The role of farmers' innovative behavior and social responsibility practices in technology adoption in apple and blueberry farmers in the Central Region of Chile.

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Abstract:

For the Chilean economy, the blueberry and apple sector have an important role regarding production and employment. To remain competitive in the export supply chain, farmers require to adjust to more efficient and productive systems. One important way to increase agricultural productivity is through the introduction of improved agricultural technologies and management systems. In particular, the study focuses on how levels of innovation, measured by complexity and investments requirements of the adopted technologies, relates to innovative behavior and complying with social responsibility practices, as two indicators of the farmer's behavior towards innovation. A typology of farmers with different technological levels was constructed based on multivariate techniques, according to the adoption of seven technologies. Findings showed three clusters: cluster I of high technology farms (32.2%), cluster II of farms with complex and low-cost technologies (27%), and cluster III of farms with low technology (40.68%). Within the cluster, it was identified that cluster I, farmers have a positive attitude toward innovation and the highest SR implementation rates. The farmers from cluster I were similar from cluster II in structural variables, but they significantly differ in innovative behavior attitudes. Cluster III, significantly differ with cluster I in structural variables, behavioral variables, and SR practices. The results showed the heterogeneity among farmers and the complexity of the adoption decision-making process shading lights on policy design to enhance innovation, research and technology transfer among farmers

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Abstract

For the Chilean economy, the blueberry and apple sector have an important role regarding production and employment. To remain competitive in the export supply chain, farmers require to adjust to more efficient and productive systems. One important way to increase agricultural productivity is through the introduction of improved agricultural technologies and management systems. In particular, the study focuses on how levels of innovation, measured by complexity and investments requirements of the adopted technologies, relates to innovative behavior and complying with social responsibility practices, as two indicators of the farmer's behavior towards innovation. A typology of farmers with different technological levels was constructed based on multivariate techniques, according to the adoption of seven technologies. Findings showed three clusters: cluster I of high technology farms (32.2%), cluster II of farms with complex and low-cost technologies (27%), and cluster III of farms with low technology (40.68%). Within the cluster, it was identified that cluster I, farmers have a positive attitude toward innovation and the highest SR implementation rates. The farmers from cluster I were similar from cluster II in structural variables, but they significantly differ in innovative behavior attitudes. Cluster III, significantly differ with cluster I in structural variables, behavioral variables, and SR practices. The results showed the heterogeneity among farmers and the complexity of the adoption decision-making process shading lights on policy design to enhance innovation, research and technology transfer among farmers

1. Introduction

To remain competitive farmers need to be constantly innovating in products, processes (Bandiera & Rasul, 2006; Bragdon & Smith, 2015), technologies and management systems (Doss, 2006), adapted to their particular circumstances throughout the value chain (Temel, Cengiz Akdeniz, & Sukan, 2009).

Technologies can vary in complexity and investment requirements giving space to a range of adoption levels (Sunding & Zilberman, 2001). The adoption of different types of technology depends not only on economic factors, such as costs-benefits-risk evaluation, but also on the farmer's capabilities, social capital, motivations, attitudes, constraints and relationship with the operating environment (Van der Veen, 2010). Farmers perceive different net benefits from the adoption of technologies according to their socio demographic characteristics. In particular, adoption is strongly related to farmers' capacity to innovate, explaining why the innovative efforts and adoption rates differ among farmers (Ariza, Rugeles, Saavedra, & Guaitero, 2012; B Kelsey, 2013; Diederen, van Meijl, Wolters, & Bijak, 2003; Nossal & Lim, 2011).

Multiple factors in the decision-making process can make individuals react differently in different circumstances (Meijer, Catacutan, Ajayi, Sileshi, & Nieuwenhuis, 2015). Entrepenuers behavioral characteristics related to innovativeness, such as the capacity to create ideas, searching for ideas, communicating ideas, and involving peers and workers (Lukeš, 2013), influence direclty organizational factors including leadership and work group relations (Park, Song, Yoon, & Kim, 2013; Young, 2012); thus, creating an favorable environment, motivating emproyeees in the direction of innovations (Lukeš, 2012;,Fernandez & Moldogaziev, 2013; Vilkė, 2014).According to Kim, Brodhag, and Mebratu (2014) long-term firm strategies related to innovation may consider not only investments in technology and R&D but also incorporating human, social, technical, and environmental investments, all factors included in Social Responsibility (SR) practices. Such practices enable companies to build a broader and deeper relationship with suppliers, employees, clients and investors and promote a higher internal capacity to innovate (Luo & Du, 2015). Also, Heyder and Theuvsen, (2009) determined that SR practices not only can encourage technology adoption but also enhance farm reputation, employee loyalty and the maintenance of legitimacy by the community and governments.

