Effects of Participation in Organic Markets and Farmer-based Organizations on the Adoption of Soil Conservation Practices among Small-scale Farmers in Honduras

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Abstract

Conservation agriculture is often perceived to provide "win-win" outcomes for farmers leading to reduced erosion and off-site sedimentation, as well as improved soil fertility and productivity. However, adoption rates for conservation agriculture in many regions of the world remain below expected levels. This paper looks at the effect of organic markets in providing incentives for farmers to adopt soil conservation practices based on the willingness of consumers to pay a price premium for the use of sustainable production technologies. Farmer-based organizations may help farmers overcome information deficiencies with respect to production processes as well as consumer preferences. Based on original survey data from 241 small-scale farm households in Honduras, we find that both participation in organic markets as well as in farmer-based groups have positive effects on the number of soil conservation practices adopted on the farm. The results indicate that besides supply-oriented policy measures, such as the provision of technical assistance and extension, demand-related factors are likely to play an important role in sustainable soil management. Demand-oriented policy measures can include support for labeling initiatives and consumer education to facilitate value-added product differentiation and market segmentation.

Introduction

Poor farmers in developing countries often depend on marginal lands with high risk of erosion and low soil fertility to make a living. In the past, extension services have focused mainly on increasing crop yields without paying adequate attention to maintaining soil functions. In many cases, resource-poor farmers lack the capital to purchase adequate fertilizers and other inputs necessary to obtain consistently high yields. As a result, farmers find themselves trapped in a downward spiral of poverty, low investment capacity, soil degradation and low agricultural productivity.

Conservation agriculture (CA) is considered a promising approach to break this cycle (FAO 2008). Conservation agriculture can entail many things, but often CA relies on soil conservation practices to maintain and improve soil functions, relying on on-farm inputs, and keeping purchased inputs to a minimum (Lee, 2005). Notwithstanding its advantages and widespread promotion for many years, adoption rates of CA practices among small-scale farmers often remain lower than expected. Given that land degradation can irrevocably destroy the resources needed for food production and agricultural income generation, it is critical to identify the factors and policies that promote farm-level adoption of CA in specific instances.

For this reason, a substantive body of literature has been dedicated to investigating the factors that determine the adoption of conservation practices at the farm level (Guerin and Guerin, 1994; Lee, 2005; Doss, 2006). A recent review of the literature concluded that seldom, if ever, can universal factors be identified that uniformly affect adoption across different studies and locations (Knowler and Bradshaw, 2007). Staal et al. (2002) suggest that the location of a farm – defining not only its natural resource base, but also its position in a rural-urban continuum – is a critical factor determining not only the value of land, but also the technologies applied in production. Many studies have included distance variables measuring the distance from the farm to the nearest market, in some cases accounting for qualitative differences in the road structure (Staal et al. 2002). However, results are not unambiguous, revealing both positive (Dimara and Skuras, 2003) and negative (Neill and Lee, 2001), as well as insignificant (Amsalu and de Graaff, 2006) effects of market access on adoption.

These diverse results can be explained by the fact that the distance to the nearest town can influence farmers' decision-making in various ways. Besides its impact on land values and on the availability of technology, proximity to an urban center will influence the access to agricultural output and input markets, the availability of information and support organizations, including lending institutions, as well as the labor pool and the opportunity costs of labor. As a result, those factors that are not explicitly included in the analysis but proxied by the location of the farm may confound the results. In this paper we argue that participation in markets that specifically remunerate farmers for using sustainable production techniques is likely to influence farmers' decisions to allocate scarce resources to soil conservation tasks. To the best of our knowledge, no previous studies have explicitly looked at the potential role of organic niche markets in providing incentives for farmers to adopt soil conservation techniques.

The main contribution of the paper is thus to analyze the effect of participation in organic niche markets on the adoption of soil conservation practices. In addition, we look at the effect that membership in farmer-based organizations has on adoption as well as on market participation. In the econometric analysis, we account for potential bias that may result from the simultaneity of farmers' decision-making, which, if ignored, would confound the statistical results. Based on the empirical findings, we derive recommendations for policy measures that provide support and incentives for the adoption of CA.

