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INFLUENCE OF EXTENSION ON THE TECHNOLOGICAL PRACTICES AND PRODUCTIVITY INDICATORS OF SMALL-HOLDING SHEEP FARMERS IN CHILOÉ, CHILE

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A B S T R A C T

The aim of this study was to evaluate the effect of an extension plan on the rate of adoption of technological practices in small-scale livestock producers, the *modi operandi* of the producers in terms of the technological practices they use and the effects on the system productivity. A hundred and one small-scale sheep farmers were included in the study. A survey with 36 closed questions was performed in September 2010 and repeated in December 2012. Five indicators of productivity were constructed, and the use of technological fifteen practices for sheep production in the study area was recorded. After analyzing and comparing data, it was found that the extension plan executed modified the set of technological practices used by sheep producers of this territory. It was also seen that the frequency of use of all technological practices evaluated set a "fingerprint" pattern that can be used as an identifier of technological management formats within a group of producers. In addition, extension generated homogenization of the productivity indicators, although notable differences between groups in the number and frequency of technological practices persisted, which greatly favored the lower technological complexity groups, to the detriment of more technologies producers. Finally, the extension plan improved the average productivity as a result of effective incorporation of technological practices that were not used or were used at low frequencies. These practices constitute an increase of structural capital of the farmers involved.

Keywords: Extension, know-how, small-scale farmers

INTRODUCTION

The idea that technology is a key variable in explaining productive growth and development has been empirically studied in several ways, as most experts tend to agree that the driving force behind productivity growth is technological learning , innovation and diffusion of technology to the whole economic system (Kibwika *et al*., 2009). However, there is also agreement in the fact that the growth exerts an uneven impact on different social groups (Tokman, 2000; CEPAL, 2000). Thus, the issue of productive specialization is associated with the problems of technological learning and the existence of technology gaps, that generate high productivity differentials between lagging and core countries (Holland and Porcile, 2005) Thus, the issue of productive specialization is associated with the problems of technological learning and the existence of technology gaps, that generate high productivity differentials between straggling and outstanding countries (Holland and Porcile, 2005). Then, the big concern in developing countries is the technological extension and how it affects the real concerns of farmers, and what skills are relevant to innovation systems for useful technology to be put in the actual conditions of the producer (Kibwika *et al*., 2009). For these reasons, among others, agricultural extension has been strongly refocused to concentrate efforts on identifying the technology demands expressed by the farmers (Davis 2008; Kokate *et al*., 2009).

Moreover, in recent years several authors increasingly agree that when knowledge and information are permanently incorporated to the production process, it becomes a kind of productive capital called intellectual

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capital or know-how (Adriessen, 2004; Bontis, 2002; Viedma, 2007, Alfaro and López, 2008; Martos *et al*., 2008), which consists of several components such as human capital (knowledge), relational capital (networking) and structural capital (recipes, protocols and productive culture). Some of these authors point out that the technological practices used by the producer are relevant incide this know-how (Adriessen, 2004; Viedma, 2007; Alfaro and López, 2008). In this regard, it is noted that structural capital is explicit and distinguishable, and emerges from the personal and technical experience of the farmer in its permanent organization of the production process through trial and error (Simó and Sallán, 2008). This is relevant in the case of small scale livestock producers, where the technological change is a normal adaptation component, since it is the mechanism that allows the producers to adjust the availability of resources to the economic and environmental changes. This Fac. places the issue of technological innovation as an internally defined mechanism in the small-hold farming (De la Barra *et al*.1998). In this regard, it must be considered that the ongoing testing and discarding of various technological practices by farmers allow them to build technical protocols that generate synergies characteristic of intellectual capital in the production process, and generate effects of productivity and competitiveness over the individual summations which can be provided by each technique separately (Gupta and Roos, 2001).

In this regard, it should be stressed that while small businesses are those with less access to technology (Ortiz-Molina and Penas, 2006), they are often the most dynamic in exploring new knowledge and experience; this innovative behavior is structural in the growth of any business (Keilbach, 2009).

