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Anna K. Müller
Ludwig Theuvsen

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Food safety standards in the Guatemalan fresh pea sector: The role of financial literacy in technology adoption

Anna K. Müller*

Ludwig Theuvsen

Georg-August University Göttingen, Department of Agricultural Economis and Rural Development, Research Training Group "Transformation of the global agri-food system – Trends, driving forces and implications for developing countries"

*Corresponding author: anna.mueller@agr.uni-goettingen.de

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Abstract

The transformation of the global agrifood system is characterized by the increasing importance of food safety and quality standards. This trend is challenging farmers in countries like Guatemala as they lack necessary skills and assets. This study analyzes the determinants of Globalgap adoption with a special focus on financial literacy. The concept has not been considered yet in technology adoption studies. Our results indicate that financial literacy indeed has a significant impact on the probability to adopt the standard. Our results hold practical implications for development interventions targeting technology and standard adoption and smallholder market integration.

Keywords: Technology adoption, food safety standards, financial literacy, developing countries, market integration
JEL Code Q14, Q12, Q16, O33, C38, C31

1. Introduction

In international trade with fresh fruit and vegetables, private certification schemes have become a predominant instrument for assuring food safety and quality (Unnevehr 2000, Reardon et al. 2009). This development has fueled a controversial debate in research and practice about the implications for farmers in developing countries. Compliance with international (and increasingly also national) quality and food safety standards is seen as an important asset for participating in agricultural value chains. Standard adoption is associated with more efficient and sustainable production as well as economic benefits. The relatively low adoption of private food safety standards and the weakness of public quality assurance institutions in many developing countries remain in sharp contrast to this tendency.[1] This is a concern because non-adoption could lead to further marginalization of already small, asset-poor farmers (Maertens and Swinnen 2012). In contrast, significant benefits for small farmers may be expected once they overcome constraints and comply with international food standards (Anders and Caswell 2007). Hence, identifying factors that favor or constrain the adoption of food standards is of empirical and practical relevance.

Existing studies stress the role of endowment factors and access indicators in the standard adoption process. A number of factors - farm land and non-land assets, collective capital and access to resources like credit, assistance and information - help farmers undertake the necessary monetary and non-monetary investments (Reardon et al. 2009; Asfaw et al. 2009; Handschuch et al. 2013; Hansen and Trifković 2014; Kersting and Wollni 2012; Subervie and Vagneron 2013).

Standard adoption is an investment decision: farmers have to decide how to allocate their capital, land and family labor. Process standards lead to changes not only in agricultural production but also in farm management, and complying with the criteria requires specific financial and managerial abilities. It might be easier for farmers with more business-related skills, like financial literacy, to comply with food safety standards as they know how to use the information and adapt to new requirements. Standard adoption is also often related to credit access. Having a higher level of financial literacy

[1] In Guatemala, GlobalGAP is adopted by less than one percent of fresh vegetable producers.

might help farmers to use this access more effectively. However, focusing only on access to resources and endowment factors might not be sufficient to explain the adoption decision. To the best of our knowledge, there is no empirical literature that considers the role of financial literacy in technology adoption or standard adoption in particular. Thus, this study contributes to the standard adoption literature by investigating whether financial literacy influences technology adoption by small farmers in developing countries.

In this paper, we examine the case of GlobalGAP adoption among small pea producers in the Guatemalan highlands. In this sector, sanitary and phytosanitary violations are prevalent problems and form one of the primary causes of export restrictions. In the absence of an effective public quality infrastructure, private investment in food safety and quality has become vital to securing Guatemala's role as a leading exporter of fresh peas. We use cross-section data from 277 pea farmers using a control-group design. The data was collected in 2012 using a stratified random sampling strategy. Descriptive results indicate that adopters and non-adopters differ in their level of financial literacy. Estimates from a bivariate probit model suggest that financial skills positively influence standard adoption. Our results hold practical implications. Acknowledging the importance of certain skills in the adoption process enables interventions to be more effectively tailored to bring farmers to adopt standards.

The remainder of the paper is structured as follows. First, we discuss the literature on the role of financial literacy in investment and technology adoption behavior. Next, we describe our research background, data and sampling strategy. After introducing our methodology in section four, we present the descriptive results in section five. In section six, we present and discuss the econometric results. The paper finishes with our conclusions.

2. Financial literacy and the adoption of process innovations

Financial literacy

Stated simply, financial literacy describes "a person's competency to manage money" (Remund 2010, p. 279). However, financial literacy embraces a variety of dimensions, such as financial knowledge, communication, financial management and decision

making, and planning (ibid.). Financial literacy is a skill that helps individuals better evaluate their personal economic situation and more effectively wield financial information in order to make the best possible decision based on their personal situation and preferences. The concept stresses the importance of the capability of individuals to use access to financial resources and financial information for their economic well-being.

Empirical evidence from developed countries suggests a positive relationship between level of financial literacy and economic decision making. Higher levels of financial literacy are associated with investments in pension funds (Lusardi and Mitchell 2005), stock market participation (van Rooij et al. 2011; Almeberg and Widmark 2011; Behrmann et al. 2010) and investments in financial products (Brown and Graf 2013). In spite of this relationship, few studies consider financial literacy in the context of developing countries. Gaurav et al. (2011) show that financial literacy training for farmers increases the take-up of index-based weather insurance. Drexler et al. (2014) find that improved financial and management knowledge has a positive effect on business outcomes among small businesses in the Dominican Republic. Cole and Sampson (2011) conclude that there is strong correlation between financial literacy and financial market participation in India and Indonesia.

Education, cognitive skills and technology adoption

In order to understand how financial literacy could affect standard adoption, we examine the literature on education, cognitive skills and technology adoption. Financial literacy is assumed to have an effect on technology adoption similar to that of education and cognitive skills (Gaurav and Singh 2012). The literature on the effect of education on the adoption of agricultural innovations in developing countries is very broad, and most adoption studies use education (in years of schooling) as a control variable (Feder et al. 1981; Foster and Rosenzweig 2010).

So, what are the paths through which education influences behavior? It is useful to distinguish between the cognitive and non-cognitive effects of education (Appleton and Bahiluta 1996). The cognitive effects of education embrace the formation of general skills, such as literacy and the transmission of specific knowledge. Non-cognitive effects include preferences and changes in attitude (e.g., being open to innovations and

changing preferences). Skills like numeracy or literacy help farmers in their everyday business (e.g., in using inputs based on the recommendations and computing the adequate dosage for their plots). It also helps them to make planning decisions relating the economic future of the farm (how to allocate family labor or whether to use a loan for investment). Non-cognitive effects influence farmers' attitudes towards new technologies, among other things.