The role of organic markets in remunerating sustainable agriculture

The decision to apply soil conservation practices on the farm is a function of the net benefits that the farmer expects to gain from adoption as compared to non-adoption of a technology or practice. The costs associated with adoption can result from higher input and labor requirements of the new technology, e.g. for the establishment of terraces and other measures or for additional weed and pest management activities (Amsalu and de Graaff, 2006). Information costs are also involved in the acquisition of new technology and the learning process, and risks are associated with trying a new technology (Baerenklau, 2005). These costs have to be weighed against the expected benefits. Benefits may include potential labor and input savings as well as increases in output resulting from improved soil fertility (Knowler and Bradshaw, 2007). In addition to these on-farm benefits, there are environmental benefits that extend beyond the boundaries of the farm. These include the prevention of erosion and leakage resulting in reduced downstream sedimentation and contamination, as well as more regularized river flow and reduced flooding (Knowler and Bradshaw, 2007). Furthermore, studies have shown the positive effect of CA, especially conservation tillage, on carbon sequestration (Lal and Kimble, 1997, Allmaras et al., 2000). By retaining fertile and functioning soils, CA can also have positive impacts on food security and biodiversity. It is clear that while most of the costs associated with the adoption decision accrue at the farm level, benefits are gained not only by farmers but also by the society as a whole. Not being able to capture the full benefits of adoption, farmers have less of an incentive to adopt, and adoption rates will typically remain below the socially desirable level. This gap between actual and desired adoption levels can be narrowed through incentive programs that compensate farmers for the services that they provide to society (Knowler and Bradshaw, 2007).

Giovannucci and Ponte (2005) note the potential of organic market segments to have a positive impact on the adoption of conservation techniques. As Hobbs et al. (2001) emphasize, consumers' search for variety, induced in part by higher per capita incomes, does not only include the attributes of the food product itself but also the production process that generates it. From the perspective of environmentally concerned consumers, the conservation technologies applied in the production process can add value to the end product. The willingness of consumers to pay price premiums for this added value provides incentives to producers to adopt conservation technologies. An important role of the marketing channel is thus to send the right signals in both directions: transmitting information about those aspects of the production process relevant to the consumer, as well as informing the producer about the preferences of consumers. While the organic market segment provides an opportunity to remunerate farmers for their conservation activities valued by consumers, there has been a tendency toward shrinking price premiums in recent years (Giovannucci and Ponte, 2005), which will undermine the provision of incentives to farmers.

When evaluating the adoption of conservation agriculture, an important issue is the competition for scarce resources between agriculture and other income-generating activities. In many regions, farm households have to supplement their agricultural income with off-farm income in order to make a living. In many rural areas, the development of infrastructure has improved access to urban centers, where more off-farm jobs are available. Previous studies have found that in regions where off-farm employment plays a major role, farmers are less likely to divert labor to conservation practices if the economic returns from off-farm labor are higher than the perceived added benefits from investing scarce labor in soil conservation (Neill and Lee, 2001; Jansen et al., 2006; Moser and Barrett, 2003; Lee, Barrett, and McPeak, 2006). In this context, price premiums for sustainably produced products can increase agricultural profitability thus inducing the allocation of scarce labor resources toward these activities.

Farmer-based organizations and transaction costs

Poor farmers face many constraints in technology adoption decisions, including limited financial resources, and limited access to information, education and extension. The latter can prove critical, especially in the case of knowledge-intensive technologies such as many forms of conservation agriculture. The application of conservation practices and integrated soil management techniques requires farmers to learn new skills and understand biophysical processes that determine the functioning of the soil and impact agricultural yields. Previous studies have documented a positive effect of extension on the adoption of conservation practices (Jansen et al., 2006; Martin and Taylor, 1995; Somda et al., 2002), education (Rahm and Huffman, 1984) and information availability (Feather and Amacher, 1994; Bekele and Drake, 2003). However, the cost of gathering information regarding a new technology and the associated market opportunities can be prohibitive for individual farmers.