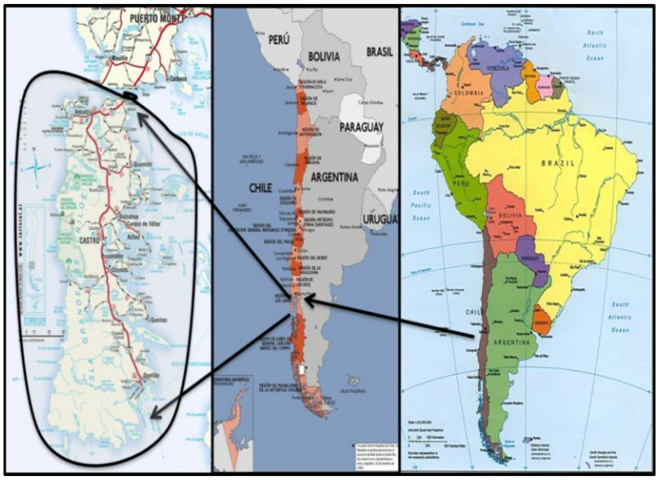
Another aspect to consider is that any action for adoption of technical practices is an essentially local phenomenon, and as such, it faces the obstacles or facilities generated by the cultural context. This aspect is crucial in rural areas, where the producer gives special relevance to the “knowledge made action”, presented as a routine practice and simplified to be transported by the producer for its own use and that of others in his community (Latour, 2005). This is relevant to the spread and adoption of technology in agriculture, because the proximity of producers allows ease of dissemination of knowledge, which is advantageous in concentrated areas of a certain type of production (Belso-Martinez, 2006). This fact is crucial to give effect to the extension actions, especially considering that the main source of technological information of a producer is not the extension but other producers (colleagues, peers) or other not-extension sources (Eicher *et al*., 2006; Adhinguru *et al*., 2009).

In this regard, it is recognized that cognitive consensus on technological practices that are indisputably useful in a production chain is little widespread among the actors involved (Ng *et al*., 2009), which have an effect on the farmer´s perception, who thinks that the useful technology required to overcome the technological gaps of the production process doesn´t arrive to him (Rivera and Alex, 2004). Therefore, it is essential to understand that without a consensus on the structural aspects of structural capital that are needed for a given production process, extension efforts may not be designed or programmed properly, generating improvised plans, which cannot be assessed and will not show measurable results (Conner *et al*., 2013). Thus, the challenge is not only to adjust a certain technological knowledge to the context of problems prioritized by the (Swanson, 2006; Akinagbe and Ajayi, 2010) but it must be translated in cognitive actions or practical techniques that can be evaluated, validated and incorporated by farmers as valid knowledge to solve an specific problem (Jarzabkowsky, 2004). In this regard, Liao *et al*. (2005) suggests the necessity to looking for patterns of association between these practice techniques and the productive performance of the system in which the producer takes the effort of innovation and entrepreneurship, because only in that way will be possible to accelerate the rate of technology adoption and assert that this have an effect on an real productivity increase.

The aim of this study was to evaluate the effect of a plan of extension on adoption of technological practices on small-scale sheep farmers, the typologies that dominate the actions of producers based on the technological practices in use, and the effects of this process on the productivity of the systems.

MATERIALS AND METHODS

Characteristics of the study area: The study was conducted on the Big Island of Chiloé Archipelago (Picture 1). In this area, sheep farming is a main productive and social activity, with a census around 150,000 heads, and where the lamb mortality 30 days after lambing is the main problem (Barra *et al*., 2011).



Location of the Archipelago of Chiloé, Chile.

Farmer selection: A hundred and one farmers from a total universe of 415 users from the Agricultural Development Institute of Chile (INDAP), whose farms were dedicated to sheep production were selected. The conditions of farmers to be selected for the study where: a) Declare to have a lamb mortality problem on their farms; b) own a minimum of twenty productive sheep; and c) written agreement in with the National Agricultural Research Institute (INIA) for joining an extension plan aimed to descent lamb mortality.