Through such cognitive and non-cognitive effects, education influences farmers' allocative ability. Allocative ability is important for adjusting to change (Feder et al. 1981). There is general agreement in the literature on the important role of human capital in dealing with the disequilibrium effects that result from the introduction of a new technology (Feder et al. 1981). Foster and Rosenzweig (1995) conceptualize three concrete channels through which education influences technology adoption. First, more educated farmers are wealthier farmers and hence are better endowed to adopt new technologies (income effect). Second, more educated people have better access to information as their educational level helps them to better gather, process and use relevant information (information effect). Third, more educated people are better at and more open towards learning new things, which is essential in technology adoption (learning effect).

Education measured as attainment in school gives an incomplete picture of the role of skills and abilities in technology adoption. In many developing countries, schooling rates are very low or the quality of education is poor (Jolliffe 1998; Hanushek and Woessmann 2008). Knowledge and skills are mainly acquired through informal channels (van Rooij et al. 2011). Farmers may learn from their peers, through extension services, through learning-by-doing or through their cultural background. Examining the role of skills in innovation adoption better reflects the complexity of education, schooling and learning. In considering the role of financial literacy in farmers' innovation adoption behavior, we contribute to a deeper understanding of the role of human capital in the innovation adoption process of small farmers.

Financial literacy and standard adoption

Considering the aforementioned literature on education and cognitive skills, we assume financial literacy to affect standard adoption through several channels. First of all,

adopting a standard is an investment decision. Farmers have to decide today on how to allocate farm resources, capital and labor in order to obtain benefits in the future. Exporters often bear most part of the certification and investment costs for small farmers. Of course, farmers invest opportunity costs since they attend training and often have to cope with a more labor intensive production process. Furthermore, exporters often intend to reduce their support over time, so farmers need to know whether they have the necessary skills to comply with the standard without support in the future.

Farmers might also be required to undertake some small on-farm investments themselves, often with the help of a loan. The inputs provided often come in the form of a loan. So farmers need to have a solid understanding of credit management. Standard adoption often makes farming more labor intensive, especially since process standards require the recording and control of all the production processes. When considering adoption, farmers need to evaluate the economic and financial consequences of standard adoption for their farms' economic and financial situation. Proper financial skills are therefore important for managing food safety and quality standards at the farm level.

In order to understand how financial literacy influences the adoption process, we rely on the argumentation laid down in the previous section. Financial literacy can have cognitive and non-cognitive effects. Farmers with better financial skills might have more capital and credit to undertake the on-farm investments that are sometimes necessary. High financial literacy is associated with a greater availability of unspent income and a higher spending capacity (Klapper et al. 2012).

Farmers with high financial literacy learn faster and can use information (e.g., on required input use) in a more efficient manner. Low levels of financial literacy may imply higher costs of information gathering (Almeberg and Widmark 2011). Farmers with better financial literacy skills might learn faster. Farmers with better financial skills might also have a more positive attitude towards new investments as they are more confident about their ability to manage change. Non-investment could be a strategy for avoiding mistakes caused by missing knowledge and skills (Almeberg and Widmark 2011). The better the level of financial literacy, the better a person may be able to exploit his or her own resources and the more successful that person will be in adopting innovations in comparison to persons with a lower level of financial literacy. Klapper et al. (2012) argue that high financial literacy levels come with a better ability to deal with

shocks, such as a high inflation rate, an unforeseen change in interest rates, and the breakdown of an exporter or even a microfinance institution. In summary, farmers with a higher level of financial literacy have a better allocative ability and are better equipped to adjust to the disequilibrium that is caused by the introduction of a new technology or situation.

3. Research background

3.1 GlobalGAP and food safety in Guatemala

GlobalGAP is the most common private food safety standard for fresh fruit and vegetable trade that affects developing countries. GlobalGAP is a pre-farm gate standard that requires the implementation of good agricultural practices as well as quality and food safety measures. This process standard is non-mandatory and applies exclusively to business-to-business relationships. It is generic in nature and sets norms that are slightly above the public regulations of the EU and the US. GlobalGAP is quasi-mandatory for supplying to several big European retail chains. In order to make GlobalGAP more accessible to small farmers, there are two certification options: individual certification and group certification. For group certification, producer groups run a joint quality management system and can share some investments, like collection centers and auditing costs. In the recertification process, only a random fraction of the group is audited, which significantly reduces certification costs. Each producer holds a contract and is obliged to market certified products exclusively through the group (see GlobalGAP general regulations 2013).

Guatemala is a country with a very low institutional capacity in food safety and quality. This challenges public and private compliance efforts and increases the costs for complying with international norms (Henson 2007). Food safety and quality problems have been widespread (Norton et al. 2003) and are jeopardizing the international competitiveness of the country in non-traditional agricultural exports (Julian et al. 2000). Pea exports in particular have experienced high detention rates due to microbiological contamination and pesticide overuse (Henson 2007). These detentions have considerable economic effects, as the export-oriented sector is dominated by capital-poor smallholders.

For several years, the non-traditional export sector has been using GlobalGAP increasingly as an instrument to reach conformance with international norms, and today it is the most important food quality standard for Guatemala. In August 2012 there were 1,233 certified farmers in Guatemala (GlobalGAP 2012). Over 800 of the certificates are held by pea producers. GlobalGAP-certified production is still marginal: Less than 1 percent of fresh fruit and vegetable producers in the country are certified by GlobalGAP.

3.2 Data

Between August and October 2012, we surveyed a sample of 277 fresh pea farmers in the departments of Chimaltenango and Sacatepéquez in the Guatemalan highlands.[2] We collected information on the socio-demographic and socio-economic situation of the farm-households as well as on agricultural production and marketing, certification and financial literacy. The recall period was from August 2011 to July 2012. The financial literacy section is based on widely used survey questions (OECD INFE 2011; Atkinson and Messy 2012). Six multiple choice questions cover general knowledge of numeracy (percentage calculation and division) and more specific financial knowledge (inflation, interest and compound interest calculation). We presented the questions as a small quiz rather than a test to the farmers to make them feel more comfortable. If a farmer was not able to answer the two general numeracy questions we did not ask them the detailed financial literacy questions. The test questions were then coded as "does not know".[3]

We use a stratified random sample. The treatment group consists of 152 farmers certified under option 2 (group certified farmers). The first control group consists of 65 non-certified farmers who are members of a farmer group. The selection of the farmer groups was a non-random process since we had information on farmer groups from collaborating exporters and one nongovernmental organization. Within the farmer group we selected certified and non-certified interviewees randomly from the member list. GlobalGAP certification within the farmer group is still an individual decision. None of the groups we dealt with for the study had reached full certification of all members.

