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HUMAN RESOURCES IN THE TECHNOLOGICAL INNOVATION OF FARMING SYSTEMS FOR SHEEP PRODUCTION IN THE WEST OF MEXICO

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ABSTRACT

Technology in farming systems has been considered an element for agricultural development, needed to increase the competitiveness. Nevertheless, it's study has ignored the human resources role in technological innovation. The study's goal was to determine the human resources' influence in technological innovation in sheep production systems in the towns of Epitacio Huerta and Contepec, Michoacan, Mexico. The information was gathered from 47 production units and the data was analyzed by frequency analysis and Rho correlation from Spearman. The considered variables were related with education, experience, work, need and training. The results indicate low innovation levels, associated to poor human resources, which is strongly conditions and limited to education, the producer's experience and their need for new knowledge. This implies that the dynamic of technological innovation in these systems, is slow; that most of the knowledge and techniques are obtained from experience of other producers, which doesn't guarantee the power to make quick and substantial changes in productive systems.

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INTRODUCTION

The human resources have been measured from an educational perspective. The human resources categories, that can be treated as investments by their impact in the development and income of the human being, are infrastructure and health services which affect the life span, the strength, the resistance, the vigor and the vitality of the people; the training at work which includes the learning method organized by the enterprises; the formal organized education in educational institutions. The training at work elevates the worker's future productivity by estimating the new technologies learning and perfecting the old ones. Education has to do with a formal teaching process within a specialized school in production training, unlike the enterprise that offers training linked to the good's production. According to Becker (1975), work training and education are complementary, in a sense that the management of certain abilities requires specialization and practical experience, which is why the knowledge must be acquired at school and partly at work (Mungaray and Ramirez, 2007). Innovation is the result of an intensive idea generator process that allows to find new and improved solutions other than the already existing ones. It's a fact that from the need of solving a problem, creative processes originate at the same time and that creativity is a fundamental element for innovation. In many cases, it's not necessary to start from scratch to solve a problem, but it's about finding the optimal use for devices or techniques that have been invented or used in other places (Ramirez, 2015). Despite the great potential of agricultural innovations, the adoption of small farmers seems to be slow, these tend to emphasize the role of extrinsic factors such as the characteristics of the adopter and the external environment in the decision-making process (Mejier *et al*., 2015). The adoption of innovations considers the importance of social media as an influencing factor in the behavior of farmers. Nevertheless, the thought of adoption has to do with the way of the intervention to a farm level (Wigboldus *et al*., 2016; Aguilar-Gallegos *et al*., 2015; Thuo *et al*. 2014). This study has as goal to determine the influence of human

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resources in the technological innovation in farming systems of sheep production. In qualitative studies in which the producer is the primary source of information, which allowed to analyze the influence of basic aspects of the human resources (education, experience and need for knowledge). Plus, it looks to establish the differences between human resources according to the producer's gender, contributing to the understanding of these factors in the productive processes of farming systems.

METHODS AND MATERIALS

The study was developed in the state Michoacan's orient region, in the creek of Tepuxtepec's dam, in the towns of Epitacio Huerta and Contepec. The study was done in 47 sheep production units; 24 of which were operated by women and 23 by men, characterized for being family farms, whose production way is semi-intensive and with a close relationship with the corn crops, which allows to consider them as farming production systems. For the selection of the production units, the main criterium was the availability of producers to make this research, the sample wasn't probabilistic. Participative technics and guided interviews were used, through the application of a structured questionnaire for the data gathering, which was validated for the producers about the content, through informal reunions. The variables to consider for the study of human resources were: age, education and experience in the field (shown in years in the activity of carrying out sheep raising). Other variables such as social and human support were analyzed, which producers have by sheep raising, in which we find: it's belonging to a work group. The number of members and the family ties inside the group, just like the number of people involved and their family relation. The complementary income sources to sheep raising were also studied, and the proportion of income that sheep raising gives to the producer's economy.

