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Learning by Doing, an Innovative Approach to Sharing Knowledge with Indigenous Farmers and Elderly Adults

Mariano Morales-Guerra[1], Karla Yuliana Cadena-Pérez[1], Pedro Cadena-Iñiguez[2], José Gabriel Berdugo-Rejón[3], Filemón Rafael Rodríguez-Hernández[1], Venancio Cuevas-Reyes[4]

[1]National Institute of Forestry, Agriculture, and Livestock Research, Central Valleys of Oaxaca Experimental Field, Oaxaca, Mexico
[2]National Institute of Forestry, Agriculture, and Livestock Research, Centro de Chiapas Experimental Field, Ocozocoautla de Espinosa, Mexico
[3]National Institute of Forestry, Agriculture, and Livestock Research, Mocochá Experimental Field, Mocochá, Mexico
[4]National Institute of Forestry, Agriculture, and Livestock Research, Valle de México Experimental Field, Texcoco, Mexico
Email: morales.mariano@inifap.gob.mx, karla.cadena.01@gmail.com, cadena.pedro@inifap.gob.mx, berdugo.jose@inifap.gob.mx, rodriguez.rafael@inifap.gob.mx, cuevas.venancio@inifap.gob.mx

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Abstract

In the Mexican southeast, subsistence agriculture is practiced, with elderly producers, speakers of indigenous languages, with no or little schooling, who have been subject to the attention of various agricultural extension programs, which have not had the expected results, derived mainly administrative and methodological problems. The aim of the work is to describe the stages to carry out technology transfer work with peasant and indigenous producers using the field school model, as well as an analysis of the results obtained in various studies with this method in order to contribute alternative schemes for technology transfer in rural areas of the country. The results identified that administrative problems in linear methods have frequently been that programs started late, fee payments were inopportune, and for the most part the technicians were dedicated to covering administrative tasks. As for the methodological aspect, it refers to the fact that field technicians do not have the capacity or preparation to work with elderly producers, speakers of indigenous languages, who understand little or no Spanish, little or no schooling, which requires an appropriate work method. However, the attention of the extension service has been conventional, with practices aimed at covering operational goals. The results, measured in the adoption rates of the technological components, indicate an average of 60% adoption of the technological components, in basic crops, lemon and tomato in the greenhouse. It is concluded that the andragogical method, mainly learning by doing, has demonstrated its efficiency in the training of adult producers.

Keywords

Field Schools, Training, Extension, Technology Transfer, Andragogy

1. Introduction

The Mexican countryside is mainly composed of Rural Economic Units (UER) with low productivity and profitability. A study conducted in 2012 identified that 22% do not produce enough food for the consumption of farming families, consequently lacking sufficient connection with the market. Meanwhile, 51% meet family needs and access the market marginally through surplus production (SAGARPA-FAO, 2012). This situation has hardly changed in the subsequent years. The most extreme conditions are found in marginalized indigenous communities in southern Mexico, particularly in the states of Chiapas, Oaxaca, Yucatán, and Guerrero, where 71% of the country's poverty is concentrated (INEGI, 2022b). Within this same territory, 50% of Mexico's indigenous producers are concentrated.

According to the 2022 Agricultural Census, Mexico has 196.5 million hectares of land in rural areas; of which, 46.1% corresponds to land with agricultural use or potential, and the rest (53.9%) without agricultural potential (including areas designated for common use by ejidos and agrarian communities that have not been allocated for the cultivation of plant species and may or may not have been used for grazing, including forestry activities).

There are 5,005,770 agricultural production units (UP) in the country, of which 565,505 are currently inactive. These units have an average land area of 5.9 hectares.

The participation of women in agricultural and rural activities is 16.2%. According to the Census, 29.3% of farmers and producers –male and female-in rural areas are over 65 years old on average, which complicates the assimilation and adoption of new technologies (INEGI, 2022a).

In Mexico, the service sector is the largest component of the GDP (60% in 2018), followed by the industrial sector (31% in 2018), and then agriculture (3% in 2018). It is estimated that 13% of the workforce is employed in agriculture, 26% in industry, and 61% in the services sector (FAO, 2024). According to STATISTA (2024), "the Mexican agricultural sector is one of the leaders in Latin America."