[2] These two departments account for around 90% of the national pea production. They are both relatively close to the capital, Guatemala City, which favors the production of export crops due to better access to modern infrastructure and lower transportation and transaction costs.

[3] See Appendix A1 for a detailed presentation of the question used in the financial literacy test.

Since some of the information on certification turned out to be outdated, we also have ex-certified farmers in our sample. Since these farmers decided to adopt in the past, they are included as adopters in our model. The second control group consists of 60 non-certified and non-organized farmers. This group sells to intermediaries or on the spot market, where there is no standardized quality selection of the product. We included this group to be able to control for group level effects. The second control group was selected by random walk method.

We use information on transportation costs and distance to the next marketing center; this data was provided by the International Food Policy Research Institute (IFRPI).

4. Methods

4.1 Empirical model of the adoption process

We model the adoption decision based on a utility maximization framework. We assume that a utility maximizing farmer opts for GlobalGAP adoption if the expected utility of adoption is higher than the expected utility of non-adoption. A farmer's utility is influenced by socioeconomic and contextual variables that also influence the decision to adopt GlobalGAP.

The utility function for GlobalGAP adoption takes the following form:

$$(1) \qquad U_i = X_i\gamma + u_i \,,$$

where U_i describes the utility of farmer i. X is a vector of contextual and socioeconomic variables assumed to influence utility. We cannot directly observe a farmer's utility of adoption as it is a latent variable. What we can actually observe is the farmer's choice between adoption and non-adoption. Based on the utility framework, we assume that a farmer adopts if the utility of GlobalGAP adoption GG_i is greater than zero, and does not adopt if it is not:

$$(2) \qquad GG_i = \begin{cases} 1 \; if \; U_i > 0 \\ 0 \; if \; U_i \leq 0. \end{cases}$$

Assuming a linear relationship, the adoption of GlobalGAP can therefore be described as

$$(3) \qquad GG_i = \beta_{i1} X_i + \beta_{i2} FL + u_i,$$

where GG_i is a binary choice variable taking the value 1 if the farmer has adopted GlobalGAP and 0 if not, X_i is a vector of observed farm and non-farm characteristics that are assumed to influence the decision, FL is our variable of interest - financial literacy - and u_i is the unobserved error term we are trying to minimize.

Small farmers have access to GlobalGAP adoption through group certification. Only those farmers who decide to be members of a group actually have the option of standard adoption. To acquire consistent estimates, we need to consider the two related decisions: first, the farmer decides whether to join a farmer group. If the farmer opts for membership, he or she can decide whether or not to adopt the standard. See figure 1 for an illustration of the decision process. We assume that non-group members do not face the decision of GlobalGAP adoption as individual certification entails very high costs.[4]

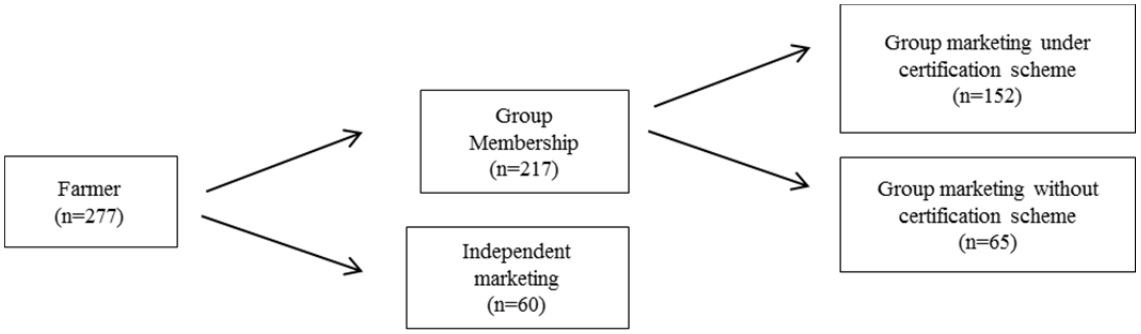

Figure 1 Conceptual framework of GlobalGAP adoption

It might be the case that the same unobservable factors drive both group membership and GlobalGAP adoption. We could think of motivation to succeed in economic terms as a driving factor for group membership and GolbalGAP adoption alike. This could cause a selection bias. Without correcting for this bias, the model would give inconsistent estimates.

To control for possible selection bias, we opt for a bivariate probit model, which allows for correlation in the error term (Greene 2003). If no correlation is found between the two error terms, then no selection bias exists and two independent probit models can be

[4] Among pea producers, the only option 1 certificates are held by exporter-owned farms.

used to interpret the results. If significant correlation exists between the two error terms, then the bivariate model corrects for the selection bias in the estimates.

The following bivariate model is adapted from Greene (2003) and Kersting and Wollni (2012):

(4) Selection equation:

$$y_{i1}^{*} = x_{i1}'\beta_{i1} + \varepsilon_{i1}, \qquad y_{i1} = 1 \; if \; y_{i1}^{*} > 0, 0 \; otherwise.$$

(5) Outcome equation:

$$y_{i2}^{*} = x_{i2}'\beta_{i2} + \varepsilon_{i2}, \qquad y_{i2} = 1 \; if \; y_{i2}^{*} > 0, 0 \; otherwise.$$

$$E\left[\varepsilon_{i1} | x_{i1}x_{i2}\right] = E\left[\varepsilon_{i2} \mid x_{i1}x_{i2}\right] = 0,$$

$$Var\left[\varepsilon_{i1} | x_{i1}x_{i2}\right] = Var\left[\varepsilon_{i2} \mid x_{i1}x_{i2}\right] = 1,$$

$$Cov\left[\varepsilon_{i1}\varepsilon_{i2} | x_{i1}x_{i2}\right] = \rho.$$

y_i^* represents the unobserved, latent variables. y_{i1}^* is the utility of being in a farmer group and y_{i2}^* is the utility of being certified with GlobalGAP. β_i' are parameter vectors, x_i' are vectors of exogenous explanatory variables and ε_i are the error terms with zero mean, unit variance and correlation ρ. The model is tested under the null hypothesis ρ=0, meaning no correlation between the error terms and no selection on unobservable factors. If ρ is found to differ significantly from 0, then we have selection bias in our model.

For our decision model, the following holds:

$y_{i1} = 1$ if the farmer *i* is member of a farmer group, 0 otherwise

$y_{i2} = 1$ if the farmer *i* has adopted GlobalGAP, 0 otherwise

We can only observe $y_{i2} = 1$ if $y_{i1} = 1$. Only if a farmer is member of a farmer group can he or she actually face the adoption decision.

