












Guidelines for a methodology to identify learning styles suitable for the Colombian agricultural sector

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Abstract

In Colombia, one of the deficiencies of technology transfer processes has been the lack of strategies that allow identifying the way producers learn, which, in turn, is reflected in the low implementation of the practices suggested in training processes. For this reason, the aim of this study was to analyze the research carried out on the identification of learning styles to generate a methodological proposal suitable to be implemented in the agricultural sector, which contributes to improving the effectiveness of the transfer processes. Models that have been studied at a global level were identified and used as input to build a methodology with four dimensions (motivational, perceptive, strategic, and social) that respond to the characteristics of the rural context and the training processes of producers. These results highlight the importance of identifying learning styles before carrying out a training process to achieve the implementation of new technologies by agricultural producers.

Keywords: agricultural extension, learning (farmers), rural communities, teaching methods, technology transfer

Lineamientos para una metodología de identificación de estilos de aprendizaje aplicables al sector agropecuario colombiano

Resumen

En Colombia, una de las deficiencias en los procedimientos de transferencia de tecnología ha sido la falta de estrategias que permitan identificar la forma en que aprenden los productores, lo que se ha reflejado en la baja implementación de prácticas sugeridas en los procesos de capacitación. El objetivo de este estudio fue analizar la literatura existente sobre identificación de estilos de aprendizaje para generar una propuesta metodológica aplicable al sector agropecuario que contribuya a mejorar la efectividad de los procesos de transferencia. Se identificaron modelos estudiados a nivel global, los cuales se usaron como insumo para construir una metodología con cuatro dimensiones (motivacional, perceptiva, estratégica y social) que responden a las características del contexto rural y los procesos de capacitación de productores. Los resultados permiten resaltar la importancia de identificar estilos de aprendizaje antes de llevar a cabo un proceso de formación para aumentar la implementación de nuevas tecnologías por parte de productores agropecuarios.

Palabras clave: aprendizaje (agricultores), comunidades rurales, extensión agrícola, métodos de enseñanza, transferencia de tecnología

Introduction

Non-formal education, also called *work and human development education* has been implemented in the rural areas of Colombia through the national development strategy to provide learning options for agricultural producers. State and private institutions have been involved in this type of non-formal educational processes with extension, training, technical assistance and technology transfer activities. These have been developed by entities such as Instituto Colombiano Agropecuario (ICA), Corporación Colombiana de Investigación Agropecuaria (AGROSAVIA, formerly Corpoica), the previous Instituto Colombiano de Reforma Agraria (Incora), Servicio Nacional de Aprendizaje (SENA), Federación Nacional de Cafeteros (FNC), Acción Cultural Popular, Fundación Manuel Mejía, and Fundación Hogares Juveniles Campesinos, among others (Rojas, 2007).

On the other hand, through Law 1876 (2017) the National System of Agricultural Innovation [Sistema Nacional de innovación Agropecuaria (SNIA)] was created as a subsystem of the National System of Competitiveness, Science, Technology and Innovation [Sistema Nacional de Competitividad, Ciencia, Tecnología e Innovación (SNCCTI)], for the management, promotion, financing, protection, and dissemination of research, technological development, and innovation in the agricultural sector. Through this same law, the National Agricultural Extension Subsystem was created as an integral part of the SNIA to manage the provision of the agricultural extension service [Servicio de Extensión Agropecuaria (SEA)] throughout the national territory. The SNIA proposes the implementation of strategies that generate and disseminate knowledge as the basis for the sustainable and competitive development of rural producers. This is a factor associated with competitiveness and innovation through good practices that allow access to knowledge at the right moment (Corporación Colombiana de Investigación Agropecuaria, 2015).

The results of the implementation of the service that preceded the current SEA, called *Direct Rural Technical Assistance*, were not the best in terms of coverage and quality; according to the 2014 National Agricultural Census (Departamento Administrativo Nacional de Estadística, 2016), the coverage of direct rural technical assistance at the national level reached just 16 %. Another deficiency of this service was the low quality associated with its planning and the lack of training of the professionals who provided it. All this has impeded the development of self-management capacities of rural communities and the strengthening of social capital that guarantees the sustainability of the processes (Rodríguez-Espinosa et al., 2016).

