Qualitative analysis in the adoption of improved silvopastoral systems in Mezcalapa, Chiapas

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Social Sciences

Synthetic glossary of technical terms:

Extensive livestock farming: cattle feeding system based on free grazing on large land extensions (Magaña et al. 2006).

Traditional Silvopastoral Systems (TSPS): endemic tree species traditionally used empirically, from which multiple benefits are obtained (pasture delimitation, shadow, wood, forage, lumber, human consumption, etc.) (Fuentealba y González-Esquivel, 2016).

Improved Silvopastoral Systems (ISPS): tree species assessed in research centers developing specialized techniques (planting density, pruning, and forage harvest timing) for animal feeding and its subsequent transplantation into the cattle raising units (Fuentealba y González-Esquivel, 2016).

Organic cattle farming: livestock production based on feeding animals using natural grass and other food products not exposed to agrochemicals (Espinoza-Villavicencio, 2007).

Abstract

This study analyzed factors involved in the adoption of improved silvopastoral systems (ISPS) through a qualitative research approach in Mezcalapa, Chiapas. A sample of 23 farmers was obtained, a questionnaire was applied, and they participated in three workshops, classifying them as adopter and non-adopter farmers. The adopters possess more land area and have a higher educational status and income. So, we identified knowledge as a key factor for ISPS adoption since adopters were capacitated through workshops, training, and financing. On the other hand, different beliefs, such as grass doesn't grow under trees, low milk price, or ISPS establishment costs, prevent ISPS in non-adopters. Therefore, it is necessary to design adequate public policy to differentiate rural populations' needs in a climate change context.

Keywords: Technology adoption, qualitative approach, extensive livestock farming, tropic.

Resumen

Este estudio analiza los factores que intervienen en la adopción de sistemas silvopastoriles mejorados (SSPm) desde un enfoque cualitativo en Mezcalapa, Chiapas. Se obtuvo una muestra de 23 productoras y productores, se les aplicó un cuestionario y participaron en tres talleres; clasificándose en adoptantes y no adoptantes. Los resultados demuestran que las personas adoptantes tienen mayor superficie de terreno, escolaridad e ingresos adicionales en comparación con los no adoptantes. El acceso a conocimiento a través de cursos, capacitaciones y financiamiento fue un factor clave para el establecimiento de SSPm en las personas adoptantes. La creencia de que el pasto no crece bajo los árboles, el bajo precio de la leche y los costos de establecimiento de los SSPm son factores que impiden la adopción de SSPm en los no adoptantes. Es necesario diseñar políticas públicas adecuadas a las necesidades diferenciadas al interior de las poblaciones rurales que respondan a un contexto de crisis climática.

Palabras clave: Adopción, enfoque cualitativo, ganadería extensiva, trópico.

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Issue addressed

The obstacles and limitations in technology adoption in the livestock sector.

Users

Livestock organizations in the process of technology transfer, and policymakers in the livestock farming sector.

Introduction

In Mexico, more than half of the national territory (58 %) is dedicated to livestock farming in an extensive system mainly located in tropical and subtropical areas (Vargas-de la Mora et al. 2021). It is characterized as a small-scale activity developed on land surfaces under 50 hectares with 30 or fewer cows for milk production (Hernández et al. 2018). This livestock activity offers socio-economic benefits (income, savings, food security, community bonds, etc.) for rural families; nevertheless, in the present, it faces extreme weather events associated with the climate crisis, such as severe drought and flooding affecting animal health and putting the income of rural families at risk (Gallardo-Chávez et al. 2019).

In this context, a feasible alternative for the adaptation of extensive livestock farming addressing the climate crisis is the use of silvopastoral systems (SPS). SPS are an agroforestry type that deliberately integrates animals, crops, shrubs and trees (Apan-Salcedo et al. 2022). Integrating trees, shrubs, and animals offers environmental and productive benefits. Among the environmental benefits we can find are flora and wildlife conservation (Murgueitio et al. 2006) and the improvement of milk and meat production yields (Chará et al. 2019). Many projects to promote SPS have been developed in Mexico, Latin America, and the Caribbean (Flores y Solorio, 2013; Murgueitio et al. 2013). In Chiapas, development agencies in collaboration with academic and research institutions have promoted alternative systems for livestock farming through SPS (Apan-Salcedo et al. 2021); however, reports show that the level of adoption of such technology has not occurred as expected (Marinidou et al. 2018; Zabala et al. 2022). Therefore, the study of technology adoption becomes relevant to identify the causes that limit or empower the adoption of the promoted technologies that aim to benefit the farmers (Duque, 2018). In this regard, studies that address technology adoption from a qualitative approach represent an alternative to mining valuable and complementary information about people's perceptions and reactions toward certain technologies (Lee et al., 2020). In Chiapas, in Mezcalapa region, double-purpose livestock farming predominates, allowing farmers and their families to get an income by selling milk and calves. It is important to mention that this region is home to a rich diversity of endemic tree species which are used traditionally in the ranches (traditional silvopastoral systems), from which multiple benefits are obtained (pasture delimitation, shadow, wood, forage, lumber, human consumption, etc.).

