Soil conservation behavior among annual crop farmers: the moderating role of intrinsic on extrinsic motivations.

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Abstract:

This article examines the influence of intrinsic and extrinsic motivations, as well as the interplay between the two, on the adoption intensity of soil conservation agriculture (SCA). It seeks to understand the drivers of SCA among annual crop farmers using three conservation practices subject to be financed by an economic incentive for degraded soils in Chile; namely conservation tillage, stubble incorporation, and use of organic manure. The incentive to conservation represents an extrinsic motivation, while intrinsic motivations was represented by several beliefs about SCA based on the Planned Behavior Approach. To account for selection bias on unobservable factors between the incentive and behavior, a two-step model was performed to estimate the intensity of SCA adoption. Farm/farmers characteristics and control variables were also included in the model. Results of the econometric analysis show that attitudes and the exogenous incentive are both significant, but also the interaction with each other. Farmers with low intrinsic motivation are heavily dependent on extrinsic motivation to adopt SCA, while those intrinsically motivated seem to act in a sustainable way regardless the existence of external rewards. Finally, soil degradation was also found to play a key role on the intensity of SCA adoption.

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Keywords: Sustainable farming, environmental awareness, Poisson model, conservation agriculture, monetary incentive.

1. Introduction

Prevailing agriculture is characterized by the intensive use of inputs and soil tillage (Lalani et al., 2016; Teklewold et al., 2013), which in addition to conventional practices of removal and burning of stubble, have generated nutritional degradation, physical erosion and loss of organic matter (Rockström et al., 2009). Changing from conventional to soil conservation agriculture (SCA) represents a radical transformation for farmers (Rockström et al., 2009), depending on economic, sociological and psychological factors (Baumgart-Getz et al., 2012; Burton, 2014; Van Hulst and Posthumus, 2016). Hence, it is important to analyze the determinants of the adoption of SCA under a broader approach, not limited to the maximization of the expected utility (Chouinard et al., 2016; Pannell et al., 2014; Reimer et al., 2014), as it has been done typically. A better understanding of the motivation and limitations of adoption of SCA could help to improve current policy programs and/or develop new ones.

Despite the numerous attempts to explain the adoption of conservation agriculture, there is no consensus on the approach nor universal variables to be used to explain such behavior (Knowler and Bradshaw, 2007; Wauters and Mathijs, 2014). Some models have focused in classical variables of production and consumption, such as socioeconomic, soil/weather conditions and extension variables (Arslan et al., 2014; Fernandez, 2017; Pedzisa et al., 2015). While other recent studies have used socio-psychological approaches, such as the Reasoned Action Approach (see Van Hulst and Posthumus, 2016), the Protection Motivation Theory (see Keshavarz and Karami, 2016), the Value-Belief-Norm Theory (see Price and Leviston, 2014), among the most relevant. They are all based on causal relationships between individual beliefs about a particular action and the intention to perform it, which become in behavior.

In particular, the Planned Behavior Theory has been widely applied in empirical studies modeling farmers' behavior. This theoretic framework is composed by three constructs: attitude towards the action, perceived social norms and personal behavioral control. Additionally, Gould et al. (1989) in his seminal study on the implementation of SCA, indicates that awareness of soil erosion is a prerequisite for adoption. This recognition of the problem, that represent the need for action, has been also tested empirically by recent studies, showing a positive impact on the adoption of SCA (Abdulai, 2016; Wauters and Mathijs, 2014). From socio-psychological variables reflecting people's motivations to conservation, attitudes is the most widely used variable in previous studies usually having a positive impact on the adoption of soil conservation practices (Wauters and Mathijs, 2014).

