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Heterogeneity of farms entering export supply chains: the case of fruit growers from central-south Chile

J. Barrena[1], L. Nahuelhual[1,*], A. Engler[2], R. Echeverría[1] and G. Cofré[2]

[1] *Instituto de Economía Agraria. Universidad Austral de Chile. Campus Isla Teja. Casilla 567. Valdivia, Chile*
[2] *Departamento de Economía Agraria. Facultad de Ciencias Agrarias. Universidad de Talca. 2 Norte 685. Talca, Chile*

Abstract

The increasing stringency of world food markets requires farmers to adjust farm structure and commercial strategies to remain integrated in export supply chains. The goal of this study was to identify and characterize different types of fresh fruit farms with regard to farm structural and commercial strategies for a representative sample of fresh fruit growers from central-south Chile exporting to world markets. A typology of farms was constructed based on multivariate analysis, according to which five types of farms were differentiated from five distinct factors. Cluster I comprised the smallest and uncertified farms (14.3% of the sample). The remaining four clusters comprised certified farms, but with different farm structural and commercial characteristics. Cluster II (15.1%) was composed of farms located further from market connections. Cluster III (23.9%) comprised farms with the highest number of fruit species, and consequently, more diversified in fruit production. Cluster IV (8.8%) was the smallest group, and comprised the largest firms. Finally, Cluster V (37.8%) was composed of highly specialized fruit farms, with the highest proportion of hectares dedicated to the production of a single fruit species. The results show the heterogeneity among fresh fruit farms and support the need for differentiated incentives and technological transfer schemes from the public sector and fruit companies in order to successfully keep farmers within export supply chains.

Additional key words: cluster analysis; commercial strategies; farm structure; farm typology; food chain; fresh fruit.

Introduction

Economic and trade liberalization in the last two decades has expanded global trade and led to the rapid growth of retail food chains from the northern hemisphere in the global south (Amekawa, 2009). In turn, consumers today have higher incomes and awareness of their health, which translates in a demand shift from processed to fresh and healthier food (Busch & Bain 2004). Social pressure to ensure food safety has resulted in an increasing set of sanitary and phytosanitary (henceforth SPS) regulations, especially from developed countries (Engler *et al.*, 2012), but also in the emergence of private voluntary standards implemented by retail chains in response to public regulation on retailers as well as certification bodies in North America and the European Union (Ouma, 2010). As argued by Henson & Humphrey (2010), private standards have *de facto* become mandatory.

Farmers in developed and developing nations must respond to the new challenges imposed by such regulations and standards (Henson & Loader, 2001; Woods *et al.*, 2006; Blazy *et al.*, 2009; Henson & Humphrey, 2010), which are more pressing for farmers attempting to integrate into food export chains. The literature has highlighted the factors that make it difficult for smallholder farmers to comply with such regulations, which include the high costs of compliance, the lack of technical capacity and knowledge, and sometimes the requirements that are difficult to implement within the local context. Within this literature, studies have focused on the structure of the

* Corresponding author: lauranahuel@uach.cl
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Abbreviations used: GAP (good agricultural practices); PCA (principal component analysis); SPS (sanitary and phytosanitary standards).

export sector, public support to exporting (Henson *et al.*, 2000; Fulponi, 2007) and compliance with technical measures, such as food safety, labeling, and quality and content regulations (Henson & Loader, 2001). Nonetheless, few studies have empirically explored how farmers incorporate current export requirements and how this relates to farm structure and commercial strategies farmers develop to cope with such requirements.

This paper contributes to this knowledge by exploring the heterogeneity among fresh fruit growers with regard to farm structure (*e.g.* farm size, fruit specialization, farmer characteristics) and commercial strategies (*e.g.* type and number of certifications) developed to comply with emerging requirements and remain integrated in supply chains. The goal is achieved by constructing a farm typology from a representative sample of fresh fruit producers from central-south Chile, oriented to export markets, using multivariate statistical methods. These methods have been commonly used in characterizing and classifying farms, usually based on structural components (Maseda *et al.*, 2004) or productive characteristics (Bernués *et al.*, 2004), technological and economic variables (Milán *et al.*, 2003; Serrano *et al.*, 2004), or social variables of the producer (Solano *et al.*, 2000; Castel *et al.*, 2003).

For several reasons Chile represents an interesting case study to explore heterogeneity among fruit producers linked to supply chains. Chile is one of the most important fresh fruit exporters in the world and the leading fruit exporting country in the southern hemisphere, with a fruit export sector composed of nearly 7,800 producers with more than 5 ha under fruit production and more than 500 exporters (Asociación Chilena de Fruta Fresca, 2010). Chilean fruit exports account for 50% of total agricultural exports, and have increased by 54% in the last decade (ODEPA, 2012). Currently, Chile exports 75 fruit species to over 100 markets (Asociación Chilena de Fruta Fresca, 2011). The sector is also relevant for the local economy by providing permanent and seasonal employment (ODEPA, 2011). Furthermore, Chile has established the goal of becoming one of the top ten food exporters by 2015. Among other challenges, this goal requires the incorporation of new large, medium and small-scale farmers into food export chains.

