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Productores agrícolas en reconversión productiva en el municipio de Atltzayanca, Tlaxcala

Agricultural producers undergoing productive reconversion in the municipality of Atltzayanca, Tlaxcala

Produtores agrícolas em reconversão produtiva no município de Atltzayanca, Tlaxcala

Armando Volterrani Trentadue
El Colegio de Tlaxcala A. C., México
armandobambino@gmail.com
https://orcid.org/0009-0009-3631-817X

José Luis Carmona Silva
Benemérita Universidad Autónoma de Puebla, México
jluiscarmona78@gmail.com
https://orcid.org/0000-0002-0858-2792

Zoila López Cadena
Benemérita Universidad Autónoma de Puebla, México
zoila.lópez@correo.buap.mx
https://orcid.org/0000-0001-9744-5361

Resumen

En México la agricultura orgánica se vincula mayormente a pequeños agricultores. El estado de Tlaxcala presenta una limitada superficie destinada a la producción orgánica, con pocas unidades productivas orgánicas y de productores orgánicos certificados. El objetivo del trabajo fue analizar el impacto generado por las prácticas agrícolas de los productores orgánicos de Atltzayanca, Tlaxcala, en el desarrollo territorial del municipio, analizando sus efectos en términos de preservación ambiental, eficiencia económica y equidad social. La metodología empleada es eminentemente cualitativa. La población objeto son los 169

productores inscritos en el programa Plan de Manejo Orgánico elaborado y gestionado por la Secretaría de Impulso Agropecuario (SIA). Se entrevistaron un total de 39 productores, 3 técnicos y se efectuaron tres entrevistas a figuras institucionales (director de Desarrollo Rural del municipio de Atltzayanca, un Comisario Ejidal y un ex regidor del Ayuntamiento). Las entrevistas a los productores y los datos obtenidos en campo evidencian un bajo impacto en el desarrollo del municipio debido, entre otros, a una insuficiente estructura organizativa de base social, a la falta de un mercado que valore la producción orgánica, a la carencia de apoyo institucional en cuanto a capacitación en las técnicas de producción orgánica, dificultades de acceso a financiamiento, escasa información del público en general sobre los beneficios de los productos orgánicos, así como la limitada difusión de la reconversión de otros productores.

Palabras clave: Agricultura orgánica, agricultura convencional, productores en reconversión, desarrollo territorial.

Abstract

In Mexico, organic agriculture is primarily associated with small farmers. The state of Tlaxcala has limited land dedicated to organic production, with few organic production units and certified organic producers. The objective of this study was to analyze the impact generated by the agricultural practices of organic producers in Altzayanca, Tlaxcala, on the territorial development of the municipality, analyzing their effects in terms of environmental preservation, economic efficiency, and social equity. The methodology employed is eminently qualitative. The target population is the 169 producers enrolled in the Organic Management Plan program developed and managed by the Secretariat for Agricultural Promotion SIA. A total of 39 producers were interviewed, three technicians and three interviews were conducted with institutional figures (the director of Rural Development of the municipality of Altzayanca, an Ejidal Commissioner, and a former City Councilor). Interviews with producers and field data reveal a low impact on the municipality's development due, among other factors, to an insufficient grassroots organizational structure, the lack of a market that values organic production, insufficient institutional support for training in organic production techniques, difficulties in accessing financing, limited public awareness of the benefits of organic products, and limited dissemination of the conversion of other producers.

Keywords: Organic agriculture, conventional agriculture, producers in transition to organic production, territorial development.

Resumo

En México la agricultura orgánica se vincula mayormente a pequeños agricultores. El estado de Tlaxcala presenta una limitada superficie destinada a la producción orgánica, con pocas unidades productivas orgánicas y de productores orgánicos certificados. El objetivo del trabajo fue analizar el impacto generado por las prácticas agrícolas de los productores orgánicos de Atltzayanca, Tlaxcala, en el desarrollo territorial del municipio, analizando sus efectos en términos de preservación ambiental, eficiencia económica y equidad social. La metodología empleada es eminentemente cualitativa. La población objeto son los 169 productores inscritos en el programa Plan de Manejo Orgánico elaborado y gestionado por la Secretaría de Impulso Agropecuario (SIA). Se entrevistaron un total de 39 productores, 3 técnicos y se efectuaron tres entrevistas a figuras institucionales (director de Desarrollo Rural del municipio de Atltzayanca, un Comisario Ejidal y un ex regidor del Ayuntamiento). Las entrevistas a los productores y los datos obtenidos en campo evidencian un bajo impacto en el desarrollo del municipio debido, entre otros, a una insuficiente estructura organizativa de base social, a la falta de un mercado que valore la producción orgánica, a la carencia de apoyo institucional en cuanto a capacitación en las técnicas de producción orgánica, dificultades de acceso a financiamiento, escasa información del público en general sobre los beneficios de los productos orgánicos, así como la limitada difusión de la reconversión de otros productores.

Palabras clave: Agricultura orgánica, agricultura convencional, productores en reconversión, desarrollo territorial.

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Introduction

The current global agro-industrial system is based on a production model almost exclusively based on monocultures, with extensive use of agrochemical inputs, synthetic fertilizers, fossil fuels, and the overexploitation of natural resources (UN, 2022), which has damaged the environment and seriously affected biodiversity. An alternative to this unsustainable system is organic agriculture in all its methodological and technical variants, but only 1.6% of the world's agricultural land is currently dedicated to organic production (Fibl , 2023). In a brief review of the literature on the definition of organic agriculture, several definitions can be found with similarities and some differences, with the sole objective of its operationalization. For this work, the definition of the International Federation of Organic Agriculture Movements (IFOAM) has been considered: "Organic agriculture is a production system that maintains and improves the health of soils, ecosystems and people. It is fundamentally based on ecological processes, biodiversity and cycles adapted to local conditions. Organic agriculture combines tradition, innovation and science to favor the environment we share, promoting fair relationships and a good quality of life for all who participate in it" (IFOAM, 2014, p. 31).

For small producers, organic farming represents an excellent option for several reasons: low environmental impact, ecosystem conservation, production of healthy products, and job creation, among others. However, this production system is far from being the dominant form of farming, as evidenced by the fact that only 1.6% of agricultural land is used for this purpose (Salinas, 2014). The choice and need for a gradual shift to organic farming has affected only a small and very limited number of producers compared to the vast majority of traditional agricultural producers. Various factors have limited the dissemination of new practices related to organic farming as a development alternative, despite the short- and medium-term unviability of the current production model based on techniques that are harmful to the environment and the health of rural producers and consumers (Morales Galindo, 2007).

Of the total Mexican agricultural area, only 0.2% is dedicated to organic production with 52,274 primary producers and 677 manufacturers/processors for a total of 425,414 tons of organic products exported to countries in the European Union and the United States of America (Research Institute of Organic Agriculture FiBL -IFOAM – Organics International 2023). In Mexico, only 15% of total organic production is consumed, and of this, only 5% is

marketed as organic, while the remaining 10% is marketed as conventional products (Díaz Víquez et al. 2015).

