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Perspectives of abandonment/continuity of typological groups of sheep farms in the semi-arid region of Central Chile

Paula Toro-Mujica[a,b], Cristian Arraño[b], Raúl Vera[b], Lizbeth Robles[c], Constanza del Río[b], Estefanía Corvalán[b] y José Luis Riveros F.[b]

ABSTRACT: An exploratory study was conducted to analyze combinations of variables that define typological groups that condition the abandonment/continuity of sheep farming in the semi-arid region of Chile. Three typological groups were identified. Group I is made up of middle-aged farmers with the largest flocks. Group II has typical farms from an arid zone, own by elderly male farmers. Group III is located in areas near urban centers and has a greater presence of women farmers. The study allowed to identify the variables that influence the continuity of sheep farmers and to determine strategies that avoid/delay the abandonment of the activity.

Perspectiva de abandono/continuidad de grupos tipológicos de productores ovinos

RESUMEN: Se realizó un estudio exploratorio para analizar las combinaciones de variables que definen grupos tipológicos, condicionantes del abandono/continuidad de los sistemas ovinos de producción en la zona semiárida de Chile. Tres grupos tipológicos fueron identificados: Grupo I, formado por ganaderos de mediana edad con los rebaños de mayor tamaño; Grupo II con explotaciones típicas de zona árida, en propiedad de ganaderos de avanzada edad y Grupo III, en áreas semi-rurales con mayor presencia de mujeres ganaderas. El estudio permitió identificar las variables que influyen en la continuidad de las explotaciones ovinas y determinar estrategias que eviten/retrasen el abandono de la actividad.

PALABRAS CLAVE / *KEYWORDS*: Smallholders, sheep farming, continuity strategies, semi-arid / *Pequeños productores, ganadería ovina, estrategias de continuidad, semiárida*.

Clasificación JEL/ *JEL Classification*: Q15, 018, R23.

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[a] Instituto de Ciencias Agronómicas y Veterinarias. Universidad de O'Higgins, San Fernando, Chile. E-mail: paula.toro@uoh.cl.

[b] Dept. de Ciencias Animales. Pontificia Universidad Católica de Chile, Santiago, Chile. E-mail: caarrano@uc.cl, rverai@uc.cl, cddelrio@uc.cl, ebcorvalan@uc.cl, jlriverosf@uc.cl.

[c] Dept. de Nutrición Animal. Universidad Autónoma del Estado de México, Toluca, México. E-mail: lizroblez@hotmail.com.

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Correspondence author: Paula Toro.

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1. Introduction

Worldwide sheep farming in semi-arid regions is typically located in marginal areas, where other animal species with greater profitability, such as beef or dairy cattle, are not adapted to use the available pastoral resources. Management of sheep farms is frequently associated with family farms that use low amounts of external inputs and technology (Li *et al.,* 2015). On the other hand, technologies such as modern irrigation systems, have allowed orchard and vineyards plantations to occupy territories commonly associated with sheep farming, generating products whose consumption is far from the production areas (Levers *et al.,* 2018). These crops generally belong to large investors who, through purchase, merge a large number of farms (Beilin *et al.,* 2014). Thus, the natural landscape changes with the disappearance of traditionally crops, natural grasslands, and associated domestic and wild animal species (Peco *et al.,* 2006). In Chile, one of the traditional sheep production areas is the semi-arid Central zone where census data show declining numbers of sheep farms that decreased from 3466 farms in 1997, to 2793 in 2007 (INE, 1997; INE, 2007). The decrease in the number of farms is a global trend that is also observed in countries such as Spain, Norway, China, among others (Flaten, 2017; Li *et al.,* 2015). In this context the typology developed by Toro-Mujica *et al*. (2015) showed the atomization of sheep farming in the area, where more than 80 % of farms corresponded to small farms, with less than 30 animal units. These farms commonly belong to elderly farmers (average 62 years), with a low level of investment in their farms, low educational level and poor prospects of continuity of their descendants in the activity (Toro-Mujica *et al.,* 2015). However, sheep production systems throughout the Mediterranean regions, in addition to be an economic activity, play an environmental and social role rarely valued (Cosentino *et al.,* 2014). This gives sheep production systems a multifunctional character (Hadgigeorgiou *et al.,* 2005) that includes landscape conservation and biodiversity (Witt *et al.,* 2011), use of agro-industrial waste, fire prevention and fixation of the rural population, among others (Baumont *et al.,* 2014; Casasús *et al.,* 2012, García-Martínez *et al.,* 2011). Another function associated with extensive sheep systems is related to their main forage resource, natural rangelands, which, if well managed, can act as modest carbon sinks (Witt *et al.,* 2011;Stokes & Howden, 2010; Conant & Paustian, 2002).

Traditionally, sheep systems have been a source of work (Paniagua, 2013), fiber and leather, and food safety through their milk and meat products. In the study area, however, the product obtained corresponds basically to meat lambs. Nevertheless, projects with government support (e.g. the Merino Seal Project for the Textile Route financed by the Fondo de Innovación para la Competitividad del Gobierno Regional de O'Higgins) are in search of improvements in the fineness of wool for further processing and sale of products with greater added value (crafts, ponchos, sweaters, etc.). Within this scope, as De Rosa *et al*. (2019) point, the family plays a key role in fostering strategic entrepreneurship and maintaining the strength and viability of multigenerational family businesses. Despite these efforts, the trend for depopulation of semi-arid areas traditionally dedicated to sheep farming has continued. As noted

by Levers *et al*. (2018) and Beilin *et al*. (2014), the causes of the abandonment of agriculture are multifactorial and therefore can differ from one area to another or between production systems. Among the main causes, it is possible to mention management variables, such as farm structure, environmental variables (such as soil quality), changes in rainfall and temperature, and economic and social aspects (Koulouri & Giourga, 2007). Taking into account the aspects related to sheep farming in the central zone of Chile and the variables that influence the abandonment of this agricultural activity, the objective of this work was to identify typological groups through a multivariate methodology to assess how the combinations of variables that define the groups determine the perspectives of abandonment/continuity of the farm.