One of the strategies not considered in the provision of the SEA is the identification of learning styles. The literature reports that this process allows establishing how people learn, design tools that effectively address each particular style, and provide an effective learning experience. According to Alonso et al. (1994), learning styles are the cognitive, affective, and physiological traits that indicate how a learning environment is perceived, interacts, and responds.

Although different authors coincide in affirming that it is essential to identify how each person learns to achieve the learning objective, the lack of consensus in the definitions, classifications, and tools implemented has generated a series of adaptations of the proposed theories and models that have resulted in more than 70 questionnaires to determine learning styles (Escanero-Marcén et al., 2016). However, the authors agree in defining the psychological aspects of cognitive and pedagogical styles sustained in the

learning process (Aguilera & Ortiz, 2009; Bahamón et al., 2012; Campos & González, 2015; Ventura, 2011).

A learning style is defined as the way in which a person thinks, learns, teaches, or talks (Gallego & Alonso, 2008) or the way something is defined (Chiang et al., 2016). It is, however, necessary to comprehend a broader concept to understand the concept of learning. In psychology and pedagogy, the study of this phenomenon has generated different theories, among which the most representative is behaviorism, Gestalt, cognitivism, and constructivism (Coon, 2005). The last two are considered as contemporary pedagogical currents (Cerezo, 2007).

In general terms, learning has been defined as a change in human behavior (Betancur, 2007), a transformation in the capacity of a person that favors a better performance in a particular activity (Rodríguez & Larios, 2011) or a modification of the cognitive structures (mental schemes). In the latter, meanings are added to the complex network of prior knowledge about the environment and the phenomena that occurred there (Guerrero & Flores, 2009).

The cognitive approach considers the human being as an information processor and gives particular relevance to higher mental processes (perception, thought, language, attention, and memory), which influence the way information is encoded (Puente, 2003). This approach also seeks to understand the processes that occur inside the mind, considering the variables that intervene when the individual generates responses as he/she interacts with the environment and considering the essential role of cognition in these processes (Rodríguez & Larios, 2011).

From a constructivist perspective, learning is the product of processes that involve the perception of environmental stimuli (Domjan, 2007) and is the construction of knowledge in contextualized situations, since it occurs when people participate directly in the elaboration of cognitive representations of reality (Serrano & Pons, 2008).

In this context, the concept of *meaningful learning* arises, defined as the process by which the individual relates new information with prior knowledge when incorporating it into mental schemes (Rodríguez, 2010). This concept is vital in the learning processes of agricultural producers because it is effective only when the producers manage to apply the knowledge acquired in training to solve a problem in its real context, for which it is essential to articulate the new information with the previous knowledge.

On the other hand, to characterize the learning processes of adults, andragogy arises, defined by Knowles (1980) as “the art and science of helping adults learn” (p. 43), which seeks to promote educational spaces in non-formal and formal contexts through various means to transmit knowledge, generate change, and promote technological adoption.

According to Ferreiro (2011), the facilitator must have a system of explicit ideas about the learning process to improve decision-making related to learning objectives, contents and didactic strategies, based on the understanding of the scientific foundations that underpin educational practice.

In this context, it is relevant to identify the learning styles of agricultural producers who participate in agrarian extension processes since having clarity about the way they prefer to learn enables the design of adequate teaching methodologies. These, according to the realities of the rural context and the characteristics of its inhabitants, will allow the appropriate incorporation of new knowledge.

Therefore, the aim of this study was to identify in relevant literature the guidelines necessary to design a methodology to identify learning styles in the Colombian agricultural sector that allows improving the effectiveness in the provision of the agricultural extension service. In this way, the facilitator will be able to select the most appropriate tools for the dissemination of new knowledge and technologies, considering the preferences of the participants, and the training processes will be more effective.

