



Application of a knowledge Management system in sheep and goat producers in Colombia

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ABSTRACT

Objective. Knowledge management contributes to the generation of competitive advantages in sheep-goat production systems. **Materials and methods.** With 66 producers, the effect of applying a knowledge management model on its level and use was evaluated. The construction of the model involved 4 phases: Characterization of the producers, Management with information systems and analysis of indicators, Intervention with knowledge management and Monitoring and evaluation; In these, the analysis of three (3) types of producers was developed: with a conventional technical assistance system, intervened and without intervention, evaluating them in terms of the level and use of appropriate knowledge. **Results.** The group that actually worked on the knowledge management model that aims to appropriate, exchange and combine the tacit with the explicit, accept that their level and use of knowledge was modified compared to what was expressed by those who contemplated a conventional technical assistance model or the that they did not have ($p < 0.05$). **Conclusions.** Continue developing works of this type that contribute to the management and construction of tacit knowledge at different levels based on the experiences and internalization of explicit knowledge.

Keywords: Knowledge management; small ruminants; tacit; explicit; level and use of knowledge (Source: DeCS, CAB).

RESUMEN

Objetivo. La gestión del conocimiento contribuye en la generación de ventajas competitivas en sistemas de producción ovino-caprinos. **Materiales y métodos.** Con 66 productores se evaluó el efecto de la aplicación de un modelo de gestión del conocimiento sobre el nivel y uso del mismo. La construcción del modelo, implicó 4 fases: Caracterización de los productores, Gestión con sistemas de información y análisis de indicadores, Intervención con gestión del conocimiento y

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Seguimiento y evaluación; en estas se desarrolló el análisis de tres (3) tipos de productores: con un sistema de asistencia técnica convencional, intervenidos y sin intervención, evaluándolos en cuanto al nivel y uso de conocimiento apropiado. **Resultados.** El grupo que trabajo propiamente el modelo de gestión del conocimiento que pretende apropiar, intercambiar y combinar lo tácito con lo explícito, acepto que su nivel y uso de conocimiento se modificó comparado con lo expresado por los que contemplaron un modelo de asistencia técnica convencional o los que no tuvieron ($p < 0.05$). **Conclusiones.** Continuar desarrollando trabajos de este tipo que contribuyan en la gestión y construcción de conocimiento tácito a diferentes niveles a partir de las experiencias e interiorización de conocimiento explícito.

Palabras clave: Gestión del conocimiento; conocimiento tácito; conocimiento explícito; nivel y uso del conocimiento (*Source: DeCS, CAB*).

INTRODUCTION

Sheep and goat production systems for consumption and transformation in Colombia have grown significantly in recent years, as well as generating some possibilities for export. The development of sheep and goat activities has been supported by producers, whose knowledge is acquired through oral tradition, myths, legends, and personal experience, usually without technical assistance or scientific support. In general, it is produced with little human intervention, considering that the animal is nearly wild, which means that nature and its capacity play a significant role in the activity, creating products with little control over their productivity and with indeterminate quality, particularly due to the little standardisation and/or uniformity of produce (1,2).

Such system behaviour in the country has drawn attention to knowledge management (KM), represented as a transition path, which contributes to the recognition of local problems and their solution along with the use and/or application of KM (3); fact, which has been recognised in different contexts, including food production (4,5,6,7).

The concept of knowledge management is very broad, even with some authors describing the process of managing as the use, creation, organisation, and application of such knowledge (8,9). It is recognised in organisations as a collective indicator of intellectual capacity and the generation of ideas, which, along with technology and intangible information, contributes to the development of new products and the ability to respond to market conditions, which translates to improvements in product competitiveness (10,11).

From the set of elements, such as the recognition of the capabilities of the environment, the quality attributes of the product, and the knowledge generated from the typification of the processes within the system, comparative advantages are identified in the production niches specific, which exalt innovation processes from within, from the use of CG (12).

Comparative advantages are determined by the difference in the endowment of production factors or by the difference in skills, whereas competitive advantages are likely to be created (13). In this sense, the use of traditional knowledge improves the adaptability of systems, strengthens the bonds between agents, and by combining it with scientific knowledge, it shall increase the capacity and frequency of knowledge transmission (14), thus contributing to sustainable development.

The combination and use of knowledge (tacit-explicit), allows to contribute to innovation processes in an organization or system (15), being increasingly necessary to deepen the relationship between them, due to their impact on the level of production (16); thus, the effective use of knowledge allows greater adoption of innovations (17), all of which generates positive effects at a strategic level.