We oversampled GlobalGAP-certified farmers. In order to control for biases caused by the sampling design, we used probability weights. We used the inverse of the probability of being included in the sample due to the sampling design. We estimated the population size of our sampled group based on data provided by GlobalGAP and the 2004 Guatemalan agricultural census (Instituto Nacional de Estadísticas 2004). We use robust standard errors.

4.2 Principal component analysis

Principal component analysis (PCA) is a multivariate statistical method. It is used to reduce a number of variables that describe the same latent phenomenon into smaller dimensions. From an initial set of *n* correlated variables, PCA creates uncorrelated components. These components account for most of the variance in the data. Each extracted component is a linearly weighted combination of the initial set of variables. For a set of variables X_1 to X_n the principal components are

$$(6) \qquad PC_1 = a_{11}X_1 + a_{12}X_2 + \cdots + a_{1n}X_n$$

…

$$(7) \quad PC_m = a_{m1}X_1 + a_{m2}X_2 + \cdots + a_{mn}X_n \,,$$

where a_{mn} is the weight for the *m*th component and the *n*th variable (Vyas and Kumaranayake 2006). The weights of the principal components are the eigenvectors of the correlation matrix. The eigenvalue of the eigenvector is the amount of explained variance (Vyas and Kumaranayake 2006; van Rooij et al. 2011). The first component accounts for the largest amount of the underlying information of the variables used (Kolenikov and Angeles 2004). It represents the linear index of all the variables used in the PCA. The other components are not correlated with the first component. They explain additional, but smaller, variation in the data. PCA assigns weights to the variables according to how much each contributes to the variation in the data (Langyintuo and Mungoma 2008). We used unrotated PCA to construct a financial literacy index and a farm asset index. Using an index has proved to be useful by other studies in financial literacy research (van Rooij et al. 2011; Behrmann et al. 2010) and poverty research (Vyas and Kumaranayake 2006).

For financial literacy, the first extracted component accounts for almost 70% of the variation (table A-1 in the appendix). The factor loadings for the first component all have the same sign and are almost equal in magnitude (table A-2, appendix). The Kaiser-Meyer-Olkin (KMO) criterion of sampling adequacy tests whether the data used is suitable for PCA (see table A-3 in the appendix). The overall KMO score is higher than 0.8, which is considered very good. Bartlett's test of sphericity tests whether the correlations between the variables used are significant. The test indicates that we can

reject the null hypothesis of zero correlations between the variables. We used the first component to construct the financial literacy index.

The same procedure was applied to the 13 variables associated with farm assets. The KMO results suggest that we can perform factor analysis, albeit the value of 0.56 is lower than in the financial literacy index. Bartlett's test indicates that the data has enough correlation in order to perform PCA (see tables A-3 to A-5 in the appendix). The farm asset index is a proxy for the asset endowment of the farm household (as we do not have the necessary information in our dataset it is not a proxy for wealth).

5. Descriptive results

5.1 Sample characteristics

In tables 1 and 2, we present the descriptive statistics. We compare the means of certified and non-certified farmers for several variables of interest and use a t-test to check whether there are statistically significant differences in mean between the two groups.

The farmers are mainly indigenous: Only around 6% in either group state that their mother tongue is Spanish. The main language in the export business and in the (public or private) extension infrastructure is Spanish. Not speaking proper Spanish might increase information asymmetries, thus disadvantaging indigenous farmers in the adoption process.

Almost two-thirds of the farm household members are to some degree involved in farming activities, which means that we are dealing with family farms. The average off-farm income per capita in a year is relatively low and does not translate to the minimum wage per month.[5] The average land size and average hectares owned puts both groups into the category of subsistence farmers with less than seven hectares of land (Instituto Nacional de Estadísticas 2005).

5 The minimum wage per month in Guatemala in 2012 for non-farm activities was 2,074 Guatemalan quetzals. (See http://www.leylaboral.com/guatemala/hotlinks/salariominimo.htm, accessed 11.11.2014.)

Table 1 Sample characteristics

	Ever certified	Never certified	Differences
Farm household and farm characteristics			
Age (head)	45.118	43.408	-1.71
Years of education (head)	4.691	4.592	-0.1
Mother tongue (0 = Spanish)	0.059	0.064	0
Total household members	6.217	5.88	-0.34
Members working on farm	3.77	3.656	-0.11
Members working off-farm	1.382	1.384	0
Total off-farm income	10,654.974	9,510.408	-1,144.57
Off-farm income per capita (quetzals)	1,867.106	2,092.827	225.7207
Total farm size in ha	1.644	1.172	-0.47**
Land owned in ha	1.446	0.957	-0.49**
Land owned before 2009 in ha	1.005	0.556	-0.45**
Share of peas in % of productive land	37.589	37.207	-0.38
Land title (0 = no title)	0.783	0.688	-0.09*
Irrigation (0 = no irrigation)	0.224	0.168	-0.06
Irrigation in pea production (0 = no irrigation)	0.204	0.144	-0.06
Farm asset index	0.293	-0.364	-0.66***
N	152	125	

Differences in mean significant at * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Certified and non-certified farmers differ significantly in total farm size and in the amount of land they actually own. On average, certified farmers possess more land and work on larger farms. A significantly higher share of certified farmers possess an official land title. A formal land title is important for accessing the formal financial market and gives security over land holdings. Unsecured property rights might hinder investments. The two groups do not differ significantly in their technological level proxied by irrigation. However, only around 20% of the farmers use irrigation, which is not a very high share.

Certified farmers score significantly better on the asset index. The farm asset index incorporates various durable farm assets as proxies for the economic situation of the farm. The higher the score in the asset index, the better endowed the farm. Certified and non-certified farmers differ significantly in group membership. This is not surprising as we were targeting group-certified farmers. Non-certified farmers also include independent farmers. Just comparing group members, certified farmers have been group members for significantly longer time. This might hint at the role of positive trustful

relationships in the certification process. Significantly more certified farmers were working with an exporter before 2009. We took 2009 as a threshold as GlobalGAP certification became more widespread afterwards. Certified farmers scored significantly higher in the financial literacy index, our variable of interest.