Hence, SR and innovative behavior are related to the promotion of an innovative environment. First, farmers with innovative behavior foster a context that enables workers to suggest creative ideas to solve problems, thus improves the capacity of the organization to respond to the conditions in the external environment (Carmeli, Gelbard, & Gefen, 2010). Similarly SR practices such as improvement of labor conditions, investment in human capital, the implementation of incentives programs and community involvement, can help to strengthen the link between companies core business with social and environmental values (Klerkx, Villalobos, & Engler, 2012); and beyond the external positive advantages of SR strategies can be decisively used as a driver of innovation (MacGregor & Fontrodona, 2008).

On this basis, the aim of this research is to unveil the relationship between farmers' technological level, SR practices and farmers' innovative behavior in blueberry and apple farmers of Central South Chile. The hypothesis is that as long as producers have a greater level of innovativeness and social responsibility, producers will engage in adopting more complex and more costly technologies. In order to address this hypothesis; first, the farmers will be grouped according to the degree of complexity and the investment of technologies; and then we analyze farmers innovative behavior and the degree on implementation of SR in the farm. It is important to signal that the subject of analyses is the owner or decision-maker of the farm, hence we can collect information of the framers and characteristics of the farm in one single instrument. We contribute to the literature by linking three concepts that have been usually analyzed separately in the literature: innovation – innovative behavior and SR. Although we do not analyze causality, we link the three concepts to better understand the characteristics that help to understand innovation and technology adoption, that may be useful in the design of agricultural policies that are crucial to enhance innovation, research and technology transfer among farmers. This also constitutes a contribution to the literature in agricultural business.

Chile represents an attractive case of study since Chilean fruit growing in the last decade was a sector of great activity, regarding production, exports, and employment generation. This industry makes a significant contribution to the economy of the country (CONICYT, 2007).

2. Materials and methods

2.1 Study Area

The research was conducted in O'Higgings, Maule, and BioBio Regions, located in the Central South Chile (2.2). Maule Region places between 34º41' and 36º33' South latitude. It borders with Liberator General Bernardo O'Higgins Region in the north, and Bio Bio Region on the south, the regional surface represents 4.0 % of the national surface. The prevailing climate corresponds to the Mediterranean climate with differences in north - south, a dry station of six months in the north, to four months in the south. The Liberator Bernardo O'Higgins Region is located in the central macro-area of the country, approximately between 34 ° and 35 ° South latitude. Its hydrographic system is constituted by rivers and reservoirs that have an important role in agricultural activities. (BCN, 2016).

2.2 Sampling and data description

The fieldwork was conducted between January and July of 2014 by the Department of Agricultural Economics, University of Talca. The data used in this study is cross-sectional and generated from a farm-level survey applied in the three most important regions in Chile regarding fruits production: Maule, O'Higgins, and Biobío Regions, known as the Central South Region. The sample size is 263.

2.3 Construction of a farm typology

The key variable to construct the typology or clusters was the level of technology adopted by the farmers. Table 1 shows the list of technologies and managerial practices considered in the analysis. To perform the cluster analysis the number of technologies were narrowed form an original list of 12 to seven, using as criteria that the percentage of adoption of the technology or practice should be in the range of 80% and 20% in order to have enough variability for the discrimination. Likewise, the technologies and practices must be able to be adopted by blueberry and apple farmers to integrate both types of producers. After the typologies were constructed, socioeconomic characteristics were used to characterize the clusters (Table 2).

TABLE 1. CLASSIFICATION OF TARGETED TECHNOLOGIES AND ADOPTION RATES.

Type	Technology	% of adoption
Complex High investment	Precision Agriculture System	22%
	Pruning	65%
Low complexity High investment	Advance irrigation methods	36%
Complex Low investment	Meteorological station	32%
	Managerial software	52%
	Managerial software	52%
	Fruit Mineralogical Analysis	68%
	Pollination	79%

The main objective of the study was to relate SR and innovative behavior to the technology clusters. In both cases we used several variables that capture each concept. Table 3 shows the variables used in each case. The selection of the variables was based on the literature review. The analysis of social responsibility comprised three major components: (1) human rights; (2) labor practices; (3) community involvement and development. Regarding the innovate behavior variables were considered two main components: (1) farmer generation of new ideas and knowledge and (2) employees participation in the generation of new ideas.