Materials and methods

An interpretive descriptive study with a qualitative approach was carried out (Denzin & Lincoln, 2000; Lamnek, 2005) using the thematic content analysis technique (Krippendorff, 2004) to identify the most critical findings in studies on the identification of learning styles both in agricultural extension as well as in the educational field. The systematic review of the bibliography consisted of three phases: planning and establishing search criteria, search and selection of required data, and presentation to validate findings (Rudas et al., 2013).

With the terms “identification,” “learning styles,” “agriculture,” and their equivalents in Spanish, a search for scientific articles was carried out in the specialized databases ScienceDirect, DOAJ, Scielo, and Dialnet. From the results, theoretical and practical elements (models) were extracted, allowing the expansion of the review spectrum (Rudas et al., 2013), obtaining a total of 100 scientific articles.

The design of the methodology was carried out in four phases: 1) generation of possible dimensions; 2) selection of typologies for each dimension and data collection instruments; 3) application and adjustment of the proposed model in pilot tests, and 4) generation of decision-making tools based on the results of the proposed model.

In the first phase (generation of possible dimensions), the articles found were analyzed using the constant comparative method and the thematic content analysis proposed by Krippendorff (2004). From this review, the research team comprised of professionals from areas such as zootechnic or animal science, agronomic engineering, agricultural engineering, administration of agricultural businesses, social communication, and psychology, developed a proposal of possible dimensions. Subsequently, a focus group session was held with the participation of five officials from the Technology Transfer Department of AGROSAVIA in charge of facilitating and promoting the linkage or transfer of research results to the productive sector. From this group, the final version of the dimensions was defined.

For the second phase (selection of typologies), the research team prepared a proposal of possible typologies based on the aspects that most affect learning according to the literature consulted. Afterward, a workshop was held with professionals from the Technology Transfer Department of AGROSAVIA to validate the typologies corresponding to each dimension and the instruments for their identification. With these inputs, the final instrument for collecting information for the pilot tests was developed.

In the third phase (application and adjustment of the proposed model), to carry out the pilot test, the proposed methodology was applied in five technology transfer events carried out by researchers from AGROSAVIA in five departments of the country: Antioquia, Cesar, Cundinamarca, Santander, and Sucre, with the voluntary participation of the producers of the sugarcane, guava, meat, vegetable, and livestock production systems. In this process, the applicability and reliability (Bernal, 2006 and Blanco, 2000, cited by Artigas & Robles, 2010) of the proposed methodology for the identification of learning styles and their user-friendliness for decision-making about the didactic strategies to be used based on the results were verified. This allowed establishing, in study units similar to the definitive ones (Artigas & Robles, 2010), the consistency of the instrument, and its adjustment.

In the fourth phase (generation of decision-making tools), the toolbox for decision-making was designed based on the results of the previous phase. Subsequently, a methodology and toolbox validation workshop was held, in which 30 researchers from the research centers of AGROSAVIA across the country participated. Based on the results of this workshop, the proposed methodology was finalized.

Results and discussion

Generation of possible dimensions

The first research on learning styles, mainly in the educational field, emerged in the early 20th century (table 1) in search for models that determine how people learn to provide an effective learning process. These studies began in 1923 with the medical doctor and psychologist Carl Jung, who based his works on experience (Pantoja et al., 2013), and up to the current century with models classified under the personological approach of Aguilera and Ortiz in 2009 (Campos & González, 2015). In this research compendium, measurement instruments such as the Learning Styles Inventory (LSI) by Kolb and Kolb (2005) and the Honey-Alonso Questionnaire of Learning Styles (CHAEA, for its acronym in Spanish) by Alonso et al. to the. (1994) are highlighted.