Mexico is the leading producer of vegetables in the Latin American region and ranks second in fruit cultivation, only behind Brazil. Agricultural activities also play an essential role in Mexico's economy, with a contribution to the gross domestic product (GDP) of 2.7% for the year 2022.

The Mexican state created the National Rural Extension System (SINDER) in 1995, which was made up of two programs; the Training and Extension Program (PCE) and the Basic Technical Assistance Program (PEAT), with limited results

in terms of innovation. In 2008, the Specialized Technical Units (UTE) were established with the participation of research and educational institutions. However, in an analysis conducted by the Autonomous University of Chapingo and the College of Postgraduates, it was concluded that there was limited impact of the extension system on the capacity development of the actors (Muñoz & Santoyo, 2010).

In the case of the rural extension component in the state of Oaxaca, specifically under the Small Farmers Support Program, the report on the adoption index of new technologies and capacity development, measured on a scale of 0 to 1, resulted in a value of 0.099. In percentage terms, this is equivalent to 9%, which is assumed a low adoption of new technologies (SAGARPA-Government of the State of Oaxaca, 2017). From the analysis of previous experiences with rural extension, we can identify two critical factors:

a) Administrative: The projects operated until 2018 had the characteristic of starting their activities late. In other words, the service begins when the producers had already planted, or the physiological state of the crops was well advanced. Also, they made the payment of the fees of the technical teams in an untimely manner. These payments were made months later or even until the end of the exercise. This resulted in field operations facing serious difficulties, as the technicians engaged in very little field activity due to a lack of financial resources to cover their transportation costs to the communities, as well as their own and their families' meals. This turned the process into a vicious circle, as, in the end, the state paid the corresponding fees, but with little or minimal impact on the service beneficiaries.

b) Methodological: The technical teams involved in the mentioned programs exhibited serious deficiencies in working with elderly farmers with little to no formal education. The formal education received in universities was neither suitable nor sufficient for working with farmers with these characteristics. Additionally, the institutions that hired them did not provide training to enhance their skills for working with farmers. As a result, the fieldwork was limited to meeting with local authorities, informing them about the program, and obtaining approval to work in the community. Subsequently, the program was promoted within the community through community assemblies, leading to the formation of work groups, marking the beginning of technical assistance to the producers. This assistance was based almost exclusively on theoretical training courses carried out in classrooms, with occasional practical fieldwork. This denoted the lack of an appropriate training methodology that could facilitate the adoption of the innovations being promoted. In summary, the extension work developed has not been adapted to the context of indigenous communities.

The experience addressed in this document corresponds to a team of researchers from the National Institute of Forestry, Agriculture, and Livestock Research (INIFAP) of Mexico. One of their main objectives is to promote and support the transfer of knowledge and technologies in forestry, agriculture, and

livestock based on the prioritized needs and demands of producers and society. Additionally, they aim to contribute to the training of human resources. In this process, various institutional models have emerged, among which Field Schools stand out. In this regard, INIFAP has undertaken efforts to achieve better impacts in technology transfer by employing various models, as documented by Cadena-Iñiguez et al. (2015), who documented the existence of 14 technology transfer models, ranging from linear schemes originating from abroad to participatory methods such as the Livestock Validation and Technology Transfer Groups (GGAVATT) model and the Farmer Experimentalist model, among others.

For the case of the Field Schools model, its adoption by INIFAP began in 2002, addressing the need to disseminate the Intercropped Milpa with Fruit Trees (MIAF) technology among indigenous Mazatec, Mixe, and Cuicatec producers. These producers are characterized by an average age of 49 years, four years of education, 26% illiteracy, and being native language speakers (León & Jiménez, 2001). The objective of this work is to describe the stages involved in conducting a technology transfer project with rural and indigenous farmers using the Field Schools model. Additionally, it includes an analysis of the results obtained in various studies using this method with the aim of contributing to alternative schemes for technology transfer in rural areas of the country.