2. Materials and methods

2.1. Study area

The study area corresponded to the semi-arid zone of Central Chile, including three regions that have sheep farms. The first corresponds to the Metropolitan Region, a region with a Mediterranean climate, where the main agricultural activity is based on irrigated fruit orchards. The region includes the country capital (Santiago), a city that concentrates 40 % of the national population (7.1 million) and 40 % of the total number of employed people in Chile (ODEPA, 2018a). The second region corresponds to the region of Valparaíso that has a temperate Mediterranean climate, a characteristic that has made it an important area for the production of fruit orchards and vineyards and that together with forestry occupies more than 75 % of the cropped surface area (ODEPA, 2018b). Livestock species include cattle and goats, with sheep in third place. The last region corresponds to Region of O'Higgins, a geographical area traditionally dedicated to sheep farming, but which today faces competition from the fruit and vineyards sectors in areas that can be irrigated. The three selected regions, despite being geographically close, sharing territorial limits and agroclimatic characteristics, have sociodemographic characteristics that differentiate them. Thus, the Metropolitan and Valparaíso regions correspond to the two regions with the largest population in the country, possessing more than 7 million and more than 1.5 million inhabitants, respectively, while the O'Higgins region occupies the 5th position in relationship to the amount of population nationwide. Another differentiating aspect is the percentage of rural population since the first two regions account for 3.7 and 9 % of the total respectively, whereas it increases to 25.6 % in the O'Higgins region (INE, 2019a).

2.2. Selection of farms

The selection of the farms was carried out through a directed sampling because the farms had to meet three conditions to be part of the study: be family farms, have sheep, and that sheep production was one of the three main sources of farm income. In the three regions, public and private agricultural advisers and extension

agents were contacted to identify farms that satisfied the above conditions. A total of 52 farms was surveyed.

2.3. Design and application of the survey

The survey consisted of 62 questions, of which 25 corresponded to open-ending questions. The closed questions allowed the farms and farmers characterization and the description of the family group. The open-ending questions helped to understand the reasons for the selection of options within the closed questions. The surveys were conducted by graduate agricultural students, professional agronomists, and veterinarians, that allowed directing the conduct of the survey towards the topic of interest.

2.4. Farms characterization

For the farms' characterization, average values and standard deviations of the quantitative variables were obtained. Regarding the qualitative variables, when these came from an open-ending question, the answers were grouped into categories, and those with greater frequency were selected. The rest of the answers were included in the category "others".

Analyses of variance and multiple means comparison test were also conducted for the quantitative variables. In the case of qualitative variables, percentages of responses were calculated within each category and contingency tables, and Chi-square tests were performed to evaluate the relationship between variables.

2.5. Farm typology

With the purpose of creating homogeneous groups and identifying the perspectives of continuity/abandonment of sheep farming, a multivariate analysis was carried out, based on the methodology of multiple correspondence analysis (MCA). The methodology considered four stages: selection of variables, multiple correspondence analysis, cluster analysis and discriminant analysis (Milán *et al.,* 2011; Uriel & Aldas, 2005; Solano *et al.,* 2000). The categorization of the qualitative variables, for their use in correspondence analysis, was based on obtaining relatively homogeneous groups in terms of the number of observations. The adequacy of incorporating variables in the MCA was evaluated using the Chi-squared test between pairs of variables, discarding those variables that showed few associations. To select the appropriate number of dimensions, those with an eigenvalue greater than the value of the mean were kept (Greenacre, 2006), and the Alpha Cronbach index was used to evaluate the relevance of the matrix of selected variables (George & Mallery, 2003). To select the cluster number, a hierarchical clustering analysis was performed. This analysis allowed grouping similar farms (least within group variance) and different from others (greater variance between groups). Clusters were developed according to the method of Ward, nearest neighbor, and farthest neighbor, using the Euclidean, squared Euclidean and Manhattan distances (Köbrich *et al.,* 2003). Finally, contingency

tables were constructed with qualitative variables and ANOVA and multiple means comparison analyses were performed for the quantitative variables.

2.6. Effect of distance to urban centers and gender

The effect of the factors distance to urban centers and the owner's gender was analyzed on the qualitative and quantitative characterization variables. Regarding distance of farms to urban centers, two categories were defined: Near Urban Centers (NUC) and Distant Urban Centers (DUC). The maximum distance to an urban center considered near was 100 kilometers, as this distance was perceived as a psychological limit of closeness. Cities with more than 1 million inhabitants were considered as urban centers.

3. Results and discussion

3.1. Farms characterization

Of the 52 surveys, 34 were conducted in the O'Higgins Region, 13 surveys in the Metropolitan region and 5 surveys in the Valparaíso region. The difference in the sample size was due to the availability of sheep farms in each of the study regions, where the O'Higgins Region in 2007 the Agricultural Census (INE, 2007) recorded a total of 2597 farms in 2007, compared to 817 in the Metropolitan Region, and 705 in the Region of Valparaiso. Due to the geographical characteristics of the regions studied, all the farms belonging to the Metropolitan and Valparaíso regions were located less than 100 km from an urban center (NUC), while all the farms in the O'Higgins Region were located at a distance greater than 100 kilometers from an urban center (DUC).

Thirty one percent of the farms surveyed were managed by women, a percentage that increased to 61 % in the NUC zone (Table 1). Some research has indicated that crop, vegetable and animal species increase when farms are managed by a woman (Nyantakyi-Frimpong, 2017). In the analyzed farms this trend was not observed, probably because in 44 % of farms managed by man, the second member of the family group was a woman, which could incorporate diversity to the farm. Most of the families lived on the farm, with no difference between the zones. The average age of farmers was 65 years, which is high if compared to the average age of the total Chilean population (35.8 years) and rural population (38.3 years) (INE, 2019a). As Beilin *et al.* (2014), points out this finding could be considered as an indicator of the decrease of agricultural activity in an area. The separation by zone or gender did not show differences in age between groups; however, women had an average age of 62 years, while men of 66 years (Table 2). 66.7 % of respondents had primary education and only 3.9 % university studies (Table 1), and there were no differences by zone or gender. Age was a significant variable in the education of the farmers ($p < 0.01$), thus, within the interval greater than 65 years 75 % of the farmers had only primary education, a percentage that decreases to 0 % in people under 40 years.

