5th										

CODE ☐☐☐☐☐☐☐

Section 4.C: Use of inputs and services on the largest potato plot during the 2011- 2012 campaign

Data on the two largest potato Plots:

1. Largest potato plot Plot code number (see Section 3A)		2. What crop did you plant in the previous campaign (2010-2011) in that plot?	3. Did you pay rent for the plot? *If "no" write "0"; if it was paid with part of the crops please say the quantity and approximate value.*			4. Did you have to pay for irrigation? *If "no" write "0"*	5. What irrigation system did you use? **Code**: 0. None 1. Water channels Other, specify
Plot	Name	Crop name	Soles, cash	Quantity, kg.	Value, in soles	Soles	Code

1. Did you use any chemical fertilizers in this plot? ☐ Yes ☐ No

Fertilizers Code

NPK 12-12-12
1. Fertisol
2. Triplemax
3. Supermix
4. Compomaster
5. UREA
6. PHOSPHATE
7. POTASSIUM CHLORIDE
8. MICRONUTRIENTS
9. HORMONES

Write the volume/weight of the unit.

2. Did you use commercial organic fertilizers or your own?
None ☐
Commercial fertilizers ☐ Own fertilizers ☐

Write the volume/weight of the unit.
The cost per unit must include the transportations costs.

3. Did you use a tractor or yoke on this plot?
Yes ☐
No ☐

	Name of product or Code	Quantity	Unit	Price	Sale unit		Name of product or Code	Quantity	Unit	Price	Sale unit		Quantity	Unit	Cost per Unit
1						1						Tractor			
2						2									
3						3									
4						4									
5						5						Yoke			
6						6									
7						7									
8						8									

CODE ☐☐☐☐☐☐☐

Have you ever applied an insecticide, fungicide or herbicide on the plot of potato during last campaign? (4.C.1)? Yes ☐ ☐QI Index

1. What products have you used? **Type of products:** Insecticide (I) Fungicide (F) Herbicide (H) Nematicide (N) **Products:** 1. Furadan 2. Sherpa 3. Regent 4. Temik 5. Tamaron 6. Ridomil 7. Fitoraz 8. Score 9. Antracol Other, specify		2.How have you applied this product? **Code**: 1. Sprinkling 2. Granules 3. Powder Other, specify	3. How many times did you apply this product?	4.If you fumigated, how many backpacks were necessary per application for each plot? *Probably the number of backpacks will increase due to the measure of the crop, write each application.*							5.For each application, what quantity of product was used for the mix? *Write the doses in milliliters assuming you have a small spoon of 10 ml.* Size of the backpack: ☐ Liter.							6. How much product did you use per unit?		7.Did you use other methods for plague control? **Code**: 1. Plastic barriers 2. Traps 3. Biocides Other, specify
Type	Code or Product	Code	Times	1	2	3	4	5	6	7	1	2	3	4	5	6	7	Soles	Vol./weight of Unit	

Section 4.D: Workforce use during the 2011-2012 campaign on the largest plot.

Read to the farmer: "**Now we want to talk in more detail about how much workforce worked in this field during last campaign and for each type of work we are interested in how many laborers were paid or how many were from neighboring**"

	1. …. For **preparation of the land**?			2. …. For the **planting and fertilizer base**?			3. …. For the **complementary fertilization**?			4. …. For the **mix and fumigation of insecticides**?			5. …. For the **mix and fumigation**?			6. …. For the **weeding**?			7. …. For **irrigation**?			8. …. For **crops**?		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Quantity																								
How many wages were women?																								
How much did you pay for **women** workforce?																								
How much did you																								

A = Family Workforce B = Community Workforce C= Paid Workforce

pay for **men** workforce?																								

Section 4.E: Limitations on the potato crops

Questions	**Potato**
1. In the last 5 years, Has your household experiences any severe ground frosts, causing damages on the potato crop?	Yes ☐ No ☐
*If YES in question 1. Go to question 2. If **NO** in question 1, go to question 4.*	
2. What month and year the ground frost(s) occurred?	
3. As ground frost(s) consequences, did having the potato seed caused any problems?	Yes ☐ No ☐
4. Besides de ground frost in the last 5 years, did your household experienced shortage or lack of the potato seed that affected any decision in the sowing?	Yes ☐ No ☐
If **YES** in question 4**,** go to the next questions. If **NO** in question 4, go to Section 6.D	
5. What was the nature of the shortage?	1. Flood ☐ 2. Seed damage ☐ 3. Theft ☐ 4. Lack of financial means ☐ 5. Institutional problems ☐ 6. Other, specify ________________ ☐
6. What month and year the shortage occurred?	
7. How long (in days) did this shortage last?	

Section 4.F: Declared impacts associated with the adoption of improved varieties of potato

2. Compared to past conditions when grown native potato variants, do you think you've also benefited from growing improved varieties of potato?

Yes ☐
No ☐

3. Has it increased cash income to your home to cultivate improved varieties? Yes ☐ No ☐

PART 5. SHARE AND MARKET ACCESS

Section 5.A: Potato market in the big campaign 2011-2012 ☐ **or small campaign 2012** ☐

One row per transaction (different moths, different buyers), reporting for each variety when it possible

1. Variety	2. Type of market **Code A** 1. Ranch 2. Communal Market 3. District/Main Market	3. Moth it was sold	4. Sold quantity *Value comes from table 6.A question. 6*	5. Price (Soles/Unit)		6. Buyer **Code D** 1. Farmer association 2. Intermediaries 3. Consumers/ others farmers 4. Government 5. Industrial company Other, specify	7. Time to get to the market (Minutes)	8. Time it took to sell the variety on the market (Minutes)	9. Transportation method **Code F** 1. Loaders 2. Horse/donkey/llama 3. Motorcycle/ mototaxi 4. Combi 5. Hired truck 6. Other, specify	10. Transportation cost (Soles)
				Soles	Unit					

PARTE 6: HOUSEHOLD CHARACTERISTICS

	What **type of material** predominates on the **walls** of the house?		What **type of material** predominates on the **roof** of the house?		What is the main **water source** of the household? (drink/cook)		Time it takes to get to the main water source *(going)*		Do you have a latrine?
1	○ Stone with mud	1	○ Calamine	1	○ Inside plumbing		___________	1	○ Yes
2	○ Stone with cement	2	○ Roof tile	2	○ Outside plumbing		minutes	2	○ No
3	○ Tapia	3	○ Other: ______________	3	○ Covered well		What do you use the most in your home for cooking?		Type of latrine
4	○ Adobe		Do you have electrical power in your home?	4	○ Uncovered well				
5	○ Adobe with cement			5	○ Channel	1	○ Firewood	1	○ Private latrine
6	○ Brick/unfinished cement	1	○ Yes	6	○ River	2	○ Charcoal	2	○ Shared latrine
7	○ Brick/finished cement	2	○ No	7	○ Pond	3	○ Gas	3	○ Communal latrine
8	○ Calamine			8	○ Other:______________	4	○ Bosta	4	○ Other: _____________
9	○ Other:____________					5	○ Other:___________		

PART 7: GOOD OF THE HOUSEHOLD

Section 7.A: What equipment and tools do you use in the potato production belong to the household? How much would you pay for […] in the same conditions?

N	Agricultural equipment	Quantity	Price	N	Agricultural equipment	Quantity	Price	N	Agricultural equipment	Quantity	Price
1	○ Shovel			4	○ Hoe			7	○ Chaquitaclla		
2	○ Iron Plow			5	○ Rake			8	○ Wheelbarrow		
3	○ Wood plow			6	○ Back Pump			9	○ Other:______________		

Section 7.B: Do you have any raising animals or work animals in the household?¿ (1.Yes; 0. No) How much would you pay for […] in the same conditions? ☐

N	Type of animals	Quantity	Price	N	Type of animals	Quantity	Price	N	Type of animals	Quantity	Price

1	○ Cows			5	○ Llamas			9	○ Chicken		
2	○ Bulls			6	○ Sheep			10	○ Donkeys		
3	○ Calf			7	○ Hog			11	○ Horse		
4	○ Alpacas			8	○ Guinea Pig			12	○ Other:_________________		

Section 7.C: From this list, How many do you own?

N	Equipment	Quantity	N	Equipment	Quantity	N	Equipment	Quantity
1	○ Radio		5	○ Cellphone		9	○ Refrigerator	
2	○ Sound system		6	○ House phone		10	○ Bicycle	
3	○ W/B TV		7	○ Computer		11	○ Motorcycle	
4	○ Color TV		8	○ Improved kitchen		12	○ Other:_________________	

PART 8. ACCESS TO AGRICULTURAL CAPITALS, FINANCE INPUTS AND INSTITUTIONS

Section 8.A: Access to extension services

1. Did you have contact with any extension workers or researcher during the last big potato campaign? Yes ☐ No ☐

If "Yes" What subject? (*See table below*).

Subject	Did you get training or information in […] during the last TWO years **Code:** 0. No; 1. Yes	Number of contacts with extension workers or researchers […] during the last TWO years
	Code	**In number of times**
1. New potato varieties		
2. Plague control and field diseases		
3. Soil and water management		
4. Crops rotation		
5. Plagues in crops storages		
9. Markets and potato prices		
11. Collective action/Farmers organizations		
12. Other, specify		

Section 8.B: Needs and credit sources for household during the big potato campaign 2011-2012

Credit Reason	Did you need credit? **Code A** 0. No 1. Yes	If **Yes in column 2**, Did you get the credit? **Code A** 0. No 1. Yes	If **NO in column 2**, Why not? **Code B:** 1. Loans are risky 2. High interest rate 3. Too much paperwork 5. I don't have any warranty 6. Moneylenders didn't give me the amount I needed it 7. There's no finance institution in the region 8. I don't know/ I can't remember Other, specify		If **Yes in column 3**...		
			1st	2nd	Did you get the quantity you ask for? **Code A** 0. No 1. Yes	How much did you get? (Soles)	Credit source, **Code C** 1. Moneylender 2. Community Bank 3. Neighbor 4. Cooperative 5. Bank 6. Relative Other, specify (why am I getting 0 on my sum??)
1. To buy seeds							
2. To buy fertilizers							

3. To buy pesticides							
4. To buy agricultural equipment							
5. Invest in transportation							
6. Other: ____________							

Section 8.C: Restrictions and access to key inputs

	Potato **Value:** from 1 to 5: 1 didn't affect me, 5 affected me a lot				
Productive inputs and limitations	Was it a problem last campaign? **(0.No; 1.Yes)**	If answer "**YES**" to a problem, value its importance	**Productive inputs and limitations**	Was it a problem last campaign? **(0.No; 1.Yes)**	If answer "**YES**" to a problem, value its importance
Socioeconomic					
1. Availability of improved seed on time.			7. Availability of credit to buy fertilizer		
2. Price of improved seed			8. Land availability		
3. Quality of seed			9. Access to information		
4. Availability of credit for seed			10. Access to markets		
5. Availability of fertilizer on time			11. Reasonable prices		
6. Price of fertilizer			12. Other limitation, specify		
Biophysical					
13. Drought			17. Diseases: Rancha		
14. Flood			19. Soil Fertility		
15. Plague: True weevils			20. Soil erosion		
16. Plague: Moth			21. Other biophysical limitations, specify:_________________		

End of the interview

Thank the farmer and let them know the interview is over

Name and signature of the interviewer: ______ Time the interview ended: ______

Name and signature of supervisor: ______

Appendix B: Components of the Vulnerability to Food Insecurity and Recurrent Natural Disasters Index

COMPONENTS USED TO CREATE VULNERABILITY TO FOOD SECURITY PORTION OF VIAFFN 2015

Components	Variables Used	Vulnerability
Food Availability	Herfindahl concentration index - H (Population and Housing Census 2007) Ratio of Agricultural Dry Land (IV National Agricultural Census 2012) Ratio of Cultivated land for subsistence (IV National Agricultural Census 2012)	Economic Fragility
Access to Food	Per capita Family Income Gap Index (Peru Human Development Report 2013 - UNDP) Agricultural EAP ratio (Population and Housing Census 2007)	Economic Fragility
	Ratio of Population in Houses with Dirt Floors (Population and Housing Census 2007) Ratio of Population in Homes Without Electricity (Population and Housing Census 2007) Ratio of Population in Process Development and Social Inclusion Programs (MIDIS 2013)	Social Fragility
Food Use	Literacy Rate for Women (Population and Housing Census 2007) Ratio of Household Heads with Incomplete Primary Educations (Population and Housing Census 2007) Ratio of Homes not Connected to the Public Water and Sewage System (Population and Housing Census 2007) Ratio of Homes not Connected to the Public Drainage System (Population and Housing Census 2007) Ratio of the Population who use Firewood and others for Cooking (Population and Housing Census 2007)	Social Fragility
Institutionalization	Local Government Management Gap Index (RENAMU 2014) State Density Gap Index (Human Development Report Peru 2013 - UNDP)	Social Resilience

COMPONENTS USED TO CREATE RECURRENCE OF NATURAL PHENOMENA (2004-2014) PORTION OF VIAFFN 2015

Components	Variables Used
Stability	Recurrence of Natural Phenomena 2004-2014 (INDECI)
	Population affected 2004-2012 (INDECI)

Source: (WFP, 2015)