The modern understanding of knowledge theorises about its epistemological and ontological dimension. From the epistemological approach, it is conceived that the knowledge used by human beings to understand, in this case, production systems (sheep-goats) is divided into two aspects: tacit knowledge and explicit knowledge (18). The first, is the product of daily experience, transmitted by oral tradition from generation to generation,

knowledge without a formal origin; the second, is the one that has been documented and can be combined, analysed, validated and disseminated. This explicit knowledge is usually of formal origin or generated through a systematic or scientific method, being used in multiple studies at the level of the organization, people, systems, among others (19,20,21,22).

A traditional livestock culture, characterised by a lack of explicit knowledge used in production process, means that the way sheep-goat farmers work is based on tacit knowledge, which in part has contributed to low levels of organisation, development, appropriation of technologies, planning and productivity, causing unequal growth that leaves aside the needs of the market, union initiatives, and the role of the State (20,23,24).

The starting point to move this knowledge inside is proposed by Nonaka and is applied through different studies, taking as a starting point, the combination of knowledge (18). This knowledge creation process occurs in different ways: it is "socialised", when such knowledge remains tacit, which happens when such knowledge is passed on from a person either orally or spontaneously, for instance, when a sheep farmer tells how he attends to a sheep calving. It is "externalised" when the knowledge goes from tacit to explicit, that is, such tacit knowledge is documented following a systematic method or model, for example, when the producer writes and analyses how he attends to a female while calving (18,20,23).

It is "combined" when explicit knowledge is mixed or synergises with other explicit knowledge and a new, more evolved product is obtained as a result, or with a greater capacity for adaptation (25,26), for example, when reading a technical manual on handling a female to calving, and this is contrasted with the document describing how it is done on the farm, and changes to the process are made. It is "internalised" when explicit knowledge is brought back to tacit and this is incorporated into the normal process of analysis and decision making. It occurs when the producer makes the decision to implement in the field the changes to the process described above (27).

Applied cases on knowledge management in Asia show that the transmission and exchange of knowledge on beekeeping becomes more efficient and effective when the type of

information channel used is adapted to the current context, background, needs, and goals of the beekeeper. (27).

The survival of knowledge is considered by Karl Popper as follows: A first world is the physical, where homeostasis and metabolism combat entropy (28,29); a second world, that of knowledge, anticipates the physical world and corresponds to the administrative and organisational system, with all its tacit knowledge used to manage the farm (28,29); a third world is the knowledge of professionals, researchers and their tools to measure and understand, from the "formal" perspective, what is happening on the farm, it is understood as explicit knowledge (28,29).

Knowledge evolves to the extent that the third world explains the first world and the second world can prove it by applying it to the first world. If this relationship is correct, knowledge survives, or, otherwise, it dies and it gives way to another. When a theory is launched by a researcher, the producer understands it, it applies it to livestock and validates whether it is true or not, and therefore, whether it survives or not (28).

In the Cybernetics of Knowledge, the following cycle is proposed: observation/orientation/decision/action (OODA cycle), which has been one of the most accepted by the world's military, given its great effectiveness in generating advantages over the enemy in combat (30,31).

For an individual or organisation to survive in constant combat in a competitive world, it is necessary that the knowledge they use fulfils the four steps of the OODA cycle (30,31).

Observation: observations made by the organisation or system of the environment. It is the knowledge that comes to the producer from other producers, family members, their imagination, friends, professionals, researchers, etc. **Orientation:** It determines the direction to make the organization evolve. In this stage, from the environment, tacit knowledge, the history of knowledge, routines, culture and tradition are affected, the selection of inputs is made, and it involves processes of collection, analysis and synthesis of knowledge. The memory and history of knowledge can be changed by the action of explicit knowledge, which also sets the orientation of the organisation. The producer analyses the knowledge it receives

and integrates it or not with its own. Decision: chosen hypothesis or action plan to execute. Action: execution of decisions, response to internal and external controls and limitations.

As for this research, it has been considered that the OODA cycle can be presented under the following interpretation: the observation or inputs to the system are called "sources of knowledge", the orientation and decision, and the "level of knowledge" that the producer has to understand its problem and define a direction strategic and the action corresponds to the "exploitation" or "use" of knowledge by the producer, thus defining three measurement points: source, level, and use of knowledge on a farm. Level and achievement are expressions of tacit knowledge.

Based on the above, this research aims to measure the effect of three forms of management on the level and use of knowledge in sheep-goat farms in 6 regions of Colombia.

MATERIALS AND METHODS

The methods used to create and apply the Knowledge Management System (KMS) have their starting point in the construction of the model, which involves 4 phases: Phase I: Producer characterisation, Phase II: Management with information systems and analysis of indicators, Phase III: Intervention with knowledge management and Phase IV: Monitoring and evaluation. In these four phases, the analysis of the three (3) types of producers is developed: Group 1. ATC (producers with a conventional technical assistance system); Group 2. PI-KMS (intervened producers in which a knowledge management system is incorporated); and Group 3. NI (producers without intervention, control group), evaluating them regarding the level and use of appropriate knowledge.