While farmers will often be unable to bear the high transaction costs themselves, cooperatives and farmer-based organizations can exploit economies of scale in the provision of services (Deininger, 1995; Weaver and Wesseler, 2004). These organizations can collect information about production technologies and consumer preferences and provide it to their members in the form of extension visits, field schools and demonstration sessions. While the cost of obtaining this information would exceed the benefits to an individual farmer, members can benefit collectively from the information collected at the cooperative level (Shaffer, 1987). Different authors have considered the important role of cooperatives and farmers' organizations in providing farmers with access to differentiated market segments (Sick, 1999; Verhaegen and van Huylenbroeck, 2001; Varangis et al., 2003) and in fostering the adoption of conservation practices (Smit and Smithers, 1992; Swinton, 2000; Rodriguez and Pascual, 2004). Thus, by reducing information search costs, cooperatives and farmer-based organizations can potentially help farmers overcome information deficiencies related to production technology as well as market access.

Research area and empirical data

The study is based on original survey data from 241 small-scale farmers in Honduras. The survey was implemented in the state of La Paz, which is located in the southwestern part of the country bordering El Salvador. Six municipalities and twenty villages were selected in a multi-stage random sampling procedure; in each village, twelve households were randomly selected. A standardized questionnaire was used to collect data on soil conservation practices, access to information and institutions, demographic and socio-economic household data, farm and plot characteristics, agricultural production and market participation. In addition, the geographic location of households was recorded using GPS, thus allowing the households to be matched with geographically-referenced data on soil types and distance to the nearest major town (CIAT 2001).

The study area is characterized by hillside agriculture, mostly basic grains (corn and beans) and coffee cultivation. The sloping terrain is highly susceptible to soil erosion and degradation. Soil conservation is promoted by different organizations ranging from NGOs and bilateral and multilateral technical cooperation projects to farmer-owned cooperatives and associations. From the traditional "training and visit" approach, the methodological focus of technical assistance and extension has shifted to more experimental and participatory methods such as farmer field schools, but successful examples of these newer approaches are still relatively sparse in the area.

The soil conservation practices most extensively applied among the households in the study sample are live barriers and mulching. In addition, about one-third of the households plant along contour lines and apply organic manure. All other conservation practices including terraces/stone walls, drainage ditches, cover crops and crop rotations, are used by only 10% or less of the households in the sample.

Chi-square test results show a strong relationship between participation in local farmer-based groups and the adoption of selected conservation techniques (see Table 1). Group members are more likely to adopt living barriers, to plant along contour lines, and to apply organic manure. Furthermore, group members use a more diverse set of conservation practices on their farms. Member households of farmer-based groups use an average of 2.4 different techniques as compared to 1.6 different practices used by non-member households on the average[1].

About one-fifth of the households in the sample produce exclusively for home consumption. However, the majority of the households sell part or all of their agricultural output in the market. For approximately one-fourth of those households that sell in the market, this merely refers to the local village market. The vast majority of the remaining households sell their products in Marcala, the local town, where coffee traders and a village market serving local farmers are located. Overall, 20% of the households in the sample sell their products in the organic market segment. Chi-square test results reveal that farmers who are members in a farmer-based group are more likely to participate in the organic market. In addition, there is a positive and significant relationship between organic marketing and the use of living barriers and organic manure on the farm (see Table 2).

Econometric model

A three-stage least-squares model is used to simultaneously analyze the factors that influence membership in farmer-based groups, participation in organic markets, and the number of soil conservation practices adopted. The econometric model is selected to control for potential endogeneity bias and the simultaneity of decision-making. Endogeneity bias arises if farmers self-select into local farmer groups resulting in the unobserved household characteristics of members being systematically different from non-members. This potential source of bias is often mentioned in the adoption literature but rarely controlled for in econometric analysis. The second issue is a result of production and marketing decisions being made simultaneously, i.e., farmers select the

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[1] Independent samples t-test is significant at 1% probability of error ($p < 0.01$).

production technology according to the target market and, at the same time, the market choice depends on the farmer's willingness and ability to produce certain crops in specific ways. In the first stage of the three-stage procedure, the endogenous variables are regressed on all the exogenous variables in the system. In the second stage, the fitted values of the endogenous variables are used to obtain two-stage least-squares parameter estimates for all equations in the system. In the third stage, generalized least-squares estimates are obtained taking into account cross-equation correlation among the disturbance terms (Zellner and Theil, 1962; Pindyck and Rubinfeld, 1998; Wooldridge, 2002).