Related literature distinguishes between two types of motivations, depending whether it arises from outside or inside the individual. Intrinsically motivated people participate in activities just because they find them satisfying, regardless the existence of external rewards (Rode et al., 2015; Ryan and Deci, 2000). In fact, it has been observed that farmers intrinsically motivated towards sustainability are more prone to adopt conservation practices than profit oriented farmers, who are strongly motivated by external factors such as government incentives (Greiner et al., 2009). In this sense, environmental policy tend to rely on market forces to guide on farmers' specific behaviors by offering economic rewards. Although this kind of mechanisms provide one important approach to address environmental degradation, there is evidence that rewards can decrease intrinsic motivation (Ryan and Deci, 2000). According to Deci et al. (1999), external rewards to influence behavior can have the unintended consequence of reducing the desired behavior as they focuses people on the reward rather the action.

In this study we explore the adoption of SCA in terms of the number of soil conservation practices adopted by farmers, evaluating the effect of an economic incentive to conservation (extrinsic motivation), attitudes towards conservation practices (intrinsic motivation), and the interplay between these two types of motivation. To the best of our knowledge, there are no studies in conservation agriculture testing empirically the interaction between intrinsic and extrinsic motivations in real contexts, at the farm level. Within this context, we investigate the Incentive for the Agro-Environmental Sustainability of Degraded Soils (SIRSD-S) that has been subsidizing the adoption of SCA in Chile since 2010. The main goal of this program is to recover the productive potential of degraded soils through five specific activities, namely: incorporation of phosphorus fertilizers, correction of essential chemical elements, vegetation cover in unprotected soils, sustainable management practices and habilitation of soils with physical impediments (ODEPA, 2017). With regard to the amount of the incentive, it varies depending basically on farmers' size, covering up to 90% of the reference costs in the case of small producers, 70% to medium and 50% to large producers (BCN, 2012).

2. Data

The study area is located in two regions of southern Chile, Biobío and Los Lagos (between 36º00' and 44º14' South). The sampling procedure consisted in a randomized selection of annual crop farmers, beneficiaries and non-beneficiaries of the SIRSD-S. Based on yearly cadastrals of the program, the group of beneficiaries were farmers who received the conservation incentive between 2012 and 2015, while non-beneficiaries were farmers that applied to the program but were rejected during the same period. This information came from two public services responsible for the assignment of the incentive: the Agricultural Development Institute (INDAP) and the Agricultural and

Livestock Service (SAG)[1]. Once farmers were identified, a survey was applied to them by 2016 in order to gather information about the characteristics of the producer, the farm, the production system and soil sustainable practices implemented, as well as a broad section on perceptions and SCA. It is worth noticing that the sample was extended to farmers personally contacted on site, only after checking the eligibility criteria to participate in the program. That being said, the database in question consisted in 425 observations.

3. Methods

3.1. Confirmatory factor analysis

The theoretic framework to conceptualize intrinsic motivation to SCA is based on the Planned Behavior Approach (Fishbein and Ajzen, 2009). It explain the intention to adopt and the subsequent behavior, based on internal beliefs of attitudes, norms, and perceived control. To measure this three constructs, a set of indicators was used. Farmers were asked to rate statements in an increasing Likert scale, from 1 to 7. However, prior to its inclusion in the model, a Confirmatory Factor Analysis (CFA) was performed with the aim to validate them and assess the loads of each indicator. Using the software STATA 14, the sentences were analyzed by the Factors Analysis method, rotated by orthogonal varimax with a cut-off point of 0.7.

2.3. Model of Soil Conservation Agriculture

To model the intensity of adoption of SCA we performed a count model. The dependent variable correspond to the number of soil conservation practices that the farmers adopt, including zero/minimum tillage, stubble incorporation, and use of organic manure. These three sustainable practices are part of the practices financed by SIRSD-S and are possible to be implemented by our sample of annual crop producers. Generally, conservation practices are composed by three axes defined by FAO[2]: minimal soil disturbance, permanent cover of the surface, and crop rotation. We decided not to include crop rotation since it is applied not only for conservation purposes, but diversification. Besides, we vary from permanent cover to stubble incorporation because the later provide similar functionalities but on soils actually dedicated to agriculture.