The results evaluated against the level and use of knowledge occur after a process of 3 years of work in different components of the production system, being phase IV (monitoring and evaluation) the object of study of this research, in which after a series of workshops, monitoring, technical and scientific work, the appropriation of knowledge was determined in terms of its level and use.

To test the objective of this study, two hypotheses were structured:

Hypothesis 1

H1a = there are no differences in the NC in type ATC, PI-KMS, or NI producers.

H1b = there are differences in the NC in type ATC, PI-KMS, or NI producers.

Hypothesis 2

H2a = there are no differences in the UC in type ATC, PI-KMS, or NI producers.

H2b = there are differences in the UC in type ATC, PI-KMS, or NI producers.

Where knowledge:

NC = Level of Knowledge of the producer to understand its problems.

UC = Use of Knowledge of the producer to understand its problems.

And the type of producer:

NI = witness producers, not intervened, with only a basic characterisation survey.

ATC = producers with management through information systems and indicator analysis workshops, with professional advice in one channel (without consensus with the producer on recommendations about the system)

PI-KMS = intervened producers, with information systems and with the knowledge management model or system (combination of tacit and explicit knowledge - creation of knowledge, consensus with the producer on measures to be taken in the system)

Study Location. Within the framework of the "Technological Management Systems for the Sheep-Goat Chain (SIGETEC)" project, developed within the context of the Agricultural Transition Programme - Ministry of Agriculture and Rural Development of Colombia, for a period of three years, which was conducted with 66 sheep-goat producers located in the departments of Cundinamarca, Boyacá, Santander, Valle del Cauca, Antioquia, Tolima, and Sucre, distributed amongst 12 producers in the - NI group; 28 producers in the - ATC group; and 26 producers in the - PI-KMS group.

Conceptual References for the Construction and Monitoring of the Knowledge Management System for Sheep-Goat Farmers. The proposed KMS is based on, first, a component that corresponds to production, containing the biological processes, in this case the livestock production system and that corresponds to the first world; a second

component of tacit knowledge, which is expressed in the administrative system with its culture, livestock tradition, and concerning to the second world; and, a third explicit component, consisting of a group of technicians or experts and the information system that measures the livestock production system (third world).

A fourth component is the knowledge creation matrix that incorporates explicit knowledge into tacit knowledge, connecting the second with the third world; and a fifth component corresponding to the cybernetics of knowledge, which rotates and provides feedback to the KMS, promoting the generation of competitive advantages in an evolving and sustainable manner (32,33).

Epistemological Basis of the Knowledge Management Model. To create competitive advantages, the system needs to create new knowledge from the combination of the "old" tacit knowledge with the "new" explicit knowledge (generated by the information system and managed by researchers or experts) through the matrix of knowledge creation consisting of four steps: dissemination, externalisation, combination, and internalisation. The new tacit knowledge created provides unprecedented elements to the producer and the professional/researcher and increases the level of formal knowledge on the farm, which leads to better and more accurate decision-making actions, which allows an increase in the degree of organisation and control of the production system, making it more competitive. As the professional/researcher incorporates new elements of tacit origin to their understanding of the problem, the elements or arguments that cannot be evidenced from the explicit are completed, generating new, more pertinent explicit knowledge.

The second world puts the newly created tacit knowledge to the test by taking it to the first world and applying it. If the first world responds positively by decreasing entropy and increasing the level of productivity, the new knowledge survives, or otherwise it disappears.

If knowledge survives, it tends to evolve by feeding back to the third and second worlds with the new results, fostering a process of cybernetic evolution, which makes the organisation adaptable, flexible and evolving, increasing the capacity to respond to the

environment and improving competitiveness. (32,33).

Model Application (KMS). This was carried out in four phases:

Phase I: Characterisation of producers. In this phase, the 66 producers being study were given a general characterisation with a survey, through which the producer and its farm were identified.

Phase II: Management with information system and analysis of indicators. From the 66 producers to 54 corresponding to the ATC "28" and PI-KMS "26" groups, an information system with monthly follow-up was set up for three years. The animals were identified, 54 databases were opened in a commercial software -OvisWebs®-, which, with the accompaniment of a regional technician, were fed every 30-45 days with the data of calving, weighing, milk control, and inventory movements, allowing monitoring, control and generation of global statistics.

Six months after the monitoring with the information system began and for 18 additional months, bi-annual workshops were held, where producers, along with professionals, defined the mission-vision of the farms. The indicators were analysed and objectives, strategies, and production goals were defined. The workshops were worked on successively, encompassing the population, reproduction, and production subsystems, envelopingly; working with the 54 producers in a conventional way in terms of technical assistance. Each producer followed the recommendations of the professional, where a work plan under permanent supervision was designed.

Phase III: Intervention with the Knowledge Management System.