Table 2 Sample characteristics continued

	Ever certified	Never certified	Differences
Organization			
Farmer group member (0 = no member)	0.98	0.52	-0.46***
Time of membership	6.538	4.189	-2.35**
Marketing			
Experience with buyer in years	5.183	6.161	0.98
Exporter before 2009 (0= no exporter)	0.428	0.152	-0.28***
Business skills			
Financial literacy index	0.391	-0.476	-0.87***
Experience in pea production in years	11.187	12.051	0.86
Access			
Distance to the next marketing center in meters	6,616.317	6,374.303	-242.0138
Transportation costs ($/kg)	0.0043417	0.0051357	.000794*
Altitude	2,216.782	2,212.607	-4.18
Savings (0 = no savings)	0.164	0.192	0.03
Remittances (0 = no remittances)	0.059	0.08	0.02
Conditional cash transfer (0 = no CCT)	0.191	0.216	0.03
Access to formal credit (0= no Access)	.355	.328	-.027
N	152	125	

Differences in mean significant at *$p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The two groups do not differ significantly in distance to the next marketing center, whereas interestingly they differ significantly in transportation costs. Non-certified farmers have significantly higher transportation costs. This could indicate that certification is somehow related to lower transaction costs. Savings, remittances and conditional cash transfer are proxies for farm households' economic situation and access to financial resources. There are no significant differences in mean between the groups for these variables. The saving rate seems quite low among the respondents (16–19%). Only 5% of the respondents receive remittances. This is surprising as the area is known for having a high migration rate to the United States. But it could be that mainly

male family members migrate, and female members are probably not so involved in pea production and certification activities.

The conditional cash transfer program is designed for needy families. They receive a small subsidy when they comply with certain criteria, like sending kids to school and attending regular medical checkups.[6] Around 20% of the sample receives this subsidy. But it seems that not only necessity influences whether a family receives the subsidy; another factor is whether the public sector is present in the area. Thus, receiving the subsidy is an incomplete proxy for poverty. We do not see any systematic difference in access to formal credit between the two groups. Around one third of the sample has access to loans from formal sources such as banks or microfinance institutions.

Certified and non-certified farmers show no systematic difference in mean in farmer or farm household characteristics. But when it comes to variables related to farm characteristics, marketing activity, financial literacy and access, we see systematic differences between the two groups.

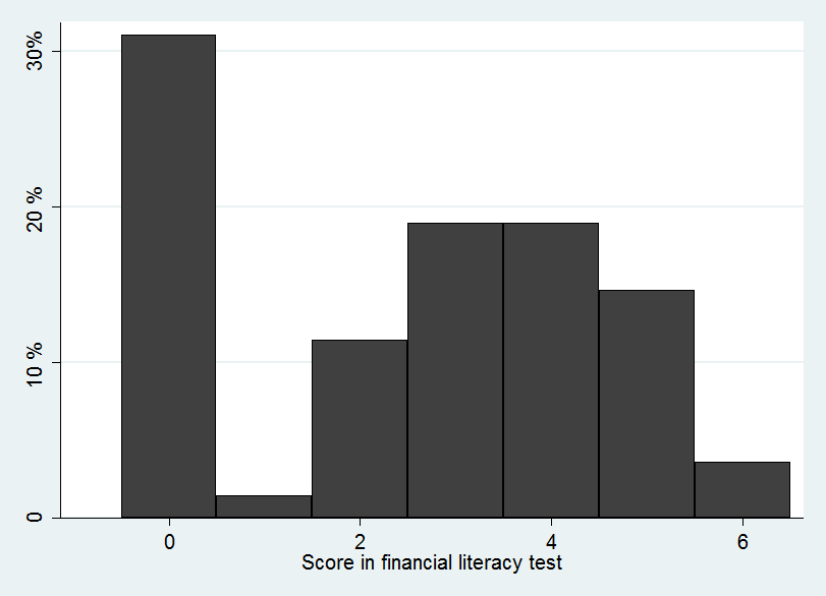

Figure 2 Distribution of correct answers in the sample N=277

6 http://www.mides.gob.gt/programas-sociales/mi-bono-seguro, accessed 20.06.2014.

5.2 Financial literacy

Around one-third of the respondents did not answer any of the questions in the financial literacy test correctly (see figure 2). Among those who managed to answer at least one question, most of the respondents scored three or four correct answers out of six (18% respectively). The median score is three correct answers out of six.

In order to better understand the possible influence of financial literacy on standard adoption, we explore the characteristics of the financially literate farmers in our sample. We stratify our sample into farmers with high and low financial literacy according to their scores in the index.[7] We use a t-test to compare the differences in mean between the two groups. The statistically significant differences are presented in table 3.

We see that farmers with a better score in the financial literacy index are on average younger and have attended more years of school. Maybe the younger farmers did not only attend more years of school, but also benefitted from higher quality of schooling, which will have improved their skills in areas important to financial literacy (numeracy, literacy etc.).

Table 3 Characteristics of farmers with high and low financial literacy

	High FL	Low FL	Differences
Age (head)	42.900	45.626	2.73*
Education	5.492	3.898	-1.59***
Total off-farm income	11,846.385	8,628.075	-3218.31*
assetX	0.182	-0.218	-0.40**
Formal credit access	0.300	0.381	0.08
Member farmer group	0.823	0.728	-0.10*
Years of membership	7.018	4.645	-2.37***
GlobalGAP	0.646	0.463	-0.18***
Observations	130	147	

Differences in mean significant at * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

It is also assumed that younger farmers are more open to innovations and changing practices. It might also be the case that younger farmers have had more experience with loans or other financial products, which in turn would influence their financial literacy level. Thus, it might have been easier for younger farmers to acquire financial literacy skills.

7 The cutoff point is the median: Scores below the median indicate low financial literacy; scores above the median indicate high financial literacy.

Farmers in the upper quintile of financial literacy have on average higher off-farm earnings and score on average better in the asset index. This reflects in part the higher educational level of highly skilled farmers: Education and skills are seen as strong determinants of earnings and wealth. In turn, financial literacy might also be influenced by income and wealth status. Interestingly, the two groups do not differ in any farm characteristics or access indicators, like access to formal credit. (We do not present the non-significant differences in table 3 due to space restrictions.) Highly financially literate farmers have a higher membership rate in farmer groups and length of membership tends to be greater. Group membership is associated with better access to information and extension services. There might also be better opportunities to learn from the experience of others. The GlobalGAP certification rate is also higher among highly skilled farmers.

The situation of financial literacy in our sample reflects the findings of other studies. In a review of studies dealing with financial literacy, (Lusardi and Mitchell 2014) find that low levels of financial literacy are associated with poorer and less educated households. Older people and women are less literate, self-employed individuals perform better than employed individuals and individuals living in rural areas tend to have lower financial literacy than those living in urban areas.

6. Estimation results

6.1 Determinants of GlobalGAP adoption

The selection equation of the bivariate probit model estimates the probability that a farmer will join a farmer group. The outcome equation estimates the probability of GlobalGAP adoption (see table 4). For a detailed explanation of the variables used in the adoption model see table A-6 in the appendix.

