Article

Cooperative learning for the transfer of MIAF technology: the mixes of Oaxaca

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Abstract

This work is part of a larger study whose purpose was to understand the practices of small farmers for caring for the environment. The objective of this study is to analyze cooperative learning, a form of socio-cultural learning among small farmers *Aayujk*, Mixe community of the municipality of Santa Maria Tlahuitoltepec, Oaxaca in Mexico. The exchange of knowledge and symbolic references during the transfer of agricultural technological packages generate diverse learning, including cooperative learning. This research is qualitative, with the application of the ethnographic method that involves direct observations as units of inductive analysis, as well as interviews with producers. Based on the results, it was found that traditional forms of social organization reinforce cooperative learning. Small farmers conclude that mutual support and learning facilitate their agricultural work, incur lower expenses, obtain products for their own consumption and enhance their marketing.

Keywords: MIAF, soil conservation, southeast Mexico.

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Introduction

Based on the research project 'local knowledge, environment and globalization: evolution of agricultural practices of small producers in Mexico, Spain and the United States of America', which aimed to analyze local practices, scientific knowledge and public policies in the construction of sustainable agricultural systems and whose results are found in De Gortari and Santos (2019), the present study emerges that focuses its analysis on cooperative learning (Ferreiro and Calderón, 2000), a learning modality that recovers the perspective social and cultural culture of the individual and conceives knowledge as a form of internalization of culture, as well as activity and communication as means to achieve it.

For the development of this research, the case of small farmers *Aayujk*, a Mixe community in Santa María Tlahuitoltepec in the state of Oaxaca in Mexico, were studied, who were considered in the aforementioned trinational study and that as part of their local practices for the conservation and land use adopted the technological package known as milpa interspersed with fruit trees (MIAF).

Based on their participation in the MIAF project, the way in which this technological proposal promoted a network of learning in small farmers where they merge, the knowledge acquired throughout life in a network of vertical relationships -from parents to children-; oblique -from one generation to another- and horizontal -between equals- (Pardo *et al*., 2014).

In cooperative learning, individuals are integrated by a common goal, establish direct communication, distribute tasks, institute roles and generate discussion spaces for collective decision making. Next, a geographical and socio-demographic description of Santa Maria Tlahuiltoltepec is made, then the social and political organization of this *Aayujk* community is described, as well as its territory and MIAF technology. Subsequently, the materials and methods, the results and discussion are presented; and finally, the conclusions.

Geographical and sociodemographic data of the Mixe area

The Mixe territory belongs to one of the eight regions of Oaxaca (Cañada, Costa, Istmo, Mixteca, Cuenca del Papaloapan, Sierra Norte, Sierra Sur and Valles Centrales) and is made up of 19 municipalities grouped into three zones: high, medium and low. The upper area serves as the gateway to this territory where the largest commercial, cultural and natural area is located, and is made up of six municipalities: San Pedro and San Pablo Ayutla, Santa María Mixistlan, Santa María Tlahuitoltepec, Tamazulapam del Espiritu Santo, Santa María Tepantlali and Santo Domingo Tepuxtepec, with an average altitude greater than 1 800 meters above sea level (López and Barajas, 2013).

According to the latest Population and Housing Census (INEGI, 2010), 139 206 people lived in the three zones, settled in the 19 municipalities, distributed in 489 localities. Of these, 34 096 were located in the upper zone (24.5%); 58 300, in the middle (41.88%) and 46 810 in the low (33.62%).

Santa María Tlahuitoltepec, located in the upper subregion, is the municipal seat, has a territorial area of 134.19 km and has a total population of 9 663 inhabitants, of which 4 680 are men and 4 983 are women (INEGI, 2015). It is the only one in the Mexican Republic that has the ascription of an ethnic group (Nahmad, 1990) and more than 90% are speakers of the Mixe language. Most of its inhabitants are bilingual, they speak Mixe and Spanish.

According to Nahmad (1990), the Mixes cannot be defined by themselves in an isolated context, but rather are in their relationship with the Zapotecs, Chinantecs and Mestizos and from this relationship with the Zapotecs they separate and form their own identity. In terms of schooling, 72.6% of people aged 15 years and over are illiterate, 16.8% have upper secondary education and only 7% have higher education (INEGI, 2015). In terms of development, it is a highly marginalized municipality to the extent that there are high percentages of vulnerability due to social deprivation and income (CONEVAL, 2010).