TABLE 1

Qualitative characterization variables according to zone (NUC and DUC) and gender

Variable		Zone			Gender			Total
		NUC	DUC	P Value	Female	Male	P value	
Live on the farm		87.90	94.40	0.45	87.50	91.70	0.63	90.20
Education	Primary	72.20	63.60	0.67	68.80	66.70	0.74	66.60
	Secondary	22.20	27.30		25.00	25.00		25.50
	College	5.60	3.00		6.30	2.80		3.90
Dedicate time to another activity		61.00	51.50	0.51	56.30	52.80	0.81	54.90
Think to continue in the sheep farming		88.90	97.10	0.22	93.80	94.40	0.92	94.20
Thinks to continue in the sheep farming for the rest of his/her life		80.00	100.00	0.01	92.30	93.80	0.86	93.30
Because he/she think to continue in the sheep farming	Pleasure or tradition	94.10	54.50	0.03	86.70	60.00	0.26	68.00
	Pleasure or tradition and using of resources	0.00	15.20		6.70	11.40		10.00
	To use of resources	0.00	15.20		0.00	14.30		10.00
	Need	5.90	15.20		6.70	14.30		12.00
She / he would like their offspring to continue in the activity		60.00	80.00	0.15	71.40	74.20	0.84	73.30
Who will continue the sheep farming?	Son/Daughter	47.10	53.60	0.87	66.70	43.30	0.26	51.10
	Nephew/Nice	3.60	5.90		0.00	6.70		4.40
	None	42.90	47.10		33.30	50.00		44.40
Gender	Female	61.10	15.20	< 0.01				30.80
	Male	38.90	84.80					69.20

Source: Own elaboration.

The average area of the farms was 38.6 hectares with a flock of 115 sheep, being significantly lower in the NCU farms, which is explained by the difference in the value of the land, given the alternative of land sales as housing plots. On the other hand, farms managed by women had a smaller area, as well as smaller flocks, which in turn is associated with the predominance of women within the NUC zone (Table 2). The ability to handle larger flocks by men is a feature that has been mentioned in some research (Aldosari, 2018). In relation to other activities carried out on farms, more than 85 % developed another activity, in addition to sheep farming, including cattle

raising (29 %), fowls (42 %) and the cultivation of vegetables (11 %) and strawberries (13.5 %) (Appendix 1).

TABLE 2

Quantitative characterization variables according to zone (NUC and DUC) and gender

Variable	Zone			Gender			Total
	NUC	DUC	p value	Female	Male	p value	
Farm surface (ha)	8.3±22[a]	55±61[b]	<0.01	14.1±21.0	49.8±61.4	0.02	39±55
Number of sheep	44±169[a]	153±167[b]	0.01	40±36.2	147.3±170.9	0.02	115±153
Number of family members	3.3±13	3.5±1.8	0.67	3.8±1.3	3.44±1.82	0.89	3.5±1,7
Farmer age (year)	65±15	65±12	0.99	62.1±15.1	65.9±13.4	0.37	65±14
Time lived on the farm (% of age)	74±32	81±33	0.47	74±32	81±32	0.44	79±32
Number of agricultural activities	7.9±3.4	7.5±4.3	0.72	8.3±4.3	7.5±3.4	0.49	7.8±3.7
Income from sheep (%)	36.7±31.4	37.5±24.6	0.91	29.4±20.8	42.4±30.1	0.12	38.4±28

Source: Own elaboration.

No significant differences were observed in terms of zone or gender. The failure to find differences between zones does not agree with the proposal by Makate *et al.* (2016), who pointed out a positive relationship between farm surface and diversity of activities. When analyzing the type of activities, there was a trend for farmers in DUC to produce strawberries, an activity that has been encouraged by projects with government funding, such as the "Pathway of Sustainable Strawberry Transfer" and "Strawberry Cultivation Transfer with Regional Identity" financed by the Innovation Fund for the Competitiveness of the Regional Government of O'Higgins. Thus, while in the NUC zone there are no farmers dedicated to the production of strawberries, in the DUC zone this activity is present in the 21 % of farms. Forest plantations were another activity with a greater presence in the DUC area (8.8 %), which again is associated with the variable dimension and value of the land (Appendix 1).

Regarding other animal species, no percentage differences were observed in the presence of fowls, cattle, goats, and horses by zone (Appendix 1). However, when the animal inventory was considered only in farms with the presence of animals in each species, there was a difference in the number of animals owned by the farms with the presence of goats, equines and fowls. Thus, the NUC zone had an average of 5.8 ± 1.7 goats per farm, whereas the average for the DUC zone was 52.0 ± 31.5.

In the case of horses, the NUC farms presented an average of 5.6 ± 2.9 animals per farm, while in the DUC zone the average decrease to 2.8 ± 1.7. In fowls, the trend was similar, with a higher average number of animals in farms in the NUC zone (81.0 ± 89.9 in NUC versus 43.1 ± 55.9 in DUC). This situation is related to the ease of handling fowls in pens, needing a limited surface area and generating products that are easy to consume and/or sell. This characteristic, in turn, is associated with the presence of women as managers of the farms; thus, fowls were present in 63 % of farms managed by women and only in 33 % of farms managed by men. The predominance of small livestock is a common feature in farms managed by women, as pointed out by Vidal (2013). With regard to sheep production 83 % of the farmers produced only meat lamb, and the remaining 17 % added wool production. The difference was mainly due to the fact that only 2 % of the respondents had Merino animals. It should be noted that according to the data from the latest livestock survey (INE, 2019b), in the study area 82.3 % of the farms have Suffolk flocks, including within this percentage 10 % of farmers that manage both breeds. The farms that own Merino animals reach 20 % in the study area. However, farms with Merino flocks do not usually correspond to family farms, so while the average flock with Suffolk breed was 243 animals, in the Merino breed, it reaches 2344 animals (INE, 2017). Sheep activity generated on average 38.4 % of income, with no difference due to the zone or gender (Table 2).

3.2. Abandonment/continuity of sheep farms

Faced with the questions, do you have the intent to continue working on the sheep activity? And how much longer do you think to continue in the sheep activity? 94 % of the producers answered affirmatively, noting in 93 % of the affirmative cases that they will continue for the rest of their lives. For the first question, no significant differences were observed between zone and gender. In the second question, 96 % of the farmers plan to continue in the activity for the rest of their lives (Table 1). 68 % of the producers intend to continue in the activity for pleasure or tradition, while 10 % in addition to the pleasure or tradition for the activity, incorporates to its response the use of the resources of the farm, an option that is also mentioned alone in 10 % of the farmers. The option "by necessity" appeared in 12 % of the answers. Differences between zones are shown in Table 1, noting the absence of differences due to gender.

Among the main problems faced by sheep farming, farmers mentioned predator attack (26.9 %), unfavorable climate (19.2 %), lack of feed (17.3 %), cattle theft (5.6 %) and low price of lambs (11.5 %). Both the unfavorable climate and lack of feed were associated with a decrease in the level of rainfall, a major constraint considering the effect that the change in precipitation and temperature patterns will have on the semi-arid regions (Rojas *et al.,* 2019; Bonelli & Meza, 2011). When asked who would continue with the activity, 51 % of the farmers affirmed that one of her/his sons, while 4.4 % mentioned a nephew. However, 44 % mentioned that no member of their family would continue with the activity (Table 1). Intuitively, who will continue with the activity is related to family conformation, thus, as shown in Table

3, in farmers who do not have children the percentage of nephews increases as well as the abandonment of the activity.

