FACtORS THAT DETerMNIE THE LEVEl OF HUMAN CAPITAL OF THE LIVESTOCK EXTENSION AGENT IN MEXICO

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INTRODUCTION

The human capital is the product of the formal education and post training and has been defined as the knowledge, skills, competences and attributes gathered in individuals that allow the creation of personal, social and economic well-being (Keeley, 2007). In addition, it has been recognized in the economic theory as a decisive factor for the economic growth (Shultz, 1960; and Becker, 1964). Furthermore, studies highlight the important contribution that the human capital has for the growth of the productivity in the labor force and for the use, adoption and generation of new technologies (Coulombe et al., 2004). In Mexico,
studies about the human capital indicate that the formal and informal schooling and administrative experience in business increase the productivity of small enterprises (Mungarayy Ramírez, 2007). In agricultural business, FAO (2010) explained that the education and knowledge, along with disponibility of land, hydrological resources, supplies and loans among others, of the farm producers are determining factors in the results obtained among cultivations and countries. One way to increase the knowledge of the producers is represented by the extension service; thus, the human capital level of the extension agent is a determinant factor to improve the conditions and income of the farmers.

In Mexico by 2012 there were about 25,000 extension agents; which were involved in various advice programs for farms producers (SAGARPA, 2012). In Sinaloa, the extension programs indicate that each extension agent must work with a group of producers (between 10 to 20 producers) to provide technical assistance on their animal species and production system. The name that receives this group of producers is GGAVATT (For its acronyms in Spanish; Grupo Ganadero de Validacion y Transferencia de Tecnologia). The extension agent obtains information, training and technology regarding the animal specie and production system from research centers (INIFAP, 2002).

Since 1996 in Sinaloa, GGAVATT has been applied. Its application has generated outstanding results in the use of livestock technologies while improving productivity and economic parameters (Martinez et al., 2004). However, Cuevas (2013) described recently that only 3% of the total of producers have received this benefit. Additionally, to our knowledge, there are few studies regarding the human capital of the extension agents that provide technical assistance to the farm producers. Therefore, the objective of the current manuscript was to determine the factors that influence the improvement of human capital of the livestock extension agent in Sinaloa.

METHODOLOGY
Area of Study and Data Collected
The study was conducted in Sinaloa that is a tropical state located in north-western of Mexico (27° 07' and 22° 20' N and 105° 22' and 109° 30' W). The weather in Sinaloa varies from subtropical on the plains to cold in the mountains. The mean temperature is 32.5°C (range 22 °C/72 °F to 43 °C/109 °F), the annual rainfall is over 600 ml and high humidity is present, mainly, in summer (INEGI, 2011).

Data were obtained from 192 farms, which are focusing on a dual-purpose cattle system (milk and calves). These farms were part of governmental program of technical assistance in Mexico named “Programa Soporte” of SAGARPA between 2010 and 2011. The selection of the groups was done by non-probabilistic sampling based on technical data key informers (researchers from the study area), in this type of sampling researcher is who decide the size of sampling (Abascal, 2005). In order to reach the research objectives, the following criteria were included: a) only farms from the SAGARPA support program can participate; b) farms from Sinaloa state; c) farms who provided full information during the study period and d) consistency of information (survey should be completed and monthly organized regarding diagnostics and use of innovations). These data was used for these analysis and collected and uploaded in the online information system of INIFAP (For its acronyms in Spanish: Instituto
Factors (graduate studies and/or specialty) that influence the human capital in a livestock extension agent were analyzed using the econometric model Probit. The models of binary distribution, likewise Probit, are characterized by the endogenous variable \( Y \) takes only two values: 0 and 1 (Aldrich and Nelson, 1984); which correspond to each one of the possible solution on which the model has to decide. In this case, the endogenous variable \( Y_i \) represents the availability of graduate studies or specialty of the extension agents (Hktec) in the farm; thus, \( Y_i = 1 \) if the livestock extension agent has more human capital (postgrad studies or specialty) or \( Y_i = 0 \) otherwise.