Twenty-four months after the start of the follow-up, after the third workshop, of the 54 producers, 26 were randomly chosen and intervened with the KMS; With these producers, the methodology proposed by the KMS was developed, in reference to knowledge management, this group corresponds to the PI-KMS.

With this group of producers, the mechanics and roles were changed according to the indicator analysis workshops that had been applied. Here, knowledge is created, not transferred, and it is the result of the interaction of the

explicit knowledge of the professional with the tacit knowledge of the producer, fulfilling the elements of the knowledge creation matrix, evolutionary epistemology, and cybernetics of knowledge through socialisation, externalisation, combination, internalisation, follow-up, and feedback (34).

Phase IV: monitoring and evaluation. Six months after the KMS workshops, a workshop was held for simultaneous monitoring and evaluation of the 66 producers, applying a survey, which, through the use of the Likert scale, allowed measuring the level and use of knowledge that the producers expressed they had after the activities performed in the different workshops.

The survey designed and applied was a personal interview structured with a written questionnaire, which was applied to the three types of producers. For the survey, 50 questions were designed, which were initially tested in a validation exercise with researchers, later with professionals, then with university students, and lastly with producers to verify their clarity and relevance. The application of all the surveys was explained and accompanied, ensuring the producer achieved the correct interpretation of each of the questions asked.

For the writing of the questions in terms of statements, the OODA cycle was taken as an orientation with the guiding concepts of modern epistemology and elements of rationalism and empiricism adapted to the circumstances of a sheep-goat producer. Each question was answered on a scale ranging from: 1 - completely disagree; 2 - disagree; 3 - indifferent; 4 - agree, and 5 - totally agree; For the evaluation of the results, the values of the survey are replaced by numbers, being 1 totally disagree and 5 totally agree, to be statistically processed.

The Likert scale is indicated to evaluate the level of knowledge of an individual, measuring the intensity of the response to a proposition, from a positive pole to a negative pole with equidistant intermediate points (35). It is an ordinal scale and uses a series of questions – statements, on which a response is obtained from a subject, which would be its attitude towards the question (36).

Statistical Analysis. The data was stored in a database built in Microsoft Access®, where the queries that process the question qualification data were developed. The results

were transferred to a Microsoft Excel® format, from which they were exported to SAS®, SPSS or Stata 11® for statistical analysis.

Analyses were performed to each response in contingency tables, taking into account the type of producer and it was determined whether there was an association or not through cluster analysis, Chi² and modified Kruskal-Wallis to calculate the difference between treatments and multivariate correspondence analysis.

RESULTS

The number of producers surveyed was 66 sorted as follows: 15 in Antioquia, 10 in Boyacá, 4 in Cundinamarca, 3 in Sucre, 7 in Tolima, and 6 in Valle del Cauca (Figure 1). This number was different in each area due to the availability of producers in each department at the time of executing the project.

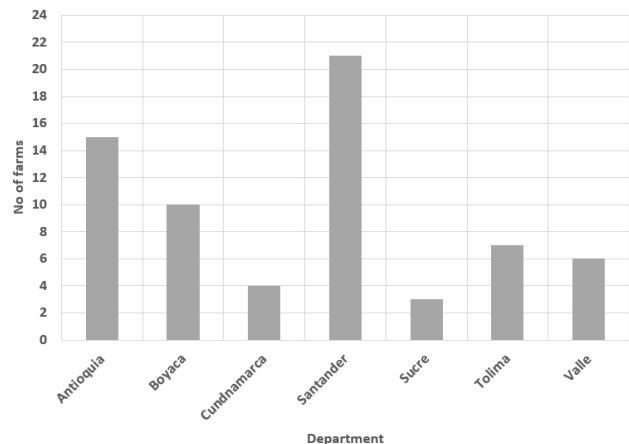


Figure 1. Distribution of farms by department.

When processing the answers of the initial survey applied by cluster analysis, it is found that they are grouped according to the type of knowledge being evaluated. According to the result of figure 2, there are two clusters identified, one associated with statements of the level of knowledge (NC) and the other associated with statements related to the use of knowledge (UC), confirming that within the statements there is an association of criteria. In the Level of Knowledge conglomerate, three assertions related to the use of knowledge were included: support for the academia, support for research and support for the group; These three elements, from the perspective of the producer, appear to be more theoretical than

applicable, and for this reason, it is believed that they could have been nested within the statements of the level of knowledge with which there is greater affinity. Likewise, from the Level of Knowledge questions, two were passed to Use of Knowledge: information systems and entrepreneurship that, due to their nature, from the point of view of a producer, better fit within the field of use or application of knowledge.