Producers in reconversion face a series of challenges that make it difficult to switch to organic agriculture. They face institutional, cultural, economic, technical and social barriers. In addition, this type of production results in lower yields compared to traditional agriculture (mainly in the reconversion period). They also have to assume higher costs per unit of production and the price per unit of labor is always higher, which leads to the need for subsidies (Moutry Jr. et al., 2009). According to Sharifi et al. (2010), lack of access to necessary inputs, natural barriers such as lack of adequate soil moisture, lack of vegetation and lack of soil fertility are important barriers that make it difficult for farmers to use organic agriculture, as well as economic barriers. Studies carried out in Greece by Karipidis and Karypidou (2021) show that the main challenges in conversion are the demand and price of organic products, the distance from agricultural activities to the market or point of sale and, in general terms, access to markets, available technologies, education in combination with knowledge transfer, peer networks and societal attitudes towards organic farming, as well as the provision of subsidies and compensation to farmers for higher costs and lower yields.

For the specific case of Mexico, Salinas (2014, p.103) warns about the problems that farmers in the process of reconversion must face, mainly in terms of costs and prices: "healing soils and waters affected by conventional agricultural practices and making a transition to replace inorganic inputs with organic inputs, which can generate an adverse impact on yields, costs and prices and requires new training for producers."

For Schwentesius Rindermann et al. (2014) consider the main limitations that hinder the development of the organic agriculture sector in Mexico to be: the lack of research on the subject, the scarcity of technical information, the insufficient production of organic inputs, as well as the lack of training of professionals in organic systems. The lack of specialized training leads to poor practices in crop health management. Similarly, the lack of accessible financing, particularly in the conversion phase, is a serious limitation to be resolved.

The State of Tlaxcala is characterized by a very limited area dedicated to organic production, a small number of production units, and certified producers. According to the registry of certified producers according to the guidelines for organic operations, there are currently only 41 in the entire state (SENASICA, 2023). The Secretariat for Agricultural Promotion of the Government of Tlaxcala made the Organic Agriculture Management Plan Project available to producers as a strategy for converting traditional agriculture to organic

agriculture by integrating agroecological practices, with the aim of increasing the number of organic producers in the state.

The project began in the spring-summer 2022 cycle and aimed to produce high-quality, healthy food free of toxic residues, preserving the genetic heritage of various crops in the state, restoring soil fertility, and improving the environment (Secretaría de Impulso Agropecuario del Gobierno de Tlaxcala, 2022).

Materials and methods

The municipality chosen to carry out this study was Atltzayanca , where organic producers are located, it is one of the 60 municipalities that make up the Mexican state of Tlaxcala. Atltzayanca is located in the east of the State of Tlaxcala and approximately 48 kilometers east of the capital Tlaxcala de Xicoténcatl. Its name comes from the Nahuatl " Azayancan " and is interpreted as: "Place where the waters break" and occupies a total area of 186,330 km², which represents 4.67% of the total state territory; it has 42 localities and a total population of 18,111 inhabitants (INEGI, 2020). Most of the area, 11,652 hectares, is dedicated to rainfed, fruit and perennial crops (Municipality of Atltzayanca , 2018). The Gini coefficient for Atltzayanca in 2020 was 0.32 (CONEVAL, 2020a). The National Council for the Evaluation of Social Development Policy (CONEVAL, 2020) also provides other significant data on this municipality, placing it among the four municipalities in the state with the highest degree of social backwardness in 2015 (CONEVAL, 2020, p. 80).

In the municipality of Atlzayanca , agriculture is the main economic activity, and 90% of the 4,500 heads of households in the 23 communities of Atlzayanca are dedicated to corn production. (Baños, 2021).

The objective of this paper was to understand and analyze the phenomenon of productive reconversion, primarily considering the perspective and perception of the municipality's producers in their living and work environment, with special emphasis on the motivations that have led them to experiment with a different production method, their concerns, the problems they are facing, the achievements obtained, and their vision of the future of work, society, and economy.

The methodological strategy chosen for this research was qualitative, which involves a set of collection and analysis processes (Hernández-Sampieri, 2014). The following logic was followed: primary data collection, instrument construction, pilot testing, and instrument administration (interview guide). The target population consisted of 169 producers enrolled

in the Organic Management Plan program developed and managed by the SIA through three agricultural technicians who serve three geographic areas of the municipality.

Sampling is defined as "the act of selecting a subset of elements from a larger set to collect data in order to answer a research problem" (Hernández-Sampieri, 2014, p. 151). For this case study, a non-probability sampling derived from the qualitative approach to research was considered. The sampling considered the selection of cases: producers in reconversion; the number of cases to be included, which defines the sample size. Regarding the time factor, the samples were taken over a 5-month period, from October 2024 to February 2025.

The information was collected from primary sources obtained through the application of semi-structured interviews with producers participating in the reconversion process .

Pilot interviews were conducted (scheduled and managed during March 2024) to test their relevance and effectiveness in terms of both implementation and results. Interviews were conducted individually and in groups using *snowball sampling,* a technique typically chosen to approach individuals or groups with accessibility difficulties, an element verified in this research. This technique is also applied to groups characterized by homogeneity, as is the case with producers undergoing reconversion (a review of secondary sources indicates that producers generally manage the same types of crops with the same techniques and began the reconversion process two years ago) and in the research. The subjects in our field were progressively expanded based on contacts provided by other subjects.

A total of 39 interviews were conducted with producers undergoing the conversion process, and three institutional figures were interviewed (the Director of Rural Development for the municipality of Altzayanca , an Ejidal Commissioner, and a former City Councilor) in order to expand and reinforce the information.

Table 1. Atlzayanca producers in conversion by location and cultivated area

Municipality	Locality	Producers	Surface (ha)
Atltzayanca	Delights	10	28
	San Felipe Carrillo Puerto	18	61,544
	Lazaro Cardenas	12	57,784
	Junguito Hill	8	17.6
	Miahuapan El Alto	1	3.6
	Nexnopala	10	27.2
	Pocitos Ranch	16	65.6
	San José Buena Vista	2	6.4
	Santa Cruz Pocitos	13	37.6
	Santa Cruz The Cave	10	39.2
	Guadalupe Neighborhood	4	9.6
	San Antonio Neighborhood	12	52.4
	Santiago neighborhood	4	16.16
	Concepción Hidalgo	21	103.68
	Nazareth	6	24.8
	San José Pilancón	10	31.6
	San José Ocotitla	9	29.28
	Xaltitla	6	30.8
	Total	169	642,848

Source: Prepared by the authors using data from the Secretariat of Agricultural Innovation (2024)

To better understand the phenomenon of conversion to organic production, we interviewed technical staff supporting producers and local and state government agencies involved in this process.

Interviews with producers undergoing conversion were conducted at the Organic Innovation and Promotion Centers (CIIO), plots where organic inputs are produced, during training sessions, and at other producer meeting points.