2. Materials and Methods

To implement the Field Schools model, bibliographic information was gathered, and the initial training sessions were conducted on a monthly basis, with a two-day duration. Later, it became necessary to adjust the duration to a single day due to the promoters' commitments in their field activities. Other adjustments were made to the original model, leading to the final version of the Field Schools training model. This process was carried out in the period 2001 to 2005, with the participation of 24 leading producers, with functions of community promoters in the same number of communities, with the direct participation of 280 indigenous Mazatec, Mixe, Nahuatl, Mixtec and Cuicatec producers (Morales Guerra & Galomo, 2006; Morales Guerra, 2007). This process took place from 2001 to 2005, involving 24 leader farmers who served as community promoters in an equal number of communities, with the direct participation of 280 indigenous Mazatec, Mixe, Nahuatl, Mixtec, & Cuicatec producers (Morales Guerra & Galomo, 2006; Morales Guerra, 2007).

Below, the model and stages to carry out the 'learning by doing' work with farmers are described.

The training model called Field Schools is a working scheme based on the andragogical method, which privileges the possibility of learning by doing, primarily with adults. This method involves a confrontation of thoughts between producers and technicians, allowing for new paradigmatic possibilities that align with the context of the producers. It has proven to be suitable for indigenous

producers.

Andragogy is an educational process that takes into account working with elderly individuals who possess knowledge acquired through their own experiences, whether theoretical or practical. They use this knowledge for the development of their productive, organizational, and self-development processes. This accumulation of knowledge and ways of being, thinking, and acting leads to the use of a much-needed working methodology between change agents and producers, involving a confrontation of ideas and ways of thinking. The result should be the development of new capacities to transform the conventional processes that guide the actions of producers. According to Derrida (1998), it involves deconstructing and reconstructing their knowledge based on an empowerment of new perspectives for carrying out productive processes. In this context, Chacón (2012) states that adults can and want to learn, choosing what they want to learn.

In the case of Field Schools, whose premise is andragogy rather than pedagogy, established steps are followed for the teaching-learning process. Generally, this process is based on three moments: Theory, Practice, and Reflection—agreements (Morales Guerra et al., 2015).

Development of Training Sessions

The training sessions begin with a welcome from the organizers, followed by a group dynamic conducted by the training session facilitator for attendee introductions. Often, a peer-to-peer exercise is used to discuss and share general information and expectations, with each participant eventually introducing their partner to the group. Knowles (1984) states that, in order to facilitate learning, the environment should be as collaborative as possible, nurturing the group with activities based on respect and trust, where participation and exchange of ideas is promoted. After the introductions, it is preceded by the first part of the training session.

a) Theory or Knowledge Exchange: It is the starting point of the Field School session and refers to the phase of sharing and exchanging information with the producers on the training topic. Initially, it involves the exchange of knowledge, where each participant shares from their own experience what they know about the topic, any doubts they have had, and the expectations they have for the current course. With these elements, the instructor becomes a facilitator of the process and shares his knowledge about the topic. This involves the background, where the technology was generated, its advantages, disadvantages, and requirements, and if possible, describe the technology in a natural way (branches, fruits, roots, finished products, etc.) or by preparing a graph with a chalkboard, a screen projection or any didactic resource that facilitates the process. This aim to generate the expectation of what the practice will be like. It is also important to mention the materials needed and the process for their elaboration. It is suggested that the theoretical part should not be longer than an hour. This is of high importance because, after a short time of being seated or inactive in a space, lis-

tening to someone else, the participant may fall into monotony. In this regard, andragogy illustrates the interactive and dynamic procedures that must be considered in any educational process. The venue for the event can be a room with facilities for projection, a classroom in a school, or preferably an open space (a school without walls) that could even be the shade of a tree in the field. Once this phase is completed, the group is invited to move to the practical session area, which may be adjacent to the place for the purposes of staff mobilization or in another place, different from the place where the theory was carried out, which above, allows a change of scene, and prepares attendees for a new experience, with their participation in the practice of the scheduled topic.

Knowles (1984) confirms the latter, in the sense that it is important to recognize people as intelligent beings, and that their contributions and comments be taken into account. Therefore, spaces for contribution should be provided, where individuals feel respected and valued. This interaction promotes the motivation of attendees on the addressed topic and enhances more effective learning.

As established by the andragogical process, the first step is to get to know the actors involved in the process through the presentation of each participant and group socialization dynamics. This aims to break down fears of change or innovation and create an environment of trust and dialogue. In this initial phase, referred to as 'theory' in Field Schools, it is actually a dialogue where knowledge is exchanged. Sharing with people of different ages and backgrounds in a room or location gives new meaning to each person's social interaction. Similarly, the opportunity and right to express their opinions implies involving them in the teaching process (Chacón, 2012).