Appendix C: Regression Results-Stata Log File

Stata Table Results:

```
* Table 4 Household Characteristics for Farmers in Peru and Farmers Planting Yungay, Canchan, Amarilis, and/or OVs
//Age
bysort h_YungayA: sum Age_HHHead
bysort h_CanchanA: sum Age_HHHead
bysort h_AmarilisA: sum Age_HHHead
bysort h_OVsA: sum Age_HHHead
sum Age_HHHead
//Male & Female
bysort  h_YungayA: tab HHHeadGender
bysort h_CanchanA: tab HHHeadGender
bysort h_AmarilisA: tab HHHeadGender
bysort h_OVsA: tab HHHeadGender
//Education
bysort h_YungayA: sum HH_EducationCont
bysort h_CanchanA: sum HH_EducationCont
bysort h_AmarilisA: sum HH_EducationCont
bysort h_OVsA: sum HH_EducationCont
sum HH_EducationCont
//Household Size
bysort h_YungayA: sum Number_in_HH
bysort h_CanchanA: sum Number_in_HH
bysort h_AmarilisA: sum Number_in_HH
bysort h_OVsA: sum Number_in_HH
sum Number_in_HH
//Total Land Area
bysort h_YungayA: sum Total_Land_Ha
bysort h_CanchanA: sum Total_Land_Ha
bysort h_AmarilisA: sum Total_Land_Ha
bysort h_OVsA: sum Total_Land_Ha
sum Total_Land_Ha
//Potato Land Area
bysort h_YungayA: sum PotatoLand
bysort h_CanchanA: sum PotatoLand
bysort h_AmarilisA: sum PotatoLand
bysort h_OVsA: sum PotatoLand
sum PotatoLand
//Household Elevation
bysort h_YungayA: sum Household_Elevation
bysort h_CanchanA: sum Household_Elevation
bysort h_AmarilisA: sum Household_Elevation
bysort h_OVsA: sum Household_Elevation
sum Household_Elevation
```

```
//Household Sells Potatoes on the Market
bysort h_YungayA: tab  HH_Sell_Potato_Market
bysort h_CanchanA: tab HH_Sell_Potato_Market
bysort h_AmarilisA: tab HH_Sell_Potato_Market
bysort h_OVsA: tab HH_Sell_Potato_Market
tab HH_Sell_Potato_Market

*Table 5 Adoption and Dis-adoption of Yungay, Canchan, Amarilis, and OVs
//Adoption and Dis-adoption Per Variety
tab EverplantedYungayA
tab DisadoptionYungayA
tab EverplantedCanchanA
tab DisadoptionCanchanA
tab EverplantedAmarilisA
tab DisadoptionAmarilisA
tab EverplantedOVsA
tab DisadoptionOVsA
//Adoption based on a farmer ever planting Yungay
tab EverplantedCanchanA  if EverplantedYungayA==1
tab EverplantedAmarilisA  if EverplantedYungayA==1
tab EverplantedOVsA  if EverplantedYungayA==1
//Dis-adoption based on a farmer ever planting Yungay
tab DisadoptionCanchanA  if EverplantedYungayA==1
tab DisadoptionAmarilisA  if EverplantedYungayA==1
tab DisadoptionOVsA  if EverplantedYungayA==1
//Adoption based on a farmer ever planting Canchan
tab EverplantedYungayA  if EverplantedCanchanA==1
tab EverplantedAmarilisA  if EverplantedCanchanA==1
tab EverplantedOVsA  if EverplantedCanchanA==1
//Dis-adoption based on a farmer ever planting Canchan
tab DisadoptionYungayA  if EverplantedCanchanA==1
tab DisadoptionAmarilisA  if EverplantedCanchanA==1
tab DisadoptionOVsA  if EverplantedCanchanA==1
//Adoption based on a farmer ever planting Amarilis
tab EverplantedYungayA  if EverplantedAmarilisA==1
tab EverplantedCanchanA  if EverplantedAmarilisA==1
tab EverplantedOVsA  if EverplantedAmarilisA==1
//Dis-adoption based on a farmer ever planting Amarilis
tab DisadoptionYungayA  if EverplantedAmarilisA==1
tab DisadoptionCanchanA  if EverplantedAmarilisA==1
tab DisadoptionOVsA  if EverplantedAmarilisA==1
//Adoption based on a farmer ever planting OVs
tab EverplantedYungayA  if EverplantedOVsA==1
tab EverplantedCanchanA  if EverplantedOVsA==1
tab EverplantedAmarilisA  if EverplantedOVsA==1
//Dis-adoption based on a farmer ever planting OVs
```

```
tab DisadoptionYungayA  if EverplantedOVsA==1
tab DisadoptionCanchanA  if EverplantedOVsA==1
tab DisadoptionAmarilisA  if EverplantedOVsA==1

*Table 6: Adoption of Yungay, Canchan, or Yungay and Canchan by Department
gen JustYungayorCanchan=1 if EverplantedYungayA==1 & EverplantedCanchanA==0
replace JustYungayorCanchan=2 if EverplantedYungayA==0 & EverplantedCanchanA==1
gen JustYungayorboth=1 if EverplantedYungayA==1 & EverplantedCanchanA==0
replace JustYungayorboth=2 if EverplantedYungayA==1 & EverplantedCanchanA==1
gen JustCanchanorboth=1 if EverplantedYungayA==0 & EverplantedCanchanA==1
replace JustCanchanorboth=2 if EverplantedYungayA==1 & EverplantedCanchanA==1
gen AllobservationsCY=.
replace AllobservationsCY=1 if JustCanchanorboth==1 |JustCanchanorboth==2
|JustYungayorCanchan==1
bysort Departamento: tab AllobservationsCY
//Cusco
gen D_1JustYungay=0 if JustYungayorCanchan==1
replace D_1JustYungay=1 if JustYungayorCanchan==1 & DepartamentoCusco==1
gen D_1JustCanchan=0 if JustYungayorCanchan==2
replace D_1JustCanchan=1 if JustYungayorCanchan==2 & DepartamentoCusco==1
gen D_1JustC_Y=0 if JustYungayorboth==2
replace D_1JustC_Y=1 if JustYungayorboth==2 & DepartamentoCusco==1
prtest D_1JustYungay==D_1JustCanchan
prtest D_1JustCanchan==D_1JustC_Y
prtest D_1JustYungay==D_1JustC_Y
//Apurimac
gen D_2JustYungay=0 if JustYungayorCanchan==1
replace D_2JustYungay=1 if JustYungayorCanchan==1 & DepartamentoApurimac==1
gen D_2JustCanchan=0 if JustYungayorCanchan==2
replace D_2JustCanchan=1 if JustYungayorCanchan==2 & DepartamentoApurimac==1
gen D_2JustC_Y=0 if JustYungayorboth==2
replace D_2JustC_Y=1 if JustYungayorboth==2 & DepartamentoApurimac==1
prtest D_2JustYungay==D_2JustCanchan
prtest D_2JustCanchan==D_2JustC_Y
prtest D_2JustYungay==D_2JustC_Y
//Libertad
gen D_3JustYungay=0 if JustYungayorCanchan==1
replace D_3JustYungay=1 if JustYungayorCanchan==1 & DepartamentoLibertad==1
gen D_3JustCanchan=0 if JustYungayorCanchan==2
replace D_3JustCanchan=1 if JustYungayorCanchan==2 & DepartamentoLibertad==1
gen D_3JustC_Y=0 if JustYungayorboth==2
replace D_3JustC_Y=1 if JustYungayorboth==2 & DepartamentoLibertad==1
prtest D_3JustYungay==D_3JustCanchan
prtest D_3JustCanchan==D_3JustC_Y
prtest D_3JustYungay==D_3JustC_Y
//Cajamarca
```

```
gen D_4JustYungay=0 if JustYungayorCanchan==1
replace D_4JustYungay=1 if JustYungayorCanchan==1 & DepartamentoCajamarca==1
gen D_4JustCanchan=0 if JustYungayorCanchan==2
replace D_4JustCanchan=1 if JustYungayorCanchan==2 & DepartamentoCajamarca==1
gen D_4JustC_Y=0 if JustYungayorboth==2
replace D_4JustC_Y=1 if JustYungayorboth==2 & DepartamentoCajamarca==1
prtest D_4JustYungay==D_4JustCanchan
prtest D_4JustCanchan==D_4JustC_Y
prtest D_4JustYungay==D_4JustC_Y
//Huanuco
gen D_5JustYungay=0 if JustYungayorCanchan==1
replace D_5JustYungay=1 if JustYungayorCanchan==1 & DepartamentoHuanuco==1
gen D_5JustCanchan=0 if JustYungayorCanchan==2
replace D_5JustCanchan=1 if JustYungayorCanchan==2 & DepartamentoHuanuco==1
gen D_5JustC_Y=0 if JustYungayorboth==2
replace D_5JustC_Y=1 if JustYungayorboth==2 & DepartamentoHuanuco==1
prtest D_5JustYungay==D_5JustCanchan
prtest D_5JustCanchan==D_5JustC_Y
prtest D_5JustYungay==D_5JustC_Y
//Junin
gen D_6JustYungay=0 if JustYungayorCanchan==1
replace D_6JustYungay=1 if JustYungayorCanchan==1 & DepartamentoJunin==1
gen D_6JustCanchan=0 if JustYungayorCanchan==2
replace D_6JustCanchan=1 if JustYungayorCanchan==2 & DepartamentoJunin==1
gen D_6JustC_Y=0 if JustYungayorboth==2
replace D_6JustC_Y=1 if JustYungayorboth==2 & DepartamentoJunin==1
prtest D_6JustYungay==D_6JustCanchan
prtest D_6JustCanchan==D_6JustC_Y
prtest D_6JustYungay==D_6JustC_Y
//Ancash
gen D_7JustYungay=0 if JustYungayorCanchan==1
replace D_7JustYungay=1 if JustYungayorCanchan==1 & DepartamentoAncash==1
gen D_7JustCanchan=0 if JustYungayorCanchan==2
replace D_7JustCanchan=1 if JustYungayorCanchan==2 &  DepartamentoAncash==1
gen D_7JustC_Y=0 if JustYungayorboth==2
replace D_7JustC_Y=1 if JustYungayorboth==2 &  DepartamentoAncash==1
prtest D_7JustYungay==D_7JustCanchan
prtest D_7JustCanchan==D_7JustC_Y
prtest D_7JustYungay==D_7JustC_Y
//Puno
gen D_9JustYungay=0 if JustYungayorCanchan==1
replace D_9JustYungay=1 if JustYungayorCanchan==1 & DepartamentoPuno==1
gen D_9JustCanchan=0 if JustYungayorCanchan==2
replace D_9JustCanchan=1 if JustYungayorCanchan==2 &  DepartamentoPuno==1
gen D_9JustC_Y=0 if JustYungayorboth==2
replace D_9JustC_Y=1 if JustYungayorboth==2 &  DepartamentoPuno==1
```

```
prtest D_9JustYungay==D_9JustCanchan
prtest D_9JustCanchan==D_9JustC_Y
prtest D_9JustYungay==D_9JustC_Y
//Ayacucho
gen D_10JustYungay=0 if JustYungayorCanchan==1
replace D_10JustYungay=1 if JustYungayorCanchan==1 & DepartamentoAyacucho==1
gen D_10JustCanchan=0 if JustYungayorCanchan==2
replace D_10JustCanchan=1 if JustYungayorCanchan==2 &  DepartamentoAyacucho==1
gen D_10JustC_Y=0 if JustYungayorboth==2
replace D_10JustC_Y=1 if JustYungayorboth==2 &  DepartamentoAyacucho==1
prtest D_10JustYungay==D_10JustCanchan
prtest D_10JustCanchan==D_10JustC_Y
prtest D_10JustYungay==D_10JustC_Y
//Huancavelica
gen D_11JustYungay=0 if JustYungayorCanchan==1
replace D_11JustYungay=1 if JustYungayorCanchan==1 & DepartamentoHuancavelica==1
gen D_11JustCanchan=0 if JustYungayorCanchan==2
replace D_11JustCanchan=1 if JustYungayorCanchan==2 &  DepartamentoHuancavelica==1
gen D_11JustC_Y=0 if JustYungayorboth==2
replace D_11JustC_Y=1 if JustYungayorboth==2 &  DepartamentoHuancavelica==1
prtest D_11JustYungay==D_11JustCanchan
prtest D_11JustCanchan==D_11JustC_Y
prtest D_11JustYungay==D_11JustC_Y

*Table 7: Adoption of Yungay, AMarilis, or Yungay and Amarilis by Department
gen JustYungayorAmarilis=1 if EverplantedYungayA==1 & EverplantedAmarilisA==0
replace JustYungayorAmarilis=2 if EverplantedYungayA==0 & EverplantedAmarilisA==1
gen JustYungayorbothA=1 if EverplantedYungayA==1 & EverplantedAmarilisA==0
replace JustYungayorbothA=2 if EverplantedYungayA==1 & EverplantedAmarilisA==1
gen JustAmarilisorboth=1 if EverplantedYungayA==0 & EverplantedAmarilisA==1
replace JustAmarilisorboth=2 if EverplantedYungayA==1 & EverplantedAmarilisA==1
gen AllobservationsAY=.
replace AllobservationsAY=1 if JustAmarilisorboth==1 |JustAmarilisorboth==2
|JustYungayorAmarilis==1
bysort Departamento: tab AllobservationsAY
//Cusco
gen D_1JustYungayA=0 if JustYungayorAmarilis==1
replace D_1JustYungayA=1 if JustYungayorAmarilis==1 & DepartamentoCusco==1
gen D_1JustAmarilis=0 if JustYungayorAmarilis==2
replace D_1JustAmarilis=1 if JustYungayorAmarilis==2 & DepartamentoCusco==1
gen D_1JustA_Y=0 if JustYungayorbothA==2
replace D_1JustA_Y=1 if JustYungayorbothA==2 & DepartamentoCusco==1
prtest D_1JustYungayA==D_1JustAmarilis
prtest D_1JustAmarilis==D_1JustA_Y
prtest D_1JustYungayA==D_1JustA_Y
//Apurimac
```

```
gen D_2JustYungayA=0 if JustYungayorAmarilis==1
replace D_2JustYungayA=1 if JustYungayorAmarilis==1 & DepartamentoApurimac==1
gen D_2JustAmarilis=0 if JustYungayorAmarilis==2
replace D_2JustAmarilis=1 if JustYungayorAmarilis==2 & DepartamentoApurimac==1
gen D_2JustA_Y=0 if JustYungayorbothA==2
replace D_2JustA_Y=1 if JustYungayorbothA==2 & DepartamentoApurimac==1
prtest D_2JustYungayA==D_2JustAmarilis
prtest D_2JustAmarilis==D_2JustA_Y
prtest D_2JustYungayA==D_2JustA_Y
//Libertad
gen D_3JustYungayA=0 if JustYungayorAmarilis==1
replace D_3JustYungayA=1 if JustYungayorAmarilis==1 & DepartamentoLibertad==1
gen D_3JustAmarilis=0 if JustYungayorAmarilis==2
replace D_3JustAmarilis=1 if JustYungayorAmarilis==2 & DepartamentoLibertad==1
gen D_3JustA_Y=0 if JustYungayorbothA==2
replace D_3JustA_Y=1 if JustYungayorbothA==2 & DepartamentoLibertad==1
prtest D_3JustYungayA==D_3JustAmarilis
prtest D_3JustAmarilis==D_3JustA_Y
prtest D_3JustYungayA==D_3JustA_Y
//Cajamarca
gen D_4JustYungayA=0 if JustYungayorAmarilis==1
replace D_4JustYungayA=1 if JustYungayorAmarilis==1 & DepartamentoCajamarca==1
gen D_4JustAmarilis=0 if JustYungayorAmarilis==2
replace D_4JustAmarilis=1 if JustYungayorAmarilis==2 & DepartamentoCajamarca==1
gen D_4JustA_Y=0 if JustYungayorbothA==2
replace D_4JustA_Y=1 if JustYungayorbothA==2 & DepartamentoCajamarca==1
prtest D_4JustYungayA==D_4JustAmarilis
prtest D_4JustAmarilis==D_4JustA_Y
prtest D_4JustYungayA==D_4JustA_Y
//Huanuco
gen D_5JustYungayA=0 if JustYungayorAmarilis==1
replace D_5JustYungayA=1 if JustYungayorAmarilis==1 & DepartamentoHuanuco==1
gen D_5JustAmarilis=0 if JustYungayorAmarilis==2
replace D_5JustAmarilis=1 if JustYungayorAmarilis==2 & DepartamentoHuanuco==1
gen D_5JustA_Y=0 if JustYungayorbothA==2
replace D_5JustA_Y=1 if JustYungayorbothA==2 & DepartamentoHuanuco==1
prtest D_5JustYungayA==D_5JustAmarilis
prtest D_5JustAmarilis==D_5JustA_Y
prtest D_5JustYungayA==D_5JustA_Y
//Junin
gen D_6JustYungayA=0 if JustYungayorAmarilis==1
replace D_6JustYungayA=1 if JustYungayorAmarilis==1 & DepartamentoJunin==1
gen D_6JustAmarilis=0 if JustYungayorAmarilis==2
replace D_6JustAmarilis=1 if JustYungayorAmarilis==2 & DepartamentoJunin==1
gen D_6JustA_Y=0 if JustYungayorbothA==2
replace D_6JustA_Y=1 if JustYungayorbothA==2 & DepartamentoJunin==1
```

```
prtest D_6JustYungayA==D_6JustAmarilis
prtest D_6JustAmarilis==D_6JustA_Y
prtest D_6JustYungayA==D_6JustA_Y
//Ancash
gen D_7JustYungayA=0 if JustYungayorAmarilis==1
replace D_7JustYungayA=1 if JustYungayorAmarilis==1 & DepartamentoAncash==1
gen D_7JustAmarilis=0 if JustYungayorAmarilis==2
replace D_7JustAmarilis=1 if JustYungayorAmarilis==2 &  DepartamentoAncash==1
gen D_7JustA_Y=0 if JustYungayorbothA==2
replace D_7JustA_Y=1 if JustYungayorbothA==2 &  DepartamentoAncash==1
prtest D_7JustYungayA==D_7JustAmarilis
prtest D_7JustAmarilis==D_7JustA_Y
prtest D_7JustYungayA==D_7JustA_Y
//Puno
gen D_9JustYungayA=0 if JustYungayorAmarilis==1
replace D_9JustYungayA=1 if JustYungayorAmarilis==1 & DepartamentoPuno==1
gen D_9JustAmarilis=0 if JustYungayorAmarilis==2
replace D_9JustAmarilis=1 if JustYungayorAmarilis==2 &  DepartamentoPuno==1
gen D_9JustA_Y=0 if JustYungayorbothA==2
replace D_9JustA_Y=1 if JustYungayorbothA==2 &  DepartamentoPuno==1
prtest D_9JustYungayA==D_9JustAmarilis
prtest D_9JustAmarilis==D_9JustA_Y
prtest D_9JustYungayA==D_9JustA_Y
//Ayacucho
gen D_10JustYungayA=0 if JustYungayorAmarilis==1
replace D_10JustYungayA=1 if JustYungayorAmarilis==1 & DepartamentoAyacucho==1
gen D_10JustAmarilis=0 if JustYungayorAmarilis==2
replace D_10JustAmarilis=1 if JustYungayorAmarilis==2 &  DepartamentoAyacucho==1
gen D_10JustA_Y=0 if JustYungayorbothA==2
replace D_10JustA_Y=1 if JustYungayorbothA==2 &  DepartamentoAyacucho==1
prtest D_10JustYungayA==D_10JustAmarilis
prtest D_10JustAmarilis==D_10JustA_Y
prtest D_10JustYungayA==D_10JustA_Y
//Huancavelica
gen D_11JustYungayA=0 if JustYungayorAmarilis==1
replace D_11JustYungayA=1 if JustYungayorAmarilis==1 & DepartamentoHuancavelica==1
gen D_11JustAmarilis=0 if JustYungayorAmarilis==2
replace D_11JustAmarilis=1 if JustYungayorAmarilis==2 &  DepartamentoHuancavelica==1
gen D_11JustA_Y=0 if JustYungayorbothA==2
replace D_11JustA_Y=1 if JustYungayorbothA==2 &  DepartamentoHuancavelica==1
prtest D_11JustYungayA==D_11JustAmarilis
prtest D_11JustAmarilis==D_11JustA_Y
prtest D_11JustYungayA==D_11JustA_Y

*Table 8: Adoption of Yungay, OVs, or Yungay and OVs by Department
gen JustYungayorOVs=1 if EverplantedYungayA==1 & EverplantedOVsA==0
```

```
replace JustYungayorOVs=2 if EverplantedYungayA==0 & EverplantedOVsA==1
gen JustYungayorbothO=1 if EverplantedYungayA==1 & EverplantedOVsA==0
replace JustYungayorbothO=2 if EverplantedYungayA==1 & EverplantedOVsA==1
gen JustOVsorboth=1 if EverplantedYungayA==0 & EverplantedOVsA==1
replace  JustOVsorboth=2 if EverplantedYungayA==1 & EverplantedOVsA==1
gen AllobservationsOY=.
replace AllobservationsOY=1 if JustOVsorboth==1 |JustOVsorboth==2 |JustYungayorOVs==1
bysort Departamento: tab AllobservationsOY
//Cusco
gen D_1JustYungayO=0 if JustYungayorOVs==1
replace D_1JustYungayO=1 if JustYungayorOVs==1 & DepartamentoCusco==1
gen D_1JustOVs=0 if JustYungayorOVs==2
replace D_1JustOVs=1 if JustYungayorOVs==2 & DepartamentoCusco==1
gen D_1JustO_Y=0 if JustYungayorbothO==2
replace D_1JustO_Y=1 if JustYungayorbothO==2 & DepartamentoCusco==1
prtest D_1JustYungayO==D_1JustOVs
prtest D_1JustOVs==D_1JustO_Y
prtest D_1JustYungayO==D_1JustO_Y
//Apurimac
gen D_2JustYungayO=0 if JustYungayorOVs==1
replace D_2JustYungayO=1 if JustYungayorOVs==1 & DepartamentoApurimac==1
gen D_2JustOVs=0 if JustYungayorOVs==2
replace D_2JustOVs=1 if JustYungayorOVs==2 & DepartamentoApurimac==1
gen D_2JustO_Y=0 if JustYungayorbothO==2
replace D_2JustO_Y=1 if JustYungayorbothO==2 & DepartamentoApurimac==1
prtest D_2JustYungay==D_2JustCanchan
prtest D_2JustCanchan==D_2JustC_Y
prtest D_2JustYungay==D_2JustC_Y
//Libertad
gen D_3JustYungayO=0 if JustYungayorOVs==1
replace D_3JustYungayO=1 if JustYungayorOVs==1 & DepartamentoLibertad==1
gen D_3JustOVs=0 if JustYungayorOVs==2
replace D_3JustOVs=1 if JustYungayorOVs==2 & DepartamentoLibertad==1
gen D_3JustO_Y=0 if JustYungayorbothO==2
replace D_3JustO_Y=1 if JustYungayorbothO==2 & DepartamentoLibertad==1
prtest D_3JustYungayO==D_3JustOVs
prtest D_3JustOVs==D_3JustO_Y
prtest D_3JustYungayO==D_3JustO_Y
//Cajamarca
gen D_4JustYungayO=0 if JustYungayorOVs==1
replace D_4JustYungayO=1 if JustYungayorOVs==1 & DepartamentoCajamarca==1
gen D_4JustOVs=0 if JustYungayorOVs==2
replace D_4JustOVs=1 if JustYungayorOVs==2 & DepartamentoCajamarca==1
gen D_4JustO_Y=0 if JustYungayorbothO==2
replace D_4JustO_Y=1 if JustYungayorbothO==2 & DepartamentoCajamarca==1
prtest D_4JustYungayO==D_4JustOVs
```

```
prtest D_4JustOVs==D_4JustO_Y
prtest D_4JustYungayO==D_4JustO_Y
//Huanuco
gen D_5JustYungayO=0 if JustYungayorOVs==1
replace D_5JustYungayO=1 if JustYungayorOVs==1 & DepartamentoHuanuco==1
gen D_5JustOVs=0 if JustYungayorOVs==2
replace D_5JustOVs=1 if JustYungayorOVs==2 & DepartamentoHuanuco==1
gen D_5JustO_Y=0 if JustYungayorbothO==2
replace D_5JustO_Y=1 if JustYungayorbothO==2 & DepartamentoHuanuco==1
prtest D_5JustYungayO==D_5JustOVs
prtest D_5JustOVs==D_5JustO_Y
prtest D_5JustYungayO==D_5JustO_Y
//Junin
gen D_6JustYungayO=0 if JustYungayorOVs==1
replace D_6JustYungayO=1 if JustYungayorOVs==1 & DepartamentoJunin==1
gen D_6JustOVs=0 if JustYungayorOVs==2
replace D_6JustOVs=1 if JustYungayorOVs==2 & DepartamentoJunin==1
gen D_6JustO_Y=0 if JustYungayorbothO==2
replace D_6JustO_Y=1 if JustYungayorbothO==2 & DepartamentoJunin==1
prtest D_6JustYungayO==D_6JustOVs
prtest D_6JustOVs==D_6JustO_Y
prtest D_6JustYungayO==D_6JustO_Y
//Ancash
gen D_7JustYungayO=0 if JustYungayorOVs==1
replace D_7JustYungayO=1 if JustYungayorOVs==1 & DepartamentoAncash==1
gen D_7JustOVs=0 if JustYungayorOVs==2
replace D_7JustOVs=1 if JustYungayorOVs==2 &  DepartamentoAncash==1
gen D_7JustO_Y=0 if JustYungayorbothO==2
replace D_7JustO_Y=1 if JustYungayorbothO==2 &  DepartamentoAncash==1
prtest D_7JustYungayO==D_7JustCanchan
prtest D_7JustCanchan==D_7JustO_Y
prtest D_7JustYungayO==D_7JustO_Y
//Puno
gen D_9JustYungayO=0 if JustYungayorOVs==1
replace D_9JustYungayO=1 if JustYungayorOVs==1 & DepartamentoPuno==1
gen D_9JustOVs=0 if JustYungayorOVs==2
replace D_9JustOVs=1 if JustYungayorOVs==2 &  DepartamentoPuno==1
gen D_9JustO_Y=0 if JustYungayorbothO==2
replace D_9JustO_Y=1 if JustYungayorbothO==2 &  DepartamentoPuno==1
prtest D_9JustYungayO==D_9JustOVs
prtest D_9JustOVs==D_9JustO_Y
prtest D_9JustYungayO==D_9JustO_Y
//Ayacucho
gen D_10JustYungayO=0 if JustYungayorOVs==1
replace D_10JustYungayO=1 if JustYungayorOVs==1 & DepartamentoAyacucho==1
gen D_10JustOVs=0 if JustYungayorOVs==2
```

```
replace D_10JustOVs=1 if JustYungayorOVs==2 &  DepartamentoAyacucho==1
gen D_10JustO_Y=0 if JustYungayorbothO==2
replace D_10JustO_Y=1 if JustYungayorbothO==2 &  DepartamentoAyacucho==1
prtest D_10JustYungayO==D_10JustOVs
prtest D_10JustOVs==D_10JustO_Y
prtest D_10JustYungayO==D_10JustO_Y
//Huancavelica
gen D_11JustYungayO=0 if JustYungayorOVs==1
replace D_11JustYungayO=1 if JustYungayorOVs==1 & DepartamentoHuancavelica==1
gen D_11JustOVs=0 if JustYungayorOVs==2
replace D_11JustOVs=1 if JustYungayorOVs==2 &  DepartamentoHuancavelica==1
gen D_11JustO_Y=0 if JustYungayorbothO==2
replace D_11JustO_Y=1 if JustYungayorbothO==2 &  DepartamentoHuancavelica==1
prtest D_11JustYungayO==D_11JustOVs
prtest D_11JustOVs==D_11JustO_Y
prtest D_11JustYungayO==D_11JustO_Y

*Table 10: Household characteristics for farmers who adopt Yungay, Canchan, or Canchan and Yungay
tab EverplantedYungayA if EverplantedCanchanA==0
gen JustYungayorCanchan=1 if EverplantedYungayA==1 & EverplantedCanchanA==0
replace JustYungayorCanchan=2 if EverplantedYungayA==0 & EverplantedCanchanA==1
gen JustYungayorboth=1 if EverplantedYungayA==1 & EverplantedCanchanA==0
replace JustYungayorboth=2 if EverplantedYungayA==1 & EverplantedCanchanA==1
gen JustCanchanorboth=1 if EverplantedYungayA==0 & EverplantedCanchanA==1
replace JustCanchanorboth=2 if EverplantedYungayA==1 & EverplantedCanchanA==1
gen AllobservationsCY=.
replace AllobservationsCY=1 if JustCanchanorboth==1 |JustCanchanorboth==2
|JustYungayorCanchan==1

//Land, Elevation, Distance to Experiment Station
ttest Total_Land_Ha, by(JustYungayorCanchan)
ttest Total_Land_Ha, by(JustCanchanorboth)
ttest Total_Land_Ha, by(JustYungayorboth)
ttest Household_Elevation, by(JustYungayorCanchan)
ttest Household_Elevation, by(JustCanchanorboth)
ttest Household_Elevation, by(JustYungayorboth)
ttest DistancetoES, by(JustYungayorCanchan)
ttest DistancetoES, by(JustCanchanorboth)
ttest DistancetoES, by(JustYungayorboth)

//Age
bysort Age_HHHead_cat: tab AllobservationsCY
//Group 0
gen Age_0JustYungay=0 if JustYungayorCanchan==1
replace Age_0JustYungay=1 if JustYungayorCanchan==1 & Age_HHHead_cat==0
```

```
gen Age_0JustCanchan=0 if JustYungayorCanchan==2
replace Age_0JustCanchan=1 if JustYungayorCanchan==2 & Age_HHHead_cat==0
gen Age_0JustC_Y=0 if JustYungayorboth==2
replace Age_0JustC_Y=1 if JustYungayorboth==2 & Age_HHHead_cat==0
prtest Age_0JustYungay==Age_0JustCanchan
prtest Age_0JustCanchan==Age_0JustC_Y
prtest Age_0JustYungay==Age_0JustC_Y
//Group 1
gen Age_1JustYungay=0 if JustYungayorCanchan==1
replace Age_1JustYungay=1 if JustYungayorCanchan==1 & Age_HHHead_cat==1
gen Age_1JustCanchan=0 if JustYungayorCanchan==2
replace Age_1JustCanchan=1 if JustYungayorCanchan==2 & Age_HHHead_cat==1
gen Age_1JustC_Y=0 if JustYungayorboth==2
replace Age_1JustC_Y=1 if JustYungayorboth==2 & Age_HHHead_cat==1
prtest Age_1JustYungay==Age_1JustCanchan
prtest Age_1JustCanchan==Age_1JustC_Y
prtest Age_1JustYungay==Age_1JustC_Y
//Group 2
gen Age_2JustYungay=0 if JustYungayorCanchan==1
replace Age_2JustYungay=1 if JustYungayorCanchan==1 & Age_HHHead_cat==2
gen Age_2JustCanchan=0 if JustYungayorCanchan==2
replace Age_2JustCanchan=1 if JustYungayorCanchan==2 & Age_HHHead_cat==2
gen Age_2JustC_Y=0 if JustYungayorboth==2
replace Age_2JustC_Y=1 if JustYungayorboth==2 & Age_HHHead_cat==2
prtest Age_2JustYungay==Age_2JustCanchan