Results

A total of 39 producers and three agricultural technicians serving the three areas of the municipality were interviewed. Three interviews were also conducted with institutional figures (the Director of Rural Development, the Ejidal Commissioner, and a former City Council member).

Table 2. Number of individual and group interviews by gender

Interviews conducted	
Men	9
Women	2
Group 1	5 men, 3 women
Group 2	16 men, 4 women
Technical	1 man, 2 women
Institutional figures	3 men

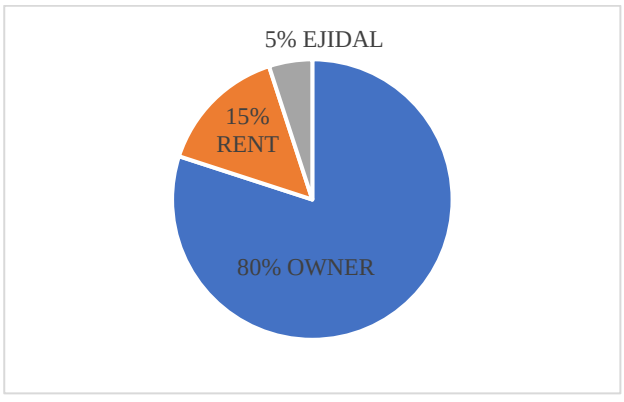
Fountain: own elaboration

The average age of the producers interviewed is 53. None are younger than 30. The youngest range in age from 40 to 45. Their economic activities are carried out in the fields and in other activities linked to companies mainly in Huamantla and Tlaxcala or on ranches around the town, such as Pocito, Los Altos, and Las Cuevas.

The gender distribution shows a male predominance, which, according to data from extension workers, has remained constant. Most producers have not completed primary education, few have completed secondary school, and a very small number have a high school diploma. The female presence is very small; few women are formally active as producers, and most enroll in the program only as representatives of a son or husband so as not to lose its benefits.

Regarding land ownership, the following data are reported:

Figure 1. Land tenure



Source: own elaboration

Regarding the size of the productive units, they cultivate on average areas between three and five hectares, there are producers with 10 hectares (this fact is important because

the program only subsidizes areas of up to 10 hectares, so several producers declare that they only work this area of land).

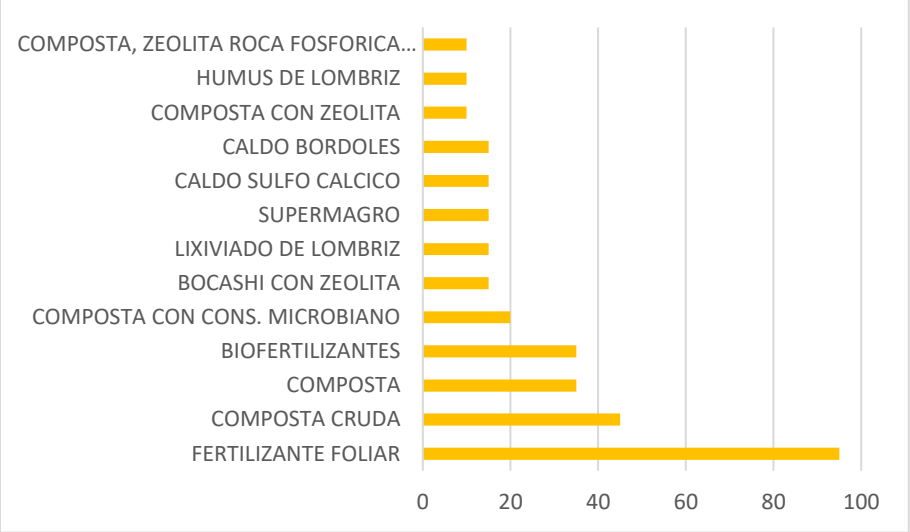
As mentioned above, individual interviews and interviews were carried out with two groups of producers, the first, made up mostly of family and friends, manage their individual plots in a mixed conventional-organic way and one plot is worked organically on a community basis (with strawberries, corn, oats, broad beans) with very limited use of synthetic inputs and, on the same plot, worm humus and compost are produced which, once mature, is mixed with zeolite, phosphate rock and some chemical fertilizer in order to produce enough for sale (SC Group).

The other group interviewed produces compost, vermicompost, and reforestation plants as a community (the group enrolled in the Sembrando Vida program) and individually cultivates their plots using a mixed conventional-organic system. There is one case of a producer , a former councilor and DP , who recently produced chemical-free yellow native beans on two of his 12 hectares, using only organic fertilizers. The high number of applications is a factor that limits further conversion to organic management, as it requires much more time to apply inputs compared to conventional management. This is in a semi-arid area with lower rainfall, high levels of ventilation, and highly eroded, largely sandy, thin soils with low organic matter content.

Most of the producers interviewed, whether in groups or individually, have been partially using organic techniques and inputs for the past three years (since the production reconversion program was launched), with a few exceptions of production units that have been managed organically for longer (the oldest being 19 years); with the exception of two producers who manage their production units completely organically (there is no form of control or certification that can verify this data in their two plots of seven and ten hectares), all producers combine conventional and organic management, that is, they manage the production system conventionally but in a part of 1-3 hectares they use organic inputs and/or production techniques: in most cases, synthetic chemical inputs applied to the soil and organic inputs and products such as foliar fertilization are used ; Three products are used as foliar fertilizers: a mixture of microbial consortium, microelements, and amino acids, at doses of two liters of each ingredient per hectare, which is theoretically applied three to four times during the corn crop; this mixture is also enriched with a bio-preparation produced at the CIIO (Organic Innovation and Promotion Centers). Figure 2 shows the most commonly used

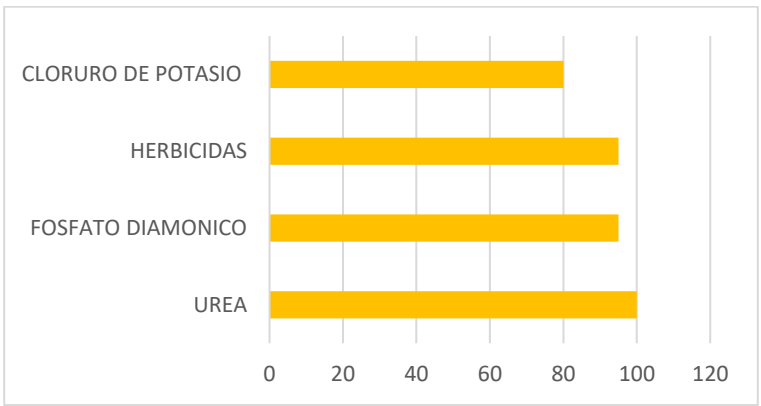
organic fertilizers on plots undergoing productive conversion, while Figure 3 shows the most commonly used synthetic fertilizers and agrochemicals.