Table 1. Chronology of research on learning styles

Year	Authors	Key elements of the model
1923	Jung	Based on experience and personality, it defines sensitive/intuitive and rational/emotional traits.
1948	Witkin and Asch	From perception, it specifies two cognitive modes: field-dependent and field-independent.
1950	Briggs and Myers	According to the personality, it presents the features extroversion/introversion, sensation/intuition, or thought/feeling and judgment/perception.
1974	Kolb	Based on experience, it proposes the convergent, divergent, assimilating, and accommodating learning styles.
1975	Grasha and Riechman	Through the social relationship, it presents the participatory/elusive, competitive/collaborative, and dependent/independent features.
1977	Ramanaiah, Ribich and Schmeck	According to the learning strategies, it exposes three learning styles: deep, under elaboration, and superficial.
1979	Gregorc	Based on experience, it defines concrete-sequential, abstract-sequential, concrete-causal, and abstract-causal learning styles.
1979	Dunn and Dunn	According to the information perception and neurolinguistic programming perception channels, they identify visual, auditory, and tactile or kinesthetic learning styles.
1983	Curry	Focused on personality, it classifies learning styles like the layers of an onion into cognitive, information processing, social interaction, and institutional preferences.
1983	Juch	Based on experience, it proposes four learning styles: perceiving, thinking, planning, and doing.
1986	Keefe and Monk	Focused on the perception of information, it defines three categories: cognitive skills, information perception, and preferences for studying and learning.
1988	Felder and Silverman	According to the experience and information processing, it proposes the active-reflective, sensitive-intuitive, visual-verbal, and sequential-global dimensions.
1995	Honey and Mumford	Based on experience, it re-thinks Kolb's theories and proposes active, reflective, theoretical, and pragmatic learning styles.
1996	Felder and Soloman	Through the information perception channels, it makes an addition to the dimensions of Felder and Silverman: inductive-deductive.
1997	Alonso et al.	From experience, it takes the contributions of Honey and Mumford to present the active, reflective, theoretical, and pragmatic learning styles.
1998	Entwistle	Focused on learning strategies, it presents superficial, deep, and strategic learning styles.
2008	Cacheiro et al.	Based on the experience and contributions of Honey and Mumford and Alonso et al., it presents four learning styles: monophasic, biphasic, triphasic, and eclectic.
2009	Aguilera and Ortiz	From a personological approach, it proposes the cognitive, affective, and metacognitive dimensions.

Source: Elaborated by the authors based on Aguilera and Ortiz (2009), Campos and González (2015), and Pantoja et al. (2013).

Concerning the learning styles of people in rural settings, in general, few studies have been carried out (table 2). The lack of knowledge of how agricultural producers learn has generated a disconnection between the way of teaching and that of learning, which may be due to a methodology that is not adapted to the learning style of the farmer.

Table 2. Research on learning styles in rural areas

References	Findings
Renick (2012)	The learning style of adult students of agricultural programs in the County of Yuma was kinesthetic.
Bristol (1994)	Milk producer women in New Zealand learn multimodally, applying all learning styles (visual, aural, reading and writing, and kinesthetic).
Johnson, Carter and Kaufman (2008)	The learning styles in the potato industry were concrete-sequential for farmers and abstract-random for persons from governmental or university entities.
Davis (2006)	The learning style of extension professionals from Ohio was field-dependent, associated with learning in a social context, with a preference for group study and project work, and a viewer approach to learning by following defined and structured goals generally organized by a facilitator.
McLeod (2006)	Male dairy farmers in New Zealand prefer to learn by reading/writing. For their part, women prefer to learn kinesthetically.
Downing and Finley (2005)	Farm owners have a practical learning style; they value the opportunity to interact with others and prefer to learn and inform themselves through active methods such as workshops, demonstration areas, and field trips.
Trede and Miller (2000)	The learning style of farmers from Iowa was primarily assimilative.
Baker, Hoover and Rudd (1998)	The learning style of extension workers in North Florida was field-dependent.
Richardson (1994)	New extensionists and extension service users prefer to learn by doing or by combining forms of learning, such as learning by seeing/doing, for extension service users, and learning by seeing/doing/debating, in new extensionists.
Rollins and Yoder (1993)	County directors and extension workers associated with agriculture programs have an accommodating learning style.
Iddings and Apps (1992)	Producers learn to operate the computer primarily by experimenting, studying user manuals, talking to other computer users, and taking classes. Learning occurs in spaces provided by software/hardware vendors, friends, family, or acquaintances.
Pigg, Busch and Lacy (1980)	The predominant learning style of the new extensionists was the accommodating, followed by the divergent.