The data obtained was processed through a frequency analysis and it was obtained from those on quantitative order, the mean, the standard deviation and the minimum and maximum value. In order to stablish the degree of association between variables described previously and technological innovation, the Spearman's correlation coefficient *Rho* was obtained through the biassorted correlations procedure, described by Pérez, (2005), using the statistic software *SPSS*®, the same way for the variables which association was significative to($p<0.05$) generated the contingency tables in which the Chi-square was determined as a measure of association and the symmetrical measures such as the Pearson's contingency coefficient and the *Phi*. For this, the grouping of the qualitative variables was needed, such as: 4 age groups: Youngsters (20 to 35 years old), adults (35 to 50 years old), mature adults (50 to 65 years old) and elderly (60+ years old) according to Martín, (2005). The variable education was grouped in the same way, those producers without formal studies, with primary studies, with middle school studies and with high school education. For experience, two groups were made; producer with less than 10 years of experience and more than 10 years. Lastly, three innovation rates were stablished, according to the lowest innovation level group to those producers whose number of innovations were lower than five, the medium level for producers between five and nine innovations and finally the highest level for those with a number of innovations above nine.

RESULTS

The identified innovations, which have a higher use percentage with women as well as with men, are those focused to animal health, such as: vaccination, treatment for internal parasites and vitamin application, which have a usage percentage in the women's case of 96.00, 100.00 and 88.00; in men of 90.91, 100.00 and 81-82% respectively. The identified innovation and the usage percentage in women and men can be observed in Table 1. In Table 2, the gender variables are shown where the women had a higher number of innovations (9 ± 3) and a higher grade of education (5.20 ± 3.15) in comparison to the men; the age mean for female producers was of 45.04 years and for men of 50.69; the number of group members was higher for men with 14, just like, more years doing sheep raising (15.05 ± 9.23), another factor was the hours of training per month with 2.33.

Table 1. Identified innovations and the usage percentage for women and men

Innovation	Innovation usage percentage	
	Women	Men
Vaccination	96.00	90.91
Parasite treatment	100.00	100.00
Salt supply	96.00	81.82
Vitamin's supply	88.00	59.09
Prairie's establishment	36.00	18.18
Hay and silage usage	76.00	18.18
Diet elaboration	52.00	36.36
Animals identification	64.00	9.09
Animals divided into lots	52.00	13.64
Registers implementation	52.00	13.64
Controlled crossbreed	28.00	9.09
Defined crossbreeding	68.00	9.09
Early weaning	88.00	50.00
Intensive fattening	8.00	0.00
Barbacoa making	16.00	9.09
Compost	16.00	9.09

Own making with data obtained from the implied producers

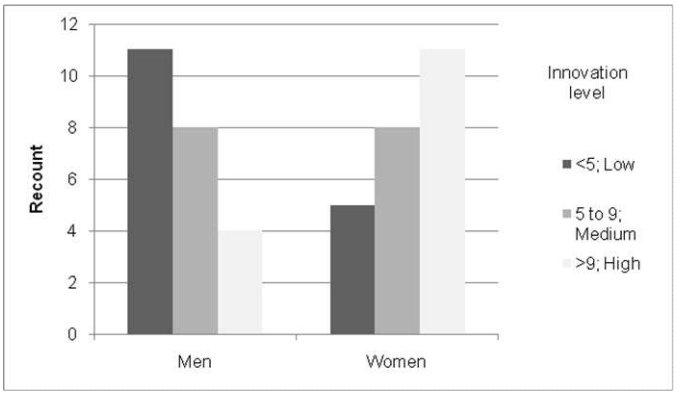

Figure 1. Technological innovation in sheep producers with gender distinction

The results indicate that technological innovation of these production systems was limited by the application of 16 innovation as maximum. A higher innovation rate was observed in women (56% of innovation), since 45.8% of them were placed in the higher innovation level; with men, this rate was lower (39.67%) because 45.8% of the ones polled is in the lower innovation group (Figure 1). The evidence showed that those producers who had not received formal education (17%) tended to use less innovations and being mainly elderly of more than 65% old (Figure 2). In this regard, it's widely documented the relevance of education over the economic

growth and development and mainly social. In this sheep activity 76.6% involves kids and wives, which clearly manifests the strong family presence and their importance as generator of a productive occupation for the members of the same system (no matter the gender of the administrator) requires an average of 2.23 ± 1.64 people for its operation (Table 2). The elder brothers or sisters are not directly involved in the activity, probably due to the age of the producers, maybe because they belong to or have another family nucleus.