Regarding the issue of training, it is important to carry out a diagnosis to know the problems and potentialities that exist in the producers' territory. This ensures that the training responds to the needs of the producers and the topics to be developed are considered highly relevant and will have a significant contribution to improving their productive, social or cultural processes.

The latter coincides with what Chacón (2012) points out, that adults need to be involved in the planning and evaluation of the learning experience. When participating in the identification of training topics, learning becomes more effective as it contributes to solving a problem or addressing a deficiency. This translates into the certainty of understanding the benefits, values, and purposes of the training program.

b) Practice; this is the central part of the training model, where ***the principle of learning by doing*** is applied, aspiring to ensure the participation of all attendees.

Before the attendees arrive at the practice site, the facilitation team will have arranged the materials to be used.

Upon arriving at the training location, a review of what was covered in the theory or knowledge exchange phase takes place. The facilitator asks attendees to form a half-moon arrangement, the curvature depending on the number of at-

tendees and the possibility for the instructor to establish direct eye contact with each one. Subsequently, the instructor will provide a complete example of what the practice will entail, using the available materials, so that attendees can see the entire process. After the facilitator's demonstration, and with the materials ready for the practice, work groups are formed, according to the topic at hand, for them to carry out a portion of the practice. In this section, the groups dedicate themselves to the preparation that corresponds to them, for which they are organized in each group. The practice has no predetermined time; its duration will depend on the topic being discussed. When finished, the group returns to the place where the theory or knowledge exchange took place.

This is the part of the process that emphasizes the capacity development aspect, called learning by doing. An adult producer, unlike a child or teenager who learns through formal pedagogical schemes (Aguilar, 1994) such as classroom teaching, where one teaches and the other learns, or where instructions are given for another to execute. In the case of adult education or the andragogical process, learning by doing usually takes place in a classroom without walls. It is an informal process of on-site participation where practices are carried out based on what was previously established in the initial theoretical phase or the confrontation of knowledge or agreements on the processes to be carried out. Importantly, each producer engages in the practice, putting into action the learned activities. Through this action, they can empower themselves with knowledge and subsequently reflect on the innovative process that will allow them to incorporate the acquired and constructed knowledge into their productive processes. Eventually, they become a transmitter and disseminator of this knowledge, preventing a dependency on those in charge of the innovative process.

Learning by doing involves putting the newly constructed knowledge into practice, combining theory and practice in an operational and reflective way. By carrying out the activity, the individual learns not only the process but also contextualizes it to their environment. They perform it based on their own capabilities and at their own pace, turning innovation into a new fabric within their own sociocultural context. The process is no longer something foreign; it becomes something personal, which is one of the outcomes of the andragogical process to avoid dependency.

Blondy (2007) asserts that practice provides the foundation for learning activities. Adults are more interested in learning if they perceive a practical and applied benefit to their reality in the learning process they undertake. The time they invest in a learning practice is usually more focused on solving a problem, or in other words, obtaining a benefit.

On the other hand, Chacón (2012) points out that associating personal experiences with learning creates an emotional impact on adults that helps their brain to appropriate the knowledge. Likewise, giving utility to this knowledge in their daily life, adults learn through direct experience. All practice should involve active participation, be adaptable, and have immediate results. Chacón

(2012) confirms this by stating that the more one can practice new skills and competencies, the better the results in the learning process.

c) Reflection-agreements; the final part of a training session is the reflective component and group agreements for next steps. Once the group has returned to the location where the theory took place, the instructor will encourage attendees to share their thoughts on the practice. They may discuss how they found the practice, whether they liked it or not, what aspects they did not like, whether they understood what was done properly, which part of the practice requires more effort to be understood, and whether the materials used are available in the community. Opinions on the cost of inputs, primarily, may also be discussed.

A product of this phase involves posing the question: When will you repeat or implement this practice that you have seen today in your plots or homes? This replication action represents the beginning of the adoption process with the trial of the new technology in their respective homes or plots. Once each producer decides the replicate practice day, the field technician agrees to being with the producer when they carry out the replication.