Academic and research institutions developed a project in the region between 2005 and 2013 with the objective of promoting the evolution of traditional silvopastoral systems (TSPS) to improved silvopastoral systems (ISPS), thus optimizing the use of local natural resources with a sustainable approach (Nahed et al. 2014). During the project's development, some livestock farmers switched to ISPS, while others did not.

Objectives

1. Describe the historical trajectory of livestock farming activity in the study area.

2. Using a qualitative approach, identify and analyze the factors involved in the adoption of ISPS among livestock farmers in Mezcalapa, Chiapas.

Materials and Methods

The study was developed in the region “III Mezcalapa” in the state of Chiapas, in the municipalities of Mezcalapa and Tecpatan, having a tropical climate with precipitation all the year and intense rain during the summer (CEIEG, 2012). In the study area, the Autonomous University of Chiapas (UNACH, as per its acronym in Spanish) and the College of the South Border (ECOSUR, as per its acronym in Spanish), both academic and research institutions, promoted the development of ISPS with the Society of Rural Production Malpaso group (SPR Grupo Malpaso, as per its acronym in Spanish), comprised of 103 members. This intervention was part of the interinstitutional project “Organic milk production systems in double-purpose

cattle in the central region of Chiapas" with the objective to get a certification of organic milk production.

Snowball sampling, a non-probability sampling method, was used to define the study population. This allowed the identification of the livestock farmers who adopted ISPS in their Cattle Production Units (UPG, as per its acronym in Spanish). In total, 11 farmers adopted ISPS. To obtain the testimonies of those who did not adopt ISPS, 12 participants identified as non-adopters, were chosen.

The study was performed from November 2013 to August 2014. The analysis period was from 2005 to 2013, which matches the project duration mentioned above. Initially, a questionnaire was used to gather socio-demographic information of all 23 participants. Afterward, the qualitative analysis was performed using three investigative workshops. The workshops were organized as follows: 1) workshop with adopters, 2) workshop with non-adopters, 3) workshop with adopters and non-adopters (Figure 1).

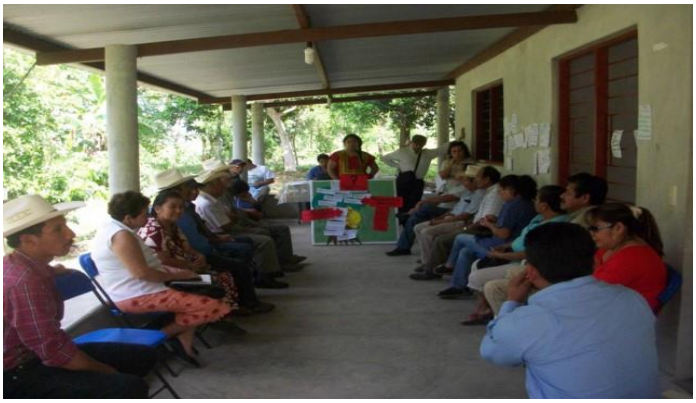

Figure 1. Workshop with livestock farmers in Mezcalapa, Chiapas.

The information gathered in the questionnaire was analyzed with descriptive statistics using the statistics software SPSS®. The qualitative information (the three workshops) was audio recorded and analyzed using the qualitative analysis software Atlas.ti®. The process generated the categories of keywords or phrases in the communication and later classified into negative and/or positive factors for the adoption of ISPS.

Results and Discussion

1. Historical trajectory of livestock farming in the study area

According to the testimonies of the participants, the first key historical moment occurred in the seventies when they arrived and were declared owners of their lands in the study area. At that time, the land that they occupied was covered by forest with plenty of flora and wildlife:

When we first came to the place where we established our crops, these were lands that provided mountains… the streams were still running, there were birds, the countryside animals that roamed the mountains, there were monkeys eating fruit (farmer, 48 years old).