Figure 2. Most commonly used organic fertilizers



Source: own elaboration

Figure 3. Most commonly used agrochemicals



Source: own elaboration

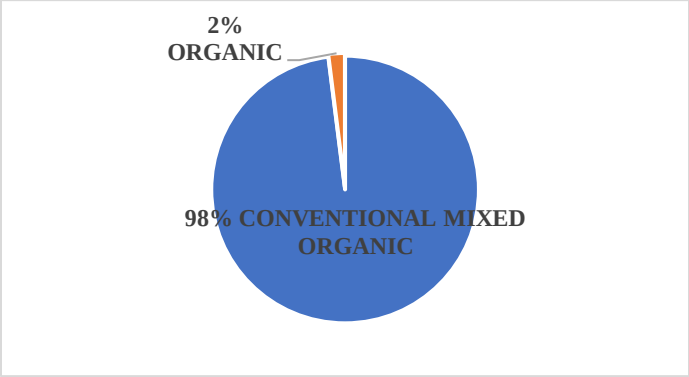
The mixture is subsidized at a cost of 800 pesos (2,000 pesos its original cost) and is applied as a foliar fertilizer while producers apply chemical fertilizer subsidized by the federal government or purchased personally to the soil.

Among the new inputs adopted by producers are bocashi , bocashi enriched with zeolite, prepared and processed compost, biofertilizers (prepared with rumen or cow or sheep belly, fruit peels such as oranges, yeast, molasses, various types of local herbs, as well as

chicalote and castor oil plant to control grasshoppers and fall armyworms), humus and worm leachate.

The vast majority of producers have not completely abandoned conventional management (see Figure 4), and synthetic fertilizers are also used in the organically managed portion of the plot, including urea in most cases, DAP (diammonium phosphate , also known as black fertilizer due to its color), and potassium chloride; compost is sometimes used mixed with zeolite, phosphate rock, and a limited amount of chemical fertilizer.

Figure 4. Plot management



Source: own elaboration

In this process of transition to organic, producers have begun to manage manure and organic waste for the production of compost (this process is called composting during which certain parameters should be controlled, such as humidity and temperature, turning the organic mass to oxygenate it and theoretically obtain in 2-3 months a product free of pathogens and suitable for use) but many times producers, due to "lack of time" do not follow the recommendations of the two extensionists and continue to use "raw" manure without composting and in this way they can create phytosanitary problems or increase pest problems, as well as the problem of the "blind buffalo" (they are beetle larvae, specifically of the Scarabaeidae family , the phytophagous species being those of the Melolonthinae subfamily . Although this subfamily has numerous species harmful to crops, the most representative genus is Phyllophaga).

Among the new techniques that have become almost universally accepted are foliar fertilization; instead of fallowing, subsoil plowing and harrowing are used (a technique that is neither widespread nor accepted); the reincorporation of crop residues with prior application of microorganisms to facilitate the decomposition of organic matter and its eventual disinfection; fertilization with compost enriched with phosphate rock, a minimal

amount of urea from biopreparations , diatoms for disease control, and microbial consortia, fungi, and bacteria; In some cases, crop rotation is applied (it is not a widespread practice: for example, producer DJLC rotates between red and blue corn, black and yellow beans, broad beans and peas; as well as producer DLJ, who “plants alfalfa for three years and then I plant corn and it gets good. Well, for about five years. Five years of corn, then alfalfa. Alfalfa or broad beans. Or oats. And then corn again” (DLJ, personal communication, November 11, 2024).

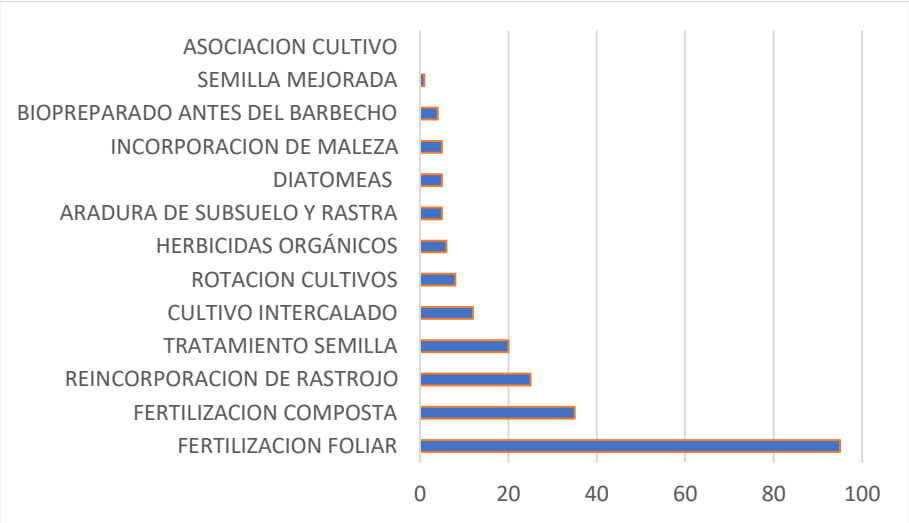
These crops are intercropped with peach, cactus, and apricot trees; instead of using raw manure, mature compost enriched with microorganisms that accelerate organic decomposition is being used; biopreparations are being produced in 1,000-liter tanks using inputs found in the production units; weeds are being incorporated into the soil instead of eliminating them with herbicides or physical methods; the area of plots to be worked is being reduced to 1,000 m^2 and managed organically to increase profitability (SC Group).

A minority of producers, according to the extensionists interviewed, harvest, apply the biopreparation loaded with microorganisms and only at this moment “the fallow is passed”, then in February “they pass a harrow” (extensionist E., personal communication, November 11, 2024) with a rail to prepare the soil (this is the third year that technicians induce producers to use this technique but not all of them apply it because they say “it is expensive” or that “they do not have time” (extensionist E. personal communication November 11, 2024); another technique that extensionists encourage and that only 20% of producers follow, is the treatment of seeds with the microbial consortium (among them Don Luis José who previously did not treat the seeds and “now the seed rots less and the weevil no longer grows” DLJ, personal communication, November 11, 2024); the technique of crop association, proposed since the first year of the program, is complicated by producers Due to the amount of work involved, it is no longer implemented (an example of an association is growing squash with corn or beans at the same time, in the style of the traditional milpa: producers, particularly those who are closer to the "urban" area and who have other economic activities, have less time to dedicate to the field and do not apply it due to the difficulty of weeding).

Among the innovations is the case of a producer, DLJ, who is using improved seed from a Mexican seed company that has been improving native corn varieties. Six varieties were tested on his plot to determine which one is best suited to this area and also to its end

use (human or animal consumption). Figure 5 shows the new techniques adopted by the producers.

Figure 5. New Techniques Adopted



Source: own elaboration.

In some cases, there has been a change in the weed control strategy, replacing synthetic herbicides with organic herbicides based on local herbs or incorporating the weeds into the soil. Another technique adopted in each CIIO is the use of worms to produce worm castings and leachate, which are subsequently used to fertilize crops. A rarely used aspect is soil analysis, which is carried out only in a very homemade manner and with limited results (using vinegar and hydrogen peroxide).