Table 2. Variable descriptors per gender

	Gender (M ± DE)	
Variable	Women (n=24)	Men (n=23)
Number of innovations applied	9 ± 3	6.35 ± 2.67
Age	45.04 ± 10.34	50.69 ± 15.29
Education	5.20 ± 3.15	4.86 ± 4.12
Number of group members	6.35 ± 1.39	14.00 ± 5.46
People involved in the activity	3.66 ± 1.90	2.78 ± 1.20
Experience in sheep raising years	6.71 ± 6.42	15.05 ± 9.23
Training hours per month	1.33 ± 0.82	2.33 1.32

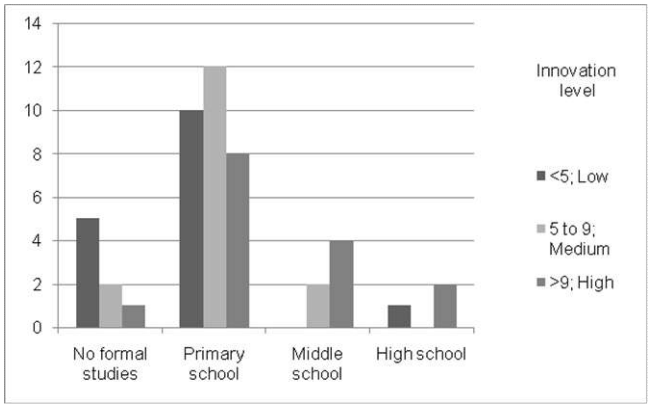

Figure 2. Sheep producer's distribution by technological level and by education

The grain production, (essentially corn) is a complementary source, so that 76.1% of the producers who involve the espouses and children produce corn as a complementary source of income. Likewise, 80.1% who need to learn more about sheep raising, also have this complementary source of income, which strengthens the nature of family and farming in the activity. It was observed that another support means, to which the producer turns to, is the belonging to work groups. 83.3% of the medium and high level technological innovation producers, belonged to a work group. Said groups were made up mainly by women (62%), and which number of members was 6.35 ± 1.39 for women and 14.00 ± 5.46 for men (Table 2), these groups are associated to technological innovation. Female groups were smaller and the most innovative. Work group formation is favored as a way of organization and spreading information; nevertheless, this association must be given in homogenous groups that allow to have affinity within the members of it. Hence, the composition of these small groups is formed between family and groups with acquittances and, at least, one relative. Groups made up by family (10% of producers) prefer conversations with neighbors, the technician's visits (10%) and, in less degree, the attendance to fairs and expositions (3%) as events to learn from up close about sheep raising, meanwhile mixed groups do it through the technician's visits (43%). As for the number of producers who are part of the group, the groups with a higher number of members (groups with more than six people) prefer as means for their learning the fairs and expositions (22% of the producers), the groups with less member are more attracted to the technician's visits to their production systems. In Figure 3 it's shown the iconic model for the variable association positively or negatively, which intervene in technological innovation. The numbers indicate the *Spearman*'s *Rho* relation coefficient. A positive association was found (0.341*)[1] between innovation and gender, but also a high variation in this variable's behavior, where women apply 9 innovations, with a standard deviation of 3 in comparison to men that was of 6.35 ± 2.67. This indicates that women look for innovating more in their sheep production processes. The number of hours dedicated to training are related to gender (-0.379*). 86% of women receive between one and two hours of training per month, compared with only 66% of the men who receive more than two hours of training per month. This training time is related to the proportion of income obtained from sheep raising (0.388*). The producers who receive more training time were those who manifested to have economic income from the activity higher than 60%. Those who received less than an hour per month of training, were also those with lower income from the activity. This is related to the current perceptionof the activity (0.288*), since the results showed that those who considered to have production system that decreases, showed to have lower incomes from this activity (<40%). It's very likely that the way of valuing the system's efficiency for the producers, is related directly to the quantity of incomes that sheep raising generates. In this regard, 14.9% of the producers considered that his activity was decreasing, 12.8% stuck, 68.1% growing ad only 4.3% considered that their activity was consolidated.