The participation in SIRDS-S program represents the farmers' extrinsic motivation to conservation, which is expected to have a positive effect on the adoption intensity of SCA. On the other hand, is also expected that farmers implementing SCA be more likely to apply for the incentive as well. This simultaneity between the predictor and dependent variable represent an endogeneity problem due to participation selection that lead to biased estimates (Bratti and Miranda, 2010). For this reason, to model SCA empirically we will use a two step estimation procedure to account for the endogenous treatment-effect. As described by Greene (2009), this estimation approach is based on a basic

[1] Both entities have different users depending on the size of the famer. The farmer belongs to INDAP if he/she had 12 Basic Irrigation Hectares (HRB) or less, otherwise belongs to SAG. HRB represent an equivalence of area according to the capacity of use or production potential (the reference of top quality is one irrigated hectare in the Maipo River Valley of Chile).

[2] FAO (Food and Agriculture Organization), 2015. What is Conservation Agriculture?. <http://www.fao.org/ag/ca/1a.html>. Accessed by 10-12-2017.

selection model. The first step estimates a participation equation, the second a count equation that includes the instrumented treatment variable from the first:

Step 1: SIRSD-S equation $$S_i = \alpha V_i + \mu_i \quad (1)$$

Step 2: SCA equation $$CA_i = \alpha A_i + \beta M_i + \gamma S_i^* + \delta S_i^* * M_i + \theta Z_i + \epsilon_i \quad (2)$$

where S_i^*, from the first step, is the SIRSD-S participation variable, V_i is a vector of exogenous characteristics that affect the condition of being beneficiary of the incentive. CA_i denotes the number of soil conservation practices implemented by farmers (beneficiaries and non-beneficiaries), A_i correspond to soil degradation awareness, M_i is a vector of intrinsic motivations including attitudes and perceived control towards conservation practices. On the other hand, S_i^* is the prediction of participating in the SIRSD-S from the first step, $S_i^* * M_i$ correspond to the interaction term between the instrumented SIRSD-S variable and attitudes towards conservation practices, and Z_i is a vector of farm and farmer characteristics related to the adoption of SCA. Finally, μ_i and ϵ_i are random errors associated with the first and second step, respectively.

The first step of the treatment effect count model consist in a probit model to explain the condition of being beneficiary or not. It includes covariates related to characteristics of the farm and the farmer. Regarding the count model of SCA equation, of main interest of this study, includes the instrumented participation in the SIRSD-S, the perception of soil degradation as a threat, and farmers' intrinsic motivation. Intrinsic motivations will be measured by the constructs participating in the Planned Behavior Approach of Fishbein and Ajzen (2009), namely attitudes, norms, and perceived control towards soil conservation practices, elicited as constructs with Factor Analysis (see section 3.1).

4. Results and Discussion

4.1. Confirmatory factor analysis and descriptive statistics

As explained in section 2.2., the statement of beliefs regarding attitudes, norms, and perceived control to implement soil conservation practices were subject to Factor Analysis in order to validate and condense the number of indicators. Using a cut-off point of 0.7, this procedure could retain only two of three factors from the Planned Behavior Approach. Results show constructs for Attitudes and Perceived Control. Norms did not result in a reliable construct. More details are presented in Appendix A.

Before starting with the regression analysis, some descriptive statistics for the variables used in the model are provided in Table 1, including those coming from the FA.

Table 1. Descriptive statistics of the variables included in the model (425 observations).

Code	Variable name	Beneficiaries (194 obs.)	No-beneficiaries (231 obs.)	T-test[a]
NUM	Sustainable practices implemented in the farm (none, one, two or three)	0.85	0.53	***
ATTI	Factor of Attitudes from Factor Analysis (normalized 0-1)	0.15	-0.18	***
PCON	Factor of Perceived Control from Factor Analysis (normalized 0-1)	0.20	-0.24	***
WOR	Soil degradation worry (increasing Likert scale from 1 to 7)	4.3	4.3	NS