Regarding the compost application technique, the guidelines are to apply at least three tons of compost per hectare before fallow, to be applied alongside biopreparations (these are used to loosen soil compaction and for other purposes); these biopreparations are prepared with materials purchased by producers or with materials obtained on the plot. Their preparation requires orange peels, yeast, and molasses as base ingredients. Local plants are then added to resolve nematode problems. Acids are added in the case of highly compacted soils (such as citric acid, some rock flours).

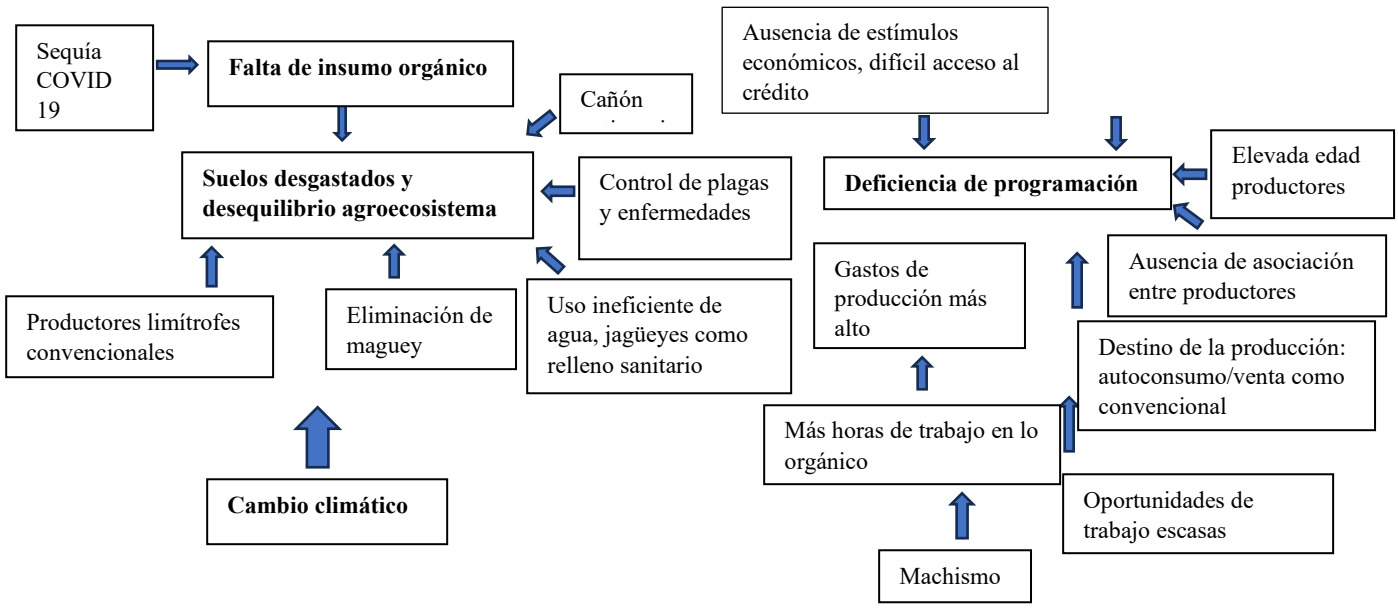
There are variations among producers regarding the preparation of compost and other inputs: for example, the SC Group prepares compost with cow dung, kitchen waste, eggshells, and field weeds, and once the composting process is complete, it is used to feed the worms; other producers use other types of manure, such as sheep or horse manure.

Among the new inputs introduced with organic management, producers affiliated with the Sembrando Vida program use supermagro (a liquid biofertilizer that improves general soil characteristics, particularly favoring its microbiological characteristics). Supermagro is obtained through anaerobic fermentation (without the presence of oxygen) and its base ingredients are fresh cow manure, molasses or piloncillo, milk or whey, among others. These same producers also use sulfocalcium broth (a fungicide and a preventative permitted for use in organic farming, made from minerals such as sulfur and lime; it is a very useful product in the prevention and control of fungal diseases such as downy mildew, powdery mildew, and botrytis. In addition, its sulfur content controls mites and thrips) and Bordeaux mixture for fertilization and pest and disease control. Bocashi (an organic fertilizer obtained from the decomposition of plant and animal waste in the presence of air) .

All the producers interviewed (except one) grow crops without using irrigation, that is, using seasonal farming, and have corn as their main crop with a production under normal rainfall conditions of 2 and 3.5 tons per hectare (6 tons per hectare in the only case of irrigated crops).

In the vast majority of cases, native seeds are used (the use of hybrid seeds is very limited) of white, yellow, red, and blue corn; only in limited cases are maguey, prickly pear, and peaches grown intercropped with the main crops.

Figure 6. Difficulties encountered in the conversion from conventional production to organic production



Source: prepared by the author based on field work

The diagram above summarizes the difficulties encountered by producers in their conversion to the organic production system.

One of the problems that worries the vast majority of producers is the lack of organic inputs in sufficient quantities to cover the nutritional and soil regeneration requirements of larger areas : during the pandemic period due to the SARS-CoV-2 virus and which has coincided with two years of prolonged drought, producers have had to sell a large part of their animals (dairy cows, goats, sheep, pigs and sheep) to cover expenses and in this way the amount of manure necessary for the production of organic inputs has been reduced.

The producers interviewed also evidence an inefficient use of water in the municipality, "the jagüeyes built by the state government now serve only as sanitary landfills because they fill with garbage, they were very expensive and of very little use" (SC Group, personal communication, October 7, 2024) the excavation of a well is complicated and expensive due to its great depth (about 200-300 meters), there are high costs of extraction and distribution of the liquid.

Related to the water problem, the natural drought conditions are compounded by the unregulated use of anti-hail cannons to protect Audi car production or the cilantro, strawberry, and blueberry crops of some ranches (DJLC, DP former councilor, DGPC, SC Group, LC Group); “I went to help a neighbor harvest corn, but there was no water because the other neighbor had to remove seeds from his cilantro crop and used an anti-hail cannon, and nobody knows anything, nobody does anything, they all turn a blind eye” (DG, personal communication, October 25, 2024).

The production obtained, whether through conventional management, or through mixed conventional-organic management, and finally that obtained through organic management (without official certification), is most frequently destined for self-consumption ("for the family and for the animals for meat and milk" (LC Group, personal communication, October 23, 2024), but any surplus is offered on the conventional market without any type of valuation or differentiation with respect to the conventional product (given that organic certification has a cost and obligations that producers cannot sustain), and there is no local organic market.

This turns out to be one of the biggest and most serious problems that hinder the growth of organic production in this municipality in both qualitative and quantitative terms: no differentiation in the price of organic production, also considering that the vast majority of those interviewed state that the production costs of these products are higher than those

obtained with the conventional method ("I invest double", DJLC, personal communication, September 18, 2024) for several reasons, as well as the use of more hours of field work for the application of organic inputs and for the simple elimination of weeds without using a herbicide due to a lack of widespread technologization in this sector (DJLC).