prtest Age_2JustCanchan==Age_2JustC_Y
prtest Age_2JustYungay==Age_2JustC_Y
//Group 3
gen Age_3JustYungay=0 if JustYungayorCanchan==1
replace Age_3JustYungay=1 if JustYungayorCanchan==1 & Age_HHHead_cat==3
gen Age_3JustCanchan=0 if JustYungayorCanchan==2
replace Age_3JustCanchan=1 if JustYungayorCanchan==2 & Age_HHHead_cat==3
gen Age_3JustC_Y=0 if JustYungayorboth==2
replace Age_3JustC_Y=1 if JustYungayorboth==2 & Age_HHHead_cat==3
prtest Age_3JustYungay==Age_3JustCanchan
prtest Age_3JustCanchan==Age_3JustC_Y
prtest Age_3JustYungay==Age_3JustC_Y

//Education
bysort HHHead_Education_Cat: tab AllobservationsCY
//Group 0
gen Edu_0JustYungay=0 if JustYungayorCanchan==1
replace Edu_0JustYungay=1 if JustYungayorCanchan==1 & HHHead_Education_Cat==0
gen Edu_0JustCanchan=0 if JustYungayorCanchan==2
replace Edu_0JustCanchan=1 if JustYungayorCanchan==2 & HHHead_Education_Cat==0
gen Edu_0JustC_Y=0 if JustYungayorboth==2
```

```
replace Edu_0JustC_Y=1 if JustYungayorboth==2 & HHHead_Education_Cat==0
prtest Edu_0JustYungay==Edu_0JustCanchan
prtest Edu_0JustCanchan==Edu_0JustC_Y
prtest Edu_0JustYungay==Edu_0JustC_Y
//Group 1
gen Edu_1JustYungay=0 if JustYungayorCanchan==1
replace Edu_1JustYungay=1 if JustYungayorCanchan==1 & HHHead_Education_Cat==1
gen Edu_1JustCanchan=0 if JustYungayorCanchan==2
replace Edu_1JustCanchan=1 if JustYungayorCanchan==2 & HHHead_Education_Cat==1
gen Edu_1JustC_Y=0 if JustYungayorboth==2
replace Edu_1JustC_Y=1 if JustYungayorboth==2 & HHHead_Education_Cat==1
prtest Edu_1JustYungay==Edu_1JustCanchan
prtest Edu_1JustCanchan==Edu_1JustC_Y
prtest Edu_1JustYungay==Edu_1JustC_Y
//Group 2
gen Edu_2JustYungay=0 if JustYungayorCanchan==1
replace Edu_2JustYungay=1 if JustYungayorCanchan==1 & HHHead_Education_Cat==2
gen Edu_2JustCanchan=0 if JustYungayorCanchan==2
replace Edu_2JustCanchan=1 if JustYungayorCanchan==2 & HHHead_Education_Cat==2
gen Edu_2JustC_Y=0 if JustYungayorboth==2
replace Edu_2JustC_Y=1 if JustYungayorboth==2 & HHHead_Education_Cat==2
prtest Edu_2JustYungay==Edu_2JustCanchan
prtest Edu_2JustCanchan==Edu_2JustC_Y
prtest Edu_2JustYungay==Edu_2JustC_Y
//Group 3
gen Edu_3JustYungay=0 if JustYungayorCanchan==1
replace Edu_3JustYungay=1 if JustYungayorCanchan==1 & HHHead_Education_Cat==3
gen Edu_3JustCanchan=0 if JustYungayorCanchan==2
replace Edu_3JustCanchan=1 if JustYungayorCanchan==2 & HHHead_Education_Cat==3
gen Edu_3JustC_Y=0 if JustYungayorboth==2
replace Edu_3JustC_Y=1 if JustYungayorboth==2 & HHHead_Education_Cat==3
prtest Edu_3JustYungay==Edu_3JustCanchan
prtest Edu_3JustCanchan==Edu_3JustC_Y
prtest Edu_3JustYungay==Edu_3JustC_Y

//VIAFFNN
bysort NewVP_65Category: tab AllobservationsCY
//Medium/Low
gen VIAFFN_0JustYungay=0 if JustYungayorCanchan==1
replace VIAFFN_0JustYungay=1 if JustYungayorCanchan==1 & NewVP_65Category==0
gen VIAFFN_0JustCanchan=0 if JustYungayorCanchan==2
replace VIAFFN_0JustCanchan=1 if JustYungayorCanchan==2 & NewVP_65Category==0
gen VIAFFN_0JustC_Y=0 if JustYungayorboth==2
replace VIAFFN_0JustC_Y=1 if JustYungayorboth==2 & NewVP_65Category==0
prtest VIAFFN_0JustYungay==VIAFFN_0JustCanchan
prtest VIAFFN_0JustCanchan==VIAFFN_0JustC_Y
```

```
prtest VIAFFN_0JustYungay==VIAFFN_0JustC_Y
//High
gen VIAFFN_1JustYungay=0 if JustYungayorCanchan==1
replace VIAFFN_1JustYungay=1 if JustYungayorCanchan==1 & NewVP_65Category==1
gen VIAFFN_1JustCanchan=0 if JustYungayorCanchan==2
replace VIAFFN_1JustCanchan=1 if JustYungayorCanchan==2 & NewVP_65Category==1
gen VIAFFN_1JustC_Y=0 if JustYungayorboth==2
replace VIAFFN_1JustC_Y=1 if JustYungayorboth==2 & NewVP_65Category==1
prtest VIAFFN_1JustYungay==VIAFFN_1JustCanchan
prtest VIAFFN_1JustCanchan==VIAFFN_1JustC_Y
prtest VIAFFN_1JustYungay==VIAFFN_1JustC_Y
//Very High
gen VIAFFN_2JustYungay=0 if JustYungayorCanchan==1
replace VIAFFN_2JustYungay=1 if JustYungayorCanchan==1 & NewVP_65Category==2
gen VIAFFN_2JustCanchan=0 if JustYungayorCanchan==2
replace VIAFFN_2JustCanchan=1 if JustYungayorCanchan==2 & NewVP_65Category==2
gen VIAFFN_2JustC_Y=0 if JustYungayorboth==2
replace VIAFFN_2JustC_Y=1 if JustYungayorboth==2 & NewVP_65Category==2
prtest VIAFFN_2JustYungay==VIAFFN_2JustCanchan
prtest VIAFFN_2JustCanchan==VIAFFN_2JustC_Y
prtest VIAFFN_2JustYungay==VIAFFN_2JustC_Y

//Sell Potatoes on Market
bysort HH_Sell_Potato_Market: tab AllobservationsCY
//No
gen Sell_0JustYungay=0 if JustYungayorCanchan==1
replace Sell_0JustYungay=1 if JustYungayorCanchan==1 & HH_Sell_Potato_Market==0
gen Sell_0JustCanchan=0 if JustYungayorCanchan==2
replace Sell_0JustCanchan=1 if JustYungayorCanchan==2 & HH_Sell_Potato_Market==0
gen Sell_0JustC_Y=0 if JustYungayorboth==2
replace Sell_0JustC_Y=1 if JustYungayorboth==2 & HH_Sell_Potato_Market==0
prtest Sell_0JustYungay==Sell_0JustCanchan
prtest Sell_0JustCanchan==Sell_0JustC_Y
prtest Sell_0JustYungay==Sell_0JustC_Y
//Yes
gen Sell_1JustYungay=0 if JustYungayorCanchan==1
replace Sell_1JustYungay=1 if JustYungayorCanchan==1 & HH_Sell_Potato_Market==1
gen Sell_1JustCanchan=0 if JustYungayorCanchan==2
replace Sell_1JustCanchan=1 if JustYungayorCanchan==2 & HH_Sell_Potato_Market==1
gen Sell_1JustC_Y=0 if JustYungayorboth==2
replace Sell_1JustC_Y=1 if JustYungayorboth==2 & HH_Sell_Potato_Market==1
prtest Sell_1JustYungay==Sell_1JustCanchan
prtest Sell_1JustCanchan==Sell_1JustC_Y
prtest Sell_1JustYungay==Sell_1JustC_Y

//Gender
```

```
bysort HHHeadGender: tab AllobservationsCY
//Male
gen Male_0JustYungay=0 if JustYungayorCanchan==1
replace Male_0JustYungay=1 if JustYungayorCanchan==1 & HHHeadGender==0
gen Male_0JustCanchan=0 if JustYungayorCanchan==2
replace Male_0JustCanchan=1 if JustYungayorCanchan==2 &HHHeadGender==0
gen Male_0JustC_Y=0 if JustYungayorboth==2
replace Male_0JustC_Y=1 if JustYungayorboth==2 & HHHeadGender==0
prtest Male_0JustYungay==Male_0JustCanchan
prtest Male_0JustCanchan==Male_0JustC_Y
prtest Male_0JustYungay==Male_0JustC_Y
//Female
gen Male_1JustYungay=0 if JustYungayorCanchan==1
replace Male_1JustYungay=1 if JustYungayorCanchan==1 & HHHeadGender==1
gen Male_1JustCanchan=0 if JustYungayorCanchan==2
replace Male_1JustCanchan=1 if JustYungayorCanchan==2 & HHHeadGender==1
gen Male_1JustC_Y=0 if JustYungayorboth==2
replace Male_1JustC_Y=1 if JustYungayorboth==2 & HHHeadGender==1
prtest Male_1JustYungay==Male_1JustCanchan
prtest Male_1JustCanchan==Male_1JustC_Y
prtest Male_1JustYungay==Male_1JustC_Y

//Planted Improved from Informal Seed System
bysort PlantedImproveseedFromInformal: tab AllobservationsCY
//NO
gen Informal_0JustYungay=0 if JustYungayorCanchan==1
replace Informal_0JustYungay=1 if JustYungayorCanchan==1 &
PlantedImproveseedFromInformal==0
gen Informal_0JustCanchan=0 if JustYungayorCanchan==2
replace Informal_0JustCanchan=1 if JustYungayorCanchan==2 &
PlantedImproveseedFromInformal==0
gen Informal_0JustC_Y=0 if JustYungayorboth==2
replace Informal_0JustC_Y=1 if JustYungayorboth==2 & PlantedImproveseedFromInformal==0
prtest Informal_0JustYungay==Informal_0JustCanchan
prtest Informal_0JustCanchan==Informal_0JustC_Y
prtest Informal_0JustYungay==Informal_0JustC_Y
//Yes
gen Informal_1JustYungay=0 if JustYungayorCanchan==1
replace Informal_1JustYungay=1 if JustYungayorCanchan==1 &
PlantedImproveseedFromInformal==1
gen Informal_1JustCanchan=0 if JustYungayorCanchan==2
replace Informal_1JustCanchan=1 if JustYungayorCanchan==2 &
PlantedImproveseedFromInformal==1
gen Informal_1JustC_Y=0 if JustYungayorboth==2
replace Informal_1JustC_Y=1 if JustYungayorboth==2 & PlantedImproveseedFromInformal==1
prtest Informal_1JustYungay==Informal_1JustCanchan
```

```
prtest Informal_1JustCanchan==Informal_1JustC_Y
prtest Informal_1JustYungay==Informal_1JustC_Y

//Asset Index
bysort AssetIndex: tab AllobservationsCY
//1
gen Asset_1JustYungay=0 if JustYungayorCanchan==1
replace Asset_1JustYungay=1 if JustYungayorCanchan==1 & AssetIndex==1
gen Asset_1JustCanchan=0 if JustYungayorCanchan==2
replace Asset_1JustCanchan=1 if JustYungayorCanchan==2 & AssetIndex==1
gen Asset_1JustC_Y=0 if JustYungayorboth==2
replace Asset_1JustC_Y=1 if JustYungayorboth==2 & AssetIndex==1
prtest Asset_1JustYungay==Asset_1JustCanchan
prtest Asset_1JustCanchan==Asset_1JustC_Y
prtest Asset_1JustYungay==Asset_1JustC_Y
//2
gen Asset_2JustYungay=0 if JustYungayorCanchan==1
replace Asset_2JustYungay=1 if JustYungayorCanchan==1 & AssetIndex==2
gen Asset_2JustCanchan=0 if JustYungayorCanchan==2
replace Asset_2JustCanchan=1 if JustYungayorCanchan==2 & AssetIndex==2
gen Asset_2JustC_Y=0 if JustYungayorboth==2
replace Asset_2JustC_Y=1 if JustYungayorboth==2 & AssetIndex==2
prtest Asset_2JustYungay==Asset_2JustCanchan
prtest Asset_2JustCanchan==Asset_2JustC_Y
prtest Asset_2JustYungay==Asset_2JustC_Y
//3
gen Asset_3JustYungay=0 if JustYungayorCanchan==1
replace Asset_3JustYungay=1 if JustYungayorCanchan==1 & AssetIndex==3
gen Asset_3JustCanchan=0 if JustYungayorCanchan==2
replace Asset_3JustCanchan=1 if JustYungayorCanchan==2 & AssetIndex==3
gen Asset_3JustC_Y=0 if JustYungayorboth==2
replace Asset_3JustC_Y=1 if JustYungayorboth==2 & AssetIndex==3
prtest Asset_3JustYungay==Asset_3JustCanchan
prtest Asset_3JustCanchan==Asset_3JustC_Y
prtest Asset_3JustYungay==Asset_3JustC_Y
//4
gen Asset_4JustYungay=0 if JustYungayorCanchan==1
replace Asset_4JustYungay=1 if JustYungayorCanchan==1 & AssetIndex==4
gen Asset_4JustCanchan=0 if JustYungayorCanchan==2
replace Asset_4JustCanchan=1 if JustYungayorCanchan==2 & AssetIndex==4
gen Asset_4JustC_Y=0 if JustYungayorboth==2
replace Asset_4JustC_Y=1 if JustYungayorboth==2 & AssetIndex==4
prtest Asset_4JustYungay==Asset_4JustCanchan
prtest Asset_4JustCanchan==Asset_4JustC_Y
prtest Asset_4JustYungay==Asset_4JustC_Y
//5
```

```
gen Asset_5JustYungay=0 if JustYungayorCanchan==1
replace Asset_5JustYungay=1 if JustYungayorCanchan==1 & AssetIndex==5
gen Asset_5JustCanchan=0 if JustYungayorCanchan==2
replace Asset_5JustCanchan=1 if JustYungayorCanchan==2 & AssetIndex==5
gen Asset_5JustC_Y=0 if JustYungayorboth==2
replace Asset_5JustC_Y=1 if JustYungayorboth==2 & AssetIndex==5
prtest Asset_5JustYungay==Asset_5JustCanchan
prtest Asset_5JustCanchan==Asset_5JustC_Y
prtest Asset_5JustYungay==Asset_5JustC_Y

*Table 11: Farmers who dis-adopt Yungay, Canchan, or Canchan and Yungay in FIAs
gen JustDYungayorCanchan=1 if DisadoptionYungayA==1 & DisadoptionCanchanA==0
replace JustDYungayorCanchan=1 if DisadoptionYungayA==1 & DisadoptionCanchanA==.
replace JustDYungayorCanchan=2 if DisadoptionYungayA==0 & DisadoptionCanchanA==1
replace JustDYungayorCanchan=2 if DisadoptionYungayA==. & DisadoptionCanchanA==1
gen JustDYungayorBoth=1 if DisadoptionYungayA==1 & DisadoptionCanchanA==0
replace JustDYungayorBoth=1 if DisadoptionYungayA==1 & DisadoptionCanchanA==.
replace JustDYungayorBoth=2 if DisadoptionYungayA==1 & DisadoptionCanchanA==1
//Medium/Low
gen VIAFFN_0JustYungayD=0 if JustDYungayorCanchan==1
replace VIAFFN_0JustYungayD=1 if JustDYungayorCanchan==1 & NewVP_65Category==0
gen VIAFFN_0JustCanchanD=0 if JustDYungayorCanchan==2
replace VIAFFN_0JustCanchanD=1 if JustDYungayorCanchan==2 & NewVP_65Category==0
gen DVIAFFN_0JustC_Y=0 if JustDYungayorBoth==2
replace DVIAFFN_0JustC_Y=1 if JustDYungayorBoth==2 & NewVP_65Category==0
gen NumberobsDCY=.
replace NumberobsDCY=1 if JustDYungayorCanchan==2 | JustDYungayorBoth==2 |
JustDYungayorBoth==1
prtest VIAFFN_0JustYungayD==VIAFFN_0JustCanchanD
prtest VIAFFN_0JustCanchanD==DVIAFFN_0JustC_Y
prtest VIAFFN_0JustYungayD==DVIAFFN_0JustC_Y
//High
gen VIAFFN_1JustYungayD=0 if JustDYungayorCanchan==1
replace VIAFFN_1JustYungayD=1 if JustDYungayorCanchan==1 & NewVP_65Category==1
gen VIAFFN_1JustCanchanD=0 if JustDYungayorCanchan==2
replace VIAFFN_1JustCanchanD=1 if JustDYungayorCanchan==2 & NewVP_65Category==1
gen DVIAFFN_1JustC_Y=0 if JustDYungayorBoth==2
replace DVIAFFN_1JustC_Y=1 if JustDYungayorBoth==2 & NewVP_65Category==1
prtest VIAFFN_1JustYungayD==VIAFFN_1JustCanchanD
prtest VIAFFN_1JustCanchanD==DVIAFFN_1JustC_Y
prtest VIAFFN_1JustYungayD==DVIAFFN_1JustC_Y
//Very High
gen VIAFFN_2JustYungayD=0 if JustDYungayorCanchan==1
replace VIAFFN_2JustYungayD=1 if JustDYungayorCanchan==1 & NewVP_65Category==2
gen VIAFFN_2JustCanchanD=0 if JustDYungayorCanchan==2
replace VIAFFN_2JustCanchanD=1 if JustDYungayorCanchan==2 & NewVP_65Category==2
```

```
gen DVIAFFN_2JustC_Y=0 if JustDYungayorBoth==2
replace DVIAFFN_2JustC_Y=1 if JustDYungayorBoth==2 & NewVP_65Category==2
prtest VIAFFN_2JustYungayD==VIAFFN_2JustCanchanD
prtest VIAFFN_2JustCanchanD==DVIAFFN_2JustC_Y
prtest VIAFFN_2JustYungayD==DVIAFFN_2JustC_Y


*Table 12: Household characteristics for farmers who adopt Yungay, Amarilis, or Amarilis and
Yungay
gen JustYungayorAmarilis=1 if EverplantedYungayA==1 & EverplantedAmarilisA==0
replace JustYungayorAmarilis=2 if EverplantedYungayA==0 & EverplantedAmarilisA==1
gen JustYungayorbothA=1 if EverplantedYungayA==1 & EverplantedAmarilisA==0
replace JustYungayorbothA=2 if EverplantedYungayA==1 & EverplantedAmarilisA==1
gen JustAmarilisorboth=1 if EverplantedYungayA==0 & EverplantedAmarilisA==1
replace JustAmarilisorboth=2 if EverplantedYungayA==1 & EverplantedAmarilisA==1
gen AllobservationsAY=.
replace AllobservationsAY=1 if JustAmarilisorboth==1 |JustAmarilisorboth==2
|JustYungayorAmarilis==1

//Land, Elevation, Distance to Experiment Station
ttest Total_Land_Ha, by(JustYungayorAmarilis)
ttest Total_Land_Ha, by(JustAmarilisorboth)
ttest Total_Land_Ha, by(JustYungayorbothA)
ttest Household_Elevation, by(JustYungayorAmarilis)
ttest Household_Elevation, by(JustAmarilisorboth)
ttest Household_Elevation, by(JustYungayorbothA)
ttest DistancetoES, by(JustYungayorAmarilis)
ttest DistancetoES, by(JustAmarilisorboth)
ttest DistancetoES, by(JustYungayorbothA)

//Age
bysort Age_HHHead_cat: tab AllobservationsAY
//Group 0
gen Age_0JustYungayA=0 if JustYungayorAmarilis==1
replace Age_0JustYungayA=1 if JustYungayorAmarilis==1 & Age_HHHead_cat==0
gen Age_0JustAmarilis=0 if JustYungayorAmarilis==2
replace Age_0JustAmarilis=1 if JustYungayorAmarilis==2 & Age_HHHead_cat==0
gen Age_0JustA_Y=0 if JustYungayorbothA==2
replace Age_0JustA_Y=1 if JustYungayorbothA==2 & Age_HHHead_cat==0
prtest Age_0JustYungayA==Age_0JustAmarilis
prtest Age_0JustAmarilis==Age_0JustA_Y
prtest Age_0JustYungayA==Age_0JustA_Y
//Group 1
gen Age_1JustYungayA=0 if JustYungayorAmarilis==1
replace Age_1JustYungayA=1 if JustYungayorAmarilis==1 & Age_HHHead_cat==1
gen Age_1JustAmarilis=0 if JustYungayorAmarilis==2
```

```
replace Age_1JustAmarilis=1 if JustYungayorAmarilis==2 & Age_HHHead_cat==1
gen Age_1JustA_Y=0 if JustYungayorbothA==2
replace Age_1JustA_Y=1 if JustYungayorbothA==2 & Age_HHHead_cat==1
prtest Age_1JustYungayA==Age_1JustAmarilis
prtest Age_1JustAmarilis==Age_1JustA_Y
prtest Age_1JustYungayA==Age_1JustA_Y
//Group 2
gen Age_2JustYungayA=0 if JustYungayorAmarilis==1
replace Age_2JustYungayA=1 if JustYungayorAmarilis==1 & Age_HHHead_cat==2
gen Age_2JustAmarilis=0 if JustYungayorAmarilis==2
replace Age_2JustAmarilis=1 if JustYungayorAmarilis==2 & Age_HHHead_cat==2
gen Age_2JustA_Y=0 if JustYungayorbothA==2
replace Age_2JustA_Y=1 if JustYungayorbothA==2 & Age_HHHead_cat==2
prtest Age_2JustYungayA==Age_2JustAmarilis
prtest Age_2JustAmarilis==Age_2JustA_Y
prtest Age_2JustYungay==Age_2JustA_Y
//Group 3
gen Age_3JustYungayA=0 if JustYungayorAmarilis==1
replace Age_3JustYungayA=1 if JustYungayorAmarilis==1 & Age_HHHead_cat==3
gen Age_3JustAmarilis=0 if JustYungayorAmarilis==2
replace Age_3JustAmarilis=1 if JustYungayorAmarilis==2 & Age_HHHead_cat==3
gen Age_3JustA_Y=0 if JustYungayorbothA==2
replace Age_3JustA_Y=1 if JustYungayorbothA==2 & Age_HHHead_cat==3
prtest Age_3JustYungayA==Age_3JustAmarilis
prtest Age_3JustAmarilis==Age_3JustA_Y
prtest Age_3JustYungayA==Age_3JustA_Y

//Education
bysort HHHead_Education_Cat: tab AllobservationsAY
//Group 0
gen Edu_0JustYungayA=0 if JustYungayorAmarilis==1
replace Edu_0JustYungayA=1 if JustYungayorAmarilis==1 & HHHead_Education_Cat==0
gen Edu_0JustAmarilis=0 if JustYungayorAmarilis==2
replace Edu_0JustAmarilis=1 if JustYungayorAmarilis==2 & HHHead_Education_Cat==0
gen Edu_0JustA_Y=0 if JustYungayorbothA==2
replace Edu_0JustA_Y=1 if JustYungayorbothA==2 & HHHead_Education_Cat==0
prtest Edu_0JustYungayA==Edu_0JustAmarilis
prtest Edu_0JustAmarilis==Edu_0JustA_Y
prtest Edu_0JustYungayA==Edu_0JustA_Y
//Group 1
gen Edu_1JustYungayA=0 if JustYungayorAmarilis==1
replace Edu_1JustYungayA=1 if JustYungayorAmarilis==1 & HHHead_Education_Cat==1
gen Edu_1JustAmarilis=0 if JustYungayorAmarilis==2
replace Edu_1JustAmarilis=1 if JustYungayorAmarilis==2 & HHHead_Education_Cat==1
gen Edu_1JustA_Y=0 if JustYungayorbothA==2
replace Edu_1JustA_Y=1 if JustYungayorbothA==2 & HHHead_Education_Cat==1
```

```
prtest Edu_1JustYungayA==Edu_1JustAmarilis
prtest Edu_1JustAmarilis==Edu_1JustA_Y
prtest Edu_1JustYungayA==Edu_1JustA_Y
//Group 2
gen Edu_2JustYungayA=0 if JustYungayorAmarilis==1
replace Edu_2JustYungayA=1 if JustYungayorAmarilis==1 & HHHead_Education_Cat==2
gen Edu_2JustAmarilis=0 if JustYungayorAmarilis==2
replace Edu_2JustAmarilis=1 if JustYungayorAmarilis==2 & HHHead_Education_Cat==2
gen Edu_2JustA_Y=0 if JustYungayorbothA==2
replace Edu_2JustA_Y=1 if JustYungayorbothA==2 & HHHead_Education_Cat==2
prtest Edu_2JustYungayA==Edu_2JustAmarilis
prtest Edu_2JustAmarilis==Edu_2JustA_Y
prtest Edu_2JustYungayA==Edu_2JustA_Y
//Group 3
gen Edu_3JustYungayA=0 if JustYungayorAmarilis==1
replace Edu_3JustYungayA=1 if JustYungayorAmarilis==1 & HHHead_Education_Cat==3
gen Edu_3JustAmarilis=0 if JustYungayorAmarilis==2
replace Edu_3JustAmarilis=1 if JustYungayorAmarilis==2 & HHHead_Education_Cat==3
gen Edu_3JustA_Y=0 if JustYungayorbothA==2
replace Edu_3JustA_Y=1 if JustYungayorbothA==2 & HHHead_Education_Cat==3
prtest Edu_3JustYungayA==Edu_3JustAmarilis
prtest Edu_3JustAmarilis==Edu_3JustA_Y
prtest Edu_3JustYungayA==Edu_3JustA_Y

//VIAFFNN
bysort NewVP_65Category: tab AllobservationsAY
//Medium/Low
gen VIAFFN_0JustYungayA=0 if JustYungayorAmarilis==1
replace VIAFFN_0JustYungayA=1 if JustYungayorAmarilis==1 & NewVP_65Category==0
gen VIAFFN_0JustAmarilis=0 if JustYungayorAmarilis==2
replace VIAFFN_0JustAmarilis=1 if JustYungayorAmarilis==2 & NewVP_65Category==0
gen VIAFFN_0JustA_Y=0 if JustYungayorbothA==2
replace VIAFFN_0JustA_Y=1 if JustYungayorbothA==2 & NewVP_65Category==0
prtest VIAFFN_0JustYungayA==VIAFFN_0JustAmarilis
prtest VIAFFN_0JustAmarilis==VIAFFN_0JustA_Y
prtest VIAFFN_0JustYungayA==VIAFFN_0JustA_Y
//High
gen VIAFFN_1JustYungayA=0 if JustYungayorAmarilis==1
replace VIAFFN_1JustYungayA=1 if JustYungayorAmarilis==1 & NewVP_65Category==1
gen VIAFFN_1JustAmarilis=0 if JustYungayorAmarilis==2
replace VIAFFN_1JustAmarilis=1 if JustYungayorAmarilis==2 & NewVP_65Category==1
gen VIAFFN_1JustA_Y=0 if JustYungayorbothA==2
replace VIAFFN_1JustA_Y=1 if JustYungayorbothA==2 & NewVP_65Category==1
prtest VIAFFN_1JustYungayA==VIAFFN_1JustAmarilis
prtest VIAFFN_1JustAmarilis==VIAFFN_1JustA_Y
prtest VIAFFN_1JustYungayA==VIAFFN_1JustA_Y
```

```
//Very High
gen VIAFFN_2JustYungayA=0 if JustYungayorAmarilis==1
replace VIAFFN_2JustYungayA=1 if JustYungayorAmarilis==1 & NewVP_65Category==2
gen VIAFFN_2JustAmarilis=0 if JustYungayorAmarilis==2
replace VIAFFN_2JustAmarilis=1 if JustYungayorAmarilis==2 & NewVP_65Category==2
gen VIAFFN_2JustA_Y=0 if JustYungayorbothA==2
replace VIAFFN_2JustA_Y=1 if JustYungayorbothA==2 & NewVP_65Category==2
prtest VIAFFN_2JustYungayA==VIAFFN_2JustAmarilis
prtest VIAFFN_2JustAmarilis==VIAFFN_2JustA_Y
prtest VIAFFN_2JustYungayA==VIAFFN_2JustA_Y

//Sell Potatoes on Market
bysort HH_Sell_Potato_Market: tab AllobservationsAY
//No
gen Sell_0JustYungayA=0 if JustYungayorAmarilis==1
replace Sell_0JustYungayA=1 if JustYungayorAmarilis==1 & HH_Sell_Potato_Market==0
gen Sell_0JustAmarilis=0 if JustYungayorAmarilis==2
replace Sell_0JustAmarilis=1 if JustYungayorAmarilis==2 & HH_Sell_Potato_Market==0
gen Sell_0JustA_Y=0 if JustYungayorbothA==2
replace Sell_0JustA_Y=1 if JustYungayorbothA==2 & HH_Sell_Potato_Market==0
prtest Sell_0JustYungayA==Sell_0JustAmarilis
prtest Sell_0JustAmarilis==Sell_0JustA_Y
prtest Sell_0JustYungayA==Sell_0JustA_Y
//Yes
gen Sell_1JustYungayA=0 if JustYungayorAmarilis==1
replace Sell_1JustYungayA=1 if JustYungayorAmarilis==1 & HH_Sell_Potato_Market==1
gen Sell_1JustAmarilis=0 if JustYungayorAmarilis==2
replace Sell_1JustAmarilis=1 if JustYungayorAmarilis==2 & HH_Sell_Potato_Market==1
gen Sell_1JustA_Y=0 if JustYungayorbothA==2
replace Sell_1JustA_Y=1 if JustYungayorbothA==2 & HH_Sell_Potato_Market==1
prtest Sell_1JustYungayA==Sell_1JustAmarilis
prtest Sell_1JustAmarilis==Sell_1JustA_Y
prtest Sell_1JustYungayA==Sell_1JustA_Y


//Gender
bysort HHHeadGender: tab AllobservationsAY
//Male
gen Male_0JustYungayA=0 if JustYungayorAmarilis==1
replace Male_0JustYungayA=1 if JustYungayorAmarilis==1 & HHHeadGender==0
gen Male_0JustAmarilis=0 if JustYungayorAmarilis==2
replace Male_0JustAmarilis=1 if JustYungayorAmarilis==2 &HHHeadGender==0
gen Male_0JustA_Y=0 if JustYungayorbothA==2
replace Male_0JustA_Y=1 if JustYungayorbothA==2 & HHHeadGender==0
prtest Male_0JustYungayA==Male_0JustAmarilis
prtest Male_0JustAmarilis==Male_0JustA_Y
```

```
prtest Male_0JustYungayA==Male_0JustA_Y
//Female
gen Male_1JustYungayA=0 if JustYungayorAmarilis==1
replace Male_1JustYungayA=1 if JustYungayorAmarilis==1 & HHHeadGender==1
gen Male_1JustAmarilis=0 if JustYungayorAmarilis==2
replace Male_1JustAmarilis=1 if JustYungayorAmarilis==2 & HHHeadGender==1
gen Male_1JustA_Y=0 if JustYungayorbothA==2
replace Male_1JustA_Y=1 if JustYungayorbothA==2 & HHHeadGender==1
prtest Male_1JustYungayA==Male_1JustAmarilis
prtest Male_1JustAmarilis==Male_1JustA_Y
prtest Male_1JustYungayA==Male_1JustA_Y

//Planted Improved from Informal Seed System
bysort PlantedImproveseedFromInformal: tab AllobservationsAY
//NO
gen Informal_0JustYungayA=0 if JustYungayorAmarilis==1
replace Informal_0JustYungayA=1 if JustYungayorAmarilis==1 &
PlantedImproveseedFromInformal==0
gen Informal_0JustAmarilis=0 if JustYungayorAmarilis==2
replace Informal_0JustAmarilis=1 if JustYungayorAmarilis==2 &
PlantedImproveseedFromInformal==0
gen Informal_0JustA_Y=0 if JustYungayorbothA==2
replace Informal_0JustA_Y=1 if JustYungayorbothA==2 &
PlantedImproveseedFromInformal==0
prtest Informal_0JustYungayA==Informal_0JustAmarilis
prtest Informal_0JustAmarilis==Informal_0JustA_Y
prtest Informal_0JustYungayA==Informal_0JustA_Y
//Yes
gen Informal_1JustYungayA=0 if JustYungayorAmarilis==1