During the sixties, the introduction of specialized corn crops started in the Sierra Madre mountain system in Chiapas, which caused deforestation in the area (Zabala et al. 2022). Subsequently, in the seventies and the eighties, families started working with cattle farming, promoted through credits from rural finance agencies for buying cattle as part of the livestock policies established in those same decades (Michel, 2009). In 1970, Chiapas had a livestock inventory of two million heads; by mid-eighties, it was more than four million, causing an accelerated expansion of grazing land to feed the livestock; 90,200 hectares of forest were lost (Villafuerte y Pontigo, 1990).

Between the eighties and early nineties, improved grass was established (Brachiaria brizantha, Brachiaria decumbes, Panicum maximum, and others), and the technical package, based on agrochemicals, that came with it. Participants declared that, despite adopting such technology, animals were showing low yields; besides, the adoption of improved grass contributed to the degradation of soil and water sources. One of the farmers says:

We started chopping down the mountain to plant (grass), which is how the mountain was depleted. Currently, the land is ruined, it is degraded with pasture, the streams are very shallow…by now, the land is quite dry, it is not as fertile as before, everything has changed (farmer, 55 years old).

In 2005, through a project regarding organic milk production managed by UNACH and ECOSUR, tutorships, courses, and financing were offered for the adoption of ISPS as an ecological

alternative to conventional livestock farming (Nahed et al. 2018). In this region, farmers traditionally use living fences, fallows, and scattered trees and shrubs in the pastures (TSPS) (Figure 2). However, these are unrelated and not linked to a systematic management scheme with an improved silvopastoral approach (planting density, pruning, and forage harvest timing) (Alpan-Salcedo et al. 2021). Thus, the research team at the academic institutions identified the transition to organic livestock farming through the adoption of ISPS as a feasible alternative:

UNACH brought the organic milk project, which is how it all started. Later we got the support from ECOSUR…but everything rose from the organic milk project. That is where the training started, and we learned a healthy way to feed the cattle using legumes that we can harvest from the soil itself, so we do not have to buy anything…to reduce costs (farmer, 65 years old).

Figure 2. Cow feeding from a living fence Gliricidia sepium in a TSPS.

The study population highlighted the relevance of the support given by these institutions, as they declared that this intervention changed their minds and allowed them to gain interest in natural resource conservation. Hence, from 2005 to 2013 (the duration of the project), out of 103 members of the SPR Grupo Malpaso, 20 earned an organic milk production certificate and 11 of those established an ISPS.

2. Farmers who adopted ISPS (adopters)

2.1 Socio-demographic characteristics

Over half (54.5 %) of the farmers who adopted ISPS are male, with an average age of 59.9, and 10.3 years of education. Nearly half (46.0 %) of this group got a bachelor's degree, and over half (54.5 %) declared additional income besides livestock farming.

The UPGs in this group are 54.1 hectares and have an average herd size of 70 heads. The improvements in the SPS adopted by this group were: protein banks, pastures with forage trees in alleys with low planting density, and pastures with forage trees in alleys in high planting density (Table 1). Most adopters (72.1%) established forage trees in alleys with low planting density (Figure 3) on an average area of 3.5 hectares.

Table 1. Average area of silvopastoral modalities adopted and planting density.

ISPS	Land area (ha)	Species used	Adopters (%)
Protein banks (40,000 plants per hectare).	0.1	*Gliricidia sepium & Erythrina sp.*	36.3
Pasture with forage trees in alleys with low density (2,000 trees per hectare).	3.5	*Gliricidia sepium & Erythrina sp.*	72.1
Pastures with forage trees in alleys in high density (30,000 plants per hectare).	1.1	*Leucaena leucocephala cv. Cunningham*	27.2

In the organic certification process, all UPGs in this group were certified as organic milk farmers.

2.2 Empowering and limiting factors in the adoption of ISPS

Based on qualitative analysis, access to knowledge was identified as a factor that favored the adoption of ISPS in the group of adopters. In contrast, factors such as economic (cost and time of establishment), lack of group work, and lack of aid from the government deterred the adoption of this technology.

In the case of access to knowledge, the closeness of academic institutions to the group of adopters was key to generating a transformation and putting new knowledge into practice, which generated a change in the paradigm that they had internalized with conventional livestock production:

Our mentality began to change when we had access to information and contact with academic institutions (farmer, 50 years old).

Figure 3. Pasture with forage trees in alleys with low planting density (ISPS).

100% of adopters received training and advice from ECOSUR and UNACH, and in half (54.5 %) of the UPGs of these people, research was carried out on establishing and managing improved silvopastoral modalities. In addition, 36.3% of the adopters received financial aid to establish ISPS. Due to this intervention, the adopters reported being aware of environmental degradation and changing their actions to benefit their relationship with the environment. That is, a "friendly" relationship was established, as the following testimony states:

I adopted the silvopastoral system for cattle feeding, soil conservation, and environmentally friendly production... to show that farming among trees is possible (farmer, 59 years old).