TABLE 3

Relationship between the number of children and who will continue with the sheep activity (%)

Family member who will continue with the sheep farming	No children	1 child	2-3 children	More than 3 children	Total	p value
Son/Daughter	0.0*	53.3	62.5	100.0*	51.1	0.01
Nephew/Nice	11.1	0.0	6.3	0.0	4.4	
None	88.9*	46.7	31.3	0.0*	44.4	
Total	20.0	33.3	35.6	11.1	100.0	

* *Groups with frequency that differ significantly from the expected value ($p < 0.05$).*

Source: Own elaboration.

When sheep farmers were asked if they were willing to move to live in the city, 98.1 % said no. The main reasons for not moving to cities were pleasure (24.6 %), habit (27.6 %) and peacefulness (17.1 %). The alternative "other reasons" accounted for 30.3 % of the responses in the DUC zone and 22 % in the NUC zone. Among the responses associated with this option are "here I have my life project and a better quality of life", "for the ease of producing my food", "it is healthy to live here" and "because life in the countryside is prettier". All answers that are associated with a positive perception of life in the field, a vision that today is shared by a large part of the world population and that in recent years has generated the use of the term "lifestyle migration". This term refers to the growing number of people who are motivated to seek a better way of life in or near rural areas (Chueh & Lu, 2018; Benson & O'Reilly, 2009). This trend, however, is not new, so, terms such as "Counterurbanization" or "rural renaissance" were used in the 70s to describe the same phenomenon (Li *et al.,* 2016). The most mentioned disadvantages of life in the countryside were the long distances (19.2 %) and the lower quality of the health centers (17.3 %). A situation that as pointed out Li *et al*. (2016) is shared worldwide. However, it is noteworthy that 30.8 % of farmers do not find any disadvantage to living in the countryside. When considering only the answers that mentioned some disadvantage, a difference between zones can be seen. The response "the lower quality of the health centers" was significantly higher in the DUC zone. This response is reaffirmed when analyzing the answers obtained to the question "What are the advantages of living in the city?" where 55 % of the farmers answered the proximity to the health, commerce and service centers. It should be noted that within this question there were significant differences for the main answers obtained: closeness to health centers, commerce,

and service; better access to education; more work and ideal for young people. Results that coincide with what was reported by Wang & Wan (2014) and Stockdale (2004) about job opportunities and health centers respectively. In relation to job opportunities for young people in the study area, 73 % of farmers mentioned agricultural work; the alternative "Other", represented 13.5 %, including answers such as education, forestry, maintenance of gardens in condominiums and tourism, not observing differences between zones or gender. Farm abandonment by offspring is due to the new family formation (40 %), studies (16 %), work (12 %) and a combined option of family and work of 28 %. Although no significant differences were observed in the main responses obtained between zones, it should be noted that the alternative "studies" was not mentioned in the NUC zone, mainly because the proximity to a large urban center allows daily transportation. The abandonment of sheep farming brings environmental and social consequences such as ecosystem services associated with that sheep farms (Rodríguez-Ortega *et al.,* 2016), which disappearance increases the likelihood of forest fires and the invasion of exotic species (Schneider & Geoghegan, 2006; Romero Calcerrada & Perry, 2004).

3.3. Typology of sheep farms and its relationship with abandonment/continuity

Eleven variables were selected for the multiple correspondence analysis (MCA). The MCA delivered three dimensions, with eigenvalues that exceeded the value of the average eigenvalue (Greenacre, 2006). These three dimensions explained 56 % of the inertia and delivered an average value of Cronbach's Alpha of 0.768, a value that is considered acceptable. The cluster analysis that presented the most significant results was that using the farthest neighbor method based on the squared Euclidean distance. Three groups were identified. A discriminant analysis correctly identified 98 % of the farms. In Figure 1 it is possible to appreciate the distribution of the farms and the groups formed.

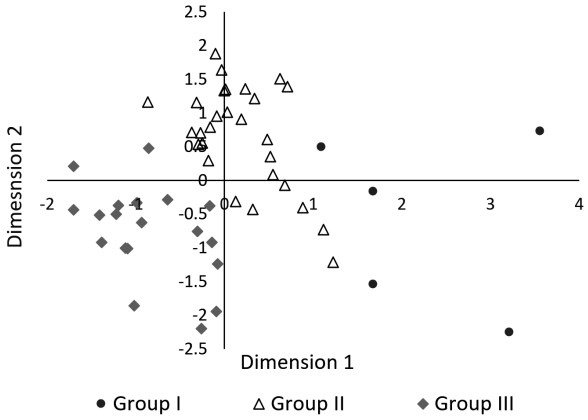
Group I. Corresponds to the smallest group, representing only 10 % of the farms. It is made up of middle-aged farmers, who have gone into sheep farming due to different circumstances, whether family-related (e.g., an uncle died, and we came to take care of the field), for work or own choice (e.g., to be in contact with the field), which means that the spent only about 30 % of their lives in the field (Table 4).

The level of education of this Group is higher than in Groups II and III, as a consequence of a lower average age (Table 5), with 80 % presenting secondary education. They have farms with an average surface of 53 ha, but manage flocks with an average number of 315 heads, much higher than the other two groups. Despite this characteristic, the percentage of income that comes from sheep production is similar to the other two groups, which implies that they carry out other activities both inside and outside the farm, with an important role in the generation of income. This characteristic means that only 60 % of the producers live on the farm (Table 4). The farms of this group are commonly in male hands, a situation that is normal in the management of sheep farms in Chile. Due to the dimensional characteristics, these farms are located in the DUC zone. Although 80 % of the farmers in this group have more than three children and 75 % indicate that they would like their children to continue

with the activity, 100 % of the producers indicate that their offspring (children or nephews) will not continue with sheep production (Table 5).

FIGURE 1

Position of the farms by groups according to dimensions 1 and 2 of MCA



Source: Authors' elaboration from survey results.