Extension plan procedures: The extension agreement with the producers lasted thirty months, and implied that a) the farmer would integrate a ten to twelve producer group (Sheep Technology Group, STG) according to geographic proximity; b) the farmer would participate in five technical programming meetings a year; and c) he would implement four technology practices (two compulsory and two free choice) out of fifteen possible. For its part, INIA committed to contribute with twelve dollars per sheep per farmer (in the form of feed concentrate and / or veterinary products) for two seasons. In addition, producers committed to attend a certification program especially developed for reducing mortality of lambs.

Contents of the extension plan: Contents of the extension plan were defined together with the farmers, in 2010. The technological practices more closely associated with reduced lamb mortality were identified by means of a survey, and afterwards, the technical package and training of farmers made were formulated.

Gathering of information and monitoring: A 36-closed question survey performed in September 2010 and 2012. This allowed the obtaining of five productivity indicators: fertility (FF), prolificacy (FP), lamb mortality (LM), lamb birth weight (LW) and stocking rate (SR). Besides, fifteen technological practices recommended for sheep production in this zone of study were obtained: Docking (DO), stabulation of ewe and lamb after lambing (HL), lambing assistance (LA), vaccination against *Clostridium* (VA), foot trimming (FT), Supplementation (SU), separation of the ram after breeding (FB), measurement of body condition score (BSR), mineral supplementation (SM), weaning (VE), use of registers (RE), use of ear tags (ET), between-leg shearing (PS) and fertilization of grasslands (FG).

Data processing and analysis: To analyze the typology of producers according to the technological practices in use, the hierarchical cluster tool by means of the Ward's method was used. For comparisons, the Student's t-test and Tukey's test were used.

RESULTS AND DISCUSSION

Figure 1 shows that, prior to the start of the expansion plan, the producers managed different groups of technological practices within the same category, which sets different modes of operation for the same item (Simó and Sallan, 2008). Four clearly differentiated groups are observed in the cluster: Groups A, B and C, are decomposed in a similar hierarchical level; however, the A group, in a somewhat lower level of hierarchy is separated into two distinct groups (A1 and A2).

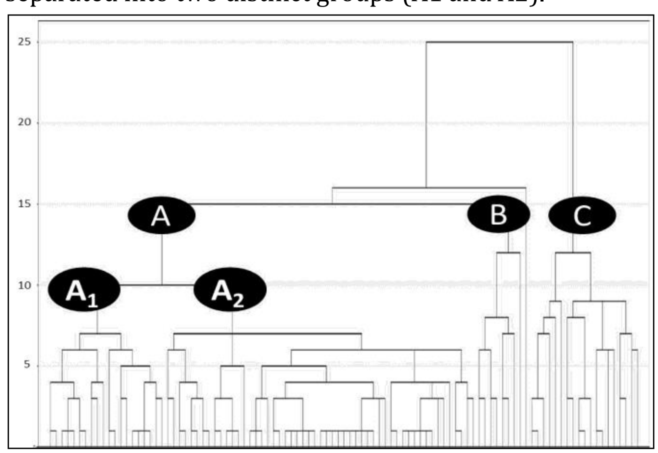


Figure 1.Typology of sheep producers grouped by technological practices in 2010, before the implementation of the extension plan.

The extension process involves organizing mechanisms of interaction between the farmer and a bounded set of technology offers, which should feed and accelerate the process of "trial and error" in which the producer evaluates such technology offer before making it part of its structural capital (Simó y Sallán, 2008; Martos *et al.*, 2008; Alfaro y López, 2008). Figure 2 shows the type of technological practices in use after the execution of the extension plan. At first glance, a transformation in management formats used by producers observed, in the sense that the typology observed in 2010 (Figure 1) has increased in hierarch. The high hierarchy groups were reduced from A, B and C in 2010 to A and B in 2012, and the subgroups that emerge from format A increased (A1, A2 and A3).