The results of this study can help both government officials and fruit companies to better understand the current diversity of fruit growers to plan incentives and technology transfer schemes accordingly and thus improve the efficiency of the agri-food chain. The results also contribute to the literature by providing knowledge on how primary producers organize their business to get involved in export chains.

Methods

Study area

The study area covers the O'Higgins and Maule Regions in central-south Chile (33°50' and 36°33' S) (Biblioteca del Congreso Nacional, 2011). Fig. 1 shows the study area and the distribution of fruit producers from which the sample was obtained.

A temperate Mediterranean climate predominates in the O'Higgins Region, with a six-month dry season (September through February) and a rainy winter. In the central valley, where fruit production is concentrated, precipitation reaches 823.5 mm annually, and annual mean temperature is 12.6°C, with a thermal range of 4.8°C and a daily range of 6.4°C (CIREN, 2010a). The Maule Region has a warm sub-humid Mediterranean climate with a dry season that lasts six months in the north of the region and four months in the south. Mean temperature in summer is 19°C, with extremes exceeding 30°C and annual average precipitation ranging between 716 and 2000 mm (CIREN, 2010b).

The climatic and morphological conditions of both regions are ideal for production of fruits such as table grapes, plums, apples, cherries, kiwis, European hazelnut, olives, strawberries and blueberries. In addition, the road network allows easy access to input markets and shipping ports. In this study we focus on the most relevant fruit species, which are table grapes, apples, cherries and kiwifruit. The two regions comprise 43% of table grape, 88.1% of apple, 79.4% of cherry and 86.5% of kiwifruit national areas, respectively (ODEPA, 2012).

Survey design and pre-testing

A questionnaire was developed aimed at gathering information on fruit producers' characteristics (*e.g.* age, years of education); productive structure of the farm (*e.g.* farm size, number of fruit species); commercialization and certification performance (*e.g.*