TABLE 4

Quantitative characterization variables according to group of farms

Variable	Group I	Group II	Group III	p value	Total
Farm surface (ha)	53.4 ± 30.1[b]	56.9 ± 64.7[b]	8.3 ± 21[a]	0.07	38.8 ± 54.7
Number of sheep	315.2 ± 366.6[b]	126 ± 86.1[b]	44.1 ± 87.2[a]	0	114.3 ± 151.7
Farmer age (year)	46 ± 11.4[a]	67.7 ± 13[b]	65.3 ± 12.4[b]	0.04	64.7 ± 13.9
Time lived on the farm (% of age)	33 ± 37.6[a]	89.5 ± 23.3[b]	75.5 ± 31.5[b]	0.01	78.9 ± 31.9
Children (n°)	1.6 ± 0.7	1.7 ± 1.8	1.4 ± 1	0.69	1.6 ± 1.5
Bovines (n°)	5 ± 7.1	6.6 ± 16.4	5.9 ± 16.6	0.97	6.2 ± 15.6
Goats (n°)	17.4 ± 38.9	4.3 ± 14.5	1.2 ± 2.5	0.13	4.4 ± 15.9
Equines (n°)	1.6 ± 2.5	1.4 ± 1.8	1.5 ± 2.9	0.98	1.5 ± 2. 3
Fowls (n°)	51 ± 100.3	11.6 ± 18.3	35.3 ± 69.1	0.16	24.1 ± 53.4
Income from sheep (%)	40 ± 23.5	39.5 ± 27.8	36.3 ± 30.6	0.92	38.4 ± 28.0
Income from an external labor source (%)	38 ± 37.7[b]	13.9 ± 31.1[ab]	3.7 ± 16.1[a]	0.04	12.5 ± 28.4
Income from other sources (%)	0 ± 0	29.6 ± 34	24.7 ± 34.7	0.19	25.0 ± 33.3

[a, b] *Averages with different superscript differ significantly according to indicated value p.*

Source: Own elaboration.

TABLE 5

Qualitative characterization variables according to groups of farms. In percentage

Variables		Group I	Group II	Group III	Total	P value
Gender	Female	20.0	14.3*	57.9*	30.8	0.05
	Male	80.0	85.7*	42.1	69.2	
Education	Primary	0.0	82.1	73.7	71.2	0.04
	Secondary	80.0*	17.9	21.1	25.0	
	College	20.0	0.0	5.3	3.9	
Zone	NUC	0.0	0.0	94.7*	34.6	0.01
	DUC	100.0	100.0	5.3*	65.4	
For How long it will continue with sheep farming	All Life	100.0*	100.0*	81.3*	93.3	0.05
	Other	0.0	0.0	18.8*	6.7	
Children	No Children	0.0	32.1	15.8	23.1	0.04
	1 or 2 children	20.0	21.4*	47.4	30.8	
	3 or 4 children	80.0*	28.6*	36.8	36.5	
	More than 4 children	0.0	17.9*	0.0	9.6	
He/She would like his/her children to continue with sheep farming		75.0	80.0	62.5	73.3	0.46
Some offspring will continue with the exploitation		0.0	65.2	55.6	55.6	0.05
Live on the farm		40.0*	96.4	94.7	90.4	0.01
He/She would like to move to live in an urban center		20.0	0.0	0.0	1.9	0.01
He/She work outside the farm		60.0*	14.3	5.3	15.4	0.01

* *Groups with frequency that differ significantly from the expected value ($p < 0.05$).*

Source: Own elaboration.

Group II. The farms of this group are the most common (54 %), they are in the hands of the oldest farmers within the groups identified and with tradition in sheep farming, so, on average 90% of their lives has been dedicated to the activity (Table 5). This tradition is reaffirmed when farms are managed by male farmers, 96 % of which live on farm. The level of education is lower than the previous group, with only 18 % of the producers having secondary education (Table 4). The farms are similar

in area to the previous group but manage smaller flocks (Table 4). Sheep production represents an important part of the income, but unlike the previous group they count on other non-agricultural sources of income, consisting mostly of retirement income rather than off-farm employment, which average 30 % of the total income. Similar to the previous group, this type of farm is located in the DUC zone (Table 5). Within this group no respondent indicated to wish to move to the city, indicating that they will continue in their farms for the rest of their lives. 80 % of producers say that they would like their children to continue with the activity; however, only 65 % of farmers answer than a family member will continue (Table 5).

Group III. It represents 36 % of the farms, shares characteristics with the group I in relation to the age of the producers, the percentage of their lives that have been dedicated to the activity and their educational level (Table 5). However, the farms are smaller in area and flock size (Table 4), mainly because they are located in the NUC zone. Other characteristics similar to group II are that more than 95 % of the producers live on the farm, no producer wants to move to live in the city, and only 5 % have off farm work (Table 5). A particular characteristic of this group is the high percentage that is in charge of a woman (58 %). In this group the farmers indicate that they will continue with the sheep activity in 81 % of the answers, indicating as reasons for not continuing the lack of water, health or small land area. 63 % of producers want their children to continue with the activity and 55.6 % point out that this will be the case.

In terms of continuity or abandonment of sheep farming, different scenarios were observed across the groups. In Group I, following what was cited by Flaten (2017), two probable trends are visualized: 1. Increase in profitability while conserving sheep activity as one of the basic income-generating activities, but complementing it with other activities (within or outside the farm), either within the current alternatives or due to the lower age of the producers of this group and their higher educational level, in new productive alternatives, 2. Abandonment of the activity due to the opportunity cost that implies the use of the family's labor in the activities of the farm. If this is added to the perception that no family member will continue with the sheep raising, the unavoidable trend is the disappearance in the medium term of this type of sheep farm. Groups II and III, on the other hand, present a less critical situation regarding the intention of continuity, in family terms, both for the present generation and the next. However, at the level of Group II, an improvement in resource management is required to obtain productive results that resemble Group I, both in terms of the number of animals handled and concerning the income structure of the farm, basically, where activities that complement the income of the sheep activity are required. Examples of complementary sources of income include encouraging the production of strawberries, minor fruit trees or complementary sheep products (wool and milk). In both groups the valorization of lamb, through the formation of cooperatives of producers that process the carcasses is required. In these cooperatives, the aim is to obtain cuts and third-range products, of a small format, that require simple preparation by the consumer and allow, through the shortening of the commercialization channel, to increase the profitability of the activity. On the other hand, obtaining charcuterie