Source: Elaborated by the authors

Based on the results of these studies and to design the learning style identification model applicable to the agricultural sector, learning styles were defined as the biological, emotional, sociological, psychological and physiological traits or characteristics by which a particular individual understands, processes, stores, remembers, and interprets the information (Campos & González, 2015) to build their own learning from their interaction with reality (Castro & Guzmán, 2005; Rodríguez et al., 2017).

The analyzed studies allowed establishing that the learning process of agricultural producers is mediated by various factors, from which they were defined as pillars for the methodology to identify learning styles: motivation against the learning process, the sensory channel of preference for learning, the instructional preference of the individual, and the size of the group with which the interaction takes place in the learning process. These aspects are consistent with what was stated by Sligo and Massey (2007), who identified as aspects that influence learning: motivation, social behaviors, personal characteristics of the individual, features, and complexity of a particular technology, among others.

Thus, the methodology for identifying learning styles for actors in the agricultural sector is based on the cognitive approach, the constructivist approach, and meaningful learning. The selection, processing, and use of information have to do with cognitive traits, while the different procedures for organizing information are related to affective traits, motivations, and learning expectations (Cazau, 2003, cited by Fernández & Peña, 2012).

In this context, the proposed methodology is based on four dimensions: 1) motivational dimension: identification of motivation and attitudes towards learning; 2) perceptive dimension: preferences for access and selection of information; 3) strategic dimension: preference for information processing and integration in the learning process; 4) socio-affective dimension: preference for interpersonal relationships and size of the interaction group in the learning process.

These dimensions are closely linked to educational theory in terms of evaluation (identification of input behaviors), pedagogical strategies (methodologies), didactical (materials and means), and the social construction of knowledge (dynamics of interaction between individuals in learning processes). The theoretical support of each of these dimensions is presented below.

Regarding the motivational dimension, the literature highlights motivation as one of the foundations of learning (Ospina, 2006) and a critical psychological condition relevant in educational and work contexts (Naranjo, 2009). Motivation is more a process than a product, it implies the existence of goals, it requires a specific activity, it is resolute, and it is sustained over time (Boza & Toscano, 2012). Adults are motivated to learn issues that help them solve problems in their lives and consider more important what has personal value for them (Knowles et al., 2005).

Some modern theories define motivation based on the link between action and beliefs, values, and goals (Eccles & Wigfield, 2002). The objective of learning is what the learner seeks to develop as a product of the instruction (Krathwohl, 2002). According to Tapia (2005), the effort that each individual makes to learn is linked to his/her motivation, and this, in turn, is related to the goals and interests that the individual intends to achieve with learning. The performance, persistence, and choice of tasks to carry out the learning process of the learner is influenced by the expectations that Eccles and Wigfield (2002) define as the beliefs of individuals about how well they will carry out an upcoming task in the short or long term.

However, few studies refer to the motivation of a producer to learn (Dollisso & Martin, 1999). Some studies have found that producers are motivated by the presence of a certain teacher, saving time, money and the possibility of increasing the efficiency and profitability of their business (Dollisso & Martin, 1999; Franz et al., 2010; Mwamakimbula, 2014; Rollinson, 2008; Strong et al., 2010). Thus, human motivation is not unitary; it is a configuration of different intrinsic and extrinsic factors related to the desire to succeed, the personal desire to learn, the usefulness of knowledge to face everyday problems, and the need and satisfaction immediacy of achievement (Dollisso & Martin, 1999; Warren, 1973).

Concerning the perceptual dimension, Velasco (1996) points out that the mental act develops in three phases: entry, elaboration, and exit. It is precisely in the first phase where perception is activated by a stimulus. Further, it is also where senses play an essential role in the selection and assimilation of information (Giraldo & Bedoya, 2006). It has been shown that in each individual, a style of perceiving and knowing reality prevails, determined by the representation system that they preferentially use. Later,

as indicated by Galindo et al. (2001), through communication, it is possible to transmit ideas between persons, carry out teaching-learning processes and generate changes in the attitudes and behaviors of individuals. Hence, it is essential to identify how producers receive and interpret information from their environment.