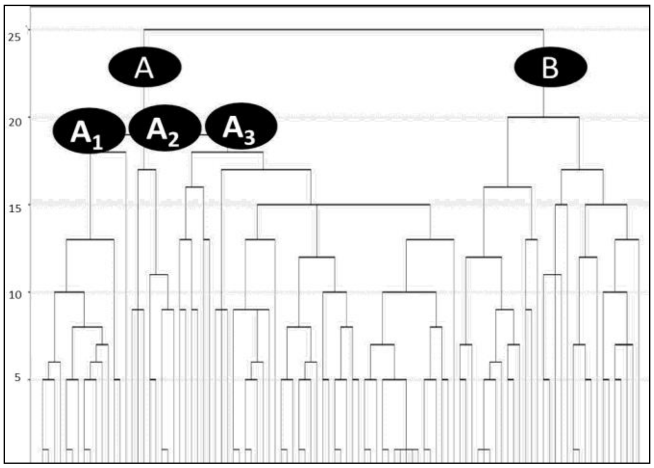


Figure 2.Typology of sheep producers grouped by technological practices in 2012, after the implementation of the extension plan.

The group B (Figure 2), appears in 2012 as a very defined group, with a notable increase over 2010. The C group disappears in 2012, and, as mentioned above, the emergence of a new subgroup within the group A occurs. The fact that the producers gradually adopt the technological practices from the supply of the extension program (some of them compulsory, like the supplementation and separation of the ram after breeding in 2010) as well as the obligation to choose other two as part of the work methodology, forecasts a change in the technological practices and a variation in the configuration of the typologies.

First, the frequency with which farmers use practices changes; on the other hand, the set of practices they use changes, producing a transference of producers between groups; and finally, both situations generate more or less robustness to the groups configured. In this respect, it can be thought that what tends to happen is that the extension plan reconfigures formats or modes of management prevailing in the territory, and that generates higher technological complexity within each mode of (Roos, 2001). Figure 3 shows that, indeed, the resulting typology of producers following the implementation of the extension plan is configured with some continuity from the previous type, but with obvious transference of farmers between groups. The C group disappears when passing all its members to groups A3 and B. Group B members continue integrating their group without any transfer, and receive members from A2. Group A3 receive members from A1, A2 and C. Meanwhile, A2 maintains as a group and also receive members from A1 .Finally, A1 persists, but is greatly reduced after transferring part of its members to A2 and A3.

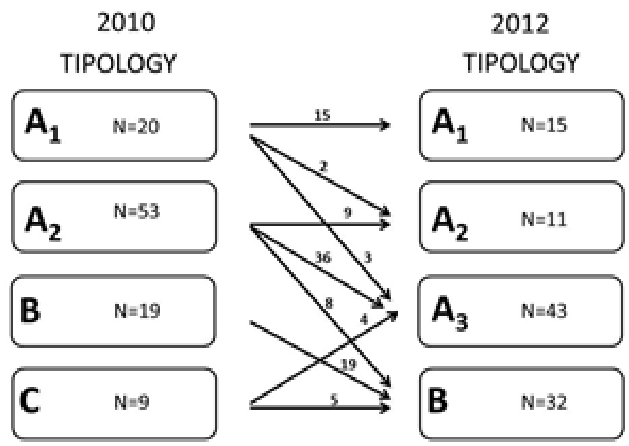


Figure 3. Origin of farmers forming the typology resulting after the execution of the extension plan, according to the technological practices used.

The evidence suggests, then, that the expansion plan executed was able to modify the set of technological practices used by sheep farmers on this territory, generating changes in the sets of prevailing practices, and modifying the assignment of farmers to the various operation modes represented by the typology. In this regard, Figure 4 shows the frequency with which each evaluated technology practice is present in each of the typologies, and how it is changed after the implementation of the expansion plan. The average frequency of use of all the technological practices evaluated configures a pattern or "fingerprint" similar to those made with molecular markers, but, referring to technological practices, is an identifier of technological management formats within a group of farmers. In this sense, it is presented as an interesting tool to characterize the changes produced by a plan of extension on the rate of adoption of certain technological practices previously absent or the intensification of the practices already present.