This coincides with a study in various regions of Chiapas, where adopters generated ecological awareness, which motivated the adoption of trees in the pastures, contributing to the conservation of natural resources (Marinidou et al. 2018).

Regarding the factors limiting the adoption of ISPS, the economic factor was the most discussed among the adopters regarding the cost and time required for establishment. Implementing a new system for the group generated greater economic costs and time to adapt. However, they have access to the raw material (endemic tree species) since any activity that is performed requires economic resources:

For silvopastoral systems, costs often hold us back… the payment of wages… so many times we stop because of that issue. We are not able to transform one or two hectares at a time; we must take it by small areas of land. That is the hardest part (farmer, 70 years old).

Although the adopters overcame the economic limitation, each individual did so based on their capabilities and needs, as the dedicated area for establishing ISPS fluctuated from 0.5 to 17 ha in this group. Marroquín-Pugas et al. (2022) reported that the economic factor was one of the main constraints for establishing a protein bank on the coast of Oaxaca. The time from the initial establishment to the effective use of the ISPS is another factor to consider, as it is closely related to the investment of economic resources. Lee et al. (2020) mentioned that the time required for farmers to see the benefits of ISPS depends on the intensity of grazing practices, the modalities, and the species used, which can be approximately 3 to 5 years. Also, Zabala et al. (2022) show that, with the adoption of ISPS, environmental and economic benefits are obtained in the long and medium term, respectively, but with the need to cover most of the economic costs in the short term. As mentioned, the benefits of an ISPS can vary over time according to the farmer's capability to invest, the established improved silvopastoral modality, and its management.

In the case of the lack of group work, the adopters state that it is clear to them that group work and good leadership are key to achieving the common good, and accomplishing the objectives set by themselves, an aspect that they still need to improve:

It is the way for us to be heard [as a group] by the government agencies, to have them turn to us, but it is no longer just one. Now each individual represents the whole group wherever they participate, so if we talk about support goods, only as a group is how things have worked out (farmer, 63 years old).

Finally, adopters stated that government aid in the form of economic resources is needed to improve infrastructure to make their ranches productive; without this support, it is quite difficult for them to get ahead:

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That is why the fellows have to stop… we have to go piece by piece [of ISPS]. Because there is no direct support (farmer, 50 years old).

Therefore, programs are required to facilitate access to credits that allow the transition of conventional pastures toward improved silvopastoral schemes (Apan-Salcedo et al. 2022).

3. Farmers who did not adopt ISPS (non-adopters)

3.1 Socio-demographic characteristics

In this group, all people are male; their average age is 58.5 years, and they have completed 4.9 years of education. In this group, less schooling is observed compared to the adopters group. In the Sierra Madre of Chiapas, the farmers with the highest degree of adoption of ISPS even went on to get postgraduate studies (Apan-Salcedo et al. 2022). Vargas-de la Mora et al. (2021) indicate that educational level is a key factor in technological adoption, not only because of the knowledge acquired, but because it allows generating skills to interact with different actors and open the way to new knowledge. Most non-adopters (83.3%) have livestock as their only income; this represents another preponderant factor since having no other sources of income makes it difficult for them to invest in new technologies.

The UPGs of the non-adopters have an average land area of 31.7 ha and a herd size of 45.2 heads. These UPGs are almost 20 ha less compared to adopters. It has been reported that the size of the land is a factor that influences the establishment of ISPS, given that adopters tend to have a larger surface area than those who do not adopt (Oliva et al. 2018). In non-adopters cases, only half (50%) managed to be certified as organic milk producers. This shows the difficulty of this group of farmers, not only in the adoption of ISPS, but also in moving towards other forms of production with an ecological approach.

3.2 Limiting factors in the adoption of ISPS

Based on the qualitative analysis, in the group of non-adopters, a greater diversity of factors that limit the adoption of ISPS in their UPGs was identified, including: 1) government aid, 2) access to knowledge, 3) the cultural aspect, 4) the market, and 5) the economic aspect.

The lack of government aid was the most discussed topic among non-adopters, emphasizing the need for support regarding economic resources and infrastructure for the adoption of new technologies:

The government should support us, it must offer more resources because sometimes our efforts and sacrifices are not enough (farmer, 51 years old).

The scarce funding for training and implementation of silvopastoral projects is a detrimental factor for the expansion of ISPS (Apan-Salcedo et al. 2021).