The three-equation system representing the farmer's decision to participate in farmers' groups (G_i) and in organic markets (O_i), and the number of soil conservation practices that is applied on the farm (S_i) is defined as:

$$S_i = \alpha_0 + \alpha_1 G_i + \alpha_2 O_i + \alpha_3 X_{1i} + \varepsilon_1$$
$$O_i = \beta_0 + \beta_1 G_i + \beta_2 X_{2i} + \varepsilon_2$$
$$G_i = \gamma_0 + \gamma_1 X_{3i} + \varepsilon_3$$

where α, β and γ are vectors of unknown parameters to be estimated, the X's are vectors of exogenous variables that include variables that are identical as well as dissimilar among the three equations, and the ε's are normally distributed random error terms with mean zero and variance σ^2.

Potential explanatory variables

In order to identify indicators for inclusion in the model and their respective hypotheses, we draw on the literature on the adoption of innovations and program participation. The *number of soil conservation practices applied* on the farm is modeled as a function of participation in farmer-based groups and organic markets as well as a number of exogenous household and plot-related variables. Membership in farmer-based groups and participation in organic markets, both endogenous variables in the model, are expected to have a positive impact on the number of soil conservation practices adopted. Furthermore, we include the age of the household head, the maximum education (in years) of household members, and household size as potential explanatory variables explaining adoption. Education is assumed to enhance the farmer's ability to access and process information and is therefore expected to have a positive effect on the adoption of new and knowledge-intensive technologies (Rahm and Huffman, 1984). The number of household members reflects the availability of family labor that could potentially be used on the farm and is therefore expected to be positively related to the number of conservation activities performed on the farm (Neill and Lee, 2001). In addition we include a dummy variable that equals one if the household head works on the farm. Assuming that the farming activity is given priority if the household head is involved with it, the effect on adoption is expected to be positive. Previous studies have found a positive impact of extension on conservation (e.g. Jansen et al., 2006). We therefore include a dummy equaling one if the household received extension services with respect to conservation practices. Based on the assumption that an ownership title of the land gives the household security and thus incentives for investment, we include a dummy variable expecting a positive impact of formal land ownership on soil conservation (Neill and Lee, 2001). Finally, we include a variable representing the number of livestock owned by the household. The hypothesized effect of this variable is ambiguous. On one hand, livestock may compete with plots for crop residues (nutrients) and labor and will thus have a negative effect on soil conservation; on the other hand, studies have also found synergies between livestock and soil management (Marenya and Barrett, 2007, Kristjanson et al., 2005).

Various plot-related variables are included in the model, most of which are typically expected to have a positive effect on the number of soil conservation practices applied on the farm. Previous studies have found plot slope and farm size to be a positive and significant determinant of soil conservation (Bekele and Drake, 2003, Neill and Lee, 2001, Amsalu and de Graaff, 2006, Marenya and Barrett, 2007). Access to irrigation as well as having a river bordering the plot is assumed to increase the value of the land, thus motivating its conservation. Moreover, the likelihood of soil fertility management is expected to increase with the number of years that the household has owned and cultivated the land. With respect to the type and quality of the soil, we include three dummy variables that represent different soil types that were classified based on their agricultural suitability (Simmons and Castellanos, 1968). Soil type MI is characterized by high productivity and the need for moderate soil conservation due to its location in hilly terrain. Soil type CR is rated as being susceptible to erosion resulting in soil conservation and tree cover being highly recommended. Soil type CO is only suitable for pastures and forest use. The soil type excluded from the model (to avoid multicollinearity) is the soil of the valley bottomlands, characterized by high productivity and mostly flat terrain.