replace Informal_1JustYungayA=1 if JustYungayorAmarilis==1 &
PlantedImproveseedFromInformal==1
gen Informal_1JustAmarilis=0 if JustYungayorAmarilis==2
replace Informal_1JustAmarilis=1 if JustYungayorAmarilis==2 &
PlantedImproveseedFromInformal==1
gen Informal_1JustA_Y=0 if JustYungayorbothA==2
replace Informal_1JustA_Y=1 if JustYungayorbothA==2 &
PlantedImproveseedFromInformal==1
prtest Informal_1JustYungayA==Informal_1JustAmarilis
prtest Informal_1JustAmarilis==Informal_1JustA_Y
prtest Informal_1JustYungayA==Informal_1JustA_Y

//Asset Index
bysort AssetIndex: tab AllobservationsAY
//1
gen Asset_1JustYungayA=0 if JustYungayorAmarilis==1
replace Asset_1JustYungayA=1 if JustYungayorAmarilis==1 & AssetIndex==1
```

```
gen Asset_1JustAmarilis=0 if JustYungayorAmarilis==2
replace Asset_1JustAmarilis=1 if JustYungayorAmarilis==2 & AssetIndex==1
gen Asset_1JustA_Y=0 if JustYungayorbothA==2
replace Asset_1JustA_Y=1 if JustYungayorbothA==2 & AssetIndex==1
prtest Asset_1JustYungayA==Asset_1JustAmarilis
prtest Asset_1JustAmarilis==Asset_1JustA_Y
prtest Asset_1JustYungayA==Asset_1JustA_Y
//2
gen Asset_2JustYungayA=0 if JustYungayorAmarilis==1
replace Asset_2JustYungayA=1 if JustYungayorAmarilis==1 & AssetIndex==2
gen Asset_2JustAmarilis=0 if JustYungayorAmarilis==2
replace Asset_2JustAmarilis=1 if JustYungayorAmarilis==2 & AssetIndex==2
gen Asset_2JustA_Y=0 if JustYungayorbothA==2
replace Asset_2JustA_Y=1 if JustYungayorbothA==2 & AssetIndex==2
prtest Asset_2JustYungayA==Asset_2JustAmarilis
prtest Asset_2JustAmarilis==Asset_2JustA_Y
prtest Asset_2JustYungayA==Asset_2JustA_Y
//3
gen Asset_3JustYungayA=0 if JustYungayorAmarilis==1
replace Asset_3JustYungayA=1 if JustYungayorAmarilis==1 & AssetIndex==3
gen Asset_3JustAmarilis=0 if JustYungayorAmarilis==2
replace Asset_3JustAmarilis=1 if JustYungayorAmarilis==2 & AssetIndex==3
gen Asset_3JustA_Y=0 if JustYungayorbothA==2
replace Asset_3JustA_Y=1 if JustYungayorbothA==2 & AssetIndex==3
prtest Asset_3JustYungayA==Asset_3JustAmarilis
prtest Asset_3JustAmarilis==Asset_3JustA_Y
prtest Asset_3JustYungayA==Asset_3JustA_Y
//4
gen Asset_4JustYungayA=0 if JustYungayorAmarilis==1
replace Asset_4JustYungayA=1 if JustYungayorAmarilis==1 & AssetIndex==4
gen Asset_4JustAmarilis=0 if JustYungayorAmarilis==2
replace Asset_4JustAmarilis=1 if JustYungayorAmarilis==2 & AssetIndex==4
gen Asset_4JustA_Y=0 if JustYungayorbothA==2
replace Asset_4JustA_Y=1 if JustYungayorbothA==2 & AssetIndex==4
prtest Asset_4JustYungayA==Asset_4JustAmarilis
prtest Asset_4JustAmarilis==Asset_4JustA_Y
prtest Asset_4JustYungayA==Asset_4JustA_Y
//5
gen Asset_5JustYungayA=0 if JustYungayorAmarilis==1
replace Asset_5JustYungayA=1 if JustYungayorAmarilis==1 & AssetIndex==5
gen Asset_5JustAmarilis=0 if JustYungayorAmarilis==2
replace Asset_5JustAmarilis=1 if JustYungayorAmarilis==2 & AssetIndex==5
gen Asset_5JustA_Y=0 if JustYungayorbothA==2
replace Asset_5JustA_Y=1 if JustYungayorbothA==2 & AssetIndex==5
prtest Asset_5JustYungayA==Asset_5JustAmarilis
prtest Asset_5JustAmarilis==Asset_5JustA_Y
```

```
prtest Asset_5JustYungayA==Asset_5JustA_Y


*Table 13: Farmers who dis-adopt Yungay, Amarilis, or Amarilis and Yungay in FIAs
//Yungay & Amarilis
gen JustDYungayorAmarilis=1 if DisadoptionYungayA==1 & DisadoptionAmarilisA==0
replace JustDYungayorAmarilis=1 if DisadoptionYungayA==1 & DisadoptionAmarilisA==.
replace JustDYungayorAmarilis=2 if DisadoptionYungayA==0 & DisadoptionAmarilisA==1
replace JustDYungayorAmarilis=2 if DisadoptionYungayA==. & DisadoptionAmarilisA==1
gen JustDYungayorBothA=1 if DisadoptionYungayA==1 & DisadoptionAmarilisA==0
replace JustDYungayorBothA=1 if DisadoptionYungayA==1 & DisadoptionAmarilisA==.
replace JustDYungayorBothA=2 if DisadoptionYungayA==1 & DisadoptionAmarilisA==1
gen NumberobsDAYA=.
replace NumberobsDAYA=1 if JustDYungayorAmarilis==2 | JustDYungayorBothA==2 |
JustDYungayorBothA==1
//Medium/Low
gen VIAFFN_0JustYungayDA=0 if JustDYungayorAmarilis==1
replace VIAFFN_0JustYungayDA=1 if JustDYungayorAmarilis==1 & NewVP_65Category==0
gen VIAFFN_0JustAmarilisD=0 if JustDYungayorAmarilis==2
replace VIAFFN_0JustAmarilisD=1 if JustDYungayorAmarilis==2 & NewVP_65Category==0
gen DVIAFFN_0JustA_Y=0 if JustDYungayorBothA==2
replace DVIAFFN_0JustA_Y=1 if JustDYungayorBothA==2 & NewVP_65Category==0
prtest VIAFFN_0JustYungayDA==VIAFFN_0JustAmarilisD
prtest VIAFFN_0JustAmarilisD==DVIAFFN_0JustA_Y
prtest VIAFFN_0JustYungayDA==DVIAFFN_0JustA_Y
//High
gen VIAFFN_1JustYungayDA=0 if JustDYungayorAmarilis==1
replace VIAFFN_1JustYungayDA=1 if JustDYungayorAmarilis==1 & NewVP_65Category==1
gen VIAFFN_1JustAmarilisDA=0 if JustDYungayorAmarilis==2
replace VIAFFN_1JustAmarilisDA=1 if JustDYungayorAmarilis==2 &
NewVP_65Category==1
gen DVIAFFN_1JustA_Y=0 if JustDYungayorBothA==2
replace DVIAFFN_1JustA_Y=1 if JustDYungayorBothA==2 & NewVP_65Category==1
prtest VIAFFN_1JustYungayDA==VIAFFN_1JustAmarilisD
prtest VIAFFN_1JustAmarilisDA==DVIAFFN_1JustA_Y
prtest VIAFFN_1JustYungayDA==DVIAFFN_1JustA_Y
//Very High
gen VIAFFN_2JustYungayDA=0 if JustDYungayorAmarilis==1
replace VIAFFN_2JustYungayDA=1 if JustDYungayorAmarilis==1 & NewVP_65Category==2
gen VIAFFN_2JustAmarilisDA=0 if JustDYungayorAmarilis==2
replace VIAFFN_2JustAmarilisDA=1 if JustDYungayorAmarilis==2 &
NewVP_65Category==2
gen DVIAFFN_2JustA_Y=0 if JustDYungayorBothA==2
replace DVIAFFN_2JustA_Y=1 if JustDYungayorBothA==2 & NewVP_65Category==2
prtest VIAFFN_2JustYungayDA==VIAFFN_2JustAmarilisD
prtest VIAFFN_2JustAmarilisDA==DVIAFFN_2JustA_Y
```

```
prtest VIAFFN_2JustYungayDA==DVIAFFN_2JustA_Y

*Table 14: Household characteristics for farmers who adopt Yungay, OVs, or OVs and Yungay
gen JustYungayorOVs=1 if EverplantedYungayA==1 & EverplantedOVsA==0
replace JustYungayorOVs=2 if EverplantedYungayA==0 & EverplantedOVsA==1
gen JustYungayorbothO=1 if EverplantedYungayA==1 & EverplantedOVsA==0
replace JustYungayorbothO=2 if EverplantedYungayA==1 & EverplantedOVsA==1
gen JustOVsorboth=1 if EverplantedYungayA==0 & EverplantedOVsA==1
replace  JustOVsorboth=2 if EverplantedYungayA==1 & EverplantedOVsA==1
gen AllobservationsOY=.
replace AllobservationsOY=1 if JustOVsorboth==1 |JustOVsorboth==2 |JustYungayorOVs==1

//Land, Elevation, Distance to Experiment Station
ttest Total_Land_Ha, by(JustYungayorOVs)
ttest Total_Land_Ha, by(JustOVsorboth)
ttest Total_Land_Ha, by(JustYungayorbothO)
ttest Household_Elevation, by(JustYungayorOVs)
ttest Household_Elevation, by(JustOVsorboth)
ttest Household_Elevation, by(JustYungayorbothO)
ttest DistancetoES, by(JustYungayorOVs)
ttest DistancetoES, by(JustOVsorboth)
ttest DistancetoES, by(JustYungayorbothO)

//Age
bysort Age_HHHead_cat: tab AllobservationsOY
//Group 0
gen Age_0JustYungayO=0 if JustYungayorOVs==1
replace Age_0JustYungayO=1 if JustYungayorOVs==1 & Age_HHHead_cat==0
gen Age_0JustOVs=0 if JustYungayorOVs==2
replace Age_0JustOVs=1 if JustYungayorOVs==2 & Age_HHHead_cat==0
gen Age_0JustO_Y=0 if JustYungayorbothO==2
replace Age_0JustO_Y=1 if JustYungayorbothO==2 & Age_HHHead_cat==0
prtest Age_0JustYungayO==Age_0JustOVs
prtest Age_0JustOVs==Age_0JustO_Y
prtest Age_0JustYungayO==Age_0JustO_Y
//Group 1
gen Age_1JustYungayO=0 if JustYungayorOVs==1
replace Age_1JustYungayO=1 if JustYungayorOVs==1 & Age_HHHead_cat==1
gen Age_1JustOVs=0 if JustYungayorOVs==2
replace Age_1JustOVs=1 if JustYungayorOVs==2 & Age_HHHead_cat==1
gen Age_1JustO_Y=0 if JustYungayorbothO==2
replace Age_1JustO_Y=1 if JustYungayorbothO==2 & Age_HHHead_cat==1
prtest Age_1JustYungayO==Age_1JustOVs
prtest Age_1JustOVs==Age_1JustO_Y
prtest Age_1JustYungayO==Age_1JustO_Y
//Group 2
```

```
gen Age_2JustYungayO=0 if JustYungayorOVs==1
replace Age_2JustYungayO=1 if JustYungayorOVs==1 & Age_HHHead_cat==2
gen Age_2JustOVs=0 if JustYungayorOVs==2
replace Age_2JustOVs=1 if JustYungayorOVs==2 & Age_HHHead_cat==2
gen Age_2JustO_Y=0 if JustYungayorbothO==2
replace Age_2JustO_Y=1 if JustYungayorbothO==2 & Age_HHHead_cat==2
prtest Age_2JustYungayO==Age_2JustOVs
prtest Age_2JustOVs==Age_2JustO_Y
prtest Age_2JustYungay==Age_2JustO_Y
//Group 3
gen Age_3JustYungayO=0 if JustYungayorOVs==1
replace Age_3JustYungayO=1 if JustYungayorOVs==1 & Age_HHHead_cat==3
gen Age_3JustOVs=0 if JustYungayorOVs==2
replace Age_3JustOVs=1 if JustYungayorOVs==2 & Age_HHHead_cat==3
gen Age_3JustO_Y=0 if JustYungayorbothO==2
replace Age_3JustO_Y=1 if JustYungayorbothO==2 & Age_HHHead_cat==3
prtest Age_3JustYungayO==Age_3JustOVs
prtest Age_3JustOVs==Age_3JustO_Y
prtest Age_3JustYungayO==Age_3JustO_Y

//Education
bysort HHHead_Education_Cat: tab AllobservationsOY
//Group 0
gen Edu_0JustYungayO=0 if JustYungayorOVs==1
replace Edu_0JustYungayO=1 if JustYungayorOVs==1 & HHHead_Education_Cat==0
gen Edu_0JustOVs=0 if JustYungayorOVs==2
replace Edu_0JustOVs=1 if JustYungayorOVs==2 & HHHead_Education_Cat==0
gen Edu_0JustO_Y=0 if JustYungayorbothO==2
replace Edu_0JustO_Y=1 if JustYungayorbothO==2 & HHHead_Education_Cat==0
prtest Edu_0JustYungayO==Edu_0JustOVs
prtest Edu_0JustOVs==Edu_0JustO_Y
prtest Edu_0JustYungayO==Edu_0JustO_Y
//Group 1
gen Edu_1JustYungayO=0 if JustYungayorOVs==1
replace Edu_1JustYungayO=1 if JustYungayorOVs==1 & HHHead_Education_Cat==1
gen Edu_1JustOVs=0 if JustYungayorOVs==2
replace Edu_1JustOVs=1 if JustYungayorOVs==2 & HHHead_Education_Cat==1
gen Edu_1JustO_Y=0 if JustYungayorbothO==2
replace Edu_1JustO_Y=1 if JustYungayorbothO==2 & HHHead_Education_Cat==1
prtest Edu_1JustYungayO==Edu_1JustOVs
prtest Edu_1JustOVs==Edu_1JustO_Y
prtest Edu_1JustYungayO==Edu_1JustO_Y
//Group 2
gen Edu_2JustYungayO=0 if JustYungayorOVs==1
replace Edu_2JustYungayO=1 if JustYungayorOVs==1 & HHHead_Education_Cat==2
gen Edu_2JustOVs=0 if JustYungayorOVs==2
```

```
replace Edu_2JustOVs=1 if JustYungayorOVs==2 & HHHead_Education_Cat==2
gen Edu_2JustO_Y=0 if JustYungayorbothO==2
replace Edu_2JustO_Y=1 if JustYungayorbothO==2 & HHHead_Education_Cat==2
prtest Edu_2JustYungayO==Edu_2JustOVs
prtest Edu_2JustOVs==Edu_2JustO_Y
prtest Edu_2JustYungayO==Edu_2JustO_Y
//Group 3
gen Edu_3JustYungayO=0 if JustYungayorOVs==1
replace Edu_3JustYungayO=1 if JustYungayorOVs==1 & HHHead_Education_Cat==3
gen Edu_3JustOVs=0 if JustYungayorOVs==2
replace Edu_3JustOVs=1 if JustYungayorOVs==2 & HHHead_Education_Cat==3
gen Edu_3JustO_Y=0 if JustYungayorbothO==2
replace Edu_3JustO_Y=1 if JustYungayorbothO==2 & HHHead_Education_Cat==3
prtest Edu_3JustYungayO==Edu_3JustOVs
prtest Edu_3JustOVs==Edu_3JustO_Y
prtest Edu_3JustYungayO==Edu_3JustO_Y

//VIAFFNN
bysort NewVP_65Category: tab AllobservationsOY
//Medium/Low
gen VIAFFN_0JustYungayO=0 if JustYungayorOVs==1
replace VIAFFN_0JustYungayO=1 if JustYungayorOVs==1 & NewVP_65Category==0
gen VIAFFN_0JustOVs=0 if JustYungayorOVs==2
replace VIAFFN_0JustOVs=1 if JustYungayorOVs==2 & NewVP_65Category==0
gen VIAFFN_0JustO_Y=0 if JustYungayorbothO==2
replace VIAFFN_0JustO_Y=1 if JustYungayorbothO==2 & NewVP_65Category==0
prtest VIAFFN_0JustYungayO==VIAFFN_0JustOVs
prtest VIAFFN_0JustOVs==VIAFFN_0JustO_Y
prtest VIAFFN_0JustYungayO==VIAFFN_0JustO_Y
//High
gen VIAFFN_1JustYungayO=0 if JustYungayorOVs==1
replace VIAFFN_1JustYungayO=1 if JustYungayorOVs==1 & NewVP_65Category==1
gen VIAFFN_1JustOVs=0 if JustYungayorOVs==2
replace VIAFFN_1JustOVs=1 if JustYungayorOVs==2 & NewVP_65Category==1
gen VIAFFN_1JustO_Y=0 if JustYungayorbothO==2
replace VIAFFN_1JustO_Y=1 if JustYungayorbothO==2 & NewVP_65Category==1
prtest VIAFFN_1JustYungayO==VIAFFN_1JustOVs
prtest VIAFFN_1JustOVs==VIAFFN_1JustO_Y
prtest VIAFFN_1JustYungayO==VIAFFN_1JustO_Y
//Very High
gen VIAFFN_2JustYungayO=0 if JustYungayorOVs==1
replace VIAFFN_2JustYungayO=1 if JustYungayorOVs==1 & NewVP_65Category==2
gen VIAFFN_2JustOVs=0 if JustYungayorOVs==2
replace VIAFFN_2JustOVs=1 if JustYungayorOVs==2 & NewVP_65Category==2
gen VIAFFN_2JustO_Y=0 if JustYungayorbothO==2
replace VIAFFN_2JustO_Y=1 if JustYungayorbothO==2 & NewVP_65Category==2
```

```
prtest VIAFFN_2JustYungayO==VIAFFN_2JustOVs
prtest VIAFFN_2JustOVs==VIAFFN_2JustO_Y
prtest VIAFFN_2JustYungayO==VIAFFN_2JustO_Y

//Sell Potatoes on Market
bysort HH_Sell_Potato_Market: tab AllobservationsOY
//No
gen Sell_0JustYungayO=0 if JustYungayorOVs==1
replace Sell_0JustYungayO=1 if JustYungayorOVs==1 & HH_Sell_Potato_Market==0
gen Sell_0JustOVs=0 if JustYungayorOVs==2
replace Sell_0JustOVs=1 if JustYungayorOVs==2 & HH_Sell_Potato_Market==0
gen Sell_0JustO_Y=0 if JustYungayorbothO==2
replace Sell_0JustO_Y=1 if JustYungayorbothO==2 & HH_Sell_Potato_Market==0
prtest Sell_0JustYungayO==Sell_0JustOVs
prtest Sell_0JustOVs==Sell_0JustO_Y
prtest Sell_0JustYungayO==Sell_0JustO_Y
//Yes
gen Sell_1JustYungayO=0 if JustYungayorOVs==1
replace Sell_1JustYungayO=1 if JustYungayorOVs==1 & HH_Sell_Potato_Market==1
gen Sell_1JustOVs=0 if JustYungayorOVs==2
replace Sell_1JustOVs=1 if JustYungayorOVs==2 & HH_Sell_Potato_Market==1
gen Sell_1JustO_Y=0 if JustYungayorbothO==2
replace Sell_1JustO_Y=1 if JustYungayorbothO==2 & HH_Sell_Potato_Market==1
prtest Sell_1JustYungayO==Sell_1JustOVs
prtest Sell_1JustOVs==Sell_1JustO_Y
prtest Sell_1JustYungayO==Sell_1JustO_Y

//Gender
bysort HHHeadGender: tab AllobservationsOY
//Male
gen Male_0JustYungayO=0 if JustYungayorOVs==1
replace Male_0JustYungayO=1 if JustYungayorOVs==1 & HHHeadGender==0
gen Male_0JustOVs=0 if JustYungayorOVs==2
replace Male_0JustOVs=1 if JustYungayorOVs==2 &HHHeadGender==0
gen Male_0JustO_Y=0 if JustYungayorbothO==2
replace Male_0JustO_Y=1 if JustYungayorbothO==2 & HHHeadGender==0
prtest Male_0JustYungayO==Male_0JustOVs
prtest Male_0JustOVs==Male_0JustO_Y
prtest Male_0JustYungayO==Male_0JustO_Y
//Female
gen Male_1JustYungayO=0 if JustYungayorOVs==1
replace Male_1JustYungayO=1 if JustYungayorOVs==1 & HHHeadGender==1
gen Male_1JustOVs=0 if JustYungayorOVs==2
replace Male_1JustOVs=1 if JustYungayorOVs==2 & HHHeadGender==1
gen Male_1JustO_Y=0 if JustYungayorbothO==2
replace Male_1JustO_Y=1 if JustYungayorbothO==2 & HHHeadGender==1
```

```
prtest Male_1JustYungayO==Male_1JustOVs
prtest Male_1JustOVs==Male_1JustO_Y
prtest Male_1JustYungayO==Male_1JustO_Y


//Planted Improved from Informal Seed System
bysort PlantedImproveseedFromInformal: tab AllobservationsOY
//NO
gen Informal_0JustYungayO=0 if JustYungayorOVs==1
replace Informal_0JustYungayO=1 if JustYungayorOVs==1 &
PlantedImproveseedFromInformal==0
gen Informal_0JustOVs=0 if JustYungayorOVs==2
replace Informal_0JustOVs=1 if JustYungayorOVs==2 & PlantedImproveseedFromInformal==0
gen Informal_0JustO_Y=0 if JustYungayorbothO==2
replace Informal_0JustO_Y=1 if JustYungayorbothO==2 &
PlantedImproveseedFromInformal==0
prtest Informal_0JustYungayO==Informal_0JustOVs
prtest Informal_0JustOVs==Informal_0JustO_Y
prtest Informal_0JustYungayO==Informal_0JustO_Y
//Yes
gen Informal_1JustYungayO=0 if JustYungayorOVs==1
replace Informal_1JustYungayO=1 if JustYungayorOVs==1 &
PlantedImproveseedFromInformal==1
gen Informal_1JustOVs=0 if JustYungayorOVs==2
replace Informal_1JustOVs=1 if JustYungayorOVs==2 & PlantedImproveseedFromInformal==1
gen Informal_1JustO_Y=0 if JustYungayorbothO==2
replace Informal_1JustO_Y=1 if JustYungayorbothO==2 &
PlantedImproveseedFromInformal==1
prtest Informal_1JustYungayO==Informal_1JustOVs
prtest Informal_1JustOVs==Informal_1JustO_Y
prtest Informal_1JustYungayO==Informal_1JustO_Y

//Asset Index
bysort AssetIndex: tab AllobservationsOY
//1
gen Asset_1JustYungayO=0 if JustYungayorOVs==1
replace Asset_1JustYungayO=1 if JustYungayorOVs==1 & AssetIndex==1
gen Asset_1JustOVs=0 if JustYungayorOVs==2
replace Asset_1JustOVs=1 if JustYungayorOVs==2 & AssetIndex==1
gen Asset_1JustO_Y=0 if JustYungayorbothO==2
replace Asset_1JustO_Y=1 if JustYungayorbothO==2 & AssetIndex==1
prtest Asset_1JustYungayO==Asset_1JustOVs
prtest Asset_1JustOVs==Asset_1JustO_Y
prtest Asset_1JustYungayO==Asset_1JustO_Y
//2
gen Asset_2JustYungayO=0 if JustYungayorOVs==1
```

```
replace Asset_2JustYungayO=1 if JustYungayorOVs==1 & AssetIndex==2
gen Asset_2JustOVs=0 if JustYungayorOVs==2
replace Asset_2JustOVs=1 if JustYungayorOVs==2 & AssetIndex==2
gen Asset_2JustO_Y=0 if JustYungayorbothO==2
replace Asset_2JustO_Y=1 if JustYungayorbothO==2 & AssetIndex==2
prtest Asset_2JustYungayO==Asset_2JustOVs
prtest Asset_2JustOVs==Asset_2JustO_Y
prtest Asset_2JustYungayO==Asset_2JustO_Y
//3
gen Asset_3JustYungayO=0 if JustYungayorOVs==1
replace Asset_3JustYungayO=1 if JustYungayorOVs==1 & AssetIndex==3
gen Asset_3JustOVs=0 if JustYungayorOVs==2
replace Asset_3JustOVs=1 if JustYungayorOVs==2 & AssetIndex==3
gen Asset_3JustO_Y=0 if JustYungayorbothO==2
replace Asset_3JustO_Y=1 if JustYungayorbothO==2 & AssetIndex==3
prtest Asset_3JustYungayO==Asset_3JustOVs
prtest Asset_3JustOVs==Asset_3JustO_Y
prtest Asset_3JustYungayO==Asset_3JustO_Y
//4
gen Asset_4JustYungayO=0 if JustYungayorOVs==1
replace Asset_4JustYungayO=1 if JustYungayorOVs==1 & AssetIndex==4
gen Asset_4JustOVs=0 if JustYungayorOVs==2
replace Asset_4JustOVs=1 if JustYungayorOVs==2 & AssetIndex==4
gen Asset_4JustO_Y=0 if JustYungayorbothO==2
replace Asset_4JustO_Y=1 if JustYungayorbothO==2 & AssetIndex==4
prtest Asset_4JustYungayO==Asset_4JustOVs
prtest Asset_4JustOVs==Asset_4JustO_Y
prtest Asset_4JustYungayO==Asset_4JustO_Y
//5
gen Asset_5JustYungayO=0 if JustYungayorOVs==1
replace Asset_5JustYungayO=1 if JustYungayorOVs==1 & AssetIndex==5
gen Asset_5JustOVs=0 if JustYungayorOVs==2
replace Asset_5JustOVs=1 if JustYungayorOVs==2 & AssetIndex==5
gen Asset_5JustO_Y=0 if JustYungayorbothO==2
replace Asset_5JustO_Y=1 if JustYungayorbothO==2 & AssetIndex==5
prtest Asset_5JustYungayO==Asset_5JustOVs
prtest Asset_5JustOVs==Asset_5JustO_Y
prtest Asset_5JustYungayO==Asset_5JustO_Y

*Table 15: Farmers who Dis-adopt Yungay, OVs, or OVs and yungay in FIAs
gen JustDYungayorOVs=1 if DisadoptionYungayA==1 & DisadoptionOVsA==0
replace JustDYungayorOVs=1 if DisadoptionYungayA==1 & DisadoptionOVsA==.
replace JustDYungayorOVs=2 if DisadoptionYungayA==0 & DisadoptionOVsA==1
replace JustDYungayorOVs=2 if DisadoptionYungayA==. & DisadoptionOVsA==1
gen JustDYungayorBothO=1 if DisadoptionYungayA==1 & DisadoptionOVsA==0
replace JustDYungayorBothO=1 if DisadoptionYungayA==1 & DisadoptionOVsA==.
```

```
replace JustDYungayorBothO=2 if DisadoptionYungayA==1 & DisadoptionOVsA==1
gen NumberobsDOY=.
replace NumberobsDOY=1 if JustDYungayorOVs==2 | JustDYungayorBothO==2 |
JustDYungayorBothO==1
//Medium/Low
gen VIAFFN_0JustYungayDO=0 if JustDYungayorOVs==1
replace VIAFFN_0JustYungayDO=1 if JustDYungayorOVs==1 & NewVP_65Category==0
gen VIAFFN_0JustOVsD=0 if JustDYungayorOVs==2
replace VIAFFN_0JustOVsD=1 if JustDYungayorOVs==2 & NewVP_65Category==0
gen DVIAFFN_0JustO_Y=0 if JustDYungayorBothO==2
replace DVIAFFN_0JustO_Y=1 if JustDYungayorBothO==2 & NewVP_65Category==0
prtest VIAFFN_0JustYungayDO==VIAFFN_0JustOVsD
prtest VIAFFN_0JustOVsD==DVIAFFN_0JustO_Y
prtest VIAFFN_0JustYungayDO==DVIAFFN_0JustO_Y
//High
gen VIAFFN_1JustYungayDO=0 if JustDYungayorOVs==1
replace VIAFFN_1JustYungayDO=1 if JustDYungayorOVs==1 & NewVP_65Category==1
gen VIAFFN_1JustOVsDO=0 if JustDYungayorOVs==2
replace VIAFFN_1JustOVsDO=1 if JustDYungayorOVs==2 & NewVP_65Category==1
gen DVIAFFN_1JustO_Y=0 if JustDYungayorBothO==2
replace DVIAFFN_1JustO_Y=1 if JustDYungayorBothO==2 & NewVP_65Category==1
prtest VIAFFN_1JustYungayDO==VIAFFN_1JustOVsD
prtest VIAFFN_1JustOVsDO==DVIAFFN_1JustO_Y
prtest VIAFFN_1JustYungayDO==DVIAFFN_1JustO_Y
//Very High
gen VIAFFN_2JustYungayDO=0 if JustDYungayorOVs==1
replace VIAFFN_2JustYungayDO=1 if JustDYungayorOVs==1 & NewVP_65Category==2
gen VIAFFN_2JustOVsDO=0 if JustDYungayorOVs==2
replace VIAFFN_2JustOVsDO=1 if JustDYungayorOVs==2 & NewVP_65Category==2
gen DVIAFFN_2JustO_Y=0 if JustDYungayorBothO==2
replace DVIAFFN_2JustO_Y=1 if JustDYungayorBothO==2 & NewVP_65Category==2
prtest VIAFFN_2JustYungayDO==VIAFFN_2JustOVsD
prtest VIAFFN_2JustOVsDO==DVIAFFN_2JustO_Y
prtest VIAFFN_2JustYungayDO==DVIAFFN_2JustO_Y


*Table 16: Heckman Probit Results All Improved (Besides Yungay)
. heckprob DisadoptionOVsAC  c.Age_HHHead##c.Age_HHHead
i.HHHead_Education_Cat_PostDefense Social_Network Total_Land_Ha i.AssetIndex
HHHeadGender i.RegionalPostDefense i.HH_Sell_Potato_Market DistancetoES
Household_Elevation  AvailabilityDistrictOVsAC i.NewVP_65Category,select
(EverplantedOVsAC = c.Age_HHHead##c.Age_HHHead
i.HHHead_Education_Cat_PostDefense Social_Network Total_Land_Ha  i.AssetIndex
HHHeadGender i.HH_Sell_Potato_Market DistancetoES i.RegionalPostDefense
Household_Elevation  AvailabilityDistrictOVsAC i.NewVP_65Category
i.PlantedImproveseedFromInformal) vce (cluster Cluster)
```

```
Fitting probit model:

Iteration 0:   log pseudolikelihood = -463.40493
Iteration 1:   log pseudolikelihood = -432.01336
Iteration 2:   log pseudolikelihood =  -431.6623
Iteration 3:   log pseudolikelihood = -431.66228

Fitting selection model:

Iteration 0:   log pseudolikelihood =  -574.0696
Iteration 1:   log pseudolikelihood = -464.55435
Iteration 2:   log pseudolikelihood = -462.42661
Iteration 3:   log pseudolikelihood = -462.41769
Iteration 4:   log pseudolikelihood = -462.41769

Fitting starting values:

Iteration 0:   log pseudolikelihood = -579.47104
Iteration 1:   log pseudolikelihood = -432.81878
Iteration 2:   log pseudolikelihood = -431.45494
Iteration 3:   log pseudolikelihood = -431.45055
Iteration 4:   log pseudolikelihood = -431.45055

Fitting full model:

Iteration 0:   log pseudolikelihood = -894.04935  (not concave)
Iteration 1:   log pseudolikelihood = -893.93552
Iteration 2:   log pseudolikelihood = -893.81363
Iteration 3:   log pseudolikelihood =  -893.8062
Iteration 4:   log pseudolikelihood = -893.80469
Iteration 5:   log pseudolikelihood = -893.80467

Probit model with sample selection              Number of obs     =      1,078
                                                Censored obs      =        242
                                                Uncensored obs    =        836

                                                Wald chi2(19)     =      52.21
Log pseudolikelihood = -893.8047                Prob > chi2       =     0.0001

                                 (Std. Err. adjusted for 115 clusters in Cluster)
---------------------------------------------------------------------------------
                                |               Robust
                                |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------------------------+------------------------------------------------
DisadoptionOVsAC                |
```