TABLE 2. SOCIO ECONOMIC VARIABLES

Category	***Code***	***Definitions***
Technology variables not included in cluster analysis		
High-density fruit orchard	Hdens	Binary variable: 1: if trees were planted in a high-density orchard; 0 otherwise
Sprinkler system	SprS	Binary variable: 1: if the farmer used a sprinkler system for protecting the crop from frost; 0 otherwise
Mechanized harvesting	MeH	Binary variable: 1: if farmer used mechanized harvesting; 0 otherwise
Farming context		
Main crop	MaCrop	Binary variable: 1 if the main crop was apple; 2 if blueberry
Main crop hectares	HeMaCro	Main crop planted hectares
Varieties of the main crop	VMCro	Main crop number of varieties planted
Other species	OthSp	Other species planted
Permanent employees	PerEmp	Number of permanent employees
Temporary employees	TemEmp	Number of temporary employees
Management		
Global GAP certification	GGAP	Binary variable: 1: if the farm had Global GAP certification; 0 otherwise
Time since the first certification	FirCert	Time elapsed since the first certification
Number of farm certifications	Ncert	Number of farm certifications
Socioeconomic		
Age	Age	Farmer's age (years)
Education Level	Educ	Farmer's Education level (years)
Percentage of the main crop income	MaCrIn	Percentage of farm income from the main fruit species
Technical Assistance	TecAsi	Binary variable: If the farmer had technical assistance paid by the exporter agribusiness; 0 otherwise
Member of an Association	MeAss	Binary variable: If farmer belongs to an association; 0 otherwise
Total technologies adopted	TecAdop	Number of technologies adopted (Units)

TABLE 3. SOCIAL RESPONSIBILITY AND INNOVATIVE BEHAVIOR COMPONENTS AND SUBCOMPONENTS

Component	**Definition**
I. Social Responsibility	
Human Rights	
Employment contract	Binary variable: 1: if employees have an employment contract; 0 otherwise
Under 18 employment	
Policy on prevention of sexual abuse	Binary variable: 1: if the farmer have any policy regarding sexual arrestment; 0 otherwise
Program for equal opportunities	Binary variable: 1: If exists a program for equal opportunities and non-discrimination employment; 0 otherwise
Labor Practices	
a. Conditions	
Bathrooms, changing and eating facilities	Binary variable: 1: If the farm have bathroom and other facilities; 0 otherwise
Improvements of infrastructure (bathrooms and dining room)	Binary variable: 1: If the farmer performs improvements of infrastructure; 0 otherwise
Resting rooms	Binary variable: 1: If the farm have resting rooms; 0 otherwise
Lunch or snacks for the employees	Binary variable: 1: If the employer provides lunch or snacks for the employees; 0 otherwise
Transportation services for employees	Binary variable: 1: If the farm provides transportation services for employees; 0 otherwise
Incentive policy for employees	Binary variable: 1: If exist an incentive policy for employees; 0 otherwise
b. Healthcare	
Health and social security agency	Binary variable: 1: If employees are associated with a health and social security agency; 0 otherwise
c. Training	
Training program for permanent workers	Binary variable: 1: if the company have a training program for permanent workers; 0 otherwise
Training program for temporary workers	Binary variable: 1: if the company have a training program for temporary workers; 0 otherwise
Community involvement and development	
Support of community schools and high schools	Binary variable: 1: if the farm supports community schools and high schools; 0 otherwise
Support of community healthcare services	Binary variable: 1: if the farm supports community healthcare services; 0 otherwise
Improvement of community services: water	Binary variable: 1: if the farm contributes to the

and electricity	improvement of community services: water and electricity; 0 otherwise
Warning before pesticides are sprayed	Binary variable: 1: if the farm warns the neighbors before the application of pesticides ; 0 otherwise
II. Innovative behavior	
Generation of ideas and knowledge	
New ideas came up from the analysis of the national or international context	Likert scale from 0 to 4 in degree of accordance
New ideas arise from experimentation	Likert scale from 0 to 4 in degree of accordance
Builds knowledge through technologies and training	Likert scale from 0 to 4 in degree of accordance
Employees participation	
Workers are important in the success of new ideas	Likert scale from 0 to 4 in degree of accordance
Workers opinions in the design of new ideas	Likert scale from 0 to 4 in degree of accordance

3. Results

3.1 Cluster Analysis

We performed the cluster analysis using Ward's and K-Mean algorithms based on the seven technologies described in Table 2. We found three clusters : Cluster I, the group with high technological level such as Precision Agriculture System (PAS), Pollination System (PolSy) and Weather Station (WeSt); Cluster II represent a group of farmers with low-cost and complex technologies such as Managerial and Administrative software (AdSoft) and Fruit Mineralogical Analysis (MinAn) and Cluster III, farms with low technology farming systems, where none of the selected variables make a positive contribution to the cluster. In Table 5 we describe the clusters with additional variables not included in the cluster analysis such as other technologies, socioeconomic and management variables are describe.

Cluster I: High technology farms (32.2%)

This group has the highest level of technology adoption. On the one side, they adopt complex technologies with a high level of investments level. They have the highest adoption rate of precision agriculture (61.18%) pruning (72,94%) and modern irrigation system (38.82%).