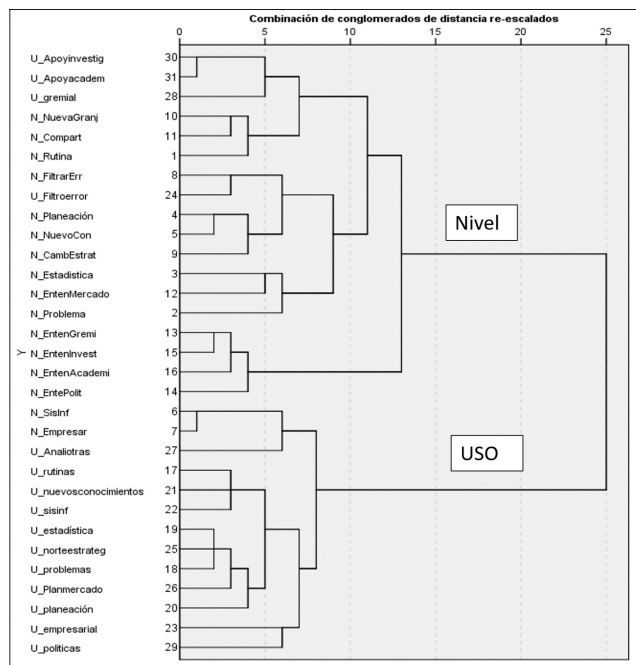


Figure 2. Dendrogram of questions from survey per type of knowledge: level and use of knowledge.

Descriptive Statistics. When tabulating the data by the three types of producers, table 1 is obtained, in which it is observed that it shows the average value in terms of weighting on the level and use of knowledge perceived by the producer.

Table 1. Average on the Likert scale measuring the level and use of knowledge according to the type of producer.

Tipo de Productor	Nivel de conocimiento	Aprovechamiento del conocimiento
NI	3,11	3,52
ATC	3,09	3,35
PI-SGC	3,78	4,11
	3,33	3,66

Regarding the Level of Knowledge (NC), when applying the survey, it is reported that the average is closer to being indifferent than agreeing, thus, the NI-type producers are found very close to being indifferent, as well as the ATC type, whereas the PI-KMS types are much closer to agreeing, taking into account that a value of 2 is disagree, 3 is indifferent, 4.0 is agree, and 5 is totally agree. It is observed that, in general, NI and ATC type producers tend to doubt that the level of knowledge they have is sufficient, while PI-KMS type producers tend to agree that they have a sufficient level of knowledge. The group of producers intervened with the KMS are more likely to accept that they have a higher level of knowledge regarding the production system than the other two.

On the other hand, regarding the use or exploitation of knowledge, when applying the survey, it is reported that the mean is at an intermediate point between indifference and agreement, observing that NI type producers are positioned at an intermediate point, not indifferent, but not agreeing either. The ATC types apparently tend to be closer to being indifferent, showing a use of knowledge that is closer to each other, while the PI-KMS type producers agree that they use or take advantage of knowledge, but they disagree. They are far from accepting that they totally agree, considering that 2 is disagree, 3.0 is indifferent, 4.0 is agree, and 5 is totally agree. The producers intervened with the KMS (PI-KMS) show they agree with the use they make of the knowledge, whereas for the producers from the ATC and NI groups, the use of the knowledge is indifferent to them.

Kruskal-Wallis Test. When applying the Kruskal-Wallis test, sorting the answers on the level of knowledge and use of knowledge by type of producer, the following was obtained: Between type NI and ATC ($p > 0.05$), between type NI and PI-KMS ($p < 0.05$) and between ATC and PI-KMS ($p < 0.05$); that is, the NI and ATC type producers are the same and these two are different from the PI-KMS type.

Chi² Analysis. Each of the statements related to the level of knowledge were taken from the survey and blocked-in contingency tables against the type of intervention NI, ATC and PI-KMS. Chi² was applied to search for association and the result shown in figure 3 was found.

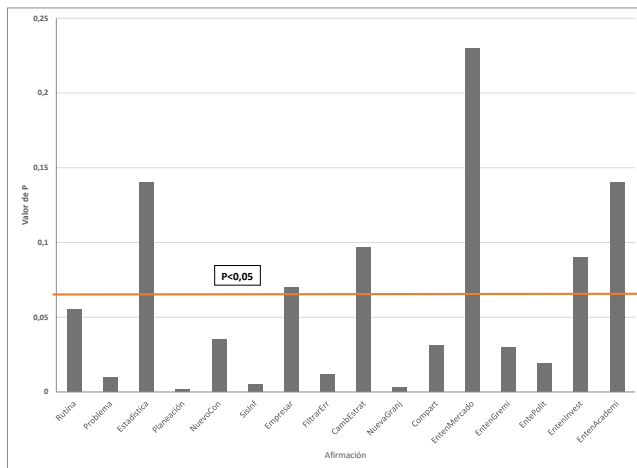


Figure 3. Expression of the association of the level of knowledge per type of intervention - Median results of statements in Chi².