The economic factor plays an unfavorable role in more producers converting to organic production. There is no economic stimulus to support producers in this productive reconversion, nor does the Guaranteed Price Program foresee a higher price for these products. The city council does not inject resources, and access to credit is almost always very difficult to obtain; banks do not lend or lend at very high interest rates (DP, former councilor).

In the vast majority of cases, producers bordering those undergoing conversion are conventional, so they continue to contaminate adjacent crops with agrochemicals (fungicides, herbicides, etc.); the soils are generally very worn and contaminated, and restoring fertility requires several organic production cycles with abundant incorporation of organic material. This means that several years of conversion are required to recover these soils, with production typically lower than conventional production, at least during this period.

One of the most difficult problems to solve with organic management is pest and disease control, and in this case, it is easier to use conventional synthetic products (which partially solve the problem but worsen the environmental situation) than organic products (also in this case, restoring a natural balance and easier pest and disease control requires time and loss of production). In units larger than 2.5-3 hectares, the application of organic inputs for fertilization and/or pest and disease control is very complicated due to the lack of adequate machinery (most producers only own a backpack sprayer for applying organic inputs). The alternative of transforming organic products is not viable in many cases, so as not to neglect production (DGPC).

The elimination of the so-called "weeds" is also a serious problem to be solved and managed, and in many cases, producers prefer to eliminate them with a herbicide instead of preparing a biopreparation that requires more time to prepare and use. One of the central pillars of the Green Revolution was the purchase and use of machinery to replace pack and work animals, but the general impoverishment of the agricultural sector has led to the inability to continue paying the installments on this machinery, which has been seized by the banks.

The economic problems are aggravated by a “financial culture that is not helping us” (DP former councilor, personal communication, October 23, 2024) and “the culture by which I am not going to pay anything, the government has to do it” (DP former councilor, personal communication, October 23, 2024) and “here a good party is preferred to a work” (DP former councilor, personal communication, October 23, 2024) but the countryside “does not provide economic security, the opportunities in the countryside are closing, but we continue working it because God squeezes, but does not strangle” (DP former councilor, personal communication, October 23, 2024).

In addition to the economic and opportunity problems, there are also problems of public order, as well as the theft of maguey plants with "the criminals who steal the mixiote, up to 10 hectares in one night" (Grupo LC, personal communication, October 23, 2024).

“The green revolution arrived late and as a cheap copy of the one implemented in the USA,” “it polluted a lot and produced little” (SC Group, personal communication, October 7, 2024): these phrases refer to practices that were abandoned, such as the cultivation of maguey to stop erosion, diversify production and use sloping land to be able to introduce heavy machinery instead of animal traction, level the land so that the machinery could work well and stop building ditches to collect rainwater.

Local culture directly influences the methods and timing of production, sometimes with negative effects, as the optimal timing for fieldwork is lost due to patron saint festivals, or a year is lost due to the introduction of a new crop (extensionist E., extensionist S., former councilor, DP). This is compounded by the effects of climate change: sowing in March and April was postponed to July or even July, with problems of frost during and after harvest (extensionist E., DLJ). The low level of crop yield is also justified at a cultural level: "whatever God commands" (extensionist E., personal communication, October 25, 2024), "even though I do everything to improve production, in the end it is God who decides" (DP, former councilor, personal communication, October 23, 2024), "Faith in God and sow" (DEA, personal communication, October 25, 2024).

The production of organic inputs using manure and other local materials is complicated because it is required in large quantities, but there is no support in infrastructure or financial resources from municipal and federal institutions (SC Group).

The establishment of an organic market in the municipality is even more problematic due to the low purchasing power of the inhabitants (normally organic products are sold at a

higher price than conventional products due to the greater amount of labor involved) (SC Group).

"The future looks bleak," "young people aren't getting involved and prefer to go to the US," and "every family has at least one or two relatives who have already left for the US" (SC Group, personal communication, October 7, 2024). The extension workers also highlight problems with suppliers of organic inputs: the same supplier that provided them with technical training at the beginning of the program before extending it to the state remains the sole provider of the program, and the coordinators of all SIA technicians are asking for incentives for producers to purchase these inputs.

A permanent problem expressed by several producers refers to the application of the North American Free Trade Agreement (NAFTA), which has been reissued as USMCA (United States, Mexico, and Canada Agreement) which, with respect to corn, costs less to import than to produce it (SC Group), as well as the system of subsidized fertilizers (which according to some producers costs less to buy it from abroad and is also of better quality) and the same with the purchase of seeds (subsidized seeds are of very poor quality and cost 13 pesos instead of 5 (SC Group).

Several producers show that "the government tells you to produce organically, but they send you to war without a rifle because they do not finance the project or support you in the transition phase as in Europe and the US and they do not buy the final product (SC Group, personal communication, October 7, 2024) which can be summarized in this phrase: "capitalism is bad, but the Mexican way is worse" said by a producer from the SC group (personal communication, October 7, 2024)

Some producers point out that the local and federal governments do not have a long-term plan for the countryside: regarding the type of production, they do not consider the local culture ("don't plant corn anymore, plant vegetables"… "but Tlaxcala is the birthplace of corn and there is no strong identity with this crop, I'm not going to produce vegetables" (SC Group, personal communication, October 7, 2024) or the characteristics of the territory (with programs that wanted to boost widespread milk production, the introduction of the drip irrigation system, or with the 1000 m2 x 1000 kilos of production program, all programs unrelated in time and without continuity.

Several producers and extension workers also point to a low capacity for innovation due to the very advanced age of a large part of the producers and their low level of education to be able to effectively convert to organic farming, as well as a lack of coordination between

producers for the creation of associative forms of production and marketing, in addition to the absence of relations with certified organic producers present in Tlaxcala (DJLC, personal communication, September 11, 2024).

A problem identified by producers and extension workers is a lack of programming, both in the SIA and in the agricultural sector, due to the lack of an annual program evaluation to correct planning errors, a lack of coordination between producers and other production and trade sectors, and a lack of more effective relationships with other local institutions to organize events that highlight producers undergoing conversion and to disseminate their production and the change in the production paradigm among the population.

Regarding the problems that producers highlighted in personal and group interviews, it is widely believed that, due to a lack of trust in associative forms such as cooperatives, the internal organization of producers undergoing conversion is practically nonexistent.

One of the biggest problems facing this municipality is related to generational change, given that the children of producers are employed in sectors outside of primary production and are employed or seek employment in nearby towns or even emigrate abroad (each family has at least two members living abroad, SC Group).

The best results to date have been obtained on limited plots of land ranging from 1.5 to 2.5 hectares, but on larger plots there are many problems due to a lack of organic inputs and also difficulties with organic applications compared to the use of conventional agrochemical inputs.

Discussion

Based on the research carried out, it can be observed that producers undergoing productive reconversion in the municipality of Atltzayanca have presented, with very few exceptions, homogeneous results: the vast majority are male, they grow corn, oats, beans, squash, and peaches; they manage their production units conventionally, but in a section of 1-3 hectares they use synthetic chemical inputs for the soil and organic inputs and products such as foliar fertilization.