The probability \( p_i \) of choosing any alternative over not choosing it can be expressed as in (1), where \( \phi \) represent the cumulative distribution of a standard normal variable (Greene, 2011).

\[
pi = \text{prob} \left[ Y_i - 1 \left[ X \right] = \int_{-\infty}^{x_i \beta} (2\pi)^{-1/2} \exp \left( -\frac{t^2}{2} \right) dt = \phi (x_i \beta) \right] \quad \text{(1)}
\]

The Probit model estimates the probability to the livestock extension agent \( i \) of having more human capital. The model can be expressed as (2):

\[
Y_i = \phi (x_i \beta) + \mu = \phi (K_i) + \mu_i \quad \text{(2)}
\]

In this model, the estimated parameters do not directly determine the marginal effect of the variations of the endogenous variables \( X \) above the probability. Its sign and magnitude, nevertheless, indicate the sense of change and relevance of such variations. The marginal effect is the result from the product of the density function of the normal standard distribution in a determined point, thus, the corresponding parameter is (3) (Greene, 2011).

\[
\frac{\partial p_i}{\partial x_k} = \frac{\partial \phi (x_i \beta)}{\partial x_k} = \phi (x_i \beta) \beta_k \quad \text{(3)}
\]

where \( \phi \) represents the normal density function (derived from function of distribution) of a standard normal variable. Probability is a function of the values of all the explanatory variables, as well as their coefficients from those observations (extension agent in the farms) where it is analyzed. For this reason, in order to obtain a representative value of the marginal effects, these are evaluated for the mid values of the regressors.

The estimation of the model is carried out by the method of maximum likelihood, that provides consistent estimators and asymptotically efficient. To contrast the individual significance of each parameter, as consequence of the explanatory variable, the Wald test was used. The statistics \( z \) of the Wald test follows a normal typified distribution. Regarding the evaluation of the global goodness of the adjustments, the habitual coefficient of determination \( R^2 \) does not result valid in this type of model. However, there are more alternatives; therefore, it is better to use the \( R^2 \) of McFadden, the statistical LR or reason of likelihood (Greene, 2011). The results of the econometric model were obtained using the STATA 10 program.

Therefore, the dependent variable in the model was the level of education or specialties of the extension agent in the farm. Regressors, such as age of the extension agents, years of experience in the extension job, farm conditions (number of permanent employees and number of livestock heads) and number of technology innovations used in the farm, were considered.
as variables of socio-demographic and economics (Wayne and Young, 2003; Defranceso et al., 2008; and Cuevas, 2013).

The \( \chi^2 \) value was used for the contrast of the global significance of the model. The null hypothesis was that all the coefficients of the equation, except the constants, are null.

**RESULTS**

*Age and Experience of the Extension Agent*

The mean age of livestock extension agent in Sinaloa was 47.8 years (range 34 to 60). The mean years of experience of the extension agent were 9.1 ± 7.7 years. A great diversity in the years of experience exist in the livestock extension work; while there are extension agents with only one year of experience, other extension agents have more than 37 years of experience (Table 1). On average, livestock producers have at least one child less than 18 years old with them (range 0 to 7); one laborer who help with daily duties (range 0 to 5) and 30 cows on average (range 4 to 237). In addition, in the last few years, on average these producers have used 21 innovations on their production system (range 0 to 32) (Table 1).

**Factors that Determine the Level of Human Capital of Livestock Extension Agent**

Table 2 shows the results of the estimation of the Probit model for the probability that livestock agent decides to increase his/her formal training. This allowed to analyze the influence of the explanatory variables on the probability to obtain postgraduate studies.

The \( \chi^2 \) analysis indicates that the number of cases correctly predicted was 77.6% (149 out of 192); meanwhile, the critical value of the table was 30.85 and the probability associated was less than 0.05. All together indicate that the null hypothesis for the \( \chi^2 \) analysis is rejected, thus, the global model is statistical significant.

Age of the livestock extension (TecAge), years of experience on the extension job (ExpExtTec), number of technical innovations applied (Innovato) and number of livestock head per farm (TotCows) differ significantly (\( P < 0.05 \)). The number of family members under 18 years (Young18Rel) and the number of permanent employees hired at the farm (EmpProd) were no statistical significant (\( P > 0.05 \)). These results suggest that the livestock producers in Sinaloa have similarities in family structure (Table 2).