As for the response obtained in the 16 questions of the survey, connected with the level of knowledge, it is evident that the median of the Chi² tests resulted in ($p < 0.05$), which indicates that there are associations in the level of knowledge by the type of intervention the producers had.

Regarding the response obtained in the 15 questions of the survey regarding the use of knowledge, it is reported that the median of the Chi² tests is ($p < 0.05$), which indicates there are associations in the use of knowledge by type of producer (Figure 4).

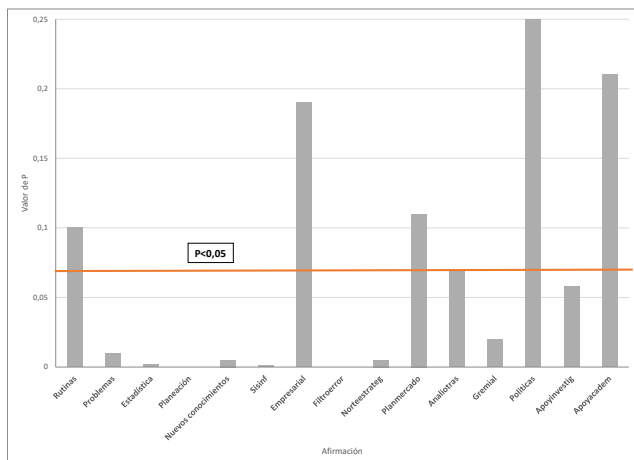


Figure 4. Expression of the association of the use of knowledge by type of intervention - Median results of statements in Chi².

Multivariate Analysis. As for level of knowledge, a Multivariate Correspondence Analysis was conducted to 12 of 16 statements from the survey in which there were differences on Chi², and the result obtained was the following (Figura 5).

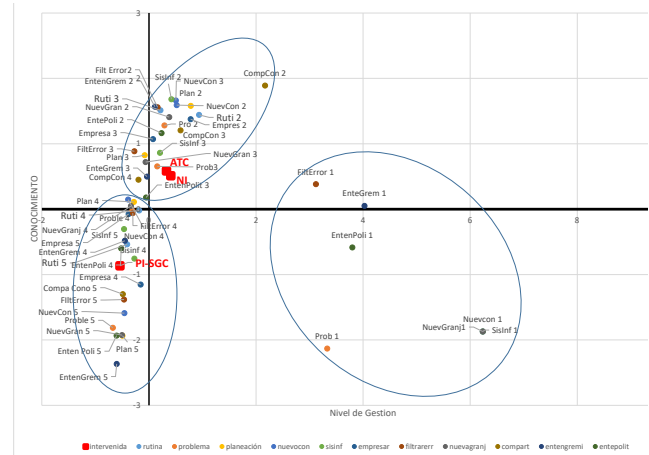


Figure 5. Multivariate correspondence analysis on level of knowledge

It is observed that the behaviour of the ATC and NI type producers is the same and that it differs from the behaviour of the PI-KMS type producers in how they responded to the statements about the level of knowledge. The ATC and NI type producers answered the questions on the Likert scale at levels 2 and 3, which means that they range from disagree to indifferent regarding the statements about the level of knowledge, whereas the PI-KMS type producers answered from 4 to 5 on the Likert scale, which means that they agree to totally agree with the statements about the level of knowledge.

The NI control group, without any intervention, has the same answers as the group of type ATC producers, which had management with information systems and analysis of indicators, which leads to the conclusion that this type of intervention does not modify the level of knowledge of the producer. The PI-KMS group intervened with the proposed KMS has responses that differ from those of the NI group and the ATC group. It may be inferred that the PI-KMS type producers agree that their level of knowledge has changed, assuming that the intervention with the KMS modifies the level

of knowledge of the producers linked to this group, compared to the producers of the other two groups, and can be considered a process towards the construction of tacit knowledge.

The differences in the level of knowledge by type of producer indicate that PI-KMS type producers evolved changing the response from being in disagreement or indifferent, to agreeing that they are capable of sharing knowledge with other producers and that these are benefited 4.5, generate new knowledge that improves the production system 4.3, understand the normal management routine of the farm 4.2, participate and contribute to the strategic planning of the farm 4.2, understand a problem on the farm and propose a solution 4.1, explain how to set up a new farm 4.1, define a change in farm strategy 4.1, understand the business elements of the farm 4.1, know how to use an information system 4.1, analyse and interpret information 4.0, understand the sheep-goat market 3.8 and understand the group's goal 3.8. They showed progress, but they are indifferent regarding: understanding and questioning the policies of the State 3.6, understanding and questioning lines of research 3.6 and understanding and questioning the academia 3.6.

For the use of knowledge, a multivariate correspondence analysis was run in Stata 11[®], with distances in Chi², to 11 of the 15 statements in the survey that resulted in differences in Chi², the result is shown in figure 6.