Participation in organic markets is modeled as a function of household variables, such as age and literacy of the household head and household size, as well as economic and location variables. Both household size, reflecting access to family labor, and literacy are expected to have a positive effect on participation in organic markets. As economic variables we include three dummy variables reflecting different crop choices as well as a variable reflecting the existence of income from salaried employment. Crop choices are represented by major categories, i.e., whether the household grows vegetables, fruit and coffee. The effect of salaried employment is ambiguous. If scarce labor resources are diverted from the farm, this can have a negative effect on participation in niche markets. On the other hand, farmers pursuing off-farm activities often have better access to information. In addition, we include a variable for participation in extension with respect to organic product markets and another for the distance to the local market of Marcala. Extension and geographical proximity are expected to increase the likelihood of participation in organic markets. Finally, as discussed earlier in this paper, membership in farmer-based organizations is expected to have a positive effect on participation in niche markets.

The equation for *participation in farmer-based organizations* also includes the age and literacy of the household head, whether the household head works on the farm, the existence of salaried employment, and participation in specific extension services as potential explanatory variables. Furthermore, female-headed households are expected to be more likely to participate in farmer-based groups, as they are specifically targeted by some of the farmer organizations in the study area. If households grow coffee, they are more likely to participate in farmer organizations, which help them with coffee marketing. Additionally, we include a dummy variable that equals one if a household member migrates to Marcala for work. Given that the main offices of the organizations are also located in the local town, we expect a positive influence on participation in farmer groups. Furthermore, we use the number of groups of which a household is a member (other than farmer organizations) as a proxy for willingness to cooperate. However, the effect could also be negative if time constraints prevent farmers from participating in multiple organizations. Finally, a reservation index is constructed reflecting the farmer's attitudes towards experimenting with new technologies, the usefulness of extension services, and his neighbors and other farmers in the community. The score of the index ranges between one, meaning that the farmer is open-minded and keen to cooperate and experiment, and three, meaning that the farmer is skeptical about cooperation and extension services (see footnote to Table 3 explaining the index in more detail). Summary statistics for the variables included in the econometric model can be found in Table 3.

Model results

The estimation results are shown in Table 4. Estimation of the three-stage least-squares model reveals that participation in both farmer-based groups and organic markets have a positive effect on the number of soil conservation practices adopted. Additionally, households that received extension services with respect to soil conservation are more likely to apply multiple practices. With respect to socio-demographic characteristics, the analysis shows that households are more likely to adopt conservation practices, if the household head works on the farm. In addition, the higher the maximum educational level attained by the household members, the more soil conservation practices are adopted. Furthermore, the number of soil conservation practices applied on the farm increases with plot-related variables such as slope, access to irrigation, and the number of years that the plot has been cultivated by the household. Similarly, soil type is found to be an important predictor for the use of soil conservation practices. Interestingly, households located on the soil type most suitable for agriculture (soil type SV, excluded from the model) as well as households located on the soil type least suitable for agriculture (soil type CO) employ fewer soil conservation practices. Soil types MI and CR have a positive and significant coefficient indicating that households apply significantly more soil conservation practices as compared to households located in areas with soil type SV (the soil type excluded from the model). An unexpected result is that the size of the family has a negative impact on adoption. In contrast to some other studies, land ownership, land size and cattle holdings are not found to be significant factors.

As expected, membership in farmer-based groups positively influences participation in organic markets. Furthermore, the likelihood of selling products as organic increases with age and literacy of the household head, as well as with family size. Additionally, farmers that grow fruit as well as households that have received extension services with respect to organic agriculture are more likely to participate in the organic market.

Finally, with respect to participation in farmer-based organizations, households are less likely to participate if they have salaried employment or are a member of another group or local organization, suggesting that these households are facing time constraints. On the other hand, households are more likely to participate in farmer-based groups if a household member migrates to Marcala for work. This likely reflects the households' greater mobility and access to information sources given that the main offices of the farmer-based groups are also located in the town. Furthermore, households that grow coffee are more likely to participate in farmer-based groups, which is most likely a result of coffee produced by small-scale farmers being largely marketed through cooperatives and farmers' associations. In addition, farmers that received extension services with respect to group organization are more likely to be a member of a farmer-based group. Finally, the reservation index has a negative sign indicating that farmers who have a positive attitude towards cooperation and innovative agricultural practices are more likely to join a farmer-based group.