Producers have begun to use organic inputs such as bocashi , to prepare compost and biopreparations , humus and worm leachate and in some cases biofertilizers such as supermagro.

Among the new organic techniques adopted by producers undergoing conversion are foliar fertilization and the incorporation of crop residues after applying microorganisms. Few organic techniques are fully accepted, such as crop rotation, intercropping, companion crops, organic weeding, and seed treatment.

The main problem expressed by producers is the lack of organic inputs in sufficient quantities to cover the nutritional and soil regeneration requirements of larger areas, a problem that has worsened during the pandemic and the prolonged drought, during which producers had to sell their animals to cover expenses .

In addition to the above, there are other problems such as the use of hail cannons, improper use of water sources, and numerous difficulties in organic pest and disease management.

socioeconomic problems are the lack of a market in which to position organic production in the process of conversion, the complete absence of productive and organizational aggregation among producers, the very limited institutional presence, and the difficulty in accessing credit and more efficient technologies. These problems mean that producers, most of whom are already older, have objective difficulties in reversing a situation of low production levels. In addition to these factors, we must consider the almost total absence of generational renewal, given that young people are forced to find employment opportunities outside the countryside, and internal and international migration is increasing.

The consequences of conventional production management are evident in worn-out soils, which are less fertile due to the continuous use of agrochemicals, and in the health of producers.

These reasons have motivated changes in production management to obtain healthy and safe products, improve the health of producers, and reduce production costs. There is also an interest in returning to the techniques and inputs used by their ancestors and comparing the results.

The lack of economic or in-kind incentives very frequently leads producers to not attend the training offered by the only two extension agents assigned by the State Secretariat for Agricultural Promotion to cover all the needs of the territory of Atltzayanca ; There are few recommended agroecological techniques that, until now, have been part of the modifications in conventional production processes and the influence of a patriarchal culture has further harmed the technical work of the two female extension agents and still permeates social relations (with an almost irrelevant presence of female producers).

On the other hand, producers have highlighted the need to build production and marketing chains that allow for the construction of a market for organic products , for the valorization of their production, and also to incentivize and build public policy with a long-term vision and not purely for electoral purposes, to efficient programs for the countryside, to easier access to credit to be able to invest in new technologies and reduce the workload.

Regarding the perceptions of the social actors interviewed regarding the impact of organic production on the municipality, the responses were mostly negative due to the factors that impede territorial development, as indicated above.

Comparing the research results with the literature in the field of organic conversion, one can note many similarities and possible contrasts.

Studies in Greece and Finland revealed that younger farmers with a better level of general and agricultural education, managing larger production units, were more likely to participate in organic conversion projects (Alexopoulosa et al., 2010; Mattila et al., 2018).

If on the one hand the main reasons for European farmers to adopt organic farming were higher prices and the certainty of positioning their production, the explanations for returning to conventional farming were the end of subsidies, the decrease in income, the lack of markets, the lack of knowledge and institutional support (Alexepoulosa et al., 2010; Panneerselvam et al., 2012): all of this raises questions about the possible resilience of Atltzayanca producers in a situation where, among other limitations, there are no subsidies or a market in which to position production.

The determining importance of an effective and coordinated institutional presence, resulting from a dialogue with producers interested in organic production and that develops public policies in support of these actors with long-term plans, is found in the literature (Abadi et al., 2020; cited in Guang Han et al., 2021) despite the fact that the percentage of organic producers in the world is very low (for example, only 0.89% of the 2 million agricultural units in the US according to USDA, 2019) but there is a constant growth in the area dedicated to organic production.

Public institutions need a true understanding of the motivations (economic, social, ideological, religious, etc.) and objectives of producers (Guang Han et al., 2021).

As evidenced in this research, the financial difficulties experienced in the transition period to organic farming, with an increase in production costs (particularly due to the increase in working hours) and a relative decrease in yields, are frequently shared in the literature (Howlett et al., 2002; Mahboubeh). Jahantab et al., 2023;), as well as a study carried

out in three regions of India (Panneerselvam et al., p.1, 2012) suggests that a “government scheme to compensate for yield loss during the conversion period and a price premium can help farmers adopt organic farming on a large scale”, as suggested by the producers in Atltzayanca .

Regarding the motivations of the municipality's producers to gradually start producing organically (obtaining healthy products, improving personal and family health, reducing production costs, increasing the effectiveness of pest and disease control), a study carried out in Oregon, USA (Lloyd and Stephenson, p.106, 2020) shows two categories of motivations, the first related to ideological/philosophical values ("it fits my values and/or my family's", "concerns for the environment" and "concerns for human health") and to economic/market motivations ("increased profit potential", "access to an expanding market for organic products" and "specific market opportunity or buyer's contract"): the study showed that economic/market motivations were more frequently presented than ideological/philosophical values.

Veisi et al. (2017) with a study carried out in Iran suggests that “economic motivations, health, security concerns and environmental issues are the predominant reasons for conversion, unlike social and ethical reasons which are of lesser importance” (p.1).

The work of Lloyd and Stephenson (2020) also shows a great similarity in the obstacles that producers in Atltzayanca encounter in the reconversion process, as well as for producers in the state of Oregon, USA, who were the subject of the research, problems evidenced in percentage in the responses: “cost of labor (73%), record keeping requirements for organic certification (73%), cost of organic certification (70%), weed management (70%), pest or disease control (60%), cost of organic inputs (55%), learning process (53%), availability of labor (53%), soil fertility management (47%), finding buyers/market for my organic products (47%), access to specialized technical knowledge on organic production (40%), obtaining adequate prices during the transition (38%), availability of organic inputs (seeds, fertilizers, etc.) (37%), availability of organic processing facilities (37%), planning crop rotations (23%), reduction in yields (17%)” (Lloyd and Stephenson, p.107, 2020).

The problems revealed among the producers of the municipality are evident and are shared in studies carried out in California, India and Iran which show that the presence of more organic markets, certification expenses, production costs, weed control, the problem of water supply, labor, low yield, large quantities of organic fertilizer necessary for organic farming, lack of modern technology in organic farming and pest control are common and

may mean a return to a conventional type of production (Panneerselvam et al., 2012; Veisi et al., 2017; Yasmeen , 2018; Rangarajan et al., 2024).

A study carried out in India shows the same results on the problems faced by producers in conversion and organic production, also highlighting that diseases affecting crops can significantly reduce production (Pooja Bhatt , 2022), as well as a study carried out in Indonesia (Sutawi et al., 2018) reveals that 47.14% of the farmers surveyed consider that pest and disease control using organic pesticides is more difficult than control with synthetic chemical pesticides.

An ideology opposed to the ideals of organic agriculture (not manifested in the producers of Atltzayanca), the uselessness of organic certification, the financial risk of converting to organic production, uncertainty about sales prices and market instability are potentially some of the most important barriers to organic conversion according to a study carried out in Germany among wine producers (Siepmann , 2018).