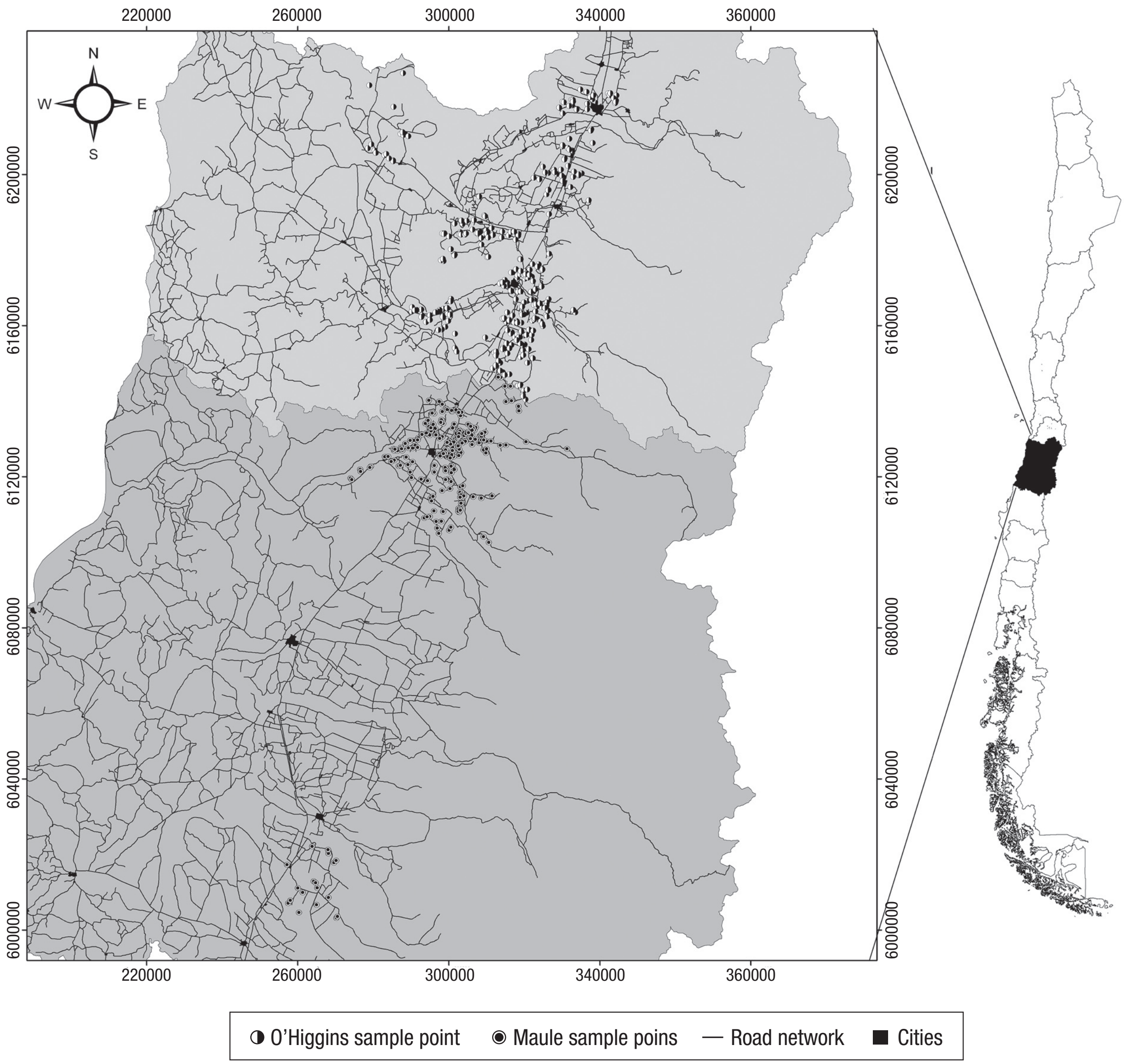

Figure 1. Distribution of fruit farms in the O'Higgins and Maule Regions

exporting method, type and number of certifications); and compliance with export requirements (*e.g.* phytosanitary application program, good agricultural practices). The survey focused on the selected fruit species in the study area and was previously pretested and adjusted with 26 producers from both regions in March and April 2011.

Sampling procedure and survey application

The size of the producer population was obtained from the Centro de Información de Recursos Naturales (CIREN) database of the 14 counties that produce most of the selected fruits. Specifically, the 14 counties accounted for 44% of the cherries, 35% of kiwi, 33% of apples and 39% of grapes. As shown in Fig. 1, the counties are mostly located in the central valley where most of the fruit production activity takes place. The individual survey was applied in person to 275 producers (138 in the O'Higgins and 137 in the Maule Region), which represented 11.6% of the total population (2,357 producers). Using the total area of the selected fruit species as a reference, a sample size error of 8.8 ha was estimated with a 95% confidence, which was considered acceptable given the range of sizes in the total population where the average was 23.3 ha, ranging from 0.42 to 2,032 ha.

In almost all cases, the interviewed person was either the owner or manager of the farm and only in few cases another person was interviewed who knew commercial and productive aspects of the farm.

Construction of a farm typology

A farm typology is a tool to simplify the diversity of farms and farming strategies in a given area, defining different groups of farms based on specific criteria. The relevance of a farm typology will therefore depend on its capacity to capture the differentiation of farm types, showing a maximum amount of heterogeneity among the types, while obtaining maximum homogeneity within particular types (Köbrich *et al.*, 2003; Iraizoz *et al.*, 2007). In most cases, farm typologies are constructed on the basis of their structural or productive characteristics, or of their techno-economic variables. In this study the commercial dimension was also included.

In the case at hand, farm structure was understood as a set of components including farm location, farm size, area under fruit production, number of fruit species and farmer characteristics, among others. In turn, the commercial strategy of farms comprised export decisions, and certification decisions.

The present study relies on a multivariate statistical analysis that allows the researcher to use a wide range of variables to generate typologies (Köbrich *et al.*, 2003; Iraizoz *et al.*, 2007).

Preliminary inspection of data and selection of variables

A preliminary inspection of the data led to the elimination of 37 observations, leaving 238 observations for the multivariate analysis. Following Hair *et al.* (1999), two criteria were used for the elimination of cases: i) to show missing information for a large number of variables; or ii) to show atypical values in some of the variables with respect to the sample. For the later purpose, a multivariate detection was performed using the Mahalanobis distance as a measure of distance of each observation on a multi-dimensional space respect to the middle center of all observations (Hair *et al.*, 1999). The following step was the selection of variables. To account for farm structural characteristics, the selected variables were: age of farmer (Age), farmer's experience in fruit production (Exp), farmer's formal education (Edu), farm size (Hfarm), number of fruit species of the farm (Nfsp), percentage of the total farm area with fruit plantation (Hfs), percentage of total fruit area with main fruit species (Hmsf), percentage of total farm income from the main fruit species (Incms), distance to nearest major city (Dcity), distance to main highway (Droad), and distance to nearest export company (Dexpf). To account for farm commercial strategy, the selected variables were: number of companies handling the export of the main fruit species (Nexpc); number of certified fruit species (Cerfs), percentage of total fruit area with certified fruits (Hcer), number of farm certifications (Ncer), and time elapsed since the first certification (Ycer).

Factor analysis

Factor analysis was used to create a smaller group of variables (factors) that replaced the original 16 variables selected. Principal component analysis (PCA) was used to extract the factors. PCA has been widely used in agricultural and rural studies, and specifically to construct farm typologies (Gaspar *et al.*, 2008; Senthilkumar *et al.*, 2009; Ansoms & McKay, 2010; Chávez *et al.*, 2010; Giorgis *et al.*, 2011; Righi *et al.*, 2011). The Kaiser-Meyer-Olkin measure of sampling adequacy and the Bartlett sphericity test were employed to measure the level of correlation of variables and assess their pertinence to develop the factor analysis (Hair *et al.*, 1999; Larose, 2006).