Conclusions and policy implications

Based on these findings, local farmer-based groups appear to be successful in fostering the adoption of soil conservation measures and in facilitating access to organic markets. Moreover, there is evidence that participation in organic markets has a positive effect on the adoption of conservation practices. The results indicate that adequate policy measures that focus on the supply side need to be designed in order to help farmers overcome information deficiencies related to conservation technologies. These measures include the support of local organizations that can effectively provide farmers with extension and information reducing the transaction costs faced by small-scale farmers. The results further suggest that demand-related factors play an important role in sustainable soil management decisions. On the demand side, organic and sustainable niche markets that remunerate farmers for using conservation practices can provide incentives for adoption. Aldy et al. (1998) suggest that one mechanism to promote sustainable agricultural practices would be for policymakers to facilitate the certification and labeling of sustainable agricultural produce to inform consumers and legitimize price premiums. While the results of this study seem promising, Giovannucci and Ponte (2005) point out the tendency of shrinking price premiums in the organic segment during recent years. This development would undermine the incentives given to farmers to adopt conservation agriculture.

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Table 1: Participation in farmer-based groups and adoption of conservation practices

Conservation practices		**Member in farmer-based group?** yes	no	**Chi-square test statistic**
Living barriers	yes	103	33	13.25**
	no	56	49	
Mulching	yes	81	37	0.73
	no	78	45	
Plant along contour lines	yes	62	16	9.38**
	no	97	66	
Organic manure	yes	59	8	20.16**
	no	100	74	
Terraces / stone walls	yes	21	4	4.04*
	no	138	78	
Drainage ditches	yes	16	5	1.07
	no	143	77	
Cover crops	yes	13	7	0.01
	no	146	75	
Crop rotations	yes	8	2	0.91
	no	151	80	

*(**) significant at 5%(1%) probability of error

Table 2: Participation in organic markets, farmers' groups and adoption of conservation practices

Farmers' groups		**Participates in organic market?** yes	no	**Chi-square test statistic**
Member in farmers' group	yes	43	116	14.88**
	no	5	77	
Conservation practices				
Living barriers	yes	35	101	6.63**
	no	13	92	
Mulching	yes	25	93	0.23
	no	23	100	
Plant along contour lines	yes	20	58	2.37
	no	28	135	
Organic manure	yes	35	32	60.78**
	no	13	161	
Terraces / stone walls	yes	4	21	0.27
	no	44	172	
Drainage ditches	yes	4	17	0.01
	no	44	176	
Cover crops	yes	4	16	0.00
	no	44	177	
Crop rotations	yes	5	5	5.92*
	no	43	188	

*(**) significant at 5%(1%) probability of error

Table 3: Summary statistics

Variable	Description	N	Mean	Std. dev.
S	number of soil conservation practices adopted	241	1.485	1.301
O	household participates in organic market (0/1)	241	0.199	0.400
G	household participates in farmer group (0/1)	241	0.660	0.475
AGE	Age of the household head (years)	241	46.477	13.417
WRITE	household head can read and write (0/1)	241	0.805	0.397
SCHOOL	maximum years of schooling of household members (yrs.)	241	7.054	2.306
FEMALE	household is female headed (0/1)	241	0.224	0.418
FARMHH	household head works on the farm (0/1)	241	0.809	0.394
HHSIZE	number of household members	241	5.627	2.157
SALARY	household pursues salaried employment (0/1)	241	0.112	0.316
MIGRA	household member migrates to Marcala for work	241	0.357	0.480
RESERV*	Reservation index describing farmer's attitude from 1 = experimental to 3 = conservative	239	1.622	0.233
NR_GROUP	number of groups that the HH participates in (excl. farmer groups)	241	0.461	0.689
COFFEE	household grows coffee (0/1)	241	0.539	0.499
EXT_G	household received extension with respect to group organization (0/1)	241	0.274	0.447
SLOPE	slope of the steepest plot (categories 1-5#)	238	1.684	0.675
AREA	cultivated land area (ha)	241	24.397	26.666
RIVER	whether a river borders the land (0/1)	238	0.382	0.487
YEARS	years that the household has cultivated the land	240	14.878	12.019
IRRIG	access to irrigation (categories 1-4##)	239	1.502	0.840
TITLE	whether household has a title for the land (0/1)	241	0.813	0.390
CATTLE	number of cattle owned	241	0.390	1.251
SOIL_MI°	soil type MI: high productivity, moderate soil conservation necessary (0/1)	234	0.436	0.497
SOIL_CR°	soil type CR: susceptible to erosion, soil conservation and tree cover highly recommended (0/1)	234	0.043	0.203
SOIL_CO°	soil type CO: only suitable for pasture and forest use (0/1)	234	0.145	0.353
EXT_S	household received extension with respect to soil conservation (0/1)	241	0.232	0.423
VEGGI	household grows vegetables (0/1)	241	0.137	0.344
FRUIT	household grows fruit (0/1)	241	0.564	0.497
DIST_M	distance to Marcala (in meters)	234	14005.590	8415.262
EXT_O	household received extension with respect to organic markets (0/1)	241	0.249	0.433