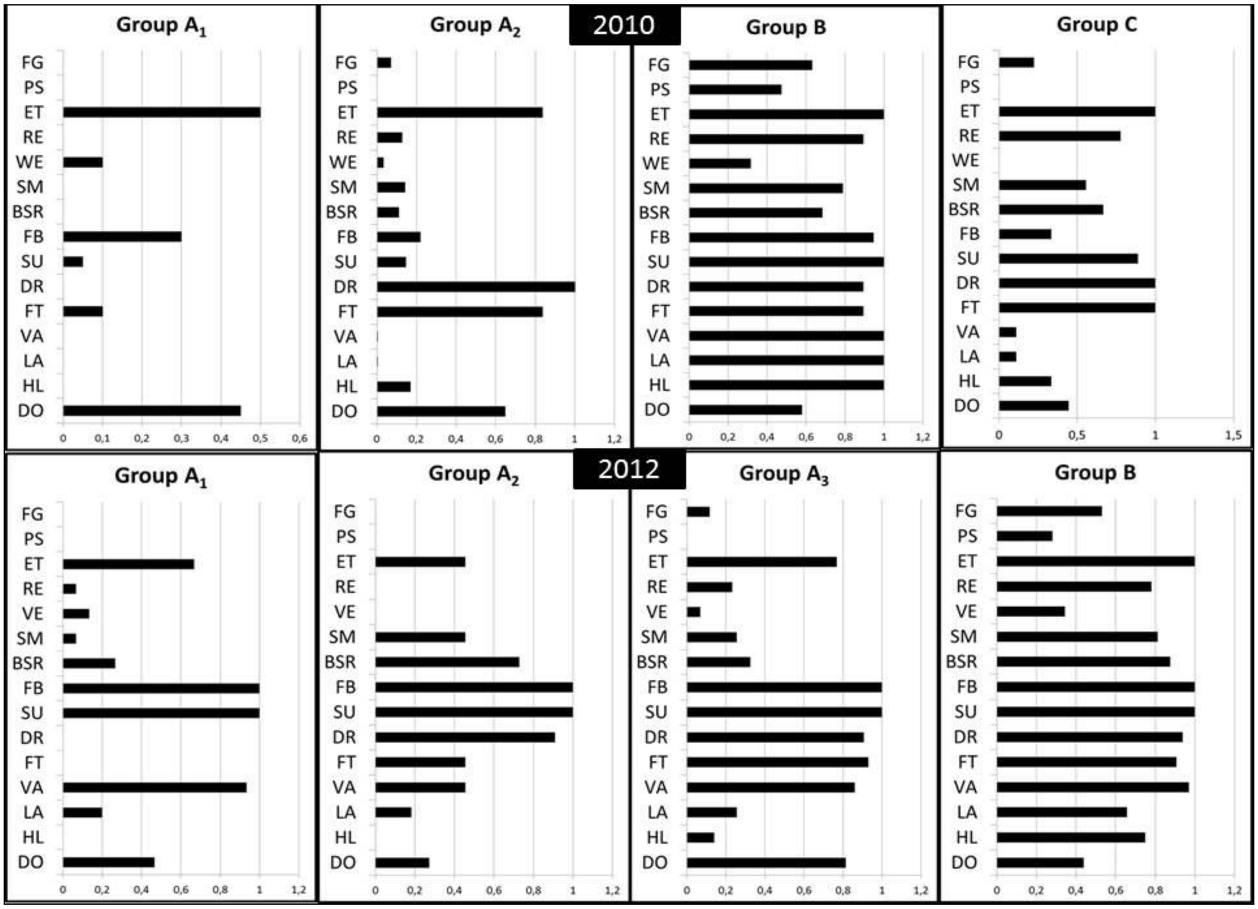


Figure 4. Comparison of the frequency of use of technological practices pattern within the farmer typologies before (2010) and after (2012) the implementation of the expansion plan.

A1 group (Figure 4) exhibits the fewer technological practices in use in 2010, increasing in number and frequency in 2012. Meanwhile, A2 tends to decrease and intensify the technological practices. Group B shows the presence of all the technological practices evaluated before and after the extension plan, with a frequency variation in some of them. A3 presents a new technological pattern, with the largest number of practices after group B, with higher frequency than A1 and A2 groups. Interestingly, the SU and FB practices, that were compulsory in the first year of the extension plan, and which showed a large variability in frequency before the plan, reached 100% frequency in all groups in 2012, despite the fact that the last years were optional. This indicates that such practices were integrated into the drive mode of different groups of farmers (Jarzabkowsky, 2004), achieving a consensus level that didn´t exist before plan extension implementation (Ng *et al*. 2009).