The latent root criterion was used to establish the exact number of factors, considering only those with eigenvalues higher than 1 (Hair *et al.*, 1999; Köbrich *et al.*, 2003). Once the final number of factors was determined, and with the purpose of obtaining a better definition of the factor loadings and simplifying the association of variables to factors, an orthogonal rotation of factors was performed using the Varimax method (Hair *et al.*, 1999; Ansoms & McKay, 2010; Barnes *et al.*, 2011). Following Hair *et al.* (1999), and considering the sample size (238 farms), the significant factor loadings were considered as those over ±0.40. The variables that did not present significant factor loadings in any of the components were eliminated from the analysis, in order to avoid an erroneous interpretation of factors from variables with which they showed a low correlation (Hair *et al.*, 1999).

In addition, communality of each variable was analyzed. Communality represents the proportion of variance of a particular variable that is shared with other variables (Larose, 2006). A variable with communality much smaller than the others suggests that this variable shares much less of the common variability and contributes less to the PCA solution. On the other hand, large communality values show that principal components have successfully extracted a large proportion of the variability in the original variables (Larose, 2006). Following Hair *et al.* (1999) and Larose (2006), variables with communality smaller than 0.50 were also eliminated from the analysis, for not having enough explanatory power.

Cluster analysis

From the factors identified by the PCA, the farms were classified by establishing groups that were internally homogeneous, but externally heterogeneous (García *et al.*, 2010). Clusters were classified in two steps, using a combination of hierarchical and non-hierarchical methods. Firstly, the optimal number of clusters and cluster means were identified by the Ward (hierarchical) method, using the squared Euclidean distance as a measure of similarity (Petrovici & Gorton, 2005; Joffre & Bosma, 2009; Ansoms & McKay, 2010). This approach starts with each observation in a single cluster and in the following steps clusters are joined, until only one cluster contains all the observations (Chávez *et al.*, 2010). The optimal number of clusters was chosen principally on the basis of changes to the agglomeration coefficient, where any large change in this coefficient indicates appropriate levels of heterogeneity within clusters (Barnes *et al.*, 2011). Secondly, a K-mean clustering technique (non-hierarchical) was used to determine the elements of each cluster.

Results

Factor analysis

Of the 16 variables originally selected, the education of the owner (Edu) and the number of exporters (Nexpc) were eliminated because they did not present significant factor loadings (<0.40) among all the factors and communality values below the acceptable level (0.47 and 0.18 respectively) (Hair *et al.*, 1999). As well, participation of hectares of the main species (Hmsf) was eliminated because it explains the same as the variable percentage of total farm income from the main fruit species (Incms). The high correlation (>0.84) among these variables, as well as model analysis including *Hmsf*, provided the arguments for this decision. This avoids redundancy and allows for better quality and significance of the factors obtained (Hair *et al.*, 1999). Thus, the 13 variables finally used in the factor analysis were: Age, Exp, Hfarm, Nfsp, Hfs, Incms, Dcity, Droad, Dexpf, Cerfs, Hcer, Ncer and Ycer.

The pertinence of the factor analysis was supported by the sphericity coefficient with a p value = 0.000 and the Kaiser-Meyer-Olkin measure of sampling adequacy with a value of 0.674 (Hair *et al.*, 1999; Larose, 2006). The analysis of main components revealed five factors with eigenvalues higher than 1, which together explain 77.5% of total variance (Table 1). Once the Varimax rotation of the factors was done, 12 of the 13 variables presented significant factor loadings (>0.50) in only one factor. The exception was Cerfs, which presented significant factor loadings in factors 1 (0.52) and 2 (0.73), but was finally associated with the latter because the load was greater with that factor (Table 1).

Factor 1 was termed *Degree of certification* (eigenvalue 3.42), given that participation of certified hectares (Hcer), number of certifications of the farm (Ncer) and number of years elapsed since the first certification (Ycer) were associated with this factor with positive factor loadings. Factor 2 was termed *Diversification of fruit production* (eigenvalue 2.34), and grouped the number of fruit species produced on the farm (Nfsp), the number of certified fruit species (Cerfs) and the percentage of income from the main species (Incms). The first two had positive factor loadings, while the latter presented a negative load. Factor 3 (eigenvalue 1.71) was termed *Distance to market connections* and included distance to the nearest main city (Dcity), distance to the main highway (Droad) and distance to the nearest export firm (Dexpf), which presented significant positive factor loadings in this factor. Distance to market connections is a proxy for accessibility to input and output markets. Factor 4 (eigenvalue 1.46) groups the variables age of the farm owner (Age) and years of experience in fruit pro-

Table 1. Rotated factor matrix showing the results from PCA based on 13 variables