Group membership is positively influenced by the age of the farmer, farm assets and experience working with an exporter (Exporter before 2009). Per capita off-farm income, remittances, cell phone use, experience in pea production and transportation costs negatively influence farm group membership.

We cannot reject the null hypothesis of zero correlation between the error terms of the two equations since ρ differs significantly from 0. We performed a likelihood ratio test,

which confirmed that the bivariate model performs better than two independent models. Hence we rely on the bivariate model to interpret our results.

Table 4 Bivariate probit model with marginal effects

	Group membership		GlobalGAP adoption			
	Coeff.	(s.e)	Coeff.	(s.e.)	Marginal effects[a]	(s.e.)
Age	0.0196**	(0.00972)	0.0126	(0.00851)	0.0019	(0.00130)
Gender	-1.039**	(0.451)	-0.745**	(0.380)	-0.111*	(0.0599)
Education	0.0282	(0.0469)	-0.00717	(0.0371)	-0.000572	(0.00527)
MembersOnFarm	0.0143	(0.0408)	0.0146	(0.0366)	0.0021	(0.00514)
Off_income	-0.000103**	(4.15e-05)	-3.08e-05	(2.19e-05)	-5.34e-06	(3.58e-06)
Ha owned before 2009	0.0877	(0.0738)	0.0562	(0.0625)	0.0085	(0.00889)
Land title	0.166	(0.226)	0.150	(0.191)	0.0217	(0.0263)
Irrigation	-0.257	(0.246)	-0.0688	(0.218)	-0.0123	(0.0301)
Remittances	-0.862**	(0.345)	-0.798**	(0.346)	-0.115**	(0.0531)
Conditional cash transfer	-0.328	(0.201)	-0.255	(0.173)	-0.0376	(0.0235)
Cell	-0.490*	(0.256)	-0.317	(0.212)	-0.0477	(0.0335)
BuyerFFV	-0.0111	(0.280)	-0.161	(0.243)	-0.0212	(0.0350)
TarmacRoad	-0.241	(0.206)	-0.0537	(0.171)	-0.0101	(0.0254)
FarmX	0.294***	(.880)	(0.0945)	(.7146)	0.034***	(0.0127)
Livestock_NR	-0.0366	(0.117)	0.113	(0.106)	0.0142	(0.0153)
Mother tongue	0.126	(0.458)	0.00356	(0.419)	0.00209	(0.0598)
Exporter before 2009	0.610***	(0.213)	0.624***	(0.167)	0.0893***	(0.0262)
Formal credit access	-0.275	(0.185)	0.190	(0.155)	0.0212	(0.0246)
Experience pea production	-0.0363***	(0.0124)	-0.0186	(0.0114)	-0.00290*	(0.00170)
Specialization	0.00345	(0.00650)	0.00149	(0.00502)	0.000239	(0.000728)
T_costs	-74.03**	(30.45)	-46.36**	(23.30)	-7.007*	(3.834)
FLX2	0.0591	(0.0477)	0.108***	(0.0399)	0.0149**	(0.00667)
Constant	2.961***	(0.742)	1.918***	(0.638)		
rho	1.483***	(0.210)				
Observations	277		152		277	

Wald test of rho=0: chi2(1) = 78.8103 Prob > chi2 = 0.0000
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
a: continuous variables at the mean value, binary variables at modal value

Unlike in other adoption studies, we do not find a significant effect from such socioeconomic variables as age, education, off-farm income, member working on farm and land size (Subervie and Vagneron 2013; Kersting and Wollni 2012). We find that male-headed households are less likely to adopt the standard than female-headed households. This result is contrary to the findings of similar studies, such as Handschuch et al. (2013).

Receiving remittances from a family member abroad significantly decreases the likelihood of adoption. This effect might result from the absence of family members of productive age. The remaining family members might not be productive enough to engage in certification-based pea production. Another reason could be that farm families do not see a necessity to upgrade agricultural production but may instead invest in non-farm activities.

The score in the asset index has a positive effect on GlobalGAP adoption, indicating that the better equipped a farmer is with farm assets, the more likely he or she is to adopt the standard *ceteris paribus.* This hints at a wealth effect also found by other studies (Kersting and Wollni 2012; Asfaw et al 2009). The farmers who are able to invest in assets may also be more able to undertake the necessary investments that are not covered by the exporters. If a farmer was already working with an exporter in 2009, this also increases the likelihood of adoption. Farmers with more experience in export markets are used to producing in line with certain quality standards and use this experience in the adoption process. This result is backed up by a study by FAO (2014): They identify pre-existing relationships with the export market as one important determinant of standard adoption. Experienced farmers are more likely to have detailed information about market requirements and future developments, which might also point to the role of trust and long-standing relationships in the certification process.

A farmer's score on the financial literacy index has a significant positive effect on GlobalGAP adoption. This finding confirms our initial assumption that financial literacy plays a significant role in the adoption decision. (For a deeper interpretation of the role of financial literacy, see the next section.) Experience in pea production influences GlobalGAP adoption significantly. Surprisingly, the effect is negative: Farmers with more years of experience in pea production are less likely to adopt GlobalGAP. More experienced farmers might be more conservative and less flexible in applying new

methods or reluctant to accept external advice. Transportation costs to the next market town also have a negative effect on our outcome of interest. The further away and the more remote a farm is, the less willing the farmer seems to invest in standard compliance. This result partly confirms results from similar studies, like that of Kersting and Wollni (2012). We refine the estimation of the distance effect using estimated transportation costs that take into consideration infrastructure and natural conditions. High transaction costs outweigh the benefits of certification for more remote farmers. Export companies may be less present in more remote areas as they also suffer from higher transaction costs in reaching those areas.

To interpret the magnitude of the estimated coefficients, we calculated the marginal effects of the probit model. For the bivariate probit model, the marginal effects are reported as joint probabilities for a success on both stages of the model (Group membership = 1 and GlobalGAP adoption = 1). For continuous variables the marginal effects are calculated at the means, and for dummy variables at the modal value of the variable. In our model female farmers are 11% more likely to be GlobalGAP adopters compared to male farmers. Receiving remittances decreases the adoption likelihood by about 11%. A one unit change in the asset score increases the likelihood of GlobalGAP adoption by 3.4%. If a farmer was working with an exporter in 2009, the adoption likelihood increases by 9%. Experience in pea production has a negative influence on adoption. The marginal effect is small: An extra year of experience in pea production decreases the likelihood by 0.3%. The reported marginal effect of transportation costs is relatively large. For a one unit increase in the financial literacy index, the likelihood of adoption increases by 1.5%.