The frequency of each technology practice for all producers before and after the extension plan. It is appreciated that there are some technological practices whose frequency was not affected by the extension plan, such as PS, HL, DO and ET. On the other hand, the frequency some technological practices noticeable and significantly increased from 2010 to 2012, as is the case of BSR (34.65), LA (16.83), VA (66.34), SM (19, 80), RE (11.88), SU (72, 28) and FB (63,37). The magnitudes of variation in the observed frequencies have clearly altered sheep management modes between farmers (Roos, 2001; Sallán, 2008) and redesigned the typology of use of such practices; therefore, the extension plan has indeed altered both the number of technological practices in use and the frequency of use. However, for the purpose of the extension plan to be fulfilled, to modify the prevailing modes of operation not enough, but it is also necessary that this modifications actually have an effect on the productivity of the system handled by farmers (Coner *et al*., 2013; De la Barra *et al*., 1998) as shown in Table 1.

Table 1.Frequency of use of technological practices before and after the implementation of the extension plan, and difference between years.

Practice (%)	2010 (a)	2012 (b)	Dif (b-a)
PS	8,91	8,91	0,00
VE	9,90	15,84	5,94*
FG	16,83	21,78	4,95
BSR	18,81	53,47	34,65***
LA	19,80	36,63	16,83***
VA	19,80	86,14	66,34***
SM	22,77	42,57	19,80***
RE	23,76	35,64	11,88**
SU	27,72	100,00	72,28***
HL	29,70	29,70	0,00
FB	36,63	100,00	63,37***
DO	58,42	58,42	0,00
FT	69,31	73,27	3,96
DR	77,23	78,22	0,99
ET	79,21	79,21	0,00

***p<0.001, ** p<0.05; t- Student test. DO: Docking; HL: stabulation of ewe and lamb after lambing; LA: lambing assistance; VA: vaccination against *Clostridium*; FT: foot trimming; SU: pre and post-partum supplementation; FB: separation of the ram after breeding; BSR: body condition score measurement; SM: mineral supplementation; VE: weaning; RE: use of registers; ET: use of ear tags; PS: between-leg shearing; FG: fertilization of grasslands.

The differences in productivity between the different management formats used by producers before implementing the extension plan. B is the group with the best indicators of productivity, and A1 is the one with the worst, coinciding with the highest and lowest number of technological practices used and the highest and lowest frequencies of use, respectively. For example, it can be appreciated that there are significant differences in LM between groups, being B the most efficient (8.79), with a mortality of lambs exhibiting competitive values; on the other hand, A1 is the group with the highest mortality of lambs (48,13), with C and A2 showing intermediate values between the extreme groups. These results reinforce the idea that technology is not neutral and generates economic inequality between social actors (Tokman, 2000). The exception is in FF, where the values are very close, despite the existence of significant differences between groups. After the execution of the extension plan, it can be appreciated (Table 3) that the productivity differences between groups were reduced, especially in LM and SR. Group B tended to stay productive, and a nivelation with other groups appeared. Therefore, the resulting productivity exhibits homogenization after the execution of the extension plan, which has greatly favored farmers with lower technological complexity but keeping at a standstill to the producers with a greater technological background as mentioned in the Table 2.

Table 2. Productivity indicators for each producer typologies, developed from the technological practices in use in 2010.

Tipology	N	FF	FP	LM	SR	LW
A_1	20	92,90^a	113,03^a	48,12^a	4,50^a	2,78^a
A_2	61	92,87^a	117,43^a	36,11^b	4,99^a	3,26^b
B	19	91,74^b	125,39^b	8,79^c	6,76^b	4,87^c
C	9	94,84^c	124,62^c	27,18^d	5,92^c	3,62^b

$^{a, b, c}$ Within a column, different superscripts indicate significant differences ($p < 0.05$). Tukey test. FF: Flock Fertility expressed as percentage; Flock Prolificacy expressed as percentage; LM: Lamb mortality expressed as percentage; SR: Stocking rate expressed as ovine equivalent (o.e.) per Hectare (ha); LW: Live weight of lambs expressed as kilograms of live weight.