The fact of belonging to a group was associated to technological innovation (0.434**). The characteristics family relation and need to learn are related with the existence of a complementary source of income ((0.547** y -0.301*) which is very important to these types of systems. A relation was found (0.314*) between the producers who had corn production as a complementary source of income with technological innovation in their sheep production systems. This type of producers was categorized in the three innovation levels (low, medium and high) in similar proportions (around 29%). But there was also a gender relation (0.355*). It was previously mentioned thet women were tose who innovated more and were also those who diversified the most their income sources, by having relatives (20.8%) or by doing activities such as employee or merchant (8%) which generated economic incomes. The producers whose complementary income source were corn production, were also those who were less willing to invest in training (62% didn't' consider the investment in training) and it's them who had low and medium innovation levels. The female producers (41%) who had complementary income sources and different grain production, invested money in training (0.310*) and were found in the high technological level (0.328*). On the other hand, in which concerns making, or not, time for training, this characteristic was related to innovation (0.358*). 25% of the producers who expresses dedicating more time to training, were placed in the high innovation level, a 23%, which also dedicated time to training, is placed in the medium innovation level, and only 12% is found in the low level.

[1] The thousandth between parenthesis represents the Spearman's *Rho* correlation coefficient and the stars the significance: * to the level of 0.05 and ** to the level 0.01