Social and political organization

As part of the social structure of the communities and ethnic groups of the entity, in the Mixe upper subregion, its form of organization is communality, defined by Robles and Cardoso (2007) as: land, mother and territory. This type of organization is strongly dependent on the territory and revolves around its possession and care of the community, the mandate of the people through the decisions of the assembly, its system of positions, the communal parties and in the tequio. Through these forms of organization and operation, cooperation, solidarity and reciprocity are generated (López and Barajas, 2013).

Confirming what was stated by (Díaz, 1997; González, 1998) they point out that the characteristic features of an indigenous community are: a) territorial space demarcated and defined by possession; b) a story that circulates by word of mouth and from generation to generation; c) a variant of the people's language from which their language is identified; d) an organization that defines the political, the cultural, the civil, the socio-economic and the religious; and e) a community system for the procurement and administration of justice.

The possession of land (communal or ejidal), as well as their forms of organization and cultural expression that have differentiated them from other social sectors, have allowed ethnic groups to persist. Local government systems are based on a ladder and hierarchical system of positions that establish the norms and commissions that cover public, civil and religious administration.

This means that the indigenous government articulates diverse spheres in a unit whose axis is the system of positions that, as a civic-religious structure, makes the participation of the community in political, religious and ceremonial life mandatory in search of a collective good. Through norms and rules, the exercise of power is developed to regulate order within the communities and establish links with the national society and with the State.

Discussions and decision-making in the communities take place in community assemblies, spaces for relations between representatives and represented, thereby avoiding the figure of a boss within the organization. It is in the assemblies where tensions can be resolved because the problems related to the community are addressed, in order to establish collective order through consensus (González, 1998).

Here, the positions of representation and their changes, the rules of social conduct, the mechanisms of regulation and surveillance, as well as the way of reconciling interests are also defined. The community-territory link is important because, as we will see throughout the process of transferring the MIAF package, the regulations that mandate it also generate a series of tacit knowledge that the community shares.

The inhabitants of Santa María Tlahuitoltepec have a worldview whose central pillars are the care, protection and preservation of natural and cultural resources that are part of community life, which has been inherited and has allowed them, through the possession of the land, perpetuate their life in community.

These forms of organization and cultural expression allow them to maintain a deep awareness of their identity, the recognition of a common past, their belonging to the territory and respect for nature that makes them different from other social sectors. They are the result of a long history of resistance against great regional caciques and the Mexican State itself (López *et al*., 1978).

Its form of organization obeys inherited principles and norms that are based on the conception of power as a service, communal property as an entity of collective enjoyment; tequio as the axis of community growth and the position system as a permanent training space to exercise public service (López *et al*., 1978).

Although tequio has been decreasing because at the state level, infrastructure works have been assumed, as well as migration, it is still used in communities such as Santa Maria Tlahuitoltepec for the common benefit. It is a form of organization and participation that is endorsed through community festivals, assemblies and agricultural activities with the support, hand in hand, which maintains the exchange of work and favors family contacts.

An element that distinguishes this town is the presence of some of its members who studied outside the municipality and who have been involved in different autonomous management processes, including the defense of its natural resources, together with the teachers of the community who have endorsed these principles through formal and informal education (Vázquez and Gómez, 2006).

The territory

The territory is conceived as a tangible public space such as the soil, flora, fauna, natural resources and wind, which are linked to culture, ethnic identity, ideology, traditional knowledge and socio-political organization. Ethnic groups, such as the Mixes, have given special importance to the land as a community space that leaves out private property and association with people outside it to seek their self-subsistence and the maintenance of the group, not only; through agriculture, but also livestock and forestry activities (Nahmad, 1990).

Generally, land tenure is the product of family inheritance, which the children cultivate in small plots, a way of caring for the land for the new generations. The territory provides them with everything they need for collective survival and in turn forces them to defend it. Control and access to natural resources is regulated by the communal property authorities, despite the tensions and conflicts that this can generate within the community.

In economic terms it is also important because a large part of the families livelihood depends on it, so most of them carry out traditional subsistence agriculture, together with the diversification of activities to cover their food, clothing and housing needs, where temporary migration occupies an important place.

In the Mixe region, corn, beans, potatoes, squash, chayote and fruit trees such as peaches, pears and apples are planted, most of the crops are used for self-consumption and the surplus for the local market. These crops, in addition to chilacayota, ayocote and peas, are characteristic of temperate and cold zones, while orange, lemon and mango are grown in warm zones.

The community-territory link is important because, as we will see throughout the MIAF technology transfer process in Santa María Tlahuitoltepec, the regulations that mandate it also generated a series of tacit knowledge that the community shares. The MIAF has been characterized as a technological package insofar as it contains knowledge, advice and a transfer process (Cadena *et al*., 1989).