Table 3. Productivity indicators for each producer typologies, developed from the technological practices in use in 2012

Tipology	N	FF	FP	LM	SR	LW
A1	15	95,69 [a]	127,05 [a]	16,21 [a]	5,26 [a]	3,24 [a]
A2	11	96,89 [a]	130,03 [a]	15,25 [a]	5,56 [a]	3,27 [a]
A3	43	94,04 [a]	141,11 [a]	11,60 [a]	5,61 [a]	3,75 [a]
B	32	94,66 [a]	141,07 [a]	9,57 [a]	6,70 [a]	4,58 [a]

[a, b, c] Within a column, same superscripts indicate no significant differences ($p > 0.05$). Tukey test. FF: Flock Fertility expressed as percentage; Flock Prolificacy expressed as percentage; LM: Lamb mortality expressed as percentage; SR: Stocking rate expressed as ovine equivalent (o.e.) per Hectare (ha); LW: Live weight of lambs expressed as kilograms of live weight.

The explanation for this probably relies on the fact that the extension plan prioritized technological practices with proven effect on lambs' mortality. These practices showed the greater increase or use (BSR 34.65; LA 16.83; VA 66.34; SM 19.80; RE 11.88; SU 72.28 and FB 63.37). Thus, the group B that previously exhibited a high frequency of use of these practices, did not have a differential impact. The overall effect of the extension plan on the producers was a significant increase in average productivity in all the indicators (Table 4). Thus, the mortality of lambs was reduced in 20.72%, birth weight of the lambs was increased in nearly half a kilogram, and the twin births increased by 22.36%. Stocking rate also increased.

In this sense, the extension plan was successful since improved the average productivity as a result of an effective incorporation of technological practices that were not used, or were used in low frequencies, and thus they constitute an increase in the structural capital of the producers evolved (Adriessen, 2004; Viedma, 2007; Alfaro y López, 2008).

However, it is necessary to think about the farmers who were technologically advanced before the implementation of the plan, known that the process had low utility for them. In this regard, it is necessary to segment farmer groups with quality diagnostic information for the process to be useful to all participants. In this case, the fact that the producers set out their own most pressing problems (such as lamb mortality), and the clarity about the technological practices in use were not enough (Jarzabkowsky, 2004), but it was crucial to have previously associated the impact of the technological practices on the problem and the relationship with the technical management modes predominant in the territory (Liao *et al*., 2005) in order to be able to estimate the effect of the plan on the potential productivity of the specific management modes used by the different typologies of producers.

Table 4. Variation in productivity indicators (2010-2012) for all sheep producers.

Years	**FF (%)**	**FP (%)**	**LM (%)**	**SR (o.e./ha)**	**LW (kg)**
2010 (a)	91,80	116,82	32,88	5,21	3,45
2012 (b)	95,74	139,18	12,16	5,96	3,92
Dif (b-a)	3,94*	22,36***	-20,72***	0,75***	0,47***

Table-4: ***$p<0.001$; *$p<0.01$; t -Student. FF: Flock Fertility expressed as percentage; FP: Prolificacy; LM: Lamb mortality expressed as percentage; SR: Stocking rate expressed as ovine equivalent (o.e.) per Hectare (ha); LW: Live weight of lambs expressed in kilograms of live weight.

CONCLUSIONS

Producers manage different groups of technological practices, which set different ways of management for the same item within a territory. The extension plan executed modified the set of technological practices used by producers, generating changes in the prevalence of certain sets of practices and modifying the assignment of producers to the different management formats. The frequency of use of all the technological practices evaluated set a "fingerprint" that can be used as a technological descriptor within a group of farmers. The extension generates homogenization of productivity indicators, although a notable difference between groups in the number and frequency of technological practices persists. The extension plan improved the average productivity as a result of an effective incorporation of technological practices that were not previously used or were used at low frequencies, and therefore these practices constitute an increase of the structural capital of the farmers involved.

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