Regarding the strategic dimension, one of the fundamental aspects in the identification of learning styles is the recognition of the characteristics and preferences of people when using or processing the information, since this directly influences the methodological design of intervention activities oriented to potentiate preferred learning styles (González-Herrera & Chávez-Morales, 2010; Lago et al., 2008).

The learning process of agricultural producers is mediated by aspects such as teaching methodologies (Franz et al., 2010), the trust environment, the logic of production with a focus on self-sustainability or market orientation (Schmelkes, 2006), values, beliefs, and knowledge (Nguyen et al., 2016), lifestyles, characteristics of modernity or postmodernity, and risk perception, among others (Kilpatrick & Rosenblatt, 1998). The identification of these aspects allows the facilitators to adapt the teaching-learning processes to generate strategies that are more effective and offer the apprentices the opportunity to carry out beneficial activities for their training (González-Herrera & Chávez-Morales, 2010).

However, it is important to determine that the agricultural producer can learn individually through his/her own experimentation, and the adaptation of knowledge and social interaction to validate his/her knowledge becoming reflective learning (Ingram, 2010; Schmelkes, 2006). This requires a learning environment that allows applying the information to real situations to meet their expectations (Kilpatrick & Rosenblatt, 1998).

Therefore, in the planning of extension actions, it is important to implement a participatory approach that allows recognizing the learning context of producers (Franz et al., 2010). Participatory methodologies should be used to identify and prioritize collective training needs (Rodríguez & Ramírez-Gómez, 2015), which seek to improve the confidence of the training environment to facilitate the learning of producers (Kilpatrick & Rosenblatt, 1998).

In relation to the social dimension, interaction with other participants in transfer activities (producers or technicians) can encourage the agricultural producer to generate technical skills and knowledge, personal development, increased confidence, and decision-making. This will improve the technology adoption process, the farm vision, and community relations (Duveskog et al., 2011).

Currently, although it is known that agricultural producers can develop knowledge through their own experimentation and empirical, tacit and explicit knowledge (Sánchez & Gamboa, 2014), it is also recognized that they can learn one by one from an informal perspective (Schmelkes, 2006), through an interactive peer group in local networks (Kilpatrick & Johns, 2003) or in larger networks with more expert producers and outside their local sphere (Franz et al., 2010).

Even knowing that there is an individual preference from the experimentation in the learning of agricultural producers, the strengthening of ties in group interaction allows them to gain confidence and decisions in a risk context (Sligo & Massey, 2007). Some producers prefer to participate in larger groups

(Franz et al., 2010), particularly in the face of complex technologies that have a higher demand for skills, knowledge, and attention to detail (Ingram, 2010).

Selection of typologies for each dimension

Based on these four dimensions and the reviewed literature, three types of individuals were defined for each dimension, allowing to define individual preferences and the profile of the group that participates in an agricultural extension process (table 3).

Table 3. Dimensions of the methodology for identifying learning styles applicable to the agricultural sector

Dimension	Typologies	Theoretical reference
Motivational	<ul style="list-style-type: none"> • Application of knowledge • New knowledge • External factor 	Eccles and Wigfield (2002) Hidi and Harackiewicz (2000) Romo et al. (2006) Aguilera and Ortiz (2009)
Perceptive	<ul style="list-style-type: none"> • Visual • Auditory • Reading and writing 	Fleming and Mills (1992) Velasco (1996) Ibarra and Eccius (2014) Dunn (1984) Felder and Silverman (1988)
Strategic	<ul style="list-style-type: none"> • Practicing • Reflecting • Theorizing 	Gregorc (1979) Kolb (1984) Alonso et al. (1994)
Social	<ul style="list-style-type: none"> • Individual (independent) • Subgroups (collaborator) • Complete group (participatory) 	Grasha and Riechmann (1975)