6.2 Financial literacy and the adoption of GlobalGAP

We identified a significant positive effect of financial literacy on GlobalGAP adoption in the case of Guatemalan fresh pea farmers. To determine the magnitude of the effect, we interpret the marginal effect of financial literacy. A one-unit increase in the financial literacy index results in a 1.5% higher probability of adopting GlobalGAP *ceteris paribus*. For example, the index ranges from -3.6 to 2.6. If a farmer shifts from the lowest quartile of financial literacy to the highest (an increase of 3 units in the index), his or her probability of standard adoption increases by 4.5%. A change from no

financial literacy to the maximum level of financial literacy increases the adoption likelihood by 9%.

While financial literacy has a positive effect on GlobalGAP adoption, we do not find a significant effect of educational level on standard adoption. This result is interesting: It seems that the financial literacy test captures different skills than we do by including years of schooling.[8] Our descriptive results show that higher scores in financial literacy come with on average more years of schooling. We can assume that the skills necessary for standard adoption do not depend on the years a farmer has attended school. Schooling quality or informal learning might be important sources of the financial skills necessary for innovation adoption. Van Rooij et al. (2011) argue that level of schooling is an incomplete proxy for financial or economic skills. Lusardi and Mitchell (2014) see financial literacy as a result of human capital investments rather than the simple result of more years of formal schooling. Studies often do not find a significant effect of years of schooling on technology adoption since schooling quality is low in developing countries (Jolliffe 1998; Hanushek and Woessmann 2008).

Our regression result suggests that asset endowment is important for the adoption of GlobalGAP. We show in the descriptive results that farmers with higher financial literacy skills tend to score better in the asset index. Although the direction of causality is not clear (on the one hand, financial literacy might help build up assets and improve a farmer's economic situation or, on the other hand, having certain asset level may require improvement in financial skills), we see in the descriptive statistics that highly skilled farmers benefit from a better asset endowment, which increases their likelihood of adoption (income effect). Being a member of a farmer group is a prerequisite for certification. Membership comes with advantages for farmers in the form of improved access to extension services, information, inputs, loans etc. Higher financial literacy may help farmers to better use the information and advice necessary for the adoption process. Low cognitive skills are associated with higher information costs. Christelis et al. (2010), for example, find that the association between cognitive skills and stock market participation is driven by information constraints. Non-cognitive effects of financial literacy might also influence adoption behavior. Financial literacy might also

[8] We also ran the model without the financial literacy index. The result was the same: Education is not significant.

influence a farmer's attitude towards certification schemes, for example, by giving more importance to planning in business and financial aspects. The findings of Burks et al. (2009) support our assumptions: They show that cognitive skills influence individuals' preferences.

Financial literacy could also influence standard adoption through the farmers' risk attitudes. Financial literacy might help them build resilience and become less vulnerable towards external shocks, like fluctuating input and output prices, inflation or interest rate changes. This ability might lower their risk aversion towards the adoption of new technologies where the future economic outcome is not clear at the moment of adoption. We do not include any measure of risk aversion in our model, but other studies confirm that low cognitive skills are associated with impatience and higher risk aversion (Dohmen et al. 2007; Burks et al. 2009).

Overall, financial literacy may improve farmers' ability to cope with the disequilibrium effect caused by new technologies. They adjust better to change and are therefore more likely to adopt innovations like the GlobalGAP standard. Financial literacy is not exogenous in our model. Our results might be biased due to some unobserved characteristics that influence financial literacy and GlobalGAP adoption alike, such as intelligence, ambition and diligence. We do not control for this due to the lack of an adequate instrument. Lusardi and Mitchell (2014) summarize the results of research papers that use an instrumental variable approach to control for the endogeneity of financial literacy. In the studies they reviewed, the effect of financial literacy on economic behavior persists even when implementing an instrumental variable approach. But there may still be unobservable variables, such as motivation or intelligence, which bias the results. To overcome this bias, panel data or experimental approaches are needed to isolate the real effect of financial literacy on economic behavior.

7. Conclusions

The increasingly integrated global food system poses new challenges for smallholders. Whether small farmers benefit from the changes might depend heavily on their skills and capacity to adapt to change. It is especially important to comply with food safety and quality standards in order to participate in the high agricultural value chains. The objective of this paper was to assess the role of financial literacy in standard adoption.

Financial literacy has only recently gained attention in agricultural economic research and has not been studied yet in relation to process innovation adoption.

This study focuses on fresh pea production in the Guatemalan highlands. This smallholder-dominated sector has suffered a great deal from sanitary and phytosanitary violations and pesticide overuse. Nevertheless, compliance with food safety standards such as GlobalGAP is very low. In our study we show that, in addition to capital endowment and access factors, financial literacy is a significant factor in the standard adoption process. Farmers with a higher score on the financial literacy index are more likely to adopt GlobalGAP than those with lower scores on the test. The results confirm the assumption that not only access and endowment factors, but also skills like financial literacy play an important role in technology adoption. Whereas cognitive skills in the form of financial literacy matter in GlobalGAP adoption, formal school education is not significant in our setting.

Our results have important practical implications for the public and private actors. Integrating small farmers from developing and transition economies into the modern agrifood system is a concern for the public sector, development organizations and private companies, such as exporters. Huge efforts in the form of extension services, development projects and public subsidy programs are designed in order to help farmers. The adoption of new technologies is an integral part of rural development policies. The public sector may take a leading role in providing the infrastructure, functioning institutions and securing access, but this is not enough. We showed that farmers' ability to use resources and access are important in the adoption process. Hence, farmers' capacity building should be an integral part of rural development policies in Guatemala. Formal schooling may not equip farmers with the skills necessary to cope with new technologies. Informal learning, learning-by-doing and learning from others seem to be important in skill development. Education policy should foster business-related learning through formal education but also informal learning opportunities like group-based learning through farmer field schools or through the use of information technologies in extension services. It might also be helpful for farmers interested in food standard adoption to learn from farmers who are already certified. Platforms for these services could be capacity-building activities or farmer field days. In Guatemalan agriculture, private actors, such as exporters, are taking the

lead when it comes to the adoption of food safety and quality standards. The extension services and training they provide is typically centered on agronomic topics. As farmers are increasingly integrated in complex global value chains, they are transforming from being subsistence farmers to being entrepreneurial farmers. Our results show that exporters should also include more business-related capacity building into their extension repertoire if they seek sustainable conformance with international food standards.