products from culled ewe carcasses (which represent about 20 % of the animals sold each year), is another viable productive alternative within the cooperative model, especially considering the current guidelines of the Ministry of Agriculture, which considers within its priorities the development of a National Associativity Plan (MINAGRI, 2019). The continuity of the sheep category in group III depends on the availability of other feed resources such as crop stubbles or by-products. The scarce surface in these farms prevents the possession of large flocks and takes into account the proximity to urban centers, the surplus value of the land currently known as urban sprawl (Serra *et al.,* 2014) or naturbanization (Prados, 2009). This group could disappear if sheep production continues as a generator of commodities products. It is therefore necessary to add value to sheep products through processing (wool, milk or meat). Also, as indicated for group II, sheep farming is required to fulfill a function of closing biogeochemical cycles, and is probably more important than sheep production, an aspect that over the medium term would benefit alternative land uses. For example, this type of farms would benefit from the sale of fresh products in local markets, with direct sales to consumers. This tendency has increased recently in developed countries such as the United States (Dreby *et al.,* 2017) and, as DiNapoli (2015) points out, can lead to family farms being considered vital in a region's economy, in addition to increase the quality of life, through environmental benefits, such as the preservation of open spaces and diversity of the landscape (Witt *et al.,* 2011). In this same line of argumentation, a complementary vision was proposed by Paniagua (2013) who points out that the processes of change in rural areas are more associated with the perspectives of the consumers than that of the producers. In the case of sheep production, it is likely considering that the consumption of sheep meat fell from 0.6 kg per capita in 2006 to 0.2 kg per capita in the year 2017. Bearing this in mind, it should support bottom-up initiatives aligned with government policies and local development plans (Li *et al.,* 2016). It should be noted that, at the national level, efforts have been made through the Innovation Fund for Competitiveness (an instrument created in 2006, part of the National Fund for Regional Development (FNDR)), to provide greater resources to national and regional initiatives associated with innovation.

It is considered that the permanence of farms in the sheep sector, in addition to a productive role, fulfills a social and cultural role. Studies such as Scortichini *et al*. (2016) indicate that the role of on-farm sheep meat consumption would limit its integration to the value chain and that the loss of productive units would generate a nutritional impoverishment of the diet. The abandonment of the sheep sector entails migration to other productive areas and the sale of rural property, which could lead to productive reconversion, land concentration, and the increase of neo-urban populations. These new populations will require support policies social, educational, and equipment and infrastructure to deliver adequate living conditions to this migrant population.

Studies in different areas of the world (Estevez-Moreno *et al.,* 2019; Austrheim *et al.*, 2016), give relevance to the permanence of sheep farming in the rural area,

promoting the preservation of local culture, regulating rural migration, strengthening food security, and strengthening agricultural land use. Given the current scenario of global change, public policies should focus on the issues above, in addition to promoting the sustainable use of pastoral resources, avoiding both over and undergrazing (Conant & Paustian, 2002). These public policies should complement the current ones, of soil reclamation (BCN, 2010), grasslands, and supplementary crops (INDAP, 2019), and incorporate training in grazing management and sheep supplementation in critical periods.

4. Conclusions

The future of sheep farming in the semi-arid zone of Central Chile, as in most similar regions, is conditioned by both structural and social factors. The structural factors in this area are related to dimensional and demographic characteristics, such as the available surface area and the ease of access to markets, health centers, and education. Farm area determines the size of the flock, given the low carrying capacity that available forages resources can support as well as production of other animal species and commercial crops that farmers may incorporate into their farms. In the study area, proximity to urban centers plays an important role, since farms in NUC zone tend to have a smaller dimension, as do farms managed by women. Social factors refer to the age of the farmers, offsprings, the opportunity cost of work, and the pleasure and tradition for life in the countryside. The older age of the farmers in groups II and III will lead to continued decreases in sheep farms by at least 44 % within the next generation unless measures are taken to encourage the permanence of the younger generations. The effect of the offspring in the permanence of farms is another factor to consider, given that at the national level family size tends to decrease. The creation of government funds for the direct support of activities related to sheep farming and other complementary activities goes in the right direction, to the extent that they generate a higher level of income for the farmer and the family labor, the social valuation of agriculture, livestock, its products, and associated environmental services, as well as closer links between producers and consumers.

References

Aldosari, F. (2018). “Gender participation in sheep and goat farming in Najran, Southern Saudi Arabia”. *Saudi Journal of Biological Sciences*, 25(1), 144-148. http://dx.doi.org/10.1016/j.sjbs.2017.03.013.

Austrheim, G., Speed, J., Evju, M., Hester, A., Holand, O., Egil, L., Martinsen, V., Mobæk, R., Mulder, J., Steen, H., Thompson,D. & Mysterud, A. (2016). “Synergies and trade-offs between ecosystem services in an alpine ecosystem grazed by sheep – An experimental approach”. *Basic and Applied Ecology,* 17(7), 596-608. http://dx.doi.org/10.1016/j.baae.2016.06.003.

Baumont, R., Carrère, P., Jouven, M., Lombardi, G., López-Francos, A., Peeters, A., Porqueddu, C. & Martin, B. (2014). "Forage resources and ecosystem services provided by Mountain and Mediterranean grasslands and rangelands". *Options méditerranéennes, Series A: Mediterranean Seminars 2015,* 109. Retrieved from: http://om.ciheam.org/om/pdf/a109/a109.pdf.

BCN. (2010). *Ley núm. 20.412. Establece un sistema de incentivos para la sustentabilidad agroambiental de los suelos agropecuarios*. Biblioteca del Congreso Nacional.

Beilin, R., Lindborg, R., Stenseke, M., Pereira, H.M., Llausàs, A., Slätmo, E., Cerqueira, Y., Navarro, L., Rodrigues, P., Reichelt, N., Munro, N. & Queiroz, C. (2014). "Analysing how drivers of agricultural land abandonment affect biodiversity and cultural landscapes using case studies from Scandinavia, Iberia and Oceania". *Land Use Policy,* 36, 60-72. http://dx.doi.org/10.1016/j.landusepol.2013.07.003.

Benson, M. & O'Reilly, K. (2009). "Migration and the Search for a Better Way of Life: A Critical Exploration of Lifestyle Migration". *The Sociological Review,* 57, 608-625. http://dx.doi.org/10.1111/j.1467-954X.2009.01864.x.

Bonelli, S. & Meza, F. (2011). "Abastecimiento de agua en la cuenca del Maipo". *Agronomía y Forestal,* 45, 4-7.

Casasús, I., Rogosic, J., Rosati, A., Stokovic, I. & Gabila, D. (2012). "Animal farming and environmental interactions in the Mediterranean Region". *EAAP Publication,* 131, Wageningen, Netherlands: Wageningen Academic.