Similar to the observed in the level of knowledge, it can be observed that the behaviour of the ATC and NI type producers is close to each other and is far from the behaviour of the PI-KMS type producers. The ATC and NI type producers answered the questions on the Likert scale at levels 2 and 3, which means that they range from in disagreement to indifferent regarding the statements about the use of knowledge, whereas producers type PI-KMS answered from 4 to 5 on the Likert scale, which means that they agree to totally agree with the statements about the use of knowledge.

The NI group has a cloud of responses similar to the group of ATC-type producers who had management with information systems and analysis of indicators, which indicates that this type of intervention does not modify the use or exploitation of knowledge by the producer.

The PI-KMS group shows a cloud of responses that differ from those of the NI and ATC groups, agreeing that the use or exploitation of knowledge has changed. The intervention with the KMS modifies the use or exploitation of the knowledge of the producers linked to this group, compared to the producers of the other two groups.

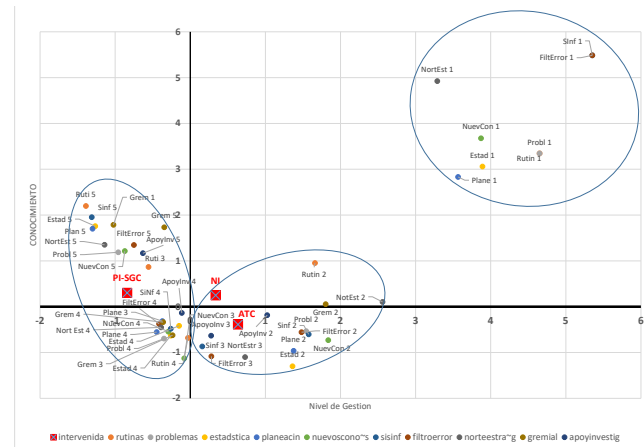


Figure 6. Multivariate correspondence analysis on the use of knowledge

The producers of the PI-KMS group state that they agree to totally agree that they use knowledge when identifying and working on problems of the farm 4.5, being clear about the strategic goal of the farm 4.3, using an information system to make decisions 4.3, create new knowledge in processes 4.3, make decisions based on information 4.3, strategic planning 4.2, evaluation and continuous improvement of routine processes 4.2, active support for academia 4.2, active support for research 4.1, considering the market when designing plans for the farm 4.0, analyse the farm against statistics from other farms 3.9 and lastly: support for union development 3.7, management of business tools 3.7, compliance with State policies 3.6. The producers of the NI and ATC groups responded to these same statements from 2.6 to 3.4.

DISCUSSION

Level of knowledge is defined as the producer's perception of "how much knowledge it has" and it is defined as the use or exploitation of knowledge in terms of "how much knowledge it is

used” to identify, understand, analyse, propose, plan, decide and take action to find solutions to problems on the farm. This is referred to as “know what” and “know how”, which implies having the knowledge and knowing how to act, identifying and understanding problems, looking for solutions, making decisions and acting to improve (26).

When applying the survey, it is understood that NI and ATC type producers tend not to agree that the level of knowledge they have is sufficient; Producers perceive that they lack a level of knowledge, similarly to mushroom producers in Ishikawa, Japan, who felt that the traditional knowledge they have is not enough to address some aspects of production (27).

When conducting the analysis of the level of knowledge through applied knowledge management models, it is found that there are no differences in the level or use of knowledge between the NI and ATC type producers ($p > 0.05$), verifying through the analysis of correspondence the fact that applying an information system or indicator analysis workshops with direct recommendations from a professional does not generate significant changes in the level of knowledge of producers, which coincides with what was stated by other authors (37) basically because, in this type of transfer, the knowledge goes from the professional/researcher as holder to the producer as recipient; the latter manages to understand the logic proposed in the analyses, but fails to internalise it, does not have a way to connect its own elements with the new ones. This disconnection will not allow the individual to incorporate the new concepts into its system of tacit knowledge, remaining as elements of explicit knowledge that are understood but not internalised, and fail to appear, are not part of its perception, are seen as distant, and therefore, when the Level or Use of knowledge is measured, the producer believes it has not increased regardless of making decisions in the workshops that have been satisfactory.

What the producer perceives is that it ignores lots of its knowledge, and that new knowledge is not assimilated or used in analysing and planning processes. This knowledge generated at workshops and the interpretation of the statistics makes it easier for the producer to take actions because they originated from outside, but not because the producer has inferred, assimilated, or internalised them;

therefore, reusing them is unlikely, as it shall require someone from the outside to provide them. The farm work plan was not developed from its tacit knowledge (38).

When comparing the NI group and the PI-KMS, significant differences are evident ($p < 0.05$), the same between the ATC group and the PI-KMS ($p < 0.05$), supported by the correspondence analysis, which indicates that there are differences in the level and use of knowledge when applying the KMS.