**Table 1: Statistical Description of the Variables Used in the Model**

<table>
<thead>
<tr>
<th>Variable*</th>
<th>Description</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tec Age</td>
<td>Age of the technician</td>
<td>34</td>
<td>60</td>
<td>47.86</td>
<td>6.68</td>
</tr>
<tr>
<td>ExpExtTec</td>
<td>Years of experience in the extension field</td>
<td>1</td>
<td>37</td>
<td>9.15</td>
<td>7.71</td>
</tr>
<tr>
<td>Young18Rel</td>
<td>Relatives younger than 18 years</td>
<td>0</td>
<td>7</td>
<td>1.27</td>
<td>1.40</td>
</tr>
<tr>
<td>EmpProd</td>
<td>Number of permanent employees</td>
<td>0</td>
<td>5</td>
<td>0.51</td>
<td>0.75</td>
</tr>
<tr>
<td>Innovato</td>
<td>Total number of innovations introduced</td>
<td>0</td>
<td>52</td>
<td>21.00</td>
<td>9.00</td>
</tr>
<tr>
<td>Totcows</td>
<td>Average number of cows</td>
<td>4</td>
<td>237</td>
<td>30.00</td>
<td>33.00</td>
</tr>
</tbody>
</table>

*Note: *description of variable: age of the extension agent [Tec Age], years of the experience in the extension job [ExpExtTec], relatives younger than 18 years [Young18Rel], number of permanent employees [EmpProd], total number of innovations [Innovato] and size of the herd [Totcows].
We observed that the use of technical innovations (Innovato) was significantly improved when the extension agent has more human capital ($P < 0.01$). The relationship was positive and linear, thus, for each technical innovation adopted by the producers; the probability, that the extension agent obtains formal training, increases by 1.0%.

Within the scale variables of the farm, the model demonstrated that the probability of having a livestock extension agent with better human capital increases by 0.29% when the size of the herd (TotCows) increases. Therefore, this indicates that the producers with more capital (size of the herd) demand extension agent with better human capital. This indicates that the technical assistance can produce multiplier effects of greater impact along time on yields for certain type of producers; therefore, it looks like that the technical assistance should be differentiated by type of producers.

In general, most of the variables were significant, but with minor marginal effects. There is a positive relationship between age and human capital of the livestock extension agent. When the livestock extension agent has more human capital, the age of the agent differs statistically. The conditional marginal effect about the age of the livestock extension agent on the probability of increasing his/her human capital shows that when the extension agent reaches age of 55, the interest decreases of getting enroll in postgraduate studies or specialty (Figure 1).

According to the marginal effects estimated by the model, we have an additional year of age increases the probability that the livestock extension agent decide to improve their level of human capital through postgraduate studies, increases linearly by 5.8% as their age increases. However, the probability that the extension agent decide to improve their level of human capital through postgraduate studies

<table>
<thead>
<tr>
<th>Variable*</th>
<th>Coefficient</th>
<th>Wald Statistic</th>
<th>Probability</th>
<th>Marginal Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>TecAge</td>
<td>0.193</td>
<td>5.324</td>
<td>0.00001***</td>
<td>0.058</td>
</tr>
<tr>
<td>ExpExtTec</td>
<td>–0.246</td>
<td>–5.067</td>
<td>0.00001***</td>
<td>–0.074</td>
</tr>
<tr>
<td>Young18Rel</td>
<td>–0.092</td>
<td>–1.016</td>
<td>0.30936</td>
<td>–0.028</td>
</tr>
<tr>
<td>EmpProd</td>
<td>0.126</td>
<td>0.634</td>
<td>0.52610</td>
<td>0.038</td>
</tr>
<tr>
<td>Innovato</td>
<td>0.034</td>
<td>2.457</td>
<td>0.01399**</td>
<td>0.010</td>
</tr>
<tr>
<td>TotCows</td>
<td>0.009</td>
<td>1.851</td>
<td>0.06416*</td>
<td>0.002</td>
</tr>
<tr>
<td>Const</td>
<td>–8.692</td>
<td>–4.700</td>
<td>0.00001***</td>
<td></td>
</tr>
</tbody>
</table>

Observations: 192  
chi²(2): 30.85 
Prob > chi²: 0.00  
Log-likelihood: –71.33  
Pseudo R²: 0.43  
ML(-2LL): 111.37

Table 2: Determining Factors of the Human Capital of the Livestock Extension in Sinaloa

Note: *** significance to 99%, ** Significance to 95%, and * Significance to 90%. *description of variable: age of the extension agent [TecAge], years of the experience in the extension job [ExpExtTec], relatives younger than 18 years [Young18Rel], number of permanent employees [EmpProd], total number of innovations [Innovato] and size of the herd [TotCows].
decreases by 7.4% as their level of experience on the job increases.

These results show that the extension agent with more experience on the job are less prone to get a postgraduate diploma. On the other hand, young extension, probably, seeks in obtaining formal knowledge as a mechanism of stability and source of better income in the future.