Age_HHHead | -.0120511 .0204797 -0.59 0.556 -.0521905 .0280883
|
c.Age_HHHead#c.Age_HHHead | .0001069 .0002423 0.44 0.659 -
.000368 .0005818
|
HHHead_Education_Cat_PostDefense |
Some of Primary | -.2157231 .1732552 -1.25 0.213 -.555297 .1238509
Secondary and above | -.16415 .1717729 -0.96 0.339 -.5008188 .1725188
|
Social_Network | -.0159746 .0277631 -0.58 0.565 -.0703894 .0384402
Total_Land_Ha | -.0058522 .0107755 -0.54 0.587 -.0269719 .0152675
|
AssetIndex |
2 | -.1482163 .215932 -0.69 0.492 -.5714353 .2750026
3 | -.2309141 .1800947 -1.28 0.200 -.5838933 .1220651
4 | -.2221337 .1971596 -1.13 0.260 -.6085593 .164292
5 | -.3774785 .2058847 -1.83 0.067 -.781005 .0260481
|
HHHeadGender | -.0549494 .2080087 -0.26 0.792 -.462639 .3527403
|
RegionalPostDefense |
2 | -.1033586 .7731484 -0.13 0.894 -1.618702 1.411984
3 | -.843453 .7912921 -1.07 0.286 -2.394357 .7074509
|
1.HH_Sell_Potato_Market | -.1727777 .2750693 -0.63 0.530 -.7119037 .3663482
DistancetoES | .0024905 .0006998 3.56 0.000 .001119 .0038621
Household_Elevation | .000019 .0002881 0.07 0.947 -.0005456 .0005836
AvailabilityDistrictOVsAC | -.0073219 .0246379 -0.30 0.766 -.0556112 .0409674
|
NewVP_65Category |
High Vulnerability | -.2631873 .2600241 -1.01 0.311 -.7728251 .2464505
Very High Vulnerability | -.4086872 .3290826 -1.24 0.214 -1.053677 .2363029
|
_cons | .5580015 2.543859 0.22 0.826 -4.42787 5.543874
--------------------------------+--
EverplantedOVsAC |
Age_HHHead | .0206701 .0181689 1.14 0.255 -.0149404 .0562805
|
c.Age_HHHead#c.Age_HHHead | -.0002628 .0001841 -1.43 0.153 -
.0006236 .000098
|
HHHead_Education_Cat_PostDefense |
Some of Primary | .0712556 .1921963 0.37 0.711 -.3054423 .4479534
Secondary and above | .040132 .2030312 0.20 0.843 -.3578018 .4380658
|
Social_Network | .0357272 .0232425 1.54 0.124 -.0098273 .0812818

```
              Total_Land_Ha |  -.001685   .0125722    -0.13   0.893    -.0263261     .022956
                            |
                 AssetIndex |
                          2 |  -.0943897   .1517824    -0.62   0.534    -.3918779    .2030984
                          3 |   .2807554   .1481684     1.89   0.058    -.0096494    .5711601
                          4 |   .2275619   .1799522     1.26   0.206    -.1251379    .5802617
                          5 |   .1157133   .1734244     0.67   0.505    -.2241922    .4556188
                            |
               HHHeadGender |  -.1474473   .1602374    -0.92   0.357    -.4615069    .1666123
     1.HH_Sell_Potato_Market |   .4159603   .1277261     3.26   0.001     .1656218    .6662988
               DistancetoES |  -.0011985   .0006386    -1.88   0.061    -.0024502    .0000532
                            |
         RegionalPostDefense |
                          2 |   .7325999   .1726735     4.24   0.000     .3941661    1.071034
                          3 |   1.149466   .2088483     5.50   0.000      .740131    1.558801
                            |
         Household_Elevation |   .0001967   .0001889     1.04   0.298    -.0001736     .000567
    AvailabilityDistrictOVsAC |   .0307101   .0079388     3.87   0.000     .0151504    .0462699
                            |
            NewVP_65Category |
          High Vulnerability  |  -.0002095   .1800935    -0.00   0.999    -.3531862    .3527672
     Very High Vulnerability  |  -.0277854   .1993922    -0.14   0.889     -.418587    .3630162
                            |
1.PlantedImproveseedFromInformal |   .2148436   .1119669     1.92   0.055    -
.0046075    .4342947
                      _cons |  -1.646266   .8389808    -1.96   0.050    -3.290638   -.0018941
-------------------------------+----------------------------------------------------------------
                    /athrho |  -.7061574    2.15377    -0.33   0.743    -4.927469    3.515154
-------------------------------+----------------------------------------------------------------
                        rho |  -.6082616   1.356914                      -.999895    .9982322
------------------------------------------------------------------------------------------------
Wald test of indep. eqns. (rho = 0): chi2(1) =     0.11   Prob > chi2 = 0.7430

. margins, dydx(*) predict (psel)

Average marginal effects                        Number of obs     =      1,078
Model VCE    : Robust

Expression   : Pr(EverplantedOVsAC), predict(psel)
dy/dx w.r.t. : Age_HHHead 2.HHHead_Education_Cat_PostDefense
3.HHHead_Education_Cat_PostDefense
               Social_Network Total_Land_Ha 2.AssetIndex 3.AssetIndex 4.AssetIndex 5.AssetIndex
HHHeadGender
               2.RegionalPostDefense 3.RegionalPostDefense 1.HH_Sell_Potato_Market
DistancetoES
```

```
            Household_Elevation AvailabilityDistrictOVsAC 1.NewVP_65Category
2.NewVP_65Category
            1.PlantedImproveseedFromInformal

------------------------------------------------------------------------------
                             |            Delta-method
                             |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-----------------------------+------------------------------------------------
                 Age_HHHead |  -.0009428   .0009871    -0.96   0.339    -.0028775    .0009918
                             |
HHHead_Education_Cat_PostDefense |
           Some of Primary  |   .0172538   .0472355     0.37   0.715     -.075326    .1098336
        Secondary and above  |   .0098078   .0500352     0.20   0.845    -.0882594    .1078751
                             |
             Social_Network |   .0085949   .0055428     1.55   0.121    -.0022689    .0194586
              Total_Land_Ha |  -.0004054   .0030283    -0.13   0.894    -.0063407    .0055299
                             |
                 AssetIndex |
                          2  |   -.024928   .0398224    -0.63   0.531    -.1029784    .0531223
                          3  |    .066536   .0354339     1.88   0.060    -.0029131    .1359851
                          4  |   .0548463   .0426131     1.29   0.198    -.0286738    .1383665
                          5  |     .02885   .0430525     0.67   0.503    -.0555314    .1132314
                             |
               HHHeadGender |  -.0354712   .0384718    -0.92   0.357    -.1108745    .0399321
                             |
         RegionalPostDefense |
                          2  |   .2046779   .0498719     4.10   0.000     .1069308     .302425
                          3  |   .2763777   .0446529     6.19   0.000     .1888596    .3638957
                             |
     1.HH_Sell_Potato_Market |   .1040196   .0319074     3.26   0.001     .0414823     .166557
               DistancetoES |  -.0002883   .0001551    -1.86   0.063    -.0005924    .0000157
         Household_Elevation |   .0000473   .0000455     1.04   0.299    -.0000419    .0001365
   AvailabilityDistrictOVsAC |   .0073879   .0018361     4.02   0.000     .0037892    .0109866
                             |
           NewVP_65Category |
         High Vulnerability  |  -.0000501   .0431104    -0.00   0.999     -.084545    .0844447
    Very High Vulnerability  |  -.0067071   .0480158    -0.14   0.889    -.1008163     .087402
                             |
1.PlantedImproveseedFromInformal |   .0517835   .0265562     1.95   0.051    -
.0002658    .1038327
------------------------------------------------------------------------------
Note: dy/dx for factor levels is the discrete change from the base level.

. margins, dydx(*) predict (pcond)

Average marginal effects                       Number of obs     =      1,078
```