This difference in the Level and Use of knowledge suggests that knowledge management modifies the level of knowledge that the producer appreciates that he/she has and/or uses. By making the intervention, the producer adds to its tacit knowledge new elements that come from explicit knowledge, which help it increase knowledge to identify, understand, analyse, propose, and plan solutions to problems on the farm, generating a competitive advantage not previously possessed (39,40,41).

The results obtained go hand in hand with the approach that distinguishes the first from the second generation of knowledge management. In the first generation, it was suggested that the most important thing was to identify knowledge as a productive asset and make it available for the organisation to use at an individual and organisational levels, regularly conducting Dofa-type analyses to develop strategic planning for the organization. This approach coincides with that of the ATC-type producers in which the farm planning exercise was carried out based on the information from the information system and the livestock knowledge of researchers; knowledge is used on this plane, but it is not created or internalised (39,40).

As for the second generation of knowledge management, it is understood that competitive advantage arises by creating new knowledge from the combination of explicit knowledge with tacit knowledge and its subsequent internalisation in strategic planning; In this second stage, there is a change in the Level and Use of knowledge of the organisation when created in the management process (39,40,41).

The fact that professional personnel may impose explicit knowledge on producers does not guarantee that it shall be incorporated, evidenced by the statement of ATC-type producers. Studies carried out in Iran conclude

that the use of tacit knowledge is privileged by the producers, with the role of the extension worker being decisive in identifying the needs and, in a certain way, seeking to combine it with explicit knowledge (42). This coincides with the results of this research, as it is evident that the level of knowledge of the producers did not increase when proposed by a technician visiting the producers; the level of knowledge increased when it was possible to combine tacit knowledge with explicit knowledge at an onsite workshop on the farm, more informally, with a face-to-face approach to the producer, which occurs with PI- KMS.

In Italy, for strategic planning to be effective, the proposal is to include tacit knowledge in its elements, or otherwise, there shall a risk of not obtaining coherence between the state of knowledge and the goal sought to reach (38).

When applying the proposed KMS there is a change in the dynamics of knowledge between the professional and the producer. By tradition, knowledge goes from the professional or holder of knowledge (Conventional Technical Assistant) to the producer or receiver of knowledge. Traditional knowledge is transferred or replaced by another generated in a different place (39,43). In such a case, knowledge is not created in the mind of the producer, but it is imposed. With the proposed KMS, the management group recognises the value of traditional knowledge and makes the producer express this pre-existing or prevalent tacit knowledge, then externalise it and therefrom combine it with the explicit knowledge that the management group produces from the analysis of the information system statistics. This combination creates new knowledge that is subsequently internalised, applied, fed back and evolved. In other words, there is construction of new knowledge from the evolution of traditional knowledge; it is not to replace or displace, but rather to evolve tacit knowledge, creating new competitive advantages that are sustainable over time (40,41,44).

Another element that arises from knowledge management is how tradition or tacit knowledge can interfere with the absorption of new knowledge, how much the producers are

open to this creation according to what has been observed, requiring an effort from both parties, which is supported by (27). Likewise, recognising and identifying the motivations that lead producers to generate knowledge systems determine its management and its success, even more so adding social, economic and environmental variables that are currently changing.

Lastly, with the proper management of knowledge management models, creation and exchange become effective. Facilitating feedback mechanisms and promoting discussion or work spaces helps to promote these models, generating at the same time innovation of different types, great result of the application and use of the types of knowledge, tacit and explicit (45).

In conclusions, when applying the KMS on PI-KMS producers, the level and use of knowledge is modified ($p < 0.05$), which can lead to improving the conditions to identify, understand, analyse, plan, decide, and act against the problems from the farm, as opposed to conventional or traditional technical assistance, with direct recommendations (ATC) or non-intervened (NI), in which a certain indifference is observed regarding the perception of improvement in the level and use or exploitation of knowledge, compared to the same tasks ($p > 0.05$).

The KMS proposed with the intervened producers (PI-KMS) contributed to the creation of knowledge, improving the competencies of the producers to understand and adequately solve the challenges and problems of the activity, contributing to improving their competitiveness.

Knowledge management is a tool that has multiple uses and advantages in any production system. In this case, the exercise carried out with the producers made it possible to share this knowledge, valuing the tacit and appropriating the explicit, a fact that is reflected in the importance that gives by the PI-KMS group. Similarly, maintaining these scenarios in which knowledge is shared allows traditions to be sustained over time and innovation to be built from the interaction of knowledge.

Conflict of interests

The authors declare that they have no conflict of interest. The funders had no role in the design of the study, nor in the collection, analysis or interpretation of data, nor in the writing of the manuscript or in the decision to publish the results.

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