Source: Elaborated by the authors

In the motivational dimension, three typologies are proposed: 1) motivation for the application of knowledge, 2) motivation for acquiring new knowledge, and 3) motivation for external factors. Motivation is considered multidimensional because it is sensitive to external factors, such as better jobs, promotions and higher wages, and to internal factors, such as the desire for satisfaction, the improvement of the work quality, self-esteem, and life quality (Knowles et al., 2005; Pintrich & Schunk, 2006; Ryan & Deci, 2000). On the other hand, Steinmann et al. (2013) state that the motivational process occurs as a result of combining intrinsic factors, such as the interests, desires, and expectations of the learner, and extrinsic factors, which are the stimuli of the context.

Likewise, Pozo (2010) raises the importance of collaborative work activities and content based on problem solving, in which individuals must transfer learning to challenges, projects, or problems to be solved in their real context. Through this approach, the relevance of starting with the needs and interests of agricultural producers when designing and executing training activities can be considered.

Three types are considered in the perceptual dimension: 1) visual, 2) auditory, and 3) reading and writing because sensory preferences are the different ways through which information is perceived: the senses of sight, hearing, touch (kinesics), smell and taste (Velasco, 1996). However, neurolinguistics proposes that

these channels can be classified as visual, auditory, and kinesthetic and that learners generally prefer one of these perception routes, although they have the capacity, in a certain way, to use them all in the learning process (Ibarra & Eccius, 2014).

In their VARK model, which refers to sensory preferences when processing information (Olague et al., 2010), Fleming and Mills (1992) classify learners according to the strategies they use, as follows. 1) visual, which they consider to be better learners if the information is delivered through graphs, images, diagrams, schemes or other forms perceptible with sight; 2) auditory, for whom it is essential to listen to the information and generate discussions around the topics covered; 3) reader/writer, who prefers everything related to reading or writing, and 4) kinesthetic, who prefers a physical, tactile experience that involves movement or manipulation of elements.

Regarding the strategic dimension, three types of styles are defined: 1) practicing, 2) reflecting, and 3) theorizing, considering how the individual encodes the information (Puente, 2003). The agricultural producer generates, disseminates, boosts, and transforms his/her knowledge through different learning styles such as observation, the transmission of secrets, and imitation, but always experimenting (Schmelkes, 2006). Guerrero and Flores (2009) considered important the context in which learning is acquired since it allows the individual who learns to display functions such as thinking, reasoning, solving problems, and developing their skills according to the needs originated in their daily lives.

Finally, referring to the social dimension, three categories of styles are established: 1) independent, with a preference for individual work; 2) collaborator, with a preference for work in subgroups, and 3) participatory, with a preference for work with the entire group. According to the learning theory, some students prefer to develop their learning individually and independently, others prefer to learn by sharing and cooperating with small groups, and others choose to develop activities together with their peers (Salas, 2008).

Application and adjustment of the model proposed in pilot tests

Pilot tests of the methodology were carried out with actors in the agricultural sector, in real processes of agricultural extension and technology transfer in various regions of the country, in different production systems and with different types of participants, allowing to adjust the guidelines of the methodology (table 4).

Table 4. System, location and target audience of pilot tests of the methodology guidelines

Production system	Municipality	Department	Target audiences
Meat livestock farming	Magangué	Bolívar	Producers and technical assistants
Sugarcane for the production of <i>panela</i>	Yolombó	Antioquia	Producers
Dual-purpose livestock farming	Codazzi	Cesar	Producers and technical assistants
Vegetables	El Peñol	Antioquia	Producers
Guava	Barbosa	Santander	Technical assistants
Sugarcane for the production of <i>panela</i>	Villeta	Cundinamarca	Producers and technical assistants

Source: Elaborated by the authors

The process of applying and adjusting the methodology allowed clarifying that the facilitator in an agricultural extension process cannot start from a supposed learning stereotype to offer non-formal educational programs in agricultural settings, since the teaching methodologies used will not always be compatible with the learning style of the producer. This, in turn, can cause demotivation, non-adoption of technologies and dropout from educational programs.