Variables	Code	Factors				
		1	2	3	4	5
Age of farmer (yr)	Age	–0.034	–0.022	–0.055	**0.871**	0.106
Farmer's experience in fruit production (yr)	Exp	0.042	0.076	–0.065	**0.862**	–0.109
Farm size (ha)	Hfarm	0.160	0.350	0.155	–0.089	**0.712**
Fruit plantation area (% of total farm area)	Hfs	0.049	0.015	–0.025	–0.060	–**0.899**
Number of fruit species of the farm (units)	Nfsp	0.122	**0.932**	0.026	0.044	0.098
Income from main fruit species (% of total farm incomes)	Incms	0.053	–**0.881**	0.036	0.001	–0.059
Number of certified fruit species (units)	Cerfs	**0.523**	**0.736**	0.011	0.051	0.130
Certified fruit area (% of fruit area)	Hcer	**0.884**	–0.056	0.036	–0.030	0.013
Number of farm certifications (units)	Ncer	**0.818**	0.134	0.108	–0.069	0.042
Time elapsed since first certification (yr)	Ycer	**0.802**	0.165	0.114	0.103	0.009
Distance to nearest major city (km)	Dcity	0.116	–0.056	**0.874**	–0.067	0.097
Distance to main highway (km)	Droad	0.103	0.015	**0.871**	–0.067	0.129
Distance to nearest export company (km)	Dexpf	0.032	0.043	**0.856**	–0.010	–0.052
Eigenvalue		3.424	2.339	1.714	1.457	1.138
Variance (%)		26.337	17.989	13.184	11.211	8.751
Accumulated variance (%)		26.337	44.326	57.51	68.721	77.471

Bold figures indicate factor loadings above 0.40 and underlining indicates the largest factor loadings of each variable linked to each factor

duction (Exp). Both presented positive factor loadings, because of which this factor was termed *Producer experience.* Finally, Factor 5 (eigenvalue 1.14) grouped the variables of total surface area of the farm (Hfarm) (factor loading = 0.71) and participation of farmland in fruit production (Hfs) (factor loading = –0.90), and was termed *Alternative land use,* in consideration that a decrease in this variable increases the possibility of other productive uses of the farm.

Cluster analysis

The hierarchical cluster analysis based on the five factors described above indicated the presence of five clusters. The non-hierarchical K-means cluster analysis was used to obtain the final profile of the clusters (types of farms). The five factors had direct influence on the conformation of the farm types. Thus, factor 1 was predominant in defining the type I farm (small uncertified farms); factor 2 was predominant in defining type III farms (diversified fruit farms with more experienced fruit producers) and type V (highly specialized fruit farms). Factor 3 was dominant in defining type II farms (farms far from market connections) and factor 4 contributed in major part to define type III farms (diversified fruit farms with more experienced fruit producers). Finally, factor 5 was predominant in defining type IV farms (large farms with alternative land use). Table 2 presents the centers of the final conglomerates, which indicates the links between the five factors and the five clusters. Table 3 presents the profile of clusters based on mean values of variables used in factor analysis and frequency or mean of additional variables not included in factor analysis.

Table 2. Contribution of the factors to the cluster centers

Factors	Clusters (farm types)				
	Type I: Small uncertified farms	**Type II: Farms far from market connections**	**Type III: Diversified fruit farms with more experienced fruit producers**	**Type IV: Large farms with alternative land use**	**Type V: Highly specialized fruit farms**
Factor 1: Degree of certification	–2.08338	0.19527	0.25421	0.13149	0.51727
Factor 2: Diversification of fruit production	–0.15615	–0.01196	1.02530	–0.10981	–0.55996
Factor 3: Distance from market connections	–0.27448	1.81069	–0.25454	0.05206	–0.47152
Factor 4: Producer experience	–0.00291	–0.13899	0.57022	0.26244	–0.36568
Factor 5: Alternative land use	–0.11962	–0.34410	–0.22370	2.53153	–0.26618

Type I farms: Small uncertified farms (14.3%)

Type I grouped all the uncertified farms in the sample, presenting the smallest average farmland area (38 ha) and the lowest number of years of education of the producer (11.7 years). In this group, 84% of farmland area was dedicated to fruit production, 66% of which was used for the production of only one species, which in 53% of the cases was apple, 29% was cherry and 9% was kiwi or grape. On average, 74% of total farm income was derived from the production of the main fruit species, the average number of fruit species per farm being two. The farms in this group were located near to cities of importance (7.6 km) and the main highway (4.0 km).

In relation to exporting, 97% of this group exported through an export firm rather than directly. In 67% of the cases, the program of phytosanitary applications was defined by an agronomist from the export firm, which shows an important level of dependence on export firms in both marketing and the definition of production activities within the farm. Finally, it should be noted that only 9% of the producers in this type declared that they belonged to an agricultural association, which is the lowest percentage of associativity of all the groups.

Type II farms: Farms far from market connections (15.1%)

The farms in this group were characterized for being far from important cities (26.3 km), the main highway (17.2 km) and export firms (11.6 km). The average farm area was 127 ha, which locates this group in the medium-small range, similar to type III farms (see Table 3). In this group, 89% of the farmland was dedicated to fruit production, 64% used for growing one species that generated 73% of total farm income. In 39% of the cases this species was apple or grape, followed by kiwi and cherry with 17% and 6% of the cases, respectively.

The form of marketing the main species was through an export firm (75% of the cases), direct exporting (22% of the cases) or a combination of both (3% of the cases). This group was in second place in the percentage of farms that exported directly, exceeded by type IV. As well, in 42% of the farms the application of phytosanitary measures was defined by a private advisor, in 31% by the owner, administrator or other person permanent involved in the farm, and in only 28% of the cases by an agronomist from the export firm. This represents a clear difference from the other farm groups, given that in all the other farm types the main person who defined this program was an agronomist from the export firm. This result also affirms the greater autonomy of the type II farms in relation to export firms, which is related to the relative distance form market connections and particularly export plants.