Regarding access to knowledge, this group stated that consultancies were unclear and even perceived that mentors "do not possess the knowledge" about ISPS. In addition, some farmers highlighted that there were few training and consultancy sessions, and others declared that they never got a notice:

Yes, there are consultancies, but they are scarce, and there is a lack of information (farmer, 70 years old).

We have not had that knowledge, and that is why we have not fully gotten into it... If they give us that, I think that many of the colleagues are going to do it, but we need to have knowledge (farmer, 54 years old).

58.3% of non-adopters received training and consultancies from ECOSUR and UNACH; however, no studies about silvopastoral systems were carried out in any of these farmers' UPGs, and these institutions granted no financial aid. In this context, the criticism must be directed towards the lack of capacity of institutions and researchers to carry out technology transfer processes with a horizontal approach where not only a sector of the intervened population benefits. Another aspect to consider is that the weaknesses of technicians can be linked to the lack of continuous capacities and skills building about the transference of knowledge to their target population and, in this case, the lack

of specialized agroforestry knowledge, which limits the adoption of this technology (Apan-Salcedo et al. 2021).

As for the cultural factor, which was mentioned only in this group, the non-adopters reported that the shade of the trees affects the growth of the grass:

There is one thing about us... we know that cattle need pasture, and the shadow of the trees degrades the pasture (farmer, 53 years old).

This shows that some livestock farmers associate the cattle ranch with monoculture in the grasslands. Other studies have reported that producers misperceive the systematic use of trees in the pastures, which generates a barrier to the establishment of ISPS (Lee et al. 2020; Marinidou et al. 2018).

Another factor that only occurred in this group of farmers was the low profitability of milk production, pointing out that the low price of milk paid by buyers (companies) does not allow them to capitalize enough to invest in the adoption of new technologies:

What we make from milk is not enough to live properly, and we barely survive (farmers, 51 years old).

In the Sierra Madre de Chiapas, it was observed that the price of milk was also a limiting factor for technological change by farmers. Therefore, it is necessary to establish an economic differential factor or incentive to produce milk under a silvopastoral system (Apan-Salcedo et al. 2022).

In the case of the economic factor, as well as in the group of adopters, the costs of establishment prevent the adoption of ISPS:

Let us say you want to plant 100 cocoites [endemic tree of the study area] you need to pay wages and all to make it look good, but we need more resources (farmer, 48 years old).

In general, non-adopters point out that the investment for the establishment of ISPS means a significant expense thus not all people have the budget to take risks and invest:

We need a project… so that we could get a budget, because it is the economic resources that have stopped us… and in the silvopastoral activitie is mandatory to invest (farmer, 59 years old).

In Colombia, it was reported that production costs increased due to the maintenance of planted trees and the protection from livestock, mainly scattered trees in the pasture (Lee et al. 2020).

In summary, the lack of government aid was the most discussed factor in this non-adopter group. Likewise, it was identified that these group of farmers had limited access to knowledge with less access to courses and training, and less involvement in research processes, compared to those who adopted the technology. This, together with a smaller size of land and the cultural belief that trees affect grass, shows a complex problem for this group of farmers that prevents them from adopting this technology.

Conclusions

Adopters have a higher education level, additional income apart from livestock farming, and a larger land area than those who did not adopt. The above factors should be considered in decision-making when promoting the adoption of improved silvopastoral modalities.

The factor that favored the adoption of ISPS in the group of adopters was the access to knowledge by academic institutions through courses, training, and financing for establishing silvopastoral modalities in their production units, something that partially happened with those who did not adopt.

In the case of the group of non-adopters, the lack of government aid was identified as the most important limiting factor given their economic situation. Thus adequate public policies are required, but without a paternalistic approach, to transition to ecological models of livestock production. Additionally, their belief that trees affect pasture growth, the low price of milk, and the costs of establishing ISPS, coupled with low education level, smaller land size, and lack of additional income, complicates the transfer of ISPS technology for the non-adopters group.

The qualitative analysis of the technology adoption processes successfully reveals the opinions and perceptions of the farmers, as demonstrated in this work. In this sense, the adoption of improved silvopastoral systems is determined by multiple

factors; therefore, the challenge for stakeholders, such as technicians, farmers, government, and academic institutions, is to improve the technology transfer processes, acknowledging communication and horizontal interaction between the actors. It is necessary to design and establish differentiated public policies appropriate for the needs of rural populations and the expansion of improved silvopastoral systems that respond to the context of the climate crisis.

Socioeconomic impact

This information will be useful for technicians, researchers, and livestock organizations to make adequate decisions on economic issues, technical assistance, government aid and cultural support in the process of technology adoption or transfer in the livestock sector.

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