SIZE1	Small scale farmers, from 0.5 to 9,4 ha (percentage)	5.8	3.1	***
SIZE2	Medium scale farmers, from 9.5 to 36 ha (percentage)	20.4	17.9	*
SIZE3	Large scale farmers, from 36,1 ha to 600 ha (percentage)	167.1	183.2	NS
ORG	Participating in community associations (percentage)	62.8	47.4	***
EDU	Educational level (years)	9.5	8.1	***
EXP	Experience (years)	38.7	38.6	NS
PENS	Amount of pensions on total income (percentage)	11.7	18.1	***
ACQU	Farmer's acquaintances who practice conservation agriculture (number)	11.4	3.1	***
ENTI	Belonging to the entity SAG rather INDAP (percentage)	18.2	25.8	*
EFAM	Being a company rather a family enterprise (percentage)	77.9	70.6	*
VALL	Belonging to the intermediate valley (percentage)	50.2	55.1	NS
REG1	Belonging to Biobío region (percentage)	66.2	65.5	NS
REG2	Belonging to Los Lagos region (percentage)	33.8	34.5	NS

[a] Significance level ***: $P < 0.01$; **: $P < 0.05$; *: $P < 0.1$; and NS means "no statistically significant".

First, we compare beneficiary (54% of the sample) and non-beneficiary (46%) farmers of the SIRSD-S. Regarding the intensity of SCA adoption, is relevant to say that 48% of the sample do not adopt any of the soil conservation practices evaluated in this study, 34% adopt just one, 14% two soil conservation practices, and 4% jointly the three. The average number of soil conservation practices is 0.7, however, this rate is significantly higher for beneficiaries of the SIRSD-S compared to non-beneficiaries (0.5 vs 0.9, respectively). The difference in adoption between both groups can be explained by the SIRSD-S incentive provided to adopt SCA. This program seeks to recover and maintain the productive potential of degraded agricultural lands[3]. On the other hand, it can also be observed that beneficiaries present higher levels of intrinsic motivation, which for the purposes of this study is associated to positive attitudes and perceived control towards SCA. However, surprisingly, there are not significant differences in terms of awareness on soil degradation between groups.

Regarding socioeconomic characteristics, farmers who received the incentive have higher educational level, participate in community associations, know a higher number of colleagues practicing conservation agriculture, and depend in a greater extent on

[3] INDAP (Institute of Agricultural Development), 2017. <https://www.indap.gob.cl/servicios-indap/plataforma-de-servicios/financiamiento/!k/programa-sistema-de-incentivos-para-la-sustentabilidad-agroambiental-de-los-suelos-agropecuarios-(sirsd-s)>. Accessed by 10-12-2017

pensions. Besides, with a 90% confidence level, the group of beneficiaries is composed mostly by family enterprises, and belong in a greater extent to INDAP (the entity in charge of favoring small-scale producers). The average farm size of the sample is 66 ha, with a large range of 0.5 to 600 ha. To have a better appreciation of the scale effect on SCA adoption, this variable was evaluated in the model as a discrete variable by dividing the sample in three groups of an equal number of farmers. Grouping size in terciles define small, medium and large farms, allowing for a useful interpretation of the impact of size on the adoption of SCA. As Table 1 shows, there are significant differences in small and medium scale farmers, where beneficiaries are larger.

Continuing with descriptive statistics without distinguishing between beneficiaries and non-beneficiaries, most of the farmers belong to INDAP (78%) compared to SAG (22%), 74% are companies while 26% are family enterprises, and in average the number of acquaintances practicing conservation agriculture is 7.6. In addition, the average experience is 39 years, and education reach 9 years. It is important to notice that the proportion of beneficiaries and non-beneficiaries belonging to the intermediate valley and region of location is quite similar, with no statistical differences. Finally, 56% participate in community organizations, and the mean dependence on pensions is 15% of total income.

4.2. Model of conservation behavior

In order to choose the most appropriate distribution model to explain the number of sustainable practices implemented by farmers, we tested several non-parametric regressions with different distribution assumptions. The standard and zero inflated versions of the Negative Binomial and Poisson distribution models were tested. Within these four possible distributional models, the conventional Poisson model was preferred since the other models do not overcome the respective statistical tests that justify their use.