Model VCE : Robust

Expression : Pr(DisadoptionOVsAC=1|EverplantedOVsAC=1), predict(pcond)
dy/dx w.r.t. : Age_HHHead 2.HHHead_Education_Cat_PostDefense 3.HHHead_Education_Cat_PostDefense
Social_Network Total_Land_Ha 2.AssetIndex 3.AssetIndex 4.AssetIndex 5.AssetIndex HHHeadGender
2.RegionalPostDefense 3.RegionalPostDefense 1.HH_Sell_Potato_Market DistancetoES
Household_Elevation AvailabilityDistrictOVsAC 1.NewVP_65Category 2.NewVP_65Category
1.PlantedImproveseedFromInformal

	dy/dx	Delta-method Std. Err.	z	P>|z|	[95% Conf. Interval]	
Age_HHHead	-.0010879	.0013345	-0.82	0.415	-.0037035	.0015277
HHHead_Education_Cat_PostDefense						
Some of Primary	-.0655822	.0638805	-1.03	0.305	-.1907857	.0596213
Secondary and above	-.0519485	.0648062	-0.80	0.423	-.1789663	.0750693
Social_Network	-.0019145	.0063937	-0.30	0.765	-.014446	.0106169
Total_Land_Ha	-.0020473	.0032675	-0.63	0.531	-.0084514	.0043568
AssetIndex						
2	-.0606517	.0470481	-1.29	0.197	-.1528643	.0315608
3	-.0530235	.0501635	-1.06	0.291	-.1513421	.0452951
4	-.0546232	.0550074	-0.99	0.321	-.1624357	.0531892
5	-.1111158	.0540818	-2.05	0.040	-.2171141	-.0051174
HHHeadGender	-.0312153	.0489493	-0.64	0.524	-.1271542	.0647235
RegionalPostDefense						
2	.0417379	.081649	0.51	0.609	-.1182913	.201767
3	-.1420033	.0737057	-1.93	0.054	-.2864638	.0024572
1.HH_Sell_Potato_Market	-.0175437	.0401067	-0.44	0.662	-.0961514	.0610641
DistancetoES	.0006968	.0002124	3.28	0.001	.0002806	.001113
Household_Elevation	.0000241	.0000614	0.39	0.695	-.0000962	.0001443
AvailabilityDistrictOVsAC	.0004285	.0037082	0.12	0.908	-.0068394	.0076963
NewVP_65Category						
High Vulnerability	-.091235	.0655241	-1.39	0.164	-.21966	.0371899
Very High Vulnerability	-.1378479	.0641641	-2.15	0.032	-.2636072	-.0120886

|
1.PlantedImproveseedFromInformal | .019574 .0581136 0.34 0.736 -
.0943266 .1334745

*Table 17: Heckman Probit Results Yungay
heckprob DisadoptionYungayA c.Age_HHHead##c.Age_HHHead
i.HHHead_Education_Cat_PostDefense Social_Network Total_Land_Ha i.AssetIndex
HHHeadGender i.RegionalPostDefense i.HH_Sell_Potato_Market DistancetoES
Household_Elevation AvailabilityDistrictYungay i.NewVP_65Category,select
(EverplantedYungayA =
c.Age_HHHead##c.Age_HHHead i.HHHead_Education_Cat_PostDefense
Social_Network Total_Land_Ha i.AssetIndex HHHeadGender i.HH_Sell_Potato_Market
DistancetoES i.RegionalPostDefense Household_Elevation AvailabilityDistrictYungay
i.NewVP_65Category i.PlantedImproveseedFromInformal) vce (cluster Cluster)

Fitting probit model:

Iteration 0: log pseudolikelihood = -354.15003
Iteration 1: log pseudolikelihood = -323.61242
Iteration 2: log pseudolikelihood = -323.31632
Iteration 3: log pseudolikelihood = -323.31632

Fitting selection model:

Iteration 0: log pseudolikelihood = -742.93241
Iteration 1: log pseudolikelihood = -423.35916
Iteration 2: log pseudolikelihood = -421.61874
Iteration 3: log pseudolikelihood = -421.61682
Iteration 4: log pseudolikelihood = -421.61682

Fitting starting values:

Iteration 0: log pseudolikelihood = -406.87739
Iteration 1: log pseudolikelihood = -323.7613
Iteration 2: log pseudolikelihood = -323.31211
Iteration 3: log pseudolikelihood = -323.3118
Iteration 4: log pseudolikelihood = -323.3118

Fitting full model:

Iteration 0: log pseudolikelihood = -744.93242
Iteration 1: log pseudolikelihood = -744.9303
Iteration 2: log pseudolikelihood = -744.9303

Probit model with sample selection Number of obs = 1,078
Censored obs = 491

Uncensored obs = 587

Wald chi2(19) = 48.60

Log pseudolikelihood = -744.9303 Prob > chi2 = 0.0002

(Std. Err. adjusted for 115 clusters in Cluster)

	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
DisadoptionYungayA						
Age_HHHead	.0210317	.0260953	0.81	0.420	-.0301142	.0721776
c.Age_HHHead#c.Age_HHHead	-.0001507	.0002629	-0.57	0.567	-.0006659	.0003645
HHHead_Education_Cat_PostDefense						
Some of Primary	-.0779357	.2137712	-0.36	0.715	-.4969196	.3410481
Secondary and above	.068042	.2306222	0.30	0.768	-.3839692	.5200532
Social_Network	.0104196	.0177625	0.59	0.557	-.0243943	.0452336
Total_Land_Ha	.0036346	.0110361	0.33	0.742	-.0179958	.025265
AssetIndex						
2	.026232	.1822009	0.14	0.886	-.3308752	.3833392
3	.284698	.2010443	1.42	0.157	-.1093416	.6787377
4	-.2304467	.1968646	-1.17	0.242	-.6162942	.1554008
5	-.1159457	.2113073	-0.55	0.583	-.5301004	.298209
HHHeadGender	.0213405	.2087795	0.10	0.919	-.3878599	.4305409
RegionalPostDefense						
2	-.8426377	.4841315	-1.74	0.082	-1.791518	.1062426
3	-.3337525	.4333742	-0.77	0.441	-1.18315	.5156454
1.HH_Sell_Potato_Market	-.129352	.1674598	-0.77	0.440	-.4575673	.1988632
DistancetoES	.0026292	.0007293	3.61	0.000	.0011998	.0040586
Household_Elevation	.0005035	.0002343	2.15	0.032	.0000443	.0009628
AvailabilityDistrictYungay	.0221049	.0190595	1.16	0.246	-.0152511	.0594609
NewVP_65Category						
High Vulnerability	.3705696	.1745803	2.12	0.034	.0283984	.7127407
Very High Vulnerability	.1513794	.1901825	0.80	0.426	-.2213715	.5241304
_cons	-3.42384	1.634129	-2.10	0.036	-6.626675	-.2210058

```
EverplantedYungayA              |
                Age_HHHead |   .018015   .0201895     0.89   0.372    -.0215556    .0575856
                           |
      c.Age_HHHead#c.Age_HHHead |  -.0002313   .0002119    -1.09   0.275    -
.0006466    .0001839
                           |
HHHead_Education_Cat_PostDefense |
           Some of Primary  |    .110616    .183048     0.60   0.546    -.2481515    .4693835
        Secondary and above  |   .0590618    .207675     0.28   0.776    -.3479738    .4660973
                           |
             Social_Network |   .0232385   .0135369     1.72   0.086    -.0032933    .0497703
              Total_Land_Ha |   .0123989   .0087208     1.42   0.155    -.0046935    .0294913
                           |
                AssetIndex |
                         2  |   -.287356   .1723215    -1.67   0.095      -.6251    .0503881
                         3  |  -.2730247   .1522122    -1.79   0.073    -.5713551    .0253056
                         4  |   .1116829   .1675652     0.67   0.505    -.2167388    .4401046
                         5  |   .0173372   .1812668     0.10   0.924    -.3379392    .3726136
                           |
               HHHeadGender |    .186193   .1878694     0.99   0.322    -.1820243    .5544103
      1.HH_Sell_Potato_Market |   .1483731   .1340765     1.11   0.268    -.1144119    .4111581
               DistancetoES |  -.0012789   .0006784    -1.89   0.059    -.0026086    .0000508
                           |
          RegionalPostDefense |
                         2  |   1.295052   .2174617     5.96   0.000      .868835    1.721269
                         3  |   .7289443   .2210854     3.30   0.001     .2956248    1.162264
                           |
          Household_Elevation |  -.0002617   .0001875    -1.40   0.163    -.0006292    .0001058
    AvailabilityDistrictYungay |   .0514943   .0075048     6.86   0.000     .0367852    .0662033
                           |
           NewVP_65Category |
          High Vulnerability  |  -.0371934    .167432    -0.22   0.824    -.3653541    .2909673
     Very High Vulnerability  |   -.148714   .1955408    -0.76   0.447    -.5319669    .2345389
                           |
1.PlantedImproveseedFromInformal |   .0782219   .0995947     0.79   0.432    -
.1169801    .2734239
                      _cons |  -.9875105    .815844    -1.21   0.226    -2.586535    .6115144
--------------------------------+----------------------------------------------------------------
                    /athrho |  -.0392846   .5456704    -0.07   0.943    -1.108779     1.03021
--------------------------------+----------------------------------------------------------------
                        rho |  -.0392644   .5448292                     -.8036304    .7739924
-------------------------------------------------------------------------------------------------
Wald test of indep. eqns. (rho = 0): chi2(1) =     0.01   Prob > chi2 = 0.9426

. margins, dydx(*) predict (psel)
```