To document how this process occurs, we resorted to the material that was collected during different actions aimed at assimilating the package, recorded through field diaries, observations and interviews with small producers.

Milpa technology interspersed with fruit trees

In 2002, when the Earth Summit was held, policies were outlined and environmental protection organizations were born, such as the global environment facility (GEF), an organization that promoted and financed projects worldwide, including the Sustainable Slopes Management Project (PMSL). In this framework, the College of Postgraduates in Agricultural Sciences (CP) presented to the Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) a research and development project to address the problem of agricultural production, soil conservation, as well as carbon capture and sequestration in hillside areas in the state of Oaxaca (Orozco, 2008).

According to Turrent *et al*. (2017) in Mexico, about half of the arable rainfed areas are on slopes with moderate slopes of 4 to 10% to steep slopes with more than 40%. The orographic characteristics of the hillside areas make the soils erodible, degraded or in the process of degradation, which makes agricultural production difficult (Turrent *et al*., 2016). In addition to the topographic characteristics of the soil, small agricultural producers face conditions of a diverse environment and geography, not very favorable for agricultural activities, thus generating a precarious economic situation.

Taking this situation into account, in 1998 and from a research/development perspective and field schools, the project promoted by the CP was presented in the communities that allowed the integration of the community for the creation of experimental plots in the Mazatec area and mixe coupled with its ethno-agriculture practices, which enables the production of subsistence food and which entails a network of empirical knowledge about the soil, biodiversity and climatic factors for its adequate application in production (Díaz *et al*., 2004).

Buckles (cited by Orozco, 2008) points out that, generally, farmers in hillside areas live in small communities, socially and economically marginalized, with diverse environmental and geographical environments, not always favorable to agricultural activities. As an alternative solution to these problems, the MIAF is presented, with the purpose of improving the labor and economic standard of living of the producer, based on the integration of crops in a sustainable soil system (Cadena-Iñiguez *et al*., 2018).

The MIAF technology package is based on a principle of sustainable agriculture that enables not only the planting of basic crops such as corn, beans and squash, but also fruit trees such as peaches, pears or apples for temperate zones and lemon, the orange, the chicozapote for warm areas that serve as a living barrier to prevent soil erosion.

It has special recognition not only for the shape of the spatial distribution of the crops and the staggered production over time, but also because it prevents soil erosion through runoff filters that also conserves moisture, regenerates the microbiological and nutritional fertility of the soil since fruit trees have the function of being a support.

The launch of the MIAF was important in the Mixe area of Oaxaca not only because it was a sustainable agriculture project that made possible the planting of basic crops, but also because of the production of fruit trees such as peaches, pears and apples, which made possible self-consumption, and commercialization. In this process of adoption of technological innovations and exchange of scientific-technological knowledge with traditional ones, various learning processes were generated, including cooperative learning.

Materials and methods

This study is part of a project whose purpose was to analyze the changes that have occurred in caring for the environment from the identification of programs and technological packages for sustainable agriculture where local knowledge is essential in the adoption of conservation practices and soil protection and for this the case of the MIAF was chosen in the *Aayujk* area, in the state of Oaxaca, Mexico with the participation of more than forty families (De Gortari and Santos, 2019).

The methodological strategy was qualitative, focused on the ethnographic method, which recovers descriptive data on the words and behavior of the actors (Taylor and Bogdan, 1987). Observations were made about their behavior and social interactions, inductive analysis units (Angrosino, 2012).

Semi-structured interviews were conducted with the members to obtain data on their forms of social organization, the way in which they coalesced from a common objective that was the transfer of this technology, their communication mechanisms, the assignment of roles, the taking of decisions, which are characteristic features of cooperative learning. The information records were concentrated in a database that integrated the recordings, the transcripts of the interviews and the monitoring of community life in field diaries of the participating families.

Results and discussion

Cooperative learning for the transfer of MIAF technology

Social constructivism locates the individual-society relationship where cultural practices, discourse as mediation and action, as well as the historical-social context are recovered (Cubero, 2005). From this perspective, knowledge is considered to be a social construction, a joint work between individuals who construct and re-construct their knowledge and learning in interaction with others because in this process social, cultural, psychological and educational factors converge in contexts specific (Levine *et al*., 1993).

Individuals interact in spaces where everyone learns from everyone, where all its members are necessary and important because they need the other to learn and to understand what they learn (Ferreiro, 2007).