DISCUSSION

Our observations about age and experience of the livestock extension concur with previous studies where indicate that the factors that influence the educational decisions of the persons are related to their personal characteristics (Rice, 1987; and Albert, 2000) or social factors or family characteristics (Lillard and Willis, 1994). Outcomes about age and experience of the extension agent differed with Galindo (1995). They observed in Zacatecas that 87.6% of the extension agents from the “Programa Elemental de Asistencia Tecnica en Zacatecas” were at least 37 years old and 53% of the total population surveyed had one year of experience in the extension job. This indicates that the extension agents, generally, do not have enough experience for the job requested. Similarly, Galindo (2007) observed that 48% of the producers of chile (Capsicum annuum) were between 32 and 40 years old and 76% of the extension agents had between 1 to 6 years of experience on extension job.

Mincer (1974) was the first in analyzing the relationship between the distribution of the payment and the human capital and developed a regression equation called “income function”. Several studies have used the Mincer regression equation and have found that additional years of schooling increase the income and the years of work experience influence the income of the people (Meng, 1987; and Blanchflower and Oswald, 1990). As explained by the theory; income increases when the worker increases his/her experience, but at the end, it reaches a maximum limit, which later end up decreasing. Some studies have demonstrated that the inflexion point is between 11 and 32 years of work experience, which is within the labour life of most of the workers (Leyva y Cárdenas, 2002). A probable explanation about why the experience of the extension work appears with a negative sign, is probably due to the fact that the extension agent increases his/her knowledge with the time in an informal way and his/her social relationships, therefore, they do not show any interest on formal training (Boateng, 2006).

Studies about the teaching quality of the professor indicated that the observed factors associated with the learning effectiveness of the students are years of experience, academic degrees/diplomas, specialized training on a specific area, the certification of better professional practice and academic test results (Wayne and Young, 2003). Although, since the
extension job is not only teach to producers new techniques; adult education is an important part of the extension job. On this matter, Pannell (2006) indicated that the extension agent must expend time with the producers in order to determine if the new technique will be adopted by the producers through the teaching and educating process about the new technique. Thus, the quality or efficiency of an extension agent with more human capital (formal or informal) is reflected by the number of technological innovations used by the producers, but more importantly, with better productive and economic parameters of the supervised farm. On the producer side, several studies have demonstrated that the education of the producer is associated with the tendency for looking for new technologies (Wozniak 1993; and Popp et al., 1999).

On the other hand, several studies conducted at micro level indicate that the training received by the workers in the enterprise has a positive and significant effect on total productivity (Tan and Batra, 1995). Therefore, it seems that producers with more training, knowledge and sources, require or demand a more capable extension agent, with more formal knowledge. This was demonstrated by Solis et al. (2009) who observed in Centro America a positive relationship among the productivity, human capital of the producer and the extension agent.

The input of livestock extension is not under direct control of farmers; it is determined in the aggregate level by the government sector (Huffman, 1980). Therefore, the extension service can be considered as an employment that should be monitored, evaluated and funded by the government. Thus, the results observed in this study contribute to the knowledge of this important input (the extension service, but more importantly to the extension agent) to improve the conditions of the producers through the use and application of innovations that contribute to increase the economic income of the families of the agricultural sector.

**CONCLUSION**

Factors that influences the human capital of the livestock extension are age of the agent, experience on the extension job and resources on the farm supervised (technical innovation implemented and the size of the herd). Producers with greater economic capacity seem to take advance of the knowledge of the extension agent. Thus, human capital of the livestock extension is an important factor, which influences the success of the governmental programs of extension. Capacity building of extension agents is a key tool for achieving impact with cottage producers.

Moreover, it is pertinent to design programs of professional training to develop abilities for extension agents. It is necessary changing the extension in Sinaloa, and probably in all the states of Mexico too, and focusing on formal training to extension agents below 55 years of age to guarantee the success of the training program and development of abilities. In this sense, the study may contribute to the efficient use of the resources used for livestock extension training in Sinaloa and developing countries with similar conditions.

This manuscript contributes to improve the understanding of one of the most important resources of the politic of agricultural extension: the extension agents. The empirical study applied to livestock extension agents allows identify the current conditions of human resources of the agents who work with livestock producers.
These results can be used to design policies and programs of agricultural extension that contribute to improve the efficiency, efficacy and impact of the livestock extension service. This will be possible by defining recruitment and training schemes, which consider age and academic level of the livestock extension agents to be employed.

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CONFLICTS OF INTEREST
The authors declare they have no conflicts of interest with regard to the work presented in this report.

REFERENCES