In relation to certification, 90% of farmland used for fruit production and an equivalent to two species per farm were certified. Of these, 100% of the farms had GlobalGAP certification, 28% had Tesco certification, 3% had UsaGAP and 11% indicated having some other type of certification (for more detail about

Table 3. Profile of clusters based on mean values (Mean), standard deviation (SD), and clusters with statistically significant differences (Sig.) for quantitative variables and percentage in each category for qualitative variables

Variable description	Code	Clusters (farm types)																			
	Code	Type I (n=34)				Type II (n=36)				Type III (n= 57)				Type IV (n=21)				Type V (n=90)			
	Quantitative	Mean	SD	Sig.		Mean	SD	Sig.		Mean	SD	Sig.		Mean	SD	Sig.		Mean	SD	Sig.	
	Qualitative category	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
Age of farmer (yr)	Age*	60.9	15.71	3		56.5	11.18	3,4		66.8	12.21	1,2,5		68.4	17.47	2,5		56.8	10.87	3,4	
Farmer's experience in fruit production (yr)	Exp*	28.4	15.28	3		26.6	13.31	3		37	11.79	all		26	17.21	3,5		24.3	11.22	3,4	
Farmer's formal education (yr)	Edu	11.7	5.38	all		16.1	2.01	1		15.1	2.91	1,4		16.4	1.98	1,3		15.4	3.43	1	
Farm size (ha)	Hfarm*	38	50.64	2,3,4		127	129.58	1,4,5		125	122.01	1,4,5		371	415.47	all		54	51.06	2,3,4	
Number of fruit species of the farm (units)	Nfsp*	2	0.92	2,3,4		2	1.24	1,3,5		4	1.01	all		3	1.24	1,3,5		2	0.73	2,3,4	
Fruit plantation area (% of total farm area)	Hfs*	84	17.48	4		89	14.34	4		86	14.37	4		29	13.92	1,2,3		89	11.68	none	
Mean fruit species area (% of fruit area)	Hmsf	66	33.31	3,5		64	34.17	3,5		39	20.6	all		67	28.78	3,5		81	23.95	all	
Income from main fruit species (% of total farm income)	Incms*	74	28.27	3		73	29.22	3		47	18.97	all		64	27.2	3,5		83	20.21	3,4	
Number of companies handling the export of the main farm fruit species (units)	Nexpc	1	0.43	3		1	0.74	none		2	0.94	1		1	0.57	none		1	0.6	none	
Distance to nearest major city (km)	Dcity*	7.6	6.1	2,4		26.3	9.03	all		9.6	5.6	2,4		15	5.81	1,2,3		9.1	5.52	2	
Distance to main highway (km)	Droad*	4	3.22	2,4		17.2	6.19	all		5.3	3.58	2,4		9.2	6.04	1,2,3		4.7	3.6	2	
Distance to nearest export company (km)	Dexpf*	4.4	3.03	2		11.6	3.93	all		5.1	3.02	2		5.4	3.56	2		4.1	2.94	2	
Categorical variable (%): 1 if farmer belongs to an association; 0 otherwise; 2 does not know	Asso	82	9	9		67	25	8		60	28	12		52	43	5		66	24	10	
Categorical variable (%): 0 if main species is cherry; 1 if apple; 2 if kiwi; 3 if table grape	Mfsp	29	53	9	9	5	39	17	39	33	35	14	18	5	62	19	14	24	47	17	12
Categorical variable (%): 1 if exporting through export company; 2 if exporting directly; 3 both	Expc		97	3	0		75	22	3		79	12	9		71	24	5		84	13	3
Categorical variable (%): 0 if respondent does not know target markets; 1 if knows before harvest; 2 if knows after harvest; 3 if knows during harvest	Tmar	50	18	27	6	19	50	17	14	21	46	16	18	14	52	24	10	24	40	16	20
Number of certified fruit species (units)	Cerfs*	0	0	all		2	1.35	1,3		3	1.55	all		2	1.59	1,3,5		2	0.71	1,3,4	
Certified fruit area (% of fruit area)	Hcer*	0	0	all		85	23.96	1,5		87	23.04	1,5		92	23.24	1,5		98	7.62	all	
Number of farm certifications (units)	Ncer*	0	0	all		1.4	0.64	1		1.3	0.53	1		1.1	0.57	1		1.4	0.62	1	
Time elapsed since the first certification (yr)	Ycer*	0	0	all		6.8	2.93	1		6.5	2.37	1		6.1	2.23	1		6.1	3.04	1	
Binary variable (%): 1 if farm has GlobalGAP and 0 otherwise	Ggap	—	—			0	100			4	97			5	95			3	97		
Binary variable (%): 1 if farm has UsaGAP and 0 otherwise	Ugap	—	—			97	3			95	5			95	5			96	4		
Binary variable (%): 1 if farm has Tesco and 0 otherwise	Tes	—	—			72	28			72	28			86	14			77	24		
Binary variable (%): 1 if farm has other certification and 0 otherwise	Ocer	—	—			89	11			98	2			100	0			96	4		
Categorical variable (%): 0 If certification was acquired in response to an export company's requirement; 1 if it was acquired to obtain a better price; 2 if it was acquired to have market access; 3 if it was acquired for another reason	Cerm	—	—			22	17	53	8	23	10	56	11	15	5	80	0	27	11	57	5
Categorical variable (%): 0 if the sanitary program is defined by the export company; 1 if defined by a professional hired by farmer; 2 if defined by farmer; 3 other	Sanp	67	12	15	6	28	42	16	14	53	23	5	19	62	5	28	5	63	21	8	8