Chueh, H. & Lu, Y.H. (2018). "My dream life in a rural world: A nonfiction media representation of rural idyll in Taiwan". *Journal of Rural Studies,* 59, 132-141. http://dx.doi.org/10.1016/j.jrurstud.2017.04.004.

Conant, R. & Paustian, K. (2002). "Potential soil carbon sequestration in overgrazed grassland ecosystems". *Global biogeochemical cycles,* 16(4), 1-7. http://dx.doi.org/10.1029/2001GB001661.

Cosentino, S.L., Porqueddu, C., Copani, V., Patanè, C., Testa, G., Scordia, D. & Melis, R. (2014). "European grasslands overview: Mediterranean region". In: Hopkins, A. *et al*. (Ed.): *EGF at 50: The Future of European Grasslands* (pp. 41-56). Aberystwyth University, United Kingdom: European Grassland Federation.

De Rosa, M., McElwee, G. & Smith, R. (2019). "Farm diversification strategies in response to rural policy: A case from rural Italy". *Land Use Policy,* 81, 291-301. http://dx.doi.org/10.1016/j.landusepol.2018.11.006.

DiNapoli, T. (2015). *The Importance of Agriculture to the New York State Economy*. New York State Comptroller, US. Retrieved from: https://osc.state.ny.us/reports/economic/importance_agriculture_ny.pdf.

Dreby, J., Jung, G. & Sullivan, R. (2017). "At the nexus of work and family: Family farms in upstate New York". *Journal of Rural Studies,* 49, 151-161. http://dx.doi.org/10.1016/j.jrurstud.2016.12.001.

Estevez-Moreno, L., Sanchez-Vera, E., Nava-Bernal,G., Estrada-Flores, J., Gomez-Demetrio, W. & Sepúlveda, W. (2019). "The role of sheep production in the livelihoods of Mexican smallholders: Evidence from a park-adjacent community". *Small Ruminant Research*, 78, 94-101. http://dx.doi.org/10.1016/j.smallrumres.2019.08.001.

Flaten, O. (2017). "Factors affecting exit intentions in Norwegian sheep farms". *Small Ruminant Research,* 150, 1-7. http://dx.doi.org/10.1016/j.smallrumres.2017.02.020.

García-Martínez, A., Bernués, A. & Olaizola, A.M. (2011). "Simulation of mountain cattle farming system changes under diverse agricultural policies and off-farm labour scenarios". *Livestock Science,* 137, 73-86. http://dx.doi.org/10.1016/j.livsci.2010.10.002.

George, D. & Mallery, P. (2003). *SPSS for Windows step by step: A simple guide and reference 11.0 update (4th ed.).* Boston, United States: Allyn & Bacon.

Greenacre, M.J. (2006). "From Simple to Multiple Correspondence Analysis." In M.J. Greenacre & J. Blasius (Eds.): *Multiple Correspondence Analysis and Related Methods* (pp. 41-76). Chapman & Hall/CRC, Boca Raton.

Hadjigeorgiou, I., Osoro, K., Fragoso de Almeida, J.P. & Molle, G. (2005). "Southern European grazing lands: Production, environmental and landscape management aspects. *Livestock Production Science,* 96(1), 51-59, http://dx.doi.org/10.1016/j.livprodsci.2005.05.016.

INDAP. (2019). *Resolución exenta Nº 075507. Modifica normas técnicas y procedimiento operativo del programa de praderas suplementarias y recursos forrajeros.* Instituto de Desarrollo Agropecuario. Ministerio de Agricultura. Gobierno de Chile.

INE. (1997). *Censo Agropecuario 1997. Base de microdatos.* Instituto Nacional de Estadísticas, Santiago, Chile.

INE. (2007). *Censo Agropecuario 2007. Base de microdatos*. Instituto Nacional de Estadísticas, Santiago, Chile.

INE. (2017). *Encuesta de Ganado ovino 2017*. Instituto Nacional de Estadísticas, Santiago, Chile.

INE. (2019a). *Síntesis de resultados censo 2017*. Instituto Nacional de Estadísticas, Santiago, Chile.

INE. (2019b). *Encuesta de Ganado ovino 2019*. Instituto Nacional de Estadísticas, Santiago, Chile.

Koulouri, M. & Giourga, C. (2007). "Land abandonment and slope gradient as key factors of soil erosion in Mediterranean terraced lands". CATENA, 69, 274-281. http://dx.doi.org/10.1016/j.catena.2006.07.001.

Köbrich, C., Rehman, T. & Khan, M. (2003). "Typification of farming systems for constructing representative farm models: two illustrations of the application of multi-variate analyses in Chile and Pakistan". *Agricultural Systems,* 76(1), 141-157. http://dx.doi.org/10.1016/S0308-521X(02)00013-6.

Levers, C., Schneider, M., Prishchepov, A., Estel, S. & Kuemmerle, T. (2018). "Spatial variation in determinants of agricultural land abandonment in Europe". *Science of The Total Environment,* 644, 95-111. http://dx.doi.org/10.1016/j.scitotenv.2018.06.326.

Li, Y., Westlund, H., Zheng, X. & Liu, Y. (2016). "Bottom-up initiatives and revival in the face of rural decline: Case studies from China and Sweden". *Journal of Rural Studies,* 47, 506-513. http://dx.doi.org/10.1016/j.jrurstud.2016.07.004.

Li, Z., Han, G., Zhao, M., Wang, J., Wang, Z., Kemp, D., Michalk, D., Wilkes, A., Behrendt, K., Wang, H. & Langford, C. (2015). "Identifying management strategies to improve sustainability and household income for herders on the desert steppe in Inner Mongolia, China". *Agricultural Systems,* 132, 62-72. http://dx.doi.org/10.1016/j.agsy.2014.08.011.

Makate, C., Wang, R., Makate, M. & Mango, N. (2016). "Crop diversification and livelihoods of smallholder farmers in Zimbabwe: Adaptive management for environmental change". *Springer Plus,* 5(1), 1-18. http://dx.doi.org/10.1186/s40064-016-2802-4.

Milán, M.J., Caja, G., González-González, R., Fernández-Pérez, A.M. & Such, X. (2011). "Structure and performance of Awassi and Assaf dairy sheep farms in northwestern Spain". *Journal Dairy Science,* 94, 771-784. http://dx.doi.org/10.3168/jds.2010-3520.

MINAGRI. (2019). *Más Unidos. Plan Nacional de Asociatividad*. Ministerio de Agricultura. Gobierno de Chile. Retrieved from: http://fucoa.cl/asociatividad/.