The reflective part and the implementation of new knowledge in their own plots, that is, the adoption and/or adaptation to the specific characteristics of each context, make this moment relevant and meaningful for productive scaling. This is where the difference between how it was done before and how it is done now becomes apparent. Whatever the practice, the reflective process will set differential guidelines and the reasons for the change. For example, if an innovation were proposed to improve soil fertility through the incorporation of beneficial microorganisms, the producer, through the learning-by-doing method and the reflective process, will already know what these microorganisms are and how to identify them. They will know how to obtain them from their own contexts, how to multiply them, and how to apply them in the appropriate form and quantities. All of this the result of what they have already done. In the process of learning by doing, they have already analyzed and reflected on the reasons for each action and its possible effects and benefits or risks. This is one of the benefits of the andragogical method that not only privileges learning but also recognizes that adults learn better when they combine learning with doing.

Knowles (1984) points out that adults need to apply what they have learned in a practical and real context, given that they do not learn for the sake of learning, adults look for learning opportunities that allow them to solve a problem, that is, they must be relevant, immediately applicable and clearly understood by the adult.

Rodríguez (2003) points out that practice allows adults to connect the new information to their experience, which favors learning, in addition to using familiar language. Chacón (2012) states that encouraging the repetition of practice in the producers' plots contributes to strengthening a sense of responsibility, control, and decision-making about their learning.

3. Results and Discussion

The application of the Field Schools methodology with elderly indigenous producers with little or no formal education was measured through technology adoption studies, as described below. Orozco et al. (2008) conducted a study comparing participants and non-participants in Field Schools. They found that participants started with an initial adoption score of 8 and ended with 70 points, representing a 62% adoption rate through Field Schools learning. On the other hand, non-participants showed an initial adoption score of 8.2 and ended with 8.6 regarding knowledge about the promoted technology. The adoption that was presented is attributed to the experiential and practical nature of the model.

Meanwhile, Gaytán et al. (2008) documented that Field Schools represent an educational means to inform, interest, accept, and adopt technologies among producers who only speak local languages. Their results indicate an adoption rate of around 63% for the promoted technological components.

In another study, in the Mixe indigenous region of Oaxaca, 50% of the producers adopted practices such as pruning, grafting, drawing contour curves, and not burning residues for planting (Ruiz et al., 2012).

Further results from the Field Schools were obtained in commercial crops, specifically for greenhouse tomato production in the southern region of Oaxaca with Zapotec indigenous producers. The authors indicated that the producers adopted 46% of the technological components promoted, among them plant production, soil disinfection and shoot pruning (Ortiz et al., 2013).

Another experience was presented in the community of Tlalcozotitlán, municipality of Copalillo, Guerrero, with indigenous Nahuatl producers, in the production of corn (*Zea mays*). This resulted in the adoption of practices of using mycorrhizae, organic fertilizers, pest control with pheromones and use of plant extracts for pest control, which increased corn production, from 0.9 t ha^{-1} to 2.03 t ha^{-1} (Noriega et al., 2019). Similarly, Vásquez et al. (2020) indicate that in the Mexican lime (*Citrus × limon*) production, producers adopted practices such as training and rejuvenation pruning, health and fructification, balanced chemical fertilization, flowering induction, and pest and disease management.

The model of Field Schools was also applied with indigenous Tzotzil producers from the community of San José del Carmen, municipality of San Cristóbal de las Casas, Chiapas, for the household production of vegetables such as cabbage (*Brassica oleracea* L.), lettuce (*Lactuca sativa*), radish (*Raphanus sativus*), onion (*Allium cepa*), carrot (*Daucus carota subsp maximus*), beetroot (*Beta vulgaris*), and cilantro (*Coriandrum sativus*), using various technologies such as bocashi compost and planting beds. The latter contributed to feeding the families, (94%), and the rest for sale in the same community (Martínez et al., 2019).

4. Conclusion

Through the andragogical method, the operatibility of working with adult producers and the efficiency in the adoption of knowledge and technology processes

by the producers have been demonstrated. In this approach, the agent of change becomes a facilitator of the process, and the producer becomes the main actor. The scheme shifts from a traditional linear transfer model to a consensus-based decision-making model and a process of critical empowerment of technological innovations tailored to each context.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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