* Variables included in the multivariate analysis. For determining statistically significant differences between each cluster and the rest (Sig), we applied the Levene test for equality of variances and then the t-test for equality of means for each pair of clusters. For qualitative variables, we present percentages in each category according to the description of the variable.

GAP certifications see Bain, 2010; Ouma, 2010; Henson *et al.*, 2011). This shows an orientation to access more demanding markets, given that, together with type III, it represents the highest percentage of Tesco certifications and the highest percentage of more specific certifications.

Type III farms: Diversified fruit farms with more experienced fruit producers (23.9%)

This group presented the highest level of diversification in the area of fruit production, showing the highest number of fruit species (4) and certified species (3), the lowest percentage of income from the main species (47%) and the lowest percentage of farmland dedicated to the production of the main species (39%). The average farmland size was 125 ha, 86% dedicated to fruit production. In 35% of the farms, the main species was apple, followed by cherry at 33%, then grape at 18% and kiwi at 14%. In 79% of the cases, products were marketed by an exporter, only 12% directly and 9% by both forms. The main types of certification were GlobalGAP (97%) and Tesco (28%).

In relation to the characteristics of producers, the producers of type III farm had the most years of experience in fruit production (37 years). It is interesting to note that while type III and type IV producers did not differ significantly in age (average of 66.8 and 68.4 years of age respectively), the former had on average 11 years more experience, which shows that in not all cases does experience increase with age.

Type IV farms: Large farms with alternative land use (8.8%)

Type IV grouped 21 farms and constituted the smallest grouping. The average farmland area was the highest of the types (371 ha) and dedicated only 29% of this area to fruit production. In the fruit production areas, 67% was dedicated to the production of only one species, 62% of which was apple, 19% kiwi, 14% grape and only 5% cherry. On average, the main species contributed close to 64% of total farm income. In 24% of the cases export was conducted directly, which represented the highest percentage of all the groups, probably reflecting the economic capacity and management of farms in of this type.

Type IV farms had an average of two certified species and 90% of the land dedicated to fruit production was certified, with an average of 6.1 years since the first certification. Like the other two farm types, the main kinds of certification were GlobalGAP (95%) and Tesco (14%), although the latter was less common than among types II and III farms.

In relation to the variables of the producers, the number of years of education was the highest among all the groups, at 16.4 years. However, the difference was only significant from that of types I and III (see Table 3). The average age of the producer was 68.4 years, which was similar to average ages of producers in types I and III, while the average number of years of experience was 26. As well, 43% stated that they were members of an agricultural association, which was the highest percentage among all the groups and reflects the level of associativity among large producers.

Finally, in more than 62% of farms, phytosanitary applications were defined by an agronomist from the export firm, while in 34% of the cases; this was defined by the owner, administrator or other person permanently involved in the farm. This contrasts with the managerial and financial autonomy and capacity of farms in this group.

Type V farms: Highly specialized fruit farms (37.8%)

Type V grouped 90 farms and was the most numerous and heterogeneous of the five farm types. It is characterized by the high degree of specialization of the farms in the production of only one species of fruit. The average farmland size was 54 ha, which is a medium size, low in comparison to the other certified types. Some 89% of farmland was dedicated to fruit production. The variables percentage of land dedicated to a main species (Hmsf) (81%) and percentage of certified land (Hcer) (98%) distinguish this farm type from the others, with the highest percentages for both variables. On average, 83% of farm income derived from the production of only one species of fruit, which in 47% of the farms was apple and in 24% was cherry, 17% kiwi and 12% grape. In 83% of the cases, export was carried out through export firms and in13% it was done directly.

In relation to certification, 97% of the farms had GlobalGAP certification and 24% had Tesco certification. In 63% of the farms, the phytosanitary program was determined by an agronomist from the export firm, while in 21% of the cases it was determined by a private advisor of the farm. The average age of the farm owner was 57 and the average number of years of experience in fruit production was 24.3. Both variables were significantly lower than those for groups III and IV.

Discussion

The results of this study ratify the heterogeneity among Chilean fresh fruit producers. The five farm groups differ mainly in their degree of certification and diversification/specialization in fruit production, and to a lesser degree in their relative distance to market connections, producers' experience and alternative farmland use. The presence or absence of certification proved to be one of the most discriminating factors, generating a distinctive group of uncertified farms that represented 14.3% of the sample. Respondents from this group showed a low level of knowledge about the destination of their fruit products: 50% stated that they did not know the final market at any stage of the exporting process, 26.5% said that they found out after harvesting, while only 17.6% stated that they knew before fruit harvest. In contrast, between 40% and 52% of respondents from the remaining four farm types stated that they knew the final market before harvest. The characteristics of type I farms, together with their high degree of dependence on export firms, supposes restrictions in decision-making and in general in the formation of export strategies because of the need to follow strategies recommended by exporters.