In Tables 2 and 3, we present the results of the estimated Poisson regression in two steps to deal with the endogenous treatment effect. The instrumental variable, TIPO, is the expected value of the first step of the model, and takes values between 0 and 1. This prediction is used in the regression equation instead of the original binary variable for the treatment. Since the parameters estimated by the model are not directly interpretable, Incidence Rate Ratios (IRR) and Marginal effects (ME) were calculated for the regression and participation equation, respectively (Tables 2 and 3). ME correspond to the effect on SCA for a one unit increase in covariates, holding constant the other variables of the model. IRR are the exponentiated coefficients of the model, showing the percentage effect on the average number of soil conservation practices for one unit increase in covariates. It is worth to point out that the average number of soil conservation practices is 0.74, over which IRR interpretations will be held.

Table 2. First step estimation results of the SIRSD-S program participation (N=425 observations).

Variable	Coefficient[a]		ME
HATOT	0.001	NS	0.000
EDUC	0.049	**	0.016
ORG	0.257	**	0.089
ACQU	0.036	***	0.012

EXP	0.012	***	0.004
ENTI	-0.408	**	-0.140
EFAM	0.510	***	0.175
PENS	-0.008	***	-0.002
REGION	-0.225	NS	-0.077
Constant	-1.309	***	
Prob>chi2= 0.000; Log likelihood= -256.332; Pseudo R2= 0.125			

[a] Significance level ***:P < 0.01; **: P < 0.05; *: P < 0.1; and NS means "no statistically significant".

Table 3. Second step estimation results of SCA adoption (N=425 observations).

Second step: SCA poisson regression			
Variable	Coefficient[a]		IRR
ATTIT	0.528	***	1.696
PCON	-0.022	NS	0.977
WOR	0.108	***	1.114
TIPO	0.674	*	1.963
TIPO*ATTIT	-0.594	*	0.551
SIZE			
Medium scale	0.300	*	1.351
Large scale	0.425	**	1.530
ORG	0.077	NS	1.080
EDUC	0.000	NS	1.000
EXP	-0.010	**	0.989
ENT	0.365	**	1.441
EFAM	-0.171	NS	0.842
VALL	-0.353	**	0.702
REGION	-0.586	***	0.556
Constant	- 1.269	***	
Prob>chi2= 0.000; Log likelihood= -442.383; Pseudo R2= 0.086			

[a] Significance level ***:P < 0.01; **: P < 0.05; *: P < 0.1; and NS means "no statistically significant".

The participation model in Table 2 was significant ($p < 0.01$), with the 67% of the cases correctly classified (see appendix B). The goodness of fit parameters of SCA equation 3 show a log pseudo-likelihood equal to -442.383 with eleven out of thirteen significant coefficients. For the purpose of this article, since our main interest is to understand the

the adoption intensity of conservation agriculture, only SCA equation will be interpreted. Regarding the intrinsic motivations towards soil conservation practices, only attitude was significant. As explained in section 3.1., attitudes is a factor constituted from indicator loadings, taking values from -4.77 to 1.56 (interval of 6.33 points). Having said that, per each point increase in attitudes towards conservation practices the average number of soil conservation practices increase by 70%.

By other hand, the awareness about soil degradation exerted a highly significant effect on the adoption of soil conservation practices. In this case, farmers with higher awareness adopt more soil conservation practices, by 11% for every unit increase in a 7 point Likert scale over the average number of soil conservation practices. Soil degradation awareness has been considered in several past studies evaluating SCA, showing a positive correlation with the adoption of soil conservation practices (Abdulai, 2016; Knowler and Bradshaw, 2007). Indeed, our finding gives support to Gould et al. (1989), who pointed out that awareness of soil erosion is a prerequisite to adopt SCA. Hence, attitudes towards behavior and awareness of the problem are crucial factors of conservation behavior (Wauters and Mathijs, 2006)