Nyantakyi-Frimpong, H. (2017). "Agricultural diversification and dietary diversity: A feminist political ecology of the everyday experiences of landless and smallholder households in northern Ghana". *Geoforum,* 86, 63-75. http://dx.doi.org/10.1016/j.geoforum.2017.09.003.

ODEPA. (2018a). *Región de Valparaíso. Información regional 2018.* Ministerio de Agricultura, Gobierno de Chile.

ODEPA. (2018b). *Región Metropolitana. Información regional 2018.* Ministerio de Agricultura, Gobierno de Chile.

Paniagua, A. (2013). "Farmers in remote rural areas: The worth of permanence in the place". *Land Use Policy,* 35, 1-7. http://dx.doi.org/10.1016/j.landusepol.2013.04.017.

Peco, B., Sánchez, A.M. & Azcárate, F.M. (2006). "Abandonment in grazing systems: Consequences for vegetation and soil". *Agriculture, Ecosystems & Environment,* 113(1-4), 284-294. http://dx.doi.org/10.1016/j.agee.2005.09.017.

Prados, M.J. (2009). "Conceptual and methodological framework of naturbanization". In Prados, M.J. (Ed.): *Naturbanization. New identities and processes for rural-natural areas*. London, United Kingdom: Taylor and Francis Group.

Rodríguez-Ortega, T., Bernués, A. & Alfnes, F. (2016). "Psychographic profile affects willingness to pay for ecosystem services provided by Mediterranean high nature value farmland". *Ecological Economics,* 128, 232-245. http://dx.doi.org/10.1016/j.ecolecon.2016.05.002.

Rojas, M., Lambert, F., Ramirez-Villegas, J. & Challinor, A.J. (2019). "Emergence of robust precipitation changes across crop production areas in the 21st century". *Proceedings of the National Academy of Sciences,* 116(14): 6673-6678. http://dx.doi.org/10.1073/pnas.1811463116.

Romero Calcerrada, R. & Perry, G.L. (2004). "The role of land abandonment in landscape dynamics in SPA. Encinares del río Alberche y Cofio, Central Spain, 1984-1999". *Landscape Urban Plan,* 66, 217-232. http://dx.doi.org/10.1016/S0169-2046(03)00112-9.

Schneider, L.C. & Geoghegan, J. (2006). "Land abandonment in an agricultural frontier after a plant invasion: the case of bracken fern in southern Yucatán, Mexico". *Agricultural and Resource Economics Review,* 35(1), 167-177. http://dx.doi.org/10.1017/S1068280500010133.

Scortichini,G., Amorena, M., Brambilla, G., Ceci, R., Chessa, R., Diletti, G., Esposito, M., Esposito, V. & Nardelli, V. (2016). "Sheep farming and the impact of environment on food safety". *Small Ruminant Research,* 135, 66-74. http://dx.doi.org/10.1016/j.smallrumres.2015.12.013.

Serra, P., Vera, A., Tulla, A.F. & Salvati, L. (2014). "Beyond urban–rural dichotomy: Exploring socioeconomic and land-use processes of change in Spain (1991–2011)". *Applied Geography,* 55, 71-81. http://dx.doi.org/10.1016/j.apgeog.2014.09.005.

Solano, C., Bernués, A., Rojas, F., Joaquín, N., Fernández, W. & Herrero, M. (2000). "Relationships between management intensity and structural and social variables in dairy and dual-purpose systems in Santa Cruz, Bolivia". *Agricultural Systems,* 65, 159-177. http://dx.doi.org/10.1016/S0308-521X(00)00030-5.

Stockdale, A. (2004). "Rural out-migration: Community consequences and individual migrant experiences". *Sociologia Ruralis,* 44(2), 167-194. http://dx.doi.org/10.1111/j.1467-9523.2004.00269.x.

Stokes, C. & Howden, M. (2010). *Adapting Agriculture to Climate Change: Preparing Australian Agriculture, Forestry, and Fisheries for the Future*. Collingwood, Victoria, Australia: CSIRO Publishing.

Toro-Mujica, P., Aguilar, C., Vera, R., Rivas, J. & García, A. (2015). "Sheep production systems in the semi-arid zone: Changes and simulated bio-economic performances in a case study in Central Chile". *Livestock Science,* 180, 209-219, http://dx.doi.org/10.1016/j.livsci.2015.07.001.

Uriel, E. & Aldas, J. (2005). *Análisis multivariante aplicado*. Madrid, España: Thomson Editores.

Vidal, D. (2013). "Work division in family farm production units: Feminine responsibilities typology in a semi-arid region of Brazil". *Journal of Arid Environments,* 97, 242-252. http://dx.doi.org/10.1016/j.jaridenv.2013.07.001.

Wang, X. & Wan, G. (2014). "China's urban employment and urbanization rate: A reestimation". *China and World Economy,* 22(1), 30-44. http://dx.doi.org/10.1111/j.1749-124X.2014.12051.x.

Witt, G., Noël, M., Bird, M., Beeton, B. & Menzies, N. (2011). "Carbon sequestration and biodiversity restoration potential of semi-arid mulga lands of Australia interpreted from long-term grazing exclosures". *Agriculture, Ecosystems and Environment,* 141, 108-118. http://dx.doi.org/10.1016/j.agee.2011.02.020.

Appendix

TABLE 6

Percentage presence of other agricultural activities according to zone (NUC and DUC) and gender

Agricultural activities		Strawberries	Vegetables	Cereals	Forest	Flows	Cattle	Equines	Goats
Zone	NUC	0.00	22.20	16.70	0.00	44.40	22.20	27.80	22.20
	DUC	20.60	5.90	8.80	8.80	41.20	32.40	50.00	11.80
	p value	0.03	0.08	0.39	< 0.01	0.82	0.44	0.12	0.32
Gender	Female	0.00	12.50	6.30	0.00	62.50	31.30	25.00	25.00
	Male	19.40	11.10	13.90	8.30	33.30	27.80	50.00	11.10
	p value	0.05	0.89	0.05	< 0.01	0.05	0.79	0.09	0.20
Group	I	0.00	0.00	0.00	0.00	60.00	40.00	60.00	20.00
	II	21.40	7.10	10.70	10.70	35.70	32.10	50.00	10.70
	III	5.30	21.10	15.80	0.00	47.40	21.10	26.30	21.10
	p value	0.18	0.24	0.60	0.26	0.51	0.60	0.19	0.6
Total		13.50	11.50	11.50	5.80	42.30	28.80	42.30	15.40

Source: Own elaboration.