Average marginal effects Number of obs = 1,078
Model VCE : Robust

Expression : Pr(EverplantedYungayA), predict(psel)
dy/dx w.r.t. : Age_HHHead 2.HHHead_Education_Cat_PostDefense 3.HHHead_Education_Cat_PostDefense
Social_Network Total_Land_Ha 2.AssetIndex 3.AssetIndex 4.AssetIndex 5.AssetIndex HHHeadGender
2.RegionalPostDefense 3.RegionalPostDefense 1.HH_Sell_Potato_Market DistancetoES
Household_Elevation AvailabilityDistrictYungay 1.NewVP_65Category 2.NewVP_65Category
1.PlantedImproveseedFromInformal

	Delta-method dy/dx	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Age_HHHead	-.0007484	.0009208	-0.81	0.416	-.002553	.0010563
HHHead_Education_Cat_PostDefense						
Some of Primary	.0241043	.0402857	0.60	0.550	-.0548543	.1030629
Secondary and above	.0129217	.045659	0.28	0.777	-.0765683	.1024116
Social_Network	.0050504	.0029034	1.74	0.082	-.0006402	.010741
Total_Land_Ha	.0026947	.0018856	1.43	0.153	-.001001	.0063903
AssetIndex						
2	-.0629034	.0375916	-1.67	0.094	-.1365816	.0107747
3	-.0596978	.0331391	-1.80	0.072	-.1246492	.0052537
4	.0236179	.0355113	0.67	0.506	-.0459829	.0932188
5	.0036978	.0386404	0.10	0.924	-.072036	.0794316
HHHeadGender	.0404652	.0407046	0.99	0.320	-.0393144	.1202449
RegionalPostDefense						
2	.3735873	.0730953	5.11	0.000	.2303232	.5168515
3	.2167493	.0701425	3.09	0.002	.0792725	.354226
1.HH_Sell_Potato_Market	.032645	.0300803	1.09	0.278	-.0263113	.0916013
DistancetoES	-.0002779	.0001485	-1.87	0.061	-.0005689	.000013
Household_Elevation	-.0000569	.0000408	-1.40	0.163	-.0001368	.000023
AvailabilityDistrictYungay	.0111912	.0014065	7.96	0.000	.0084346	.0139479
NewVP_65Category						
High Vulnerability	-.0080379	.0361748	-0.22	0.824	-.0789393	.0628634

```
      Very High Vulnerability  |  -.0324276    .042531    -0.76   0.446    -.1157868    .0509316
                               |
1.PlantedImproveseedFromInformal |   .0171177   .0219179     0.78   0.435    -
.0258406    .0600761
------------------------------------------------------------------------------------------------
Note: dy/dx for factor levels is the discrete change from the base level.

. margins, dydx(*) predict (pcond)

Average marginal effects                    Number of obs     =      1,078
Model VCE    : Robust

Expression   : Pr(DisadoptionYungayA=1|EverplantedYungayA=1), predict(pcond)
dy/dx w.r.t. : Age_HHHead 2.HHHead_Education_Cat_PostDefense
3.HHHead_Education_Cat_PostDefense
             Social_Network Total_Land_Ha 2.AssetIndex 3.AssetIndex 4.AssetIndex 5.AssetIndex
HHHeadGender
             2.RegionalPostDefense 3.RegionalPostDefense 1.HH_Sell_Potato_Market
DistancetoES
             Household_Elevation AvailabilityDistrictYungay 1.NewVP_65Category
2.NewVP_65Category
             1.PlantedImproveseedFromInformal

------------------------------------------------------------------------------------------------
                               |            Delta-method
                               |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------------------------+----------------------------------------------------------------
                  Age_HHHead |   .0022164   .0014773     1.50   0.134    -.0006791     .005112
                               |
HHHead_Education_Cat_PostDefense |
            Some of Primary  |  -.0236586   .0677608    -0.35   0.727    -.1564672    .1091501
        Secondary and above  |   .0224322   .0744568     0.30   0.763    -.1235004    .1683648
                               |
              Social_Network |   .0035129    .005502     0.64   0.523    -.0072709    .0142966
               Total_Land_Ha |   .0012559   .0036115     0.35   0.728    -.0058225    .0083344
                               |
                  AssetIndex |
                          2  |   .0064692   .0558666     0.12   0.908    -.1030274    .1159658
                          3  |   .0952676    .065762     1.45   0.147    -.0336236    .2241587
                          4  |  -.0704294    .058869    -1.20   0.232    -.1858105    .0449517
                          5  |  -.0367123   .0666552    -0.55   0.582     -.167354    .0939294
                               |
                HHHeadGender |   .0081813   .0648182     0.13   0.900      -.11886    .1352226
                               |
         RegionalPostDefense |
                          2  |  -.2571676   .0777586    -3.31   0.001    -.4095715   -.1047636
```

```
                 3  |  -.1093685   .0985942    -1.11   0.267    -.3026097    .0838727
                    |
 1.HH_Sell_Potato_Market |  -.0407646   .0554271    -0.74   0.462    -.1493998    .0678706
          DistancetoES |   .0008356   .0002176     3.84   0.000     .0004091     .001262
    Household_Elevation |   .0001599   .0000725     2.20   0.027     .0000178    .0003021
AvailabilityDistrictYungay |    .007468   .0028685     2.60   0.009     .0018459    .0130901
                    |
       NewVP_65Category |
    High Vulnerability  |   .1171881   .0529906     2.21   0.027     .0133284    .2210479
 Very High Vulnerability  |    .044565   .0574215     0.78   0.438    -.0679791    .1571092
                    |
1.PlantedImproveseedFromInformal |   .0005565   .0080006     0.07   0.945    -
.0151244    .0162375
```

*Table 18 Heckman Probit Canchan
heckprob DisadoptionCanchanA c.Age_HHHead##c.Age_HHHead i.HHHead_Education_Cat_PostDefense Social_Network Total_Land_Ha i.AssetIndex HHHeadGender i.RegionalPostDefense i.HH_Sell_Potato_Market DistancetoES Household_Elevation AvailabilityDistrictCanchan i.NewVP_65Category,select (EverplantedCanchanA = c.Age_HHHead##c.Age_HHHead i.HHHead_Education_Cat_PostDefense Social_Network Total_Land_Ha i.AssetIndex HHHeadGender i.HH_Sell_Potato_Market DistancetoES i.RegionalPostDefense Household_Elevation AvailabilityDistrictCanchan i.NewVP_65Category i.PlantedImproveseedFromInformal) vce (cluster Cluster)

```
Fitting probit model:

Iteration 0:   log pseudolikelihood = -426.00272
Iteration 1:   log pseudolikelihood = -402.77832
Iteration 2:   log pseudolikelihood = -402.69318
Iteration 3:   log pseudolikelihood = -402.69317

Fitting selection model:

Iteration 0:   log pseudolikelihood = -735.59199
Iteration 1:   log pseudolikelihood = -667.04722
Iteration 2:   log pseudolikelihood = -666.88698
Iteration 3:   log pseudolikelihood = -666.88698

Fitting starting values:

Iteration 0:   log pseudolikelihood = -428.36496
Iteration 1:   log pseudolikelihood = -401.07344
Iteration 2:   log pseudolikelihood = -401.02164
Iteration 3:   log pseudolikelihood = -401.02164
```

```
Fitting full model:

Iteration 0:   log pseudolikelihood = -1219.2893
Iteration 1:   log pseudolikelihood = -1169.7252  (not concave)
Iteration 2:   log pseudolikelihood = -1081.4921  (not concave)
Iteration 3:   log pseudolikelihood = -1080.1463
Iteration 4:   log pseudolikelihood = -1068.2107  (not concave)
Iteration 5:   log pseudolikelihood = -1067.9688
Iteration 6:   log pseudolikelihood = -1067.5969
Iteration 7:   log pseudolikelihood = -1066.1458
Iteration 8:   log pseudolikelihood = -1065.0051
Iteration 9:   log pseudolikelihood =  -1064.843
Iteration 10:  log pseudolikelihood = -1064.8218
Iteration 11:  log pseudolikelihood = -1064.8156
Iteration 12:  log pseudolikelihood = -1064.8131
Iteration 13:  log pseudolikelihood = -1064.8128
Iteration 14:  log pseudolikelihood = -1064.8119
Iteration 15:  log pseudolikelihood = -1064.8116
Iteration 16:  log pseudolikelihood = -1064.8115  (backed up)
Iteration 17:  log pseudolikelihood = -1064.8115

Probit model with sample selection            Number of obs     =      1,078
                                              Censored obs      =        460
                                              Uncensored obs    =        618

                                              Wald chi2(19)     =      53.50
Log pseudolikelihood = -1064.812              Prob > chi2       =     0.0000

                                 (Std. Err. adjusted for 115 clusters in Cluster)
------------------------------------------------------------------------------
                              |               Robust
                              |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
------------------------------+-----------------------------------------------
DisadoptionCanchanA           |
                 Age_HHHead |  -.0039277   .0173672    -0.23   0.821    -.0379668    .0301113
                              |
      c.Age_HHHead#c.Age_HHHead |   .0000646   .0001821     0.35   0.723    -
.0002923    .0004215
                              |
HHHead_Education_Cat_PostDefense |
            Some of Primary  |  -.0599757   .1734379    -0.35   0.729    -.3999079    .2799564
         Secondary and above  |  -.1114373   .1684726    -0.66   0.508    -.4416376     .218763
                              |
               Social_Network |   .0050923   .0166599     0.31   0.760    -.0275605    .0377451
                Total_Land_Ha |  -.0172895   .0079351    -2.18   0.029    -.0328419    -.001737
                              |
```

AssetIndex						
2	-.0509093	.1430192	-0.36	0.722	-.3312217	.2294031
3	-.0736486	.1392093	-0.53	0.597	-.3464937	.1991966
4	-.0562681	.1355325	-0.42	0.678	-.3219069	.2093708
5	-.3045626	.1477667	-2.06	0.039	-.5941801	-.0149451
HHHeadGender	.203951	.140839	1.45	0.148	-.0720882	.4799903
RegionalPostDefense						
2	-.253057	.1472358	-1.72	0.086	-.5416338	.0355199
3	.3032683	.1662361	1.82	0.068	-.0225486	.6290851
1.HH_Sell_Potato_Market	-.0158639	.1099445	-0.14	0.885	-.2313512	.1996234
DistancetoES	.0007755	.0005767	1.34	0.179	-.0003547	.0019058
Household_Elevation	-.0003406	.0001661	-2.05	0.040	-.0006663	-.000015
AvailabilityDistrictCanchan	-.0147393	.0084856	-1.74	0.082	-.0313708	.0018921
NewVP_65Category						
High Vulnerability	-.0417748	.1519483	-0.27	0.783	-.3395881	.2560385
Very High Vulnerability	.0640521	.179309	0.36	0.721	-.2873871	.4154913
_cons	2.146262	.8782983	2.44	0.015	.4248289	3.867695
EverplantedCanchanA						
Age_HHHead	.0343531	.0184976	1.86	0.063	-.0019016	.0706078
c.Age_HHHead#c.Age_HHHead	-.0004089	.0001927	-2.12	0.034	-.0007866	-.0000313
HHHead_Education_Cat_PostDefense						
Some of Primary	-.1195275	.1800196	-0.66	0.507	-.4723595	.2333045
Secondary and above	.0183814	.1881681	0.10	0.922	-.3504212	.387184
Social_Network	.0125649	.0162145	0.77	0.438	-.0192149	.0443446
Total_Land_Ha	.0147761	.0084266	1.75	0.080	-.0017396	.0312918
AssetIndex						
2	.0369308	.1274014	0.29	0.772	-.2127714	.286633
3	.2354033	.1288464	1.83	0.068	-.017131	.4879376
4	.2929549	.1365441	2.15	0.032	.0253334	.5605764
5	.1762664	.1317824	1.34	0.181	-.0820224	.4345552
HHHeadGender	-.1609657	.1282153	-1.26	0.209	-.4122631	.0903317
1.HH_Sell_Potato_Market	.3285753	.1091833	3.01	0.003	.1145799	.5425706
DistancetoES	.0002474	.0005738	0.43	0.666	-.0008773	.0013722

```
          RegionalPostDefense |
                            2  |  .4890833   .1539538     3.18   0.001     .1873394    .7908272
                            3  |  -.1472844     .19906    -0.74   0.459    -.5374349     .242866
                               |
          Household_Elevation |   .0002196   .0001779     1.23   0.217     -.000129    .0005682
    AvailabilityDistrictCanchan |   .0156482   .0085588     1.83   0.068    -.0011267    .0324232
                               |
            NewVP_65Category |
          High Vulnerability  |  -.2334148   .1595128    -1.46   0.143    -.5460541    .0792246
       Very High Vulnerability  |  -.2161967   .1877209    -1.15   0.249    -.5841228    .1517295
                               |
1.PlantedImproveseedFromInformal
|   .1836603   .0658215     2.79   0.005     .0546525     .312668
                        _cons |  -1.969989   .9100837    -2.16   0.030     -3.75372   -.1862573
-------------------------------+----------------------------------------------------------------
                      /athrho |  -11.61931   .5539584   -20.98   0.000    -12.70505   -10.53357
-------------------------------+----------------------------------------------------------------
                          rho |         -1   1.79e-10                            -1          -1
------------------------------------------------------------------------------------------------
Wald test of indep. eqns. (rho = 0): chi2(1) =   439.95   Prob > chi2 = 0.0000

. margins, dydx(*) predict (psel)

Average marginal effects                    Number of obs     =      1,078
Model VCE    : Robust

Expression   : Pr(EverplantedCanchanA), predict(psel)
dy/dx w.r.t. : Age_HHHead 2.HHHead_Education_Cat_PostDefense
3.HHHead_Education_Cat_PostDefense
               Social_Network Total_Land_Ha 2.AssetIndex 3.AssetIndex 4.AssetIndex 5.AssetIndex
HHHeadGender
               2.RegionalPostDefense 3.RegionalPostDefense 1.HH_Sell_Potato_Market
DistancetoES
               Household_Elevation AvailabilityDistrictCanchan 1.NewVP_65Category
2.NewVP_65Category
               1.PlantedImproveseedFromInformal

------------------------------------------------------------------------------------------------
                               |            Delta-method
                               |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------------------------+----------------------------------------------------------------
                   Age_HHHead |  -.0011091   .0011779    -0.94   0.346    -.0034178    .0011995
                               |
HHHead_Education_Cat_PostDefense |
             Some of Primary  |  -.0422849   .0628189    -0.67   0.501    -.1654077     .080838
         Secondary and above  |   .0064311   .0659901     0.10   0.922    -.1229071    .1357694
```

```
                 |
   Social_Network |   .0044037    .005679     0.78   0.438    -.0067269    .0155343
    Total_Land_Ha |   .0051787   .0029372     1.76   0.078    -.0005781    .0109355
                 |
       AssetIndex |
               2  |  .0132696   .0458183     0.29   0.772    -.0765325    .1030718
               3  |  .0835883    .045583     1.83   0.067    -.0057528    .1729294
               4  |   .103466   .0479585     2.16   0.031     .0094691    .1974629
               5  |  .0628795   .0471175     1.33   0.182    -.0294692    .1552282
                 |
    HHHeadGender |  -.0564148   .0443892    -1.27   0.204    -.1434161    .0305865
                 |
RegionalPostDefense |
               2  |  .1753623   .0550238     3.19   0.001     .0675177     .283207
               3  | -.0550643   .0739596    -0.74   0.457    -.2000225    .0898939
                 |
1.HH_Sell_Potato_Market |   .1179348   .0391568     3.01   0.003     .0411889    .1946806
      DistancetoES |   .0000867    .000201     0.43   0.666    -.0003072    .0004807
Household_Elevation |    .000077   .0000621     1.24   0.215    -.0000448    .0001987
AvailabilityDistrictCanchan |   .0054843   .0029533     1.86   0.063     -.000304    .0112727
                 |
NewVP_65Category |
High Vulnerability  |  -.0812596    .0551081    -1.47   0.140    -.1892695    .0267503
Very High Vulnerability  |  -.0751434     .064648    -1.16   0.245    -.2018512    .0515644
                 |
1.PlantedImproveseedFromInformal
|   .0646598   .0231622     2.79   0.005     .0192627    .1100569
------------------------------------------------------------------------------------------------
Note: dy/dx for factor levels is the discrete change from the base level.


margins, dydx(*) predict (pcond)
Expression   : Pr(DisadoptionCanchanA=1|EverplantedCanchanA=1), predict(pcond)
dy/dx w.r.t. : Age_HHHead 2.HHHead_Education_Cat_PostDefense
3.HHHead_Education_Cat_PostDefense
             Social_Network Total_Land_Ha 2.AssetIndex 3.AssetIndex 4.AssetIndex 5.AssetIndex
HHHeadGender
             2.RegionalPostDefense 3.RegionalPostDefense 1.HH_Sell_Potato_Market
DistancetoES
             Household_Elevation AvailabilityDistrictCanchan 1.NewVP_65Category
2.NewVP_65Category
             1.PlantedImproveseedFromInformal

------------------------------------------------------------------------------------------------
                 |          Delta-method
                 |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
```

```
-------------------------------+------------------------------------------------------------
                  Age_HHHead |  -.0002115   .0337792    -0.01   0.995    -.0664174    .0659945
                             |
HHHead_Education_Cat_PostDefense |
             Some of Primary  |  -.0814594   .0764039    -1.07   0.286    -.2312082    .0682894
         Secondary and above  |   -.059086   .0741576    -0.80   0.426    -.2044322    .0862602
                             |
              Social_Network |   .0079203   .0127257     0.62   0.534    -.0170217    .0328622
               Total_Land_Ha |  -.0048333   .0373731    -0.13   0.897    -.0780833    .0684167
                             |
                  AssetIndex |
                          2  |  -.0167844   .0710611    -0.24   0.813    -.1560617    .1224929
                          3  |   .0454177   .0750038     0.61   0.545     -.101587    .1924225
                          4  |   .0740373   .0712632     1.04   0.299     -.065636    .2137106
                          5  |  -.1159433   .0711838    -1.63   0.103    -.2554611    .0235745
                             |
                HHHeadGender |    .062137   .4331041     0.14   0.886    -.7867314    .9110054
                             |
          RegionalPostDefense |
                          2  |   .0299988   .0640072     0.47   0.639     -.095453    .1554506
                          3  |   .1326463   .0757054     1.75   0.080    -.0157336    .2810263
                             |
       1.HH_Sell_Potato_Market |   .1205444   .0500198     2.41   0.016     .0225074    .2185814
                DistancetoES |   .0005664   .0005957     0.95   0.342    -.0006011    .0017338
          Household_Elevation |  -.0001227   .0006503    -0.19   0.850    -.0013973    .0011519
    AvailabilityDistrictCanchan |  -.0029485    .034857    -0.08   0.933    -.0712671      .06537
                             |
             NewVP_65Category |
          High Vulnerability  |  -.1095003   .0654556    -1.67   0.094     -.237791    .0187904
     Very High Vulnerability  |  -.0369317   .0749609    -0.49   0.622    -.1838523     .109989
                             |
1.PlantedImproveseedFromInformal
|   .0702241   .0241206     2.91   0.004     .0229485    .1174996
--------------------------------------------------------------------------------------------
Note: dy/dx for factor levels is the discrete change from the base level.
```

*Table 19 Heckman Probit Amarilis

```
 heckprob DisadoptionAmarilisA c.Age_HHHead##c.Age_HHHead
i.HHHead_Education_Cat_PostDefense Social_Network To
> tal_Land_Ha i.AssetIndex HHHeadGender i.RegionalPostDefense i.HH_Sell_Potato_Market
DistancetoES Household_El
> evation  AvailabilityDistrictAmarilis i.NewVP_65Category,select (EverplantedAmarilisA =
c.Age_HHHead##c.Age_H
> HHead i.HHHead_Education_Cat_PostDefense
Social_Network  Total_Land_Ha  i.AssetIndex HHHeadGender i.HH_Sell_P
```

```
> otato_Market DistancetoES i.RegionalPostDefense
Household_Elevation  AvailabilityDistrictAmarilis i.NewVP_65C
> ategory i.PlantedImproveseedFromInformal) vce (cluster Cluster)

Fitting probit model:

Iteration 0:   log pseudolikelihood = -187.20041
Iteration 1:   log pseudolikelihood = -161.22125
Iteration 2:   log pseudolikelihood = -160.90917
Iteration 3:   log pseudolikelihood = -160.90875
Iteration 4:   log pseudolikelihood = -160.90875

Fitting selection model:

Iteration 0:   log pseudolikelihood = -664.00804
Iteration 1:   log pseudolikelihood = -390.98657
Iteration 2:   log pseudolikelihood = -387.94994
Iteration 3:   log pseudolikelihood = -387.93507
Iteration 4:   log pseudolikelihood = -387.93507

Fitting starting values:

Iteration 0:   log pseudolikelihood = -228.73857
Iteration 1:   log pseudolikelihood = -161.07038
Iteration 2:   log pseudolikelihood = -160.06088
Iteration 3:   log pseudolikelihood = -160.05986
Iteration 4:   log pseudolikelihood = -160.05986

Fitting full model:

Iteration 0:   log pseudolikelihood = -554.67431
Iteration 1:   log pseudolikelihood = -549.47993  (not concave)
Iteration 2:   log pseudolikelihood = -549.21908
Iteration 3:   log pseudolikelihood = -548.47483  (not concave)
Iteration 4:   log pseudolikelihood = -548.46687
Iteration 5:   log pseudolikelihood = -548.41209
Iteration 6:   log pseudolikelihood = -548.27999
Iteration 7:   log pseudolikelihood = -548.24206
Iteration 8:   log pseudolikelihood = -548.21866
Iteration 9:   log pseudolikelihood = -548.21413
Iteration 10:  log pseudolikelihood = -548.21403
Iteration 11:  log pseudolikelihood = -548.21403

Probit model with sample selection             Number of obs     =      1,078
                                               Censored obs      =        748
                                               Uncensored obs    =        330
```