In terms of extrinsic motivation, being beneficiary of the SIRSD-S was marginally significant ($p<0.9$). The incidence rate ratio for the incentive explains that beneficiaries, compared to non-beneficiaries, increase the average number of soil conservation practices by 96%. This finding is in line with descriptive statistics in section 4.1., which show that beneficiaries adopted a higher number of soil conservation practices than non-beneficiaries. However, rather than the effect of the incentive by itself, our goal is to analyze the interaction between the SIRSD-S incentive and attitudes towards conservation practices. The interaction term included in the model was significant only at the 90% confidence level, and present a negative sign. Figure 1 shows graphically how the incentive is affected by farmers' attitudes. This result gives support to our hypothesis about the role of intrinsic motivation on extrinsic motivation to adopt SCA. We find that the SIRSDS incentive have a scarce impact on the adoption of SCA when farmers are intrinsically motivated, but a large effect when attitudes are low. This result is consistent with Ryan et al. (2003), who showed that intrinsically motivated farmers implement conservation agriculture regardless the existence of economic compensation. Conversely, people with lower attitude seems to be dependent on external rewards to act in a sustainable way. This is also suggested by Greiner et al. (2009), who analyze motivations and risk perceptions on the adoption of conservation practices in Australia.

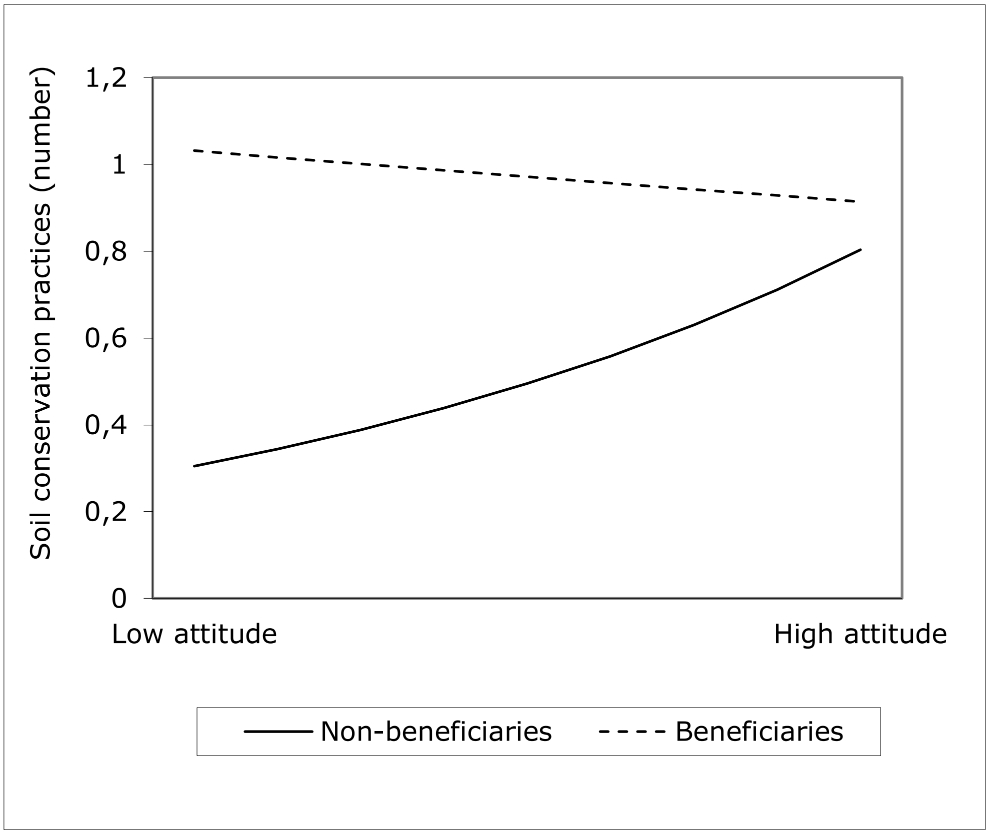

Figure 1. Two way interaction between the SIRSDS incentive and attitudes towards conservation practices.

Control variables have also an impact on SCA adoption. Physical capital, measured as the size of the farmer and categorized in three groups, was relevant in the explanation of SCA. Results indicate that farms moving from small to medium scale increase the average number of conservation practices by 35%, while moving from medium to large also increase the adoption but now by 18%. These results suggest that using a continuous variable for size which estimates a constant marginal effect could potentially hide the effect that size really has. Social capital, measured as participating in community organizations, was not statistically significant. Similarly, human capital appear to be not relevant on the explanation of SCA.