As found in the tests carried out, to increase the efficiency in the extension and transfer of knowledge processes with people from the agricultural sector, it is important to know their preferences for learning and the way through which they would like to receive information and process it at the modal, group, and individual levels. Learning activities designed from the predominant learning styles of the participants can increase their motivation and achieve changes in their attitudes and behaviors towards learning (McLeod, 2006).

Therefore, the pilot tests allowed validating and adjusting some terms used in the typologies of each dimension to integrate the elements that determine each of the dimensions proposed in this document. Likewise, the exercises carried out revealed the need to work with a diversity of tools, techniques, methods, and strategies that, consistent with the identified learning styles, respond to the identified preferences.

There was also a challenge for the role of the facilitator, who must modify his/her message transmission techniques in learning scenarios, i.e., he/she must transcend teaching styles. While most research on teaching styles and learning styles has been independently addressed and their relationship has not been accurately tested, they are closely linked, since learning styles are mediated by experience, and teaching styles contemplate these experiences (Escanero-Marcén et al., 2016; Rojas et al., 2016). Consequently, it is necessary to continue research in this line to identify the relationships in the agricultural context between learning and teaching styles, considering that both can be adjusted to the context, practices, and experiences (Rojas et al., 2016), either at the beginning, in the middle or at the end of the training process (Aguilera & Ortiz, 2009; Bahamón et al., 2012).

Generation of tools for decision-making

Ventura (2011) reported that learning is facilitated to the extent that the teacher identifies the preferred learning style of the student in a psycho-pedagogical framework that supports educational quality. Therefore, the strategies must be diversified, responding to the way of learning of the student (Campos & González, 2015) to avoid biasing the educational process and the deliberate delivery of information (Hoover & Connor, 2001; Ismail et al., 2010).

Consequently, the facilitator must have a series of tools that allow him/her to attend to the learning styles identified in a group of producers who participate in agricultural extension activities, and for this purpose, the methodology proposed here was designed. Felder and Silverman (1988) propose some modalities of teaching styles for each learning style: the concrete/abstract learning style corresponds to a material type teaching style; the visual/verbal corresponds the presentation mode; the active/passive corresponds to promoted forms of communication and the participation of students, and the sequential/global corresponds to exposure (Bahamón et al., 2012).

Thus, a toolbox was designed with a series of activities that respond to the four dimensions selected and their three typologies. Its aim is to offer activities that facilitate learning processes within the framework of agricultural extension and knowledge transfer processes implemented by agricultural researchers, extensionists, and technical assistants based on the identified learning styles.

Conclusions

The results of this research allow us to conclude that a methodology for the identification of learning styles applicable to the agricultural sector must consider four dimensions of analysis: motivational, strategic, perceptive, and social. The motivational dimension encompasses the internal and external aspects of the target audience associated with the context; the perceptive dimension is related to the preferences of participants for access and selection of information; the strategic dimension refers to the preference for processing and integration of information, and the social dimension groups the preferences of the apprentice against the social interaction.

These four dimensions demonstrate the importance of considering in this type of process other complementary aspects to the thematic contents, which have an impact on the development of the capacities of the apprentices and, consequently, on the process of adopting agricultural innovations. Accordingly, the training processes in the agricultural sector must start from the identification of the learning styles of the actors who participate in the learning process based on the analysis of their needs, motivations, preferences, environment, and interactions. Although four dimensions are proposed for the style identification process, a sequential or hierarchical order is not established; therefore, this process will be flexible and based on the availability of time and resources that the facilitator has.

The diagnosis of the learning styles based on these four dimensions establishes guidelines for the facilitator to improve the trust environment, motivation, and interaction of actors in the agricultural sector in training processes. However, it is necessary to investigate more about the teaching styles of the facilitators to synchronize them with the learning styles identified based on the guidelines outlined.

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Disclaimers

The authors declare that there is no conflict of interest in this study.

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