While certification is not a requirement of all final markets and type I farms can orient their production to less demanding markets, the lack of certification limits their export potential given that it is the policy of export firms to gradually eliminate farms that cannot access minimal certification, such as GlobalGAP, which is the most widely used farm certification system worldwide (Bain, 2010). Through certification, exporters seek to ensure a minimal level of good agricultural practices associated with fruit production that would allow for marketing their products to a wide range of markets. It is probable that some of the type I farms have tried to obtain certification but have not been successful, while other producers have not attempted to do so because of the costs involved. According to Fulponi (2007), the costs and requirements associated with meeting export standards, as well as traceability and record-keeping requirements, can be difficult for small farms that have fewer physical and human resources.

This is particularly important given that certification is required to export food products, in particular fresh fruit, to developed countries, which are the main target markets for Chilean fruit (ODEPA, 2011). Lack of certification implies losing the possibility of entering a significant number of markets. In fact, the great majority of producers in the four farm types with certification indicated that their main motivation in obtaining certification was to access markets rather than obtaining higher prices or satisfying the demands of the exporting firm, which shows that certification is considered a necessary insurance for marketing. Producers do not appear to experience an improvement in prices associated with certification, which reinforces the idea of certification as a key tool remaining in the markets and not as a mechanism to improve income through better prices.

For the remaining four farm types with certification, the results show a high degree of homogeneity in the variables related to certification (Cerfs, Hcer, Ncer and Ycer) and probably reflect the predominant trend among farmers currently integrated in fresh fruit supply chains. Nevertheless, it is possible to identify different farm structures and commercial strategies that are also related to personal aspects of the farm owner such as experience and level of education.

The results of this study can be useful for targeting public policies in fruit production as well as developing complementary research. In relation to the former, Chile is posed with the challenge of becoming one of the top ten world food exporters by 2015, which cannot be achieved without involving large numbers of small and medium-sized farmers. Meeting this goal raises questions as to what type of producers will be able to continue participating in the export food chain and obtain the required certifications, what profile and performance they need to have and what type of government incentives are required to facilitate their participation and certification. In this sense, it is possible that producers who do not meet a minimum set of standards (*i.e.* specific private certifications) will be excluded from markets in the short run and eventually forced to exit the sector. According to the results obtained, this consequence could be important for small and medium farms, which may lack the capacity to meet the stringent technical conditions imposed by the food chain (Fulponi, 2006). Projecting our results to the universe of producers in the two regions (2,357 producers), just in the area of study near 337 farms would not have any type of certification, 50% of these being farms of less than 15 ha. This suggests the need for conversion on the part of farmers that are unable to comply with the requirements, which undoubtedly will involve relevant but unmeasured social costs.

Possible actions by the public sector through specific institutions could include: continue enhancing farmer organizations and promoting specific financing instruments to them, rather than on an individual basis; reducing interest rates on productive loans in initial years (soft credit); finance export firms to expand their services to other farmers (*i.e.* direct support to infrastructure); continue "professionalizing" farmers with more and improved technical assistance; and to promote public-private alliances (*i.e.* Supplier Development Program - INDAP) to support the inclusion of farmers.

On the other hand, it is expected that the private sector will respond to the country's goals by expanding support to farmers. Currently, most export firms provide assistance to producers and training on productive and GAP topics. However, incentives for certified producers are not fully structured and returns from exports are not directly defined by specific criteria. In this sense, the private sector could increase the incentives to help promote certification and include small producers in the export chain.

As well, the results obtained in this study can be useful to complement future research. The most relevant elements of differentiation among the groups are certification and the level of specialization in fruit species, because of which it would be interesting to identify the impact these variables can have on the efficiency and profitability of the productive system. Certification can have a direct effect on the return per hectare or profitability and scale, and specialization can affect economic efficiency and final profitability of the productive system. To the best of our knowledge, studies relating efficiency, productivity and GAP are scarce in the literature, and this could be a gap to be filled in the future. As well, the different types of farms can be a useful tool to complement research in the construction of models to represent agricultural decision-making (Köbrich *et al.*, 2003), to design management strategies (Gaspar *et al.*, 2008), to evaluate new technologies (Olaizola *et al.*, 2008) or to evaluate the sustainability of farm production systems in the fruit sector (Nahed *et al.*, 2006).

In conclusion, the identification and characterization of fruit production farms in relation to their structure and export strategy resulted in defining five types of farms. Among these, one covers all farms without certification, while the others were differentiated mainly on the basis of their degree of specialization/diversification in fruit production. The results of this study suggest the degree of vulnerability of uncertified farm in terms of remaining in the agro-export chain. This reveals the importance of providing incentive and differentiated policies on the part of both the public and private sectors that take into account the characteristics and composition of each farm type, with the objective of ensuring the sustainability of a wide number of producers in the export chain, above all among those who are most vulnerable.

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