In addition to the multiple learning that is generated, various skills are also developed, at least nine, according to González and García (2007), such as: a) communication, which is the ability to verbalize, understand, explain, to debate; b) the capacity for synthesis; c) analysis and reflection (deliberation, thought and analysis of alternatives for decision-making); d) constructive criticism, which is the possibility of establishing a debate without competing with the partner or canceling it, without impositions, trying to recover the contributions of each one; e) the implication that means, the integration of suggestions or ideas for the development of the activities from the beginning to the end of the process; f) autonomy, which is the possibility of solving activities using one's own resources without resorting to external aid; g) creativity; h) self-assessment; that is, the possibility of recognizing the difficulty and potential of working cooperatively; and i) self-planning, which is the management of one's own time.

In this exchange of knowledge, those who have a formal education -that imparted through the *curriculum*- converge, as well as those who have an informal education -that is, traditional or local knowledge- resulting from a socio-cultural tradition such as that of the small farmers. In this interaction, a third educational modality is generated, non-formal education such as training, counseling and orientation (Martínez and Lozano, 2019). Regardless of the modality they adopt, formal, non-formal and informal, the truth is that cooperative learning is generated in all of them, learning between equals where everyone learns from everyone because they are united by a common goal.

This exchange of knowledge presumes a network of vertical, horizontal and oblique relationships (Pardo *et al*., 2014), allowing that, throughout life and through cooperative work, learning is generated within the communities or ethnic groups that are linked from specific intentions from which tasks and concrete actions derive from their reality (Cubero, 2005). As a social construction, it recovers the knowledge, capacities, abilities, methods, procedures, techniques, values, attitudes, as well as the convictions of individuals (Ferreiro, 2003) that are located in historical-social and culturally specific contexts.

Cooperative learning refers to an alternative way of organizing cognitive structures that are generated in the teaching and learning process inside and outside the classroom (González and García, 2007), it is a way of uniting individuals because it converges what individual and collective, so it becomes the ideal setting to learn to dialogue, to learn to live together and to be in solidarity (Pujolás, 2009).

The local knowledge learned throughout life (Martínez, 2020) in the *Aayujk* farmers, are part of their informal education and were initial references in the cognitive structure for the setting of the new information that was presented by the researchers, thus promoting meaningful learning (Ausubel *et al*., 1976), that type of learning that lasts over time and goes beyond the mechanical adoption of content.

Researchers with their scientific knowledge (Asheim, 2007) and farmers with their traditional knowledge, learned from each other, reached the common goal from communication and organization of work. From this process, small farmers not only learned to apply MIAF technology, but also strengthened community social ties, as well as the transformation and commercialization of their products.

United for a common goal

Ester, a member of Santa Maria Tlahuitoltepec, tells us that the transfer of MIAF technology began in a nearby community called Cacalotepec and later an invitation was made to its communal property authorities to visit the work in that locality. The small farmers of this community discussed the possibility of knowing the technological package that allowed the recovery of their crops, the basis of their diet, in addition to the production of fruit trees such as the creole peach for self-consumption, transformation and marketing.

Ester tells us how they coalesced around a common goal: 'This project was carried out in three stages: the first began in 2002 and was in a community called Cacalotepec, approximately an hour and a half from Tlahuitoltepec. There they began with demonstration plots of coffee and fruit trees such as orange, lime, lemon, crops typical of warm areas. However, due to the fact that Tlahuiltoltepec is a cold climate, in 2004 the project began with nurseries, looking for seeds of creole peach, looking for inputs, fertilizer, suppliers of inputs and vegetative material. In the first stage, around ten families participated, including the producer, his partner and his children. In the second, thirty families participated and in the last stage more people from the community were integrated. They told us how to sow, the distance between plant and plant, the type of variety to provide shade, pruning and thinning techniques, fertilization formulas, soil degradation and leave the margin so that it can be mulched. This technology is very useful and has many benefits for the plant, for soil conservation' (Martínez, 2019).

Families were gradually integrated around a common goal, the adoption of MIAF technology. Little by little, its members recognized the virtues and advantages of including these innovations in their traditional practices, which enriched their local knowledge. As a result of this new knowledge, small farmers learned the efficient use of seeds and the type of fertilizers to use for the

production of their crops. This is how Catalina and Alejandro put it: 'We learned the dose and types of fertilizers to use. Likewise, the type of seeds and how many to sow, in the case of corn instead of 6, we started working with only three' (Martínez, 2019).