On the other hand, experience in agriculture was negatively related to SCA, where more experienced farmers present lower chances of adopting SCA, reducing the average soil conservation practices by 1% per each year of experience. This result is expected considering that experienced famers have managed their crops in a certain way for a long period, thus are more reluctant to change (Engler et al., 2016). Another relevant variable is the nature of the farm, where companies implement a less number of conservation practices than family enterprises, around 16% less. This result could be associated with having different goals, where family farms not only pursue profits but also personal and family well-being (Greiner and Gregg, 2011)**.** Finally, specific soil and weather conditions and location were significant in the model. In fact, farmers located on the intermediate valley of the country adopt 30% less soil conservation practices. This result is expected since these areas crossing longitudinally the country are the more fertile and is where intensive agriculture take place. In addition, the region of latitudinal location was significant, showing that in Los Lagos region, south of Chile, farmers adopt 45% less SCA compared to Biobío, central–south Chile. This could be explained since

Biobío is more agricultural oriented, while Los Lagos is more oriented to livestock activities.

Conclusions

This article analyzes the intensity of adoption of SCA among annual crop farmers in Chile based on intrinsic and extrinsic motivations. A Two-step regression model was employed to account for self-selection between conservation behavior and the assignment of an economic incentive. Regarding factors influencing the intensity of adoption, the findings indicate that farmers' attitudes towards conservation practices and soil degradation awareness have a positive effect on the number of soil conservation practices. Similarly, extrinsic motivation represented by the SIRSD-S incentive was significant increasing SCA, although marginally. However, the most interesting finding is the interaction between intrinsic and extrinsic motivations, where attitudes exert a moderating role on the influence of the conservation incentive. Farmers who depend on the incentive to adopt SCA are those who have less positive attitudes towards conservation practices. Conversely, intrinsically motivated farmers do not need for the incentive to implement a higher number of sustainable conservation practices.

Regarding human, social and physical capital, only the later had a significant effect on SCA, where larger farms have higher probabilities of adopting. Experience in agriculture was also relevant, with a negative effect on the number of soil conservation practices adopted by farmers. In addition, structural variables related to specific soil and weather conditions were determinant, highlighting the importance to control for location and land quality when evaluating SCA. The results of this study have implications for policy makers since economic instruments for conservation are increasingly being used to change behavior. However, it was found that the role of intrinsic motivations are determinant. Therefore, environmental policy should be focused more on persuasive changes towards attitudes, but also on degradation awareness, rather than increasing extrinsic motivations. However, since motivations are dynamic and context specific, more in-depth studies are required to understand how and what are the drivers to perform environmentally at the farm level.

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Appendix A

Table A.1. Rotated factor loadings from Factor Analysis.

Variable	Sentence (increasing Likert scale from 1 to 7)	Factor 1	Factor 2	Factor 3	Uniqueness
acti_prod	Sustainable agricultural practices allow to improve soil productivity	0.85			0.26
acti_ingr	Sustainable agricultural practices allow to increase profits	0.87			0.22
norm_deb	I feel it is my duty to implement sustainable practices	0.74			0.36
norm_psoc	I think there are people who would like me to implement sustainable practices				0.47
norm_cons	I use sustainable practices because they help to conserve the resource for future generations				0.45
perc_recu	I have economic resources to invest in costly sustainable practices		0.75		0.42
perc_pers	I count with people or companies on which I can stand to implement sustainable practices		0.74		0.43

Blank cells represent loadings < 0.7

Appendix B

Table B.1. Classification table after Probit model.

Classified	Beneficiary group	Non- beneficiary group	Total
Correctly	166	75	241
Uncorrectly	65	119	184
Total	231	194	425

Sensitivity	71.9%
Specificity	61.3%
Positive prediction	68.9%
Negative prediction	64.7%
Correctly classified	67.1%