Wald chi2(19) = 75.78

Log pseudolikelihood = -548.214 Prob > chi2 = 0.0000

(Std. Err. adjusted for 115 clusters in Cluster)

	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
DisadoptionAmarilisA						
Age_HHHead	.0228098	.0496805	0.46	0.646	-.0745623	.1201818
c.Age_HHHead#c.Age_HHHead	-.0002125	.0005633	-0.38	0.706	-.0013166	.0008915
HHHead_Education_Cat_PostDefense						
Some of Primary	-.1990164	.3161732	-0.63	0.529	-.8187044	.4206716
Secondary and above	-.0000628	.3051013	-0.00	1.000	-.5980504	.5979247
Social_Network	-.0067349	.0324606	-0.21	0.836	-.0703566	.0568867
Total_Land_Ha	.0067407	.012864	0.52	0.600	-.0184723	.0319537
AssetIndex						
2	-.1929341	.2504819	-0.77	0.441	-.6838697	.2980014
3	-.0492152	.2891745	-0.17	0.865	-.6159867	.5175563
4	-.2386205	.2292325	-1.04	0.298	-.6879078	.2106669
5	-.0398607	.241053	-0.17	0.869	-.5123158	.4325944
HHHeadGender	-.0076183	.2771649	-0.03	0.978	-.5508515	.535615
RegionalPostDefense						
2	.1447802	.4620866	0.31	0.754	-.7608929	1.050453
3	-1.049579	.4576446	-2.29	0.022	-1.946546	-.1526118
1.HH_Sell_Potato_Market	.1925753	.2164181	0.89	0.374	-.2315963	.6167469
DistancetoES	.0022611	.0024748	0.91	0.361	-.0025894	.0071116
Household_Elevation	.0003311	.0003864	0.86	0.392	-.0004263	.0010884
AvailabilityDistrictAmarilis	-.0479775	.0445212	-1.08	0.281	-.1352374	.0392823
NewVP_65Category						
High Vulnerability	-.1984186	.2868524	-0.69	0.489	-.7606389	.3638017
Very High Vulnerability	-.702965	.6576052	-1.07	0.285	-1.991848	.5859175
_cons	-.5832638	3.38473	-0.17	0.863	-7.217212	6.050685
EverplantedAmarilisA						

Age_HHHead	.0599638	.0217453	2.76	0.006	.0173437	.1025839
c.Age_HHHead#c.Age_HHHead	-.000763	.0002124	-3.59	0.000	-.0011794	-.0003467
HHHead_Education_Cat_PostDefense						
Some of Primary	.0874566	.2174718	0.40	0.688	-.3387804	.5136935
Secondary and above	-.0543236	.2120801	-0.26	0.798	-.469993	.3613459
Social_Network	.0041753	.0175247	0.24	0.812	-.0301724	.0385231
Total_Land_Ha	-.000687	.0091743	-0.07	0.940	-.0186684	.0172943
AssetIndex						
2	-.1166885	.1835136	-0.64	0.525	-.4763685	.2429914
3	.382608	.166586	2.30	0.022	.0561054	.7091106
4	.1077025	.1674613	0.64	0.520	-.2205158	.4359207
5	.2833234	.1762518	1.61	0.108	-.0621238	.6287706
HHHeadGender	-.0007217	.1583016	-0.00	0.996	-.3109871	.3095436
1.HH_Sell_Potato_Market	-.078924	.1414134	-0.56	0.577	-.3560892	.1982412
DistancetoES	.0005908	.0009078	0.65	0.515	-.0011884	.00237
RegionalPostDefense						
2	-.3013665	.2142073	-1.41	0.159	-.721205	.118472
3	1.215309	.3124009	3.89	0.000	.6030148	1.827604
Household_Elevation	-.0001473	.0001707	-0.86	0.388	-.0004819	.0001873
AvailabilityDistrictAmarilis	.0847844	.0125874	6.74	0.000	.0601135	.1094553
NewVP_65Category						
High Vulnerability	.123601	.2169341	0.57	0.569	-.301582	.5487841
Very High Vulnerability	-.0106795	.2754917	-0.04	0.969	-.5506334	.5292743
1.PlantedImproveseedFromInformal	.079451	.1155539	0.69	0.492	-.1470304	.3059325
_cons	-2.371816	.8891389	-2.67	0.008	-4.114496	-.6291358
/athrho	-.8754034	1.129942	-0.77	0.438	-3.090049	1.339242
rho	-.7041091	.569751			-.9958681	.87149

Wald test of indep. eqns. (rho = 0): chi2(1) = 0.60 Prob > chi2 = 0.4385

. margins, dydx(*) predict (psel)

Average marginal effects Number of obs = 1,078

Model VCE : Robust

Expression : Pr(EverplantedAmarilisA), predict(psel)
dy/dx w.r.t. : Age_HHHead 2.HHHead_Education_Cat_PostDefense 3.HHHead_Education_Cat_PostDefense
Social_Network Total_Land_Ha 2.AssetIndex 3.AssetIndex 4.AssetIndex 5.AssetIndex HHHeadGender
2.RegionalPostDefense 3.RegionalPostDefense 1.HH_Sell_Potato_Market DistancetoES
Household_Elevation AvailabilityDistrictAmarilis 1.NewVP_65Category 2.NewVP_65Category
1.PlantedImproveseedFromInformal

	Delta-method					
	dy/dx	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Age_HHHead	-.0015205	.0008747	-1.74	0.082	-.0032349	.0001938
HHHead_Education_Cat_PostDefense						
Some of Primary	.0176045	.043039	0.41	0.683	-.0667504	.1019593
Secondary and above	-.0106137	.0418695	-0.25	0.800	-.0926764	.0714491
Social_Network	.000819	.0034413	0.24	0.812	-.0059258	.0075639
Total_Land_Ha	-.0001348	.0017988	-0.07	0.940	-.0036604	.0033909
AssetIndex						
2	-.020793	.0322125	-0.65	0.519	-.0839283	.0423423
3	.0763578	.0337597	2.26	0.024	.0101899	.1425256
4	.0202069	.0313843	0.64	0.520	-.0413051	.0817189
5	.0553126	.0343993	1.61	0.108	-.0121088	.122734
HHHeadGender	-.0001416	.0310539	-0.00	0.996	-.0610062	.060723
RegionalPostDefense						
2	-.0680941	.048731	-1.40	0.162	-.1636052	.0274169
3	.3413133	.0946526	3.61	0.000	.1557975	.526829
1.HH_Sell_Potato_Market	-.015496	.0280514	-0.55	0.581	-.0704758	.0394838
DistancetoES	.0001159	.0001771	0.65	0.513	-.0002313	.0004631
Household_Elevation	-.0000289	.000034	-0.85	0.395	-.0000954	.0000377
AvailabilityDistrictAmarilis	.0166317	.0023405	7.11	0.000	.0120443	.0212191
NewVP_65Category						
High Vulnerability	.0244916	.0431539	0.57	0.570	-.0600884	.1090717
Very High Vulnerability	-.002057	.0530534	-0.04	0.969	-.1060397	.1019257

```
                              |
1.PlantedImproveseedFromInformal |   .0157362   .0234617     0.67   0.502    -
.0302479    .0617203
--------------------------------------------------------------------------------------------------
Note: dy/dx for factor levels is the discrete change from the base level.

. margins, dydx(*) predict (pcond)

Average marginal effects                      Number of obs     =      1,078
Model VCE    : Robust

Expression   : Pr(DisadoptionAmarilisA=1|EverplantedAmarilisA=1), predict(pcond)
dy/dx w.r.t. : Age_HHHead 2.HHHead_Education_Cat_PostDefense
3.HHHead_Education_Cat_PostDefense
               Social_Network Total_Land_Ha 2.AssetIndex 3.AssetIndex 4.AssetIndex 5.AssetIndex
HHHeadGender
               2.RegionalPostDefense 3.RegionalPostDefense 1.HH_Sell_Potato_Market
DistancetoES
               Household_Elevation AvailabilityDistrictAmarilis 1.NewVP_65Category
2.NewVP_65Category
               1.PlantedImproveseedFromInformal

--------------------------------------------------------------------------------------------------
                              |            Delta-method
                              |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------------------------+------------------------------------------------------------------
                   Age_HHHead |  -.0004945   .0018694    -0.26   0.791    -.0041584    .0031695
                              |
HHHead_Education_Cat_PostDefense |
             Some of Primary  |  -.0561328   .0996564    -0.56   0.573    -.2514558    .1391903
         Secondary and above  |  -.0112591   .1073565    -0.10   0.916    -.2216741    .1991558
                              |
               Social_Network |  -.0016633    .011698    -0.14   0.887     -.024591    .0212644
                Total_Land_Ha |    .002367   .0032223     0.73   0.463    -.0039486    .0086825
                              |
                   AssetIndex |
                           2  |  -.0924136   .1029933    -0.90   0.370    -.2942767    .1094495
                           3  |   .0617436   .0740949     0.83   0.405    -.0834798    .2069669
                           4  |  -.0655592   .0808946    -0.81   0.418    -.2241096    .0929913
                           5  |   .0446569    .083156     0.54   0.591    -.1183258    .2076396
                              |
                 HHHeadGender |  -.0029765   .0985283    -0.03   0.976    -.1960884    .1901355
                              |
          RegionalPostDefense |
                           2  |  -.0092538    .144299    -0.06   0.949    -.2920746     .273567
                           3  |  -.1568064    .128348    -1.22   0.222    -.4083639     .094751
```

```
                    |
    1.HH_Sell_Potato_Market |   .0554058   .0712894     0.78   0.437    -.0843188    .1951304
               DistancetoES |   .0009591   .0004113     2.33   0.020     .0001531    .0017652
         Household_Elevation |   .0000934   .0001179     0.79   0.428    -.0001377    .0003245
  AvailabilityDistrictAmarilis |  -.0007792   .0065979    -0.12   0.906    -.0137108    .0121524
                    |
          NewVP_65Category |
         High Vulnerability  |  -.0544012   .1034391    -0.53   0.599    -.2571381    .1483358
     Very High Vulnerability  |  -.2526418   .1195315    -2.11   0.035    -.4869193   -.0183644
                    |
1.PlantedImproveseedFromInformal |   .0160144   .0311754     0.51   0.607    -
.0450882     .077117
```

Stata Figure Results:

*Figure 3: Distribution of varieties nationally and per department based on quantity (kg) of seed used in the 2011 to 2012 harvest season

```
// Total Seed in Peru //
egen Total_qty_seed = total(seedquant_kg)
label var Total_qty_seed "Total quantity of potato seed"
 // seed per variety in all Peru//
bysort  Potato_Var: egen qty_seed_sum_Peru_var = sum(seedquant_kg)
label var qty_seed_sum_Peru_var "Total qty of seeds (kg) planted per variety in all of Peru"
// Adoption rates per variety in all Peru//
gen Adoption_rate_Peru_var= qty_seed_sum_Peru_var/ Total_qty_seed
label var Adoption_rate_Peru_var "Adoption rate per variety in Peru"
gen Adoption_perc_Peru_var= Adoption_rate_Peru_var*100
label var Adoption_perc_Peru_var "Adoption percentage per variety in Peru"
bysort Potato_Var: tab  Adoption_perc_Peru_var
label define imp_v_n 0"Other" 1"Canchan" 2"Amarilis" 3"Unica" 4"Andina" 5"Chaska"
6"Perricholi" 7"Serranita" 8"Roja Ayacuchana" 9"Yungay"
label value Potato_Var imp_v_n
label define department  1"Cusco" 2"Apurimac" 3"La Libertad" 4"Cajamarca" 5"Huanuco"
6"Junin" 7"Ancash"  9"Puno" 10"Ayacucho" 11"Huancavelica"
label value Departamento  department
// seed per Departamento//
bysort Departamento: egen qty_seed_sum_dep= sum(seedquant_kg)
label var qty_seed_sum_dep "Total qty of seeds (kg) planted per departamento"
 // seed per Departamento and variety //
bysort Departamento Potato_Var: egen qty_seed_sum_dep_var = sum(seedquant_kg)
label var qty_seed_sum_dep_var "Total qty of seeds (kg) planted per departamento and variety"
browse  A Departamento Potato_Var seedquant_kg qty_seed_sum_dep qty_seed_sum_dep_var
```

```
// adoption rates
gen adoption_rate_dep_var = qty_seed_sum_dep_var  / qty_seed_sum_dep
label var adoption_rate_dep_var "Adoption rates (based on qty of seeds) per variety per
Departamento"
gen adoption_Percentage_dep_var=  adoption_rate_dep_var*100
bysort Potato_Var: tab adoption_Percentage_dep_var if  Departamento==11
bysort Potato_Var: tab adoption_Percentage_dep_var if  Departamento==10
bysort Potato_Var: tab adoption_Percentage_dep_var if  Departamento==9
bysort Potato_Var: tab adoption_Percentage_dep_var if  Departamento==7
bysort Potato_Var: tab adoption_Percentage_dep_var if  Departamento==6
bysort Potato_Var: tab adoption_Percentage_dep_var if  Departamento==5
bysort Potato_Var: tab adoption_Percentage_dep_var if  Departamento==4
bysort Potato_Var: tab adoption_Percentage_dep_var if  Departamento==3
bysort Potato_Var: tab adoption_Percentage_dep_var if  Departamento==2
bysort Potato_Var: tab adoption_Percentage_dep_var if  Departamento==1

*Figure 4: Percentage of farmers ever adopting yungay, canchan, and amarilis over time
//Yungay
. tab EverplantedYungayA

  Household |
 has at one |
   point in |
time during |
  or before |
the 2011 to |
       2012 |
 harvesting |      Freq.     Percent        Cum.
------------+-----------------------------------
          0 |        491       45.55       45.55
          1 |        587       54.45      100.00
------------+-----------------------------------
      Total |      1,078      100.00
*Create graph using this command
tab Yungay_YrFirstPlanted5 if EverplantedYungayA==1
//Canchan
. tab EverplantedCanchanA

  Household |
 has at one |
   point in |
time during |
  or before |
the 2011 to |
       2012 |
 harvesting |      Freq.     Percent        Cum.
```

```
------------+-----------------------------------
          0 |        460       42.67       42.67
          1 |        618       57.33      100.00
------------+-----------------------------------
      Total |      1,078      100.00
*Create graph using this command
tab Canchan_YrFirstPlanted3 if EverplantedCanchanA==1
//Amarilis
 . tab EverplantedAmarilisA

  Household |
 has at one |
   point in |
time during |
  or before |
the 2011 to |
       2012 |
harvesting  |      Freq.     Percent        Cum.
------------+-----------------------------------
          0 |        748       69.39       69.39
          1 |        330       30.61      100.00
------------+-----------------------------------
      Total |      1,078      100.00
*Create graph using this command
tab Amarilis_YrFirstPlanted3 if EverplantedAmarilisA==1
//OVs
 . tab EverplantedOVsA
  Household |
 has at one |
   point in |
time during |
  or before |
the 2011 to |
       2012 |
harvesting  |      Freq.     Percent        Cum.
------------+-----------------------------------
          0 |        701       65.03       65.03
          1 |        377       34.97      100.00
------------+-----------------------------------
      Total |      1,078      100.00
*Create graph using this command
tab OVs_YrFirstPlanted4 if EverplantedOVsA==1
//All improved Varieties Except Yungay
 . tab EverplantedOVsAC

  Household |
```

```
 has at one |
   point in |
time during |
  or before |
the 2011 to |
       2012 |
 harvesting |      Freq.     Percent        Cum.
------------+-----------------------------------
          0 |        242       22.45       22.45
          1 |        836       77.55      100.00
------------+-----------------------------------
      Total |      1,078      100.00
```

*Create graph using this command
tab OVsAC_YrFirstPlanted3 if EverplantedOVsAC==1

*Figure 5:Percentages of farmers ever adopting yungay, canchan, and amarilis over time in the north
//Yungay
. tab EverplantedYungayA if Regional==3

```
  Household |
 has at one |
   point in |
time during |
  or before |
the 2011 to |
       2012 |
 harvesting |      Freq.     Percent        Cum.
------------+-----------------------------------
          0 |         94       27.01       27.01
          1 |        254       72.99      100.00
------------+-----------------------------------
      Total |        348      100.00
```

//Create graph using this command
tab Yungay_YrFirstPlanted5 if EverplantedYungayA==1 & Regional==3
//Canchan
. tab EverplantedCanchanA if Regional==3

```
  Household |
 has at one |
   point in |
time during |
  or before |
the 2011 to |
       2012 |
 harvesting |      Freq.     Percent        Cum.
------------+-----------------------------------
          0 |        170       48.85       48.85
```

```
         1 |        178       51.15      100.00
------------+-----------------------------------
      Total |        348      100.00
//Create graph using this command
tab Canchan_YrFirstPlanted3 if EverplantedCanchanA==1 & Regional==3
//Amarilis
 . tab EverplantedAmarilisA if Regional==3
  Household |
 has at one |
   point in |
time during |
  or before |
the 2011 to |
       2012 |
harvesting  |      Freq.     Percent        Cum.
------------+-----------------------------------
         0 |        150       43.10       43.10
         1 |        198       56.90      100.00
------------+-----------------------------------
      Total |        348      100.00
//Create graph using this command
tab Amarilis_YrFirstPlanted3 if EverplantedAmarilisA==1 & Regional==3
```

*Figure 6: Percentages of farmers ever adopting yungay, canchan, and amarilis over time in the central highlands

```
//Yungay
. tab EverplantedYungayA if Regional==2
  Household |
 has at one |
   point in |
time during |
  or before |
the 2011 to |
       2012 |
harvesting  |      Freq.     Percent        Cum.
------------+-----------------------------------
         0 |         50       16.34       16.34
         1 |        256       83.66      100.00
------------+-----------------------------------
      Total |        306      100.00
//Create graph using this command
tab Yungay_YrFirstPlanted5 if EverplantedYungayA==1 & Regional==2
//Canchan
. tab EverplantedCanchanA if Regional==2
  Household |
 has at one |
```

```
   point in |
time during |
  or before |
the 2011 to |
       2012 |
 harvesting |      Freq.     Percent        Cum.
------------+-----------------------------------
          0 |         67       21.90       21.90
          1 |        239       78.10      100.00
------------+-----------------------------------
      Total |        306      100.00
//Create graph using this command
tab Canchan_YrFirstPlanted3 if EverplantedCanchanA==1 & Regional==2
//Amarilis
 . tab EverplantedAmarilisA if Regional==2
   Household |
 has at one |
   point in |
time during |
  or before |
the 2011 to |
       2012 |
 harvesting |      Freq.     Percent        Cum.
------------+-----------------------------------
          0 |        227       74.18       74.18
          1 |         79       25.82      100.00
------------+-----------------------------------
      Total |        306      100.00
//Create graph using this command
tab Amarilis_YrFirstPlanted3 if EverplantedAmarilisA==1 & Regional==2

*Figure 7: Percentages of farmers ever adopting yungay, canchan, and amarilis over time in the south
//Yungay
. tab EverplantedYungayA if Regional==1

  Household |
 has at one |
   point in |
time during |
  or before |
the 2011 to |
       2012 |
 harvesting |      Freq.     Percent        Cum.
------------+-----------------------------------
          0 |        347       81.84       81.84
```

```
        1 |         77       18.16      100.00
------------+-----------------------------------
      Total |        424      100.00
//Create graph using this command
tab Yungay_YrFirstPlanted5 if EverplantedYungayA==1 & Regional==1
//Canchan
. tab EverplantedCanchanA if Regional==1
  Household |
 has at one |
   point in |
time during |
  or before |
the 2011 to |
       2012 |
harvesting  |      Freq.     Percent        Cum.
------------+-----------------------------------
          0 |        223       52.59       52.59
          1 |        201       47.41      100.00
------------+-----------------------------------
      Total |        424      100.00
//Create graph using this command
tab Canchan_YrFirstPlanted3 if EverplantedCanchanA==1 & Regional==1
//Amarilis
 . tab EverplantedAmarilisA if Regional==1

  Household |
 has at one |
   point in |
time during |
  or before |
the 2011 to |
       2012 |
harvesting  |      Freq.     Percent        Cum.
------------+-----------------------------------
          0 |        371       87.50       87.50
          1 |         53       12.50      100.00
------------+-----------------------------------
      Total |        424      100.00
//Create graph using this command
tab Amarilis_YrFirstPlanted3 if EverplantedAmarilisA==1 & Regional==1
```