Among the wealth that this technological package entailed were the specific sowing techniques, the care and conservation of the soil, the selection of the seeds, the sowing and harvesting periods, as well as the grafting, thinning, fertilization and pruning.

Face-to-face communication, role assignment and decision making

A central aspect of cooperative learning is face-to-face communication, a core aspect that allows the integration of learning groups. As part of significant learning, the small farmers began to produce the trees that were to supply the region's fields and collectively established a nursery. This implied the training of other members of the community to establish plots with low supply costs that increased their profitability. As key factors that enhanced their collaborative motivation were the search for compost, soil, seed and resources.

Margarita and Cirilo tell us how they were organized: 'on average we would meet every two or three weeks when required, then the committee would notify us and we would meet. Our representatives informed us and sometimes it was voiced over the sound' (Martínez, 2019). Rafael emphasizes decision-making: 'to make decisions, it was first discussed in the assemblies and then what was considered most pertinent was voted on' (Martínez, 2019).

Initially, this *Aayujk* community was united around a common goal; however, in order for the goal to be achieved, direct communication from its members was necessary, who made use of their communication skills to understand, explain and express their opinions in the assemblies, an ancestral space generated by them for decision-making. The assemblies became the spaces for analysis and discussion on the relevance of adopting and adapting this technological package to their territory, recovering their socio-cultural traditions and their forms of social organization to achieve the objective.

The richness of group work for multiple learning

For the participants, teamwork was important and necessary because they learned, not only from the engineers who gave them advice, but also from the colleagues who participated in the project. They pointed out that despite how difficult it is to work in a group, it is also enriching because they acquire multiple knowledge. The group work allowed them a feedback on their knowledge, strengthened their forms of community cohesion, facilitated work, they advanced in the agreed direction and of course, they learned from others, from each and every one of the participants.

Juan says that: 'it is important to work as a team because it makes work easier, progresses more and spends less; we are also learning from other people' (Martínez, 2019). Ester points out that: 'from teamwork you can do things that impact people. In fact, this work has influence in other regions because there are already grafts such as peaches and other varieties of plants. Now we see other uses in fruit trees such as peach or apple jam' (Martínez, 2019). Likewise, teamwork

strengthens the integration of the community because, according to Alejandro: 'In Tlahui there were no longer meetings and we really need that' (Martínez, 2019). This process also allows young people to get involved for generational replacement, as expressed by Rafael who points out that: 'it is necessary to integrate young people because one is already old' (Martínez, 2019).

Peer learning will always bring new learning, in this case they were multiple because not only did they learn about MIAF technology that allowed them to improve their agricultural practices, but they also acquired learning and social skills such as: strengthening their communication mechanisms, the relevance of discussing with the other to find the best alternatives for the group, to make the right decisions in specific circumstances, to recognize and respect the other. This enables a greater impact on the community since the links between farmers are strengthened in cooperation. With this, the *Aayujk* ratify their ethnic tradition on the importance of collective work, communal work and the unity of the group around the land, which historically has given them an identity and has allowed them to preserve their autonomy from other ethnic groups and from the Mexican nation (Nahmad, 1990).

Conclusions

With the ethnolinguistic diversity that characterizes the state of Oaxaca, the Mixes like any other ethnic group require a congruent policy for the recognition of their history, their language, their culture, and from there to program their own path (Nahmad, 1990). In the transfer of the MIAF, the CP researchers took into account the geographical, physical, cultural and ethnic characteristics of Santa María Tlahuitoltepec to provide the appropriate alternatives, in order to make the adoption of the technology viable.

The community with its traditional forms of social organization and with its local knowledge assumed this objective as a cooperative learning group and reinforced its already long history of cohesion and fulfillment of tasks for the common good. It also observed that their achievements had an impact in the region, since other communities were willing to learn and adopt new agricultural practices.

This experience allowed the *Aayujk* community to recognize that working as a team is a difficult task that, at times, is not achieved due to various problems such as: access to financing, the distribution of the harvest, the assignment of roles, among others. Despite these drawbacks, the advantages of cooperative work are recovered because it puts into practice the traditional knowledge learned throughout life and transmitted in that network of vertical, horizontal and oblique relationships where everyone learns from everyone.

Small farmers expressed that collective work facilitates the work, generates less expenses, allows to obtain products for self-consumption and commercialize the surplus. In addition, they highlighted the richness of their organization to enable the new generations to integrate and replace the old ones. In this research it was observed that mutual support, solidarity and common work, as well as the interaction of ancestral knowledge with new ones, are experiences that communities appreciate to facilitate the transfer of agricultural technological packages.

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