On the other side, producers also have high percentages of adoption of technologies that require a high level of knowledge and low level of investment; all the farmers in this group have a pollination system, the 81.18% use managerial and administrative software, and 94.12% make a mineralogical analysis. Conversely, regarding the technologies that require low levels of knowledge and high investment cost, they have the highest percentages of the three groups such as high density seeded orchard (26.83%) and mechanized harvesting. Accordingly, on average farmers adopted a greater number of technologies in comparison with clusters II and III.

Regarding the size of the farm, this group concentrtate the largest producers (average of 44.9 hectares), which is significantly different for Cluster II and Cluster III. On average farmers planted 4.5 different fruit varieties, which is similar to Cluster II. The 36.5% of the farmers plant between one and three different varieties, 56.5% plant between four and seven and 7.1% have more than eight varieties. Regarding, farm level diversification, 36.6% of the farmers plant at least one crop and 34.1% between two to four different crops.

Also, this group has the highest percentage of Global G.A.P certifications (92.9%), which is significantly different from the others groups. The remaining 7.1% are non-certified farmers. On average the fisrt certification was 9.52 years ago from the moment of the survey, higher compared to the other two groups. Regarding the number of certifications (Global GAP, Tesco, US GAP, Fairtrade or Organic) 89.4% have one and two certifications and 8.3% have between three and four certifications.

Regarding technical assistance, 55.42% of the farmers hire technical assistance, showing a significant difference with cluster III. Moreover, the majority of farmers (68.24%) are not associated with an organization, significantly different with Cluster III farms.

Finally, in this group are the youngest farmers (41.93 years old), are farmers with the highest educational level (15.40 years), both significantly different with Cluster III farms. On average, the 73.5% of the income depends on the primary fruit variety, significantly different with Cluster II farms.

Cluster II: Farms with low-cost and complex technologies (27%)

In this cluster 43.66% have a pollination system; 52.11% use a managerial and administrative software, and the majority of farmers (97.18%) does fruit mineralogical analysis. All the technologies mentioned above require a higher level of knowledge and low investment for the adoption.

They plant on average 31.12 hectares; and approximately 4 different varieties of the main crop, 64.8% of the farmer's plant between one and four different varieties, and the remaining 35.2% plant between five and ten varieties. Concerning farm diversification, they cultivate on average 1.41 other crops; 32.4% of farmers are not diversified, and the remaining 50.7% plant between one and two different species.

The 81.7% of farmers have Global G.A.P certification. The remaining 18.3% of the farmers are not certified,were mainly blueberry producers. Regarding the number of total certifications 67.6% have one certification, and 28.2% have more than two certifications, similarly to Cluster I farms and the remaning 4.2% did not have a certification. On average they have 8.56 years since the first certification; 56.3% have between 9 and 17 years since the first certification, and 40.8% have between 18 and 26 years, without any differences with the other clusters.

Regarding technical assistance, 52.17% of the farmers hire assistance, without a significant difference among groups. As well, 33.80% of the farmers are members of a producer organization. In terms of socioeconomic characteristics, farmers, are on average 42 years old, their education level on average is 14.82 years. On average, 61.71% of the income depends on the main fruit variety, being the group with the less dependent on the main fruit.

Cluster III: Farms with low technological level. (40.68%)

Farmers of this group have the lowest technology adoption rates in low-cost or high-cost technologies as well as simple and complex technologies. The 31.78% of the producers invest in irrigation technologies, only 28.04% have a managerial software, and 27.10% make a mineralogical analysis. Less than 1% adopt precision agriculture system, and only 1.87% had mechanized harvesting. This group is significantly different from Cluster I.

The main crop has on average 19.69 hectares; 57% of the farmer plant between 1.90 and 11 hectares, being significantly different from cluster I. Regarding main crop varieties, 55.1% of the farmers have one and three different varieties; 36.7% plant between four and six varieties and the remaining 15.9% seed more than six types, which is similar to Cluster II farms. Also, the 57% of the farmers do not plant others crops, farmers in this group have the lowest diversification levels, showing significant differences with Cluster I and II. The remaining 43% seed at least one other species, the 15.2% plant kiwi,10.9% cherry, 13% of the blueberry farmers seed jointly apple and 8.7% of the farmers plant raspberry.

In the case of Global G.A.P certification, this group has the lowest percentage of certified producers (78.5%) in comparison with the other groups. Concerning the number of certifications, 15% of the farmers do not have any certifications and 72% of them have only one. Also, the 80% are certified for only two to ten years.

Regarding technical assistance, the group has a low percentage of external technical assistance hired by them (31.8%), significantly different from the others groups. However, the farmers have the highest proportion of technical support offered by the exporter company (57.9%). This group has the lowest percentage of membership in an association (11.21%), significantly different with both types of farms.

The producers of this group are the oldest; they are on average 47.08 years. Similarly, on average their educational level is the lowest (13.66 years) among groups. The 74.60% of their income is from the main crop, for 49.5% of the producers the main crop represents 100% of the revenue.