We acknowledge that we have to interpret our results with care. We did not control for endogeneity in the form of an omitted variable problem as we lack a valid instrument. Factors like ambition, intelligence or openness might influence financial literacy and standard adoption alike. We are aware that our results might have limited external validity. Nevertheless our work is a first explorative step towards a better understanding of the role of cognitive skills like financial literacy in agricultural innovation adoption.

Small farmers in developing countries are faced with an ever more complex decision environment. Being equipped with the necessary skills to make proper decisions is vital. Better knowledge of financial matters helps farmers to improve their decision-making ability, their capacity to foresee and adapt to market trends and their resilience and entrepreneurial independence. We took an initial exploratory step towards a better understanding of the role of financial literacy in standard adoption. Further research should deepen the understanding of how financial literacy affects technology adoption. This could be done by considering different dimensions of financial literacy in the analysis or by stratifying the sample based on literacy groups. The effect of financial literacy may also depend on interactions with other variables. To improve the validity of the results, endogeneity problems should be addressed by such means as randomized control trials and other experimental approaches. Looking deeper into the sources of financial literacy - whether developed through formal education or through informal learning and experience - could help improve the design of training programs.

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9. Appendix

A1 Numeracy and financial literacy test

If there is a possibility of 10% of getting ill, how many persons out of 100 would get ill?

Five persons have bought the winning number in a lottery. The prize is 2,000 quetzals. How much will each winner receive?

Imagine you had 1,000 quetzals in a savings account. The annual interest rate is 2% (20 quetzals in the first year). After five years, how much will you have in the saving account if you do not touch the money?

- More than 1020 quetzals
- Exactly 1020 quetzals
- Less than 1020 quetzals

Imagine that your income will double next year. The prices of all the products that you consume will also double. With your income, how much will you be able to buy next year?

- More than this year
- The same as this year
- Less that this year

The bank has leant you 3,000 quetzals; the interest rate is 1% every month. If you pay 30 quetzals every month, when will you have paid back the loan?

- In less than five years
- In less than ten years
- Never

Imagine you get a loan of 1,000 quetzals from the bank. Which option is better for you?

- To pay 5% interest every month
- To pay 24% interest a year

A2 Principal Component analysis for financial literacy test

Table A-1 Principal components for financial literacy

Principal components/correlation
Number of obs. = 277
Rotation: (unrotated = principal)
Rho = 1.0000

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	4.10547	3.30873	0.6842	0.6842
Comp2	0.796745	0.373399	0.1328	0.8170
Comp3	0.423346	0.15087	0.0706	0.8876
Comp4	0.272477	0.0172805	0.0454	0.9330
Comp5	0.255196	0.108431	0.0425	0.9755
Comp6	0.146765	0.	0.0245	1.0000

Table A-2 Factor loadings for component 1

Principal (eigenvectors)	components
Variable	Comp1
Probability skills	0.3610
Division skills	0.3033
Interest	0.4553
Inflation	0.4363
Credit repayment	0.4187
Interest2	0.4524

Table A-3 Kaiser-Meyer-Olkin measure of sampling adequacy

Variable	KMO
Probability skills	0.8972
Division skills	0.8668
Interest	0.8617
Inflation	0.9122
Credit repayment	0.9283
Interest2	0.8698
Overall	0.8888

Table A-4 Bartlett's test of sphericity

Chi-square	1163.503
Degrees of freedom	15
p-value	0.000

A3 Principal component analysis for asset index

Table A-5 Principal components for the asset index

Principal components/correlation
Number of obs. = 277
Rotation: (unrotated = principal)
Rho = 1.0000

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	1.84616	0.429529	0.1420	0.1420
Comp2	1.41664	0.139036	0.1090	0.2510
Comp3	1.2776	0.0526699	0.0983	0.3493
Comp4	1.22493	0.16598	0.0942	0.4435
Comp5	1.05895	0.0197427	0.0815	0.5249
Comp6	1.03921	0.140667	0.0799	0.6049
Comp7	0.89854	0.0263536	0.0691	0.6740
Comp8	0.872187	0.0525365	0.0671	0.7411
Comp9	0.81965	0.105628	0.0671	0.7411
Comp10	0.714022	0.015416	0.0549	0.8591
Comp11	0.698606	0.0892119	0.0537	0.9128
Comp12	0.609394	0.0852783	0.0469	0.9597
Comp13	0.524116		0.0403	1.0000

Table A-6 Factor loadings for component 1

Principal component 1 (eigenvectors)	
Variable	Comp1
Car	0.1752
Pickup	0.3797
Motorbike	0.1257
Bike	0.0525
Truck	0.3073
Knapsack sprayer	0.2996
Knapsack manual	0.1785
Irrigation	0.3449
Reservoir	0.3278
Storage silo	0.1088
TV	0.3500
Radio	0.2796
Mobile	0.3895

Table A-7 Bartlett's test and KMO

Bartlett's test of sphericity	
Chi-square	1163.503
Degrees of freedom	15
p-value	0.000
KMO	0.560

A4 Variables used in the adoption model

Table A-6 Variables, specification and expected effects of the variables used in the adoption model

Variable	***Specification***	***Expected effect***
Age	Age of household head in years	+
Gender	Dummy, 1 if male 0 if female	
Education	Education of household head in years of formal schooling	+
Members	Number of household members working on farm	+
Off-income	Household off-farm income per capita in quetzals	+
Ha owned in 2009	Total ha with formal property title in 2009	+
Land title	Dummy, 1 if farmer has any formal land title, 0 otherwise	+
Irrigation	Dummy, 1 if farmer is using irrigation on at least one plot, 0 otherwise	+
Remesas	Dummy, 1 if household is receiving remittances, 0 otherwise	+
BonoSeguro	Dummy, 1 if household is part of conditional cash transfer program	
Cell	Dummy, 1 if farmer is using cell phone, 0 otherwise	
BuyerFFV	Dummy, 1 if there is a buyer for fresh fruit and vegetables in the village, 0 otherwise	+
TarmacRoad	Dummy, 1 if the village is connected via tarmac road, 0 otherwise	+
Asset	Index of farm assets	+
LivestockNR	Number if Livestock owned	
Mother tongue	Dummy, 1 if mother tongue of the farmer is Spanish, 0 otherwise	+
Exporter before 2009	Dummy, 1 if farmer has worked with an exporter before 2009	+
FLX	Financial literacy index	+
Credit_formal	Dummy, 1 if farm-household has access to formal credit, 0 otherwise	+
Experience pea	Experience in pea production in years	+
Specialization	Share of land allocated to pea production in 2011/12 in %	+
T_costs	Transportation costs to the next market measured in dollars per kg	-