* reservation index: includes 4 variables scaled from 1 to 3. Scores are added up and total score is divided by 4. Interpretation: 1 = experimental, 3 = conservative. Questions regard the farmer's attitude towards new agricultural practices, extension services, and opinion about his neighbours' attitude.

Slope is categorized into 5 levels: 1 = 0-20%, 2 = 21-40%, 3 = 41-60%, 4 = 61-80%, 5 = 81-100%

Access to irrigation is categorized into 4 levels: 1 = no access (169 households), 2 = gravity irrigation (24 households), 3 = sprinkler irrigation (42 households), 4 = drip irrigation (4 households)

° Local soil classification based on agricultural suitability according to Simmons and Castellanos (1968). Geo-referenced map is available at http://gisweb.ciat.cgiar.org (The Mitch Atlas). Soil type that is left out of the econometric model to prevent multicollinearity is soil type SV: "soil of the valleys", high productivity and mostly flat terrain.

Table 4: Model results (three-stage least-squares model)

	Number of soil conservation practices			Participation in organic markets			Participation in farmer-based groups		
	Coeff.			Coeff.			Coeff.		
O (groups)	0.870	(0.346)	***	0.202	(0.099)	**			
M (organic)	0.706	(0.387)	*						
AGE	-0.002	(0.006)		0.004	(0.002)	**	0.002	(0.002)	
SCHOOL	0.079	(0.030)	***						
WRITE				0.102	(0.060)	*	0.070	(0.076)	
HHSIZE	-0.078	(0.033)	**	0.021	(0.011)	**			
FARMHH	0.286	(0.175)	*				0.057	(0.075)	
FEMALE							0.113	(0.072)	
SLOPE	0.405	(0.100)	***						
AREA	0.004	(0.003)							
RIVER	0.177	(0.155)							
YEARS	0.013	(0.006)	**						
IRRIG	0.316	(0.082)	***						
TITLE	-0.010	(0.168)							
CATTLE	-0.022	(0.056)							
SOIL_MI	0.841	(0.161)	***						
SOIL_CR	0.986	(0.338)	***						
SOIL_CO	0.233	(0.218)							
EXT_S	0.416	(0.181)	**						
EXT_O				0.236	(0.063)	***			
SALARY				0.116	(0.075)		-0.227	(0.094)	**
VEGGI				-0.087	(0.069)				
FRUIT				0.214	(0.057)	***			
COFFEE				-0.008	(0.069)		0.129	(0.055)	**
DIST_M				0.000	(0.000)				
MIGRA							0.131	(0.064)	**
RESERV							-0.461	(0.118)	***
NR_GROUP							-0.173	(0.039)	***
EXT_G							0.365	(0.065)	***
Constant	-1.494	(0.537)	***	-0.481	(0.141)	***	1.083	(0.250)	***
N	228			228			228		
R^2	0.447			0.265			0.272		
chi^2	191.34 ***			90.09 ***			83.64 ***		

Note: Standard errors in brackets
*(**)[***] The null-hypothesis is rejected at a level of significance of p=0.10 (0.05) [0.01]