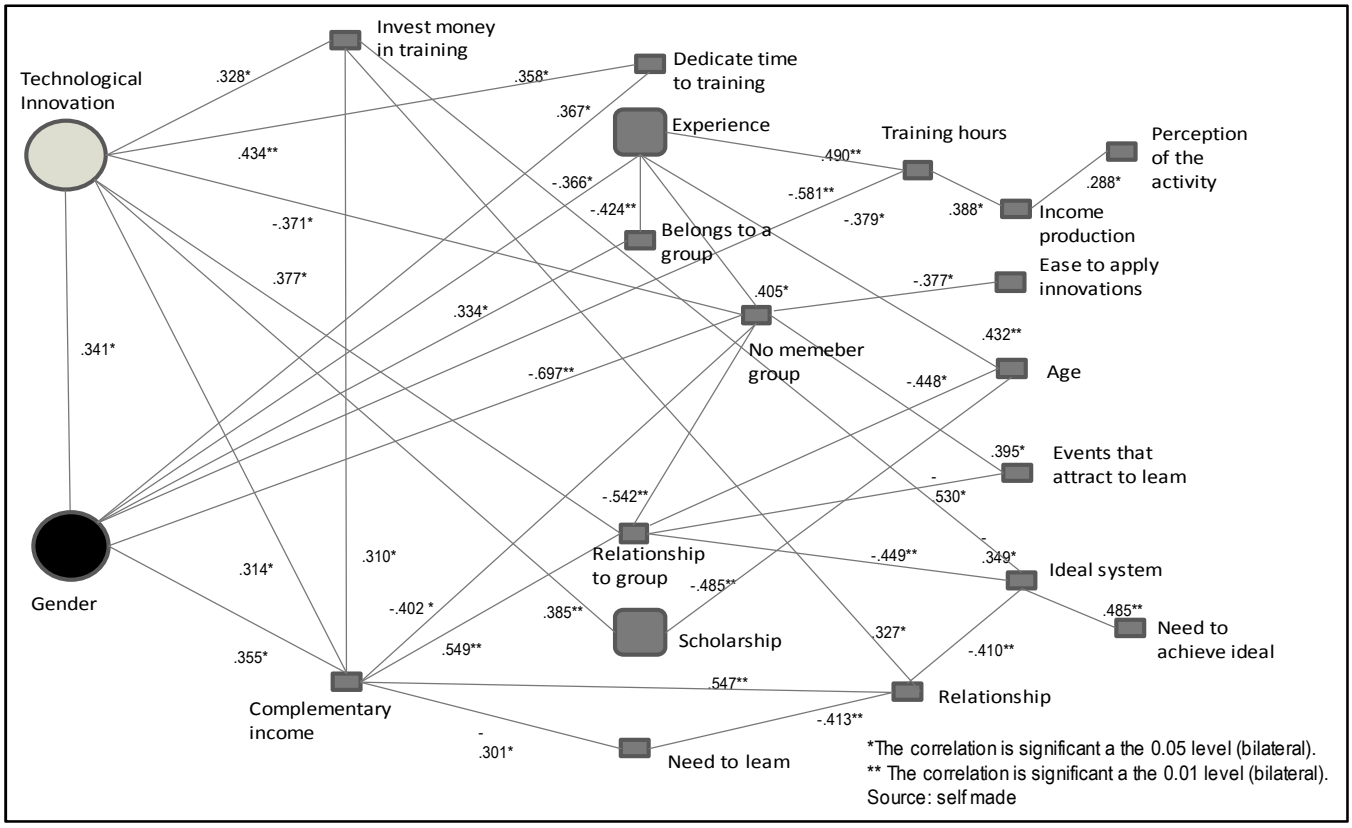

Figure 3. Iconic model of the variable association which intervenes in the technological innovation of sheep production systems

On the contrary, those who didn't dedicate time for training are in the low innovation group. There are some gender association with this variable (0.367*). 79% of the women dedicated more time to training, while 56% of the men didn't dedicate time to be trained. These groups, specially the relatives, share a vision of an ideal system, which have the best facilities, most sheep, better animals and to produce more and with better market (-0.449**), in addition to an existing relation (-0.448) with the age of the producers. These work groups were related to experience (0.424**). Those producers who have less experience tend to turn to other producers for support so they can find together alternatives for the solution of their problems. Lastly, the producers who belong to big groups, showed an ease to apply innovation, which is the opposite for the groups with 5 and 6 members to whom it is difficult to apply innovation.

DISCUSSION

Sheep raising is a secondary activity in farming systems, being agriculture the main activity, which associates to the cereal cultivation, mainly to corn production, existing a fertility and availability dependency of agricultural land and shepherding or access to these lands, it all depends on the family labor. The sheep production in farming systems complements the production unit's income (Bobadilla *et al*., 2015; Reyes *et al*., 2011). The number of innovation was positively associated with education (0.385**), which the majority of the producers (60%) has a primary level. It was also found that education related as well, but in a negative way, with the age of the producers (-0.485). This suggests that the producer's population in these systems marks the beginning of the drop of the productivity rates (Martín, 2005). In addition, the information showed that younger producers were those with a higher education level and these were the producers with the higher rates of innovation. This helps to confirm that age is not associated, directly, with the application of technological innovations in the farming systems, but it does allow to think that young people, who's had access to education, is more likely to innovate in sheep raising. Specifically, it was found that characteristics such as age, few education years, but enough experience in sheep raising, are related to a better understanding of the production processes, the facility to accept technological innovations and improve the system's productivity (Vázquez-Martínez *et al*., 2009). Different authors point out that it doesn't exist a positive relationship between the producer's age and the adoption degree of technologies and their ability to innovate (Hernández *et al*., 2013; Goswami *et al*., 2001). The attitudes and perceptions about innovations are influenced by the characteristics of the farmer, which include personal characteristics (gender, age, marital status, etc.), socio-economic characteristics (incomes, goods, education, self-esteem, independence, etc.), social media status (size of the network, connection, interaction frequency, etc.), status's characteristics (control of political power or economic resources) and closeness with technology (Mejier *et al*., 2015). The producer's age was associated positively (0.432**) with the numbers of years of experience in sheep raising, which also is associated with gender. In addition, it's related in a positive way with the hours per month that a producer receives of training; for the producers with least experience said training is approximatively of an hour per month and for the ones with more than 10 years of experience, these can reach four hours per month.

Conclusions

Human resources, for adoption and technology development, in the sheep production system, is poor. It's strongly conditioned and limited to an education that exists in the rural

environment, to the experience of the producers and their need of new knowledge. These systems have a low education level, a lot of experience and little training, which implies that the dynamic of technological innovation in this system is slow. Most of the knowledge and technics are obtained from the experience of other producers, which doesn't guarantee the ability to make quick and substantial changes to the production systems for their insertion on the markets and the regional and national economy.

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