Extending the comparison to the agroecological literature, this is very precise in defining that the substitution of conventional inputs (fertilizers, pesticides, herbicides, etc.) with others of an organic nature (compost, biofertilizers, amino acids, etc.) does not address the root of the problem because it attacks the symptom (e.g., corn weevil infestation on the same crop resolved with the application of an organic insecticide) without going to the root of the problem, which is a structural imbalance in the system (Altieri and Nicholls, 2007). For this purpose, a well-defined and agreed-upon plan would be needed between producers and government bodies for the implementation of policies for the field that indicate a gradual and effective line to support the path of the actors involved in all its phases, from the reconversion period to their recognition as organic producers managing their plots agroecologically.

On the other hand, the replacement of conventional inputs with organic ones, as is being handled in the conversion in Atltzayanca , follows the same paradigm as conventional agriculture in which the objective is to overcome the limiting factor, although this time it is done with alternative inputs and not agrochemicals.

This type of management ignores the fact that the limiting factor (a pest, a nutritional deficiency, etc.) is merely a symptom of an ecological process not functioning properly, and that adding what's missing does little to optimize the irregular process. It's clear that input substitution has lost its agroecological potential, as it addresses not the root of the problem but the symptom (Altieri, Nicholls, 2007).

The reconversion that the producers of Atltzayanca are facing presupposes a change that is not only the substitution of inputs (according to the vision of conventional agriculture that considers natural resources as a factor that can be modified according to convenience), rather it has to be seen as a productive and social transformation process with a "redefinition of the relationship between techniques, nature, territory, markets and consumers" (Lamine and Bellon , p.11, 2009), a process, as can be seen, much more complicated and where more social and technical disciplines intervene with a view to sustainability and social equity.

The need for effective, long-term public policies, the result of constant dialogue between producers and other local stakeholders, that align common interests and materialize in shared spaces, strongly influences a development process that is empty and ineffective, discouraging these producers in the process of reconversion and alienating other potential producers from a shift in production paradigms.

Economically, the Atltzayanca region is characterized by a process of expulsion of the young peasant labor force towards secondary and tertiary production sectors, immigration to the United States, a change in land use, a penalized primary production price, and an increase in the prices of inputs that forces producers towards different forms of subsistence.

The lack of concerted public policies resulting from constant dialogue between the parties, the absence of a network between producers and other complementary services, weak social cohesion, incomplete decentralization that is not consistently applied at the local level, a very weak connection and communication system, a very complicated social and economic environment—all these elements add up and explain why the agricultural sector in general is in a state of survival and why the agricultural sector in the process of reconversion is encountering even more obstacles in expanding and establishing itself.

The Green Revolution, the Free Trade Agreement (FTA), globalization, new production organization systems, and productive relocation and offshoring have influenced local production systems, changing the various social, economic, and productive expressions over time; the result is a socially disaggregated, economically depressed, and environmentally depleted territory.

The conversion to organic farming is therefore part of a global process that does not favor it. On the contrary, the evidence gathered reveals the elements that explain its poor results and impact at the local level: there is no real political-institutional will to develop the territory, nor the will and reality of local actors who can guide this process endogenously.

Conclusions

The factors that have hindered more extensive conversion are technical and environmental in nature, as well as political, economic, and social: the presence of worn-out and unbalanced soils resulting from years of applying agrochemicals and agronomic techniques that have diminished fertility and productive capacity; insufficient production of the organic fertilizers necessary for organic conversion; difficulties in agroecological pest and disease control; the elimination of crops that balanced the ecosystem, such as the maguey; the environmental imbalance caused by the use of anti-hail cannons; the lack of public policy programming; the low level of association among producers; their advanced age; the absence of an organic market; higher production costs; and the lack of adequate economic incentives.

Regarding the impact and perception of organic agriculture on the development of the municipality, the evidence gathered shows a still incipient panorama given that producers who were supposed to be organic, in reality, still turned out to be very tied to a conventional production system.

There is still a very superficial perception of organic production in the region, which is of interest to only a small fraction of all agricultural producers present. Furthermore, they have a very low production volume, almost entirely destined for personal consumption, and a surplus goes to the conventional market, given the absence of a local market for organic or converted products.

The current situation revealed in the research suggests the presence of impediments that hamper the development process structurally, at its founding bases.

The social, economic, political, institutional, and cultural aspects of the territory explain why the productive conversion to organic farming is finding it difficult to take root in this municipality, given the weak institutional presence, the absence of a producer network, limited and poorly disseminated innovations, very limited connectivity with the urban environment, poor production diversification, and lack of evident entrepreneurial capacity. Added to all this is a difficult economic environment, the high average age of producers, and the growing number of new generations seeking better economic opportunities.

The agroecosystems in the municipality's territory are severely damaged and depleted by decades of conventional agriculture, and an effort from all social stakeholders is needed to understand and resolve them. Among the most widely shared proposals is the call for more effective, long-term public policies that address problems from the ground up.

This study highlights the lack of planning and results measurement of the institutional organic production program and its inadequacy in terms of human and in-kind resources employed; this factor is also associated with poor communication between institutions and local stakeholders.

Future lines of research

This research encourages different incentives to be analyzed in subsequent studies, as well as to consider the aspect of gender separation more comprehensively with all the implications this entails, as well as to collect and analyze more in-depth data on the economic levels of producers.

should also be considered , at least a full agricultural year, to cover different production processes, field work, and the production and management of organic and synthetic inputs. Finally, research should be expanded to include family members of producers and municipal residents who are not directly interested in the conversion process but who could provide valuable information on the social perception of the conversion at the local level.

The limitations of this work become recommendations for future research, including a more in-depth study of the public policies implemented in the region and the productive and economic effects of the new crops that some producers are implementing to counter the effects of climate change and the repeated droughts affecting the region.

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Contribution Role	Author(s)
Conceptualization	Armando Volterrani Trentadue Equal José Luis Carmona Silva Same Zoila López Cadena Igual
Methodology	Armando Volterrani Trentadue Equal José Luis Carmona Silva Same Zoila López Cadena Igual
Software	Not applicable
Validation	Armando Volterrani Trentadue Equal José Luis Carmona Silva Same Zoila López Cadena Igual
Formal Analysis	Armando Volterrani Trentadue Equal José Luis Carmona Silva Same Zoila López Cadena Igual
Investigation	Armando Volterrani Trentadue Equal José Luis Carmona Silva Same Zoila López Cadena Support
Resources	Armando Volterrani Trentadue Equal José Luis Carmona Silva Same Zoila López Cadena Igual
Data curation	Armando Volterrani Trentadue Equal José Luis Carmona Silva Same Zoila López Cadena Igual
Writing - Preparing the original draft	Armando Volterrani Trentadue Equal José Luis Carmona Silva Same Zoila López Cadena Support
Writing - Review and Editing	Armando Volterrani Trentadue Equal José Luis Carmona Silva Same Zoila López Cadena Igual
Display	Armando Volterrani Trentadue Equal José Luis Carmona Silva Same Zoila López Cadena Igual
Supervision	Armando Volterrani Trentadue Equal José Luis Carmona Silva Same Zoila López Cadena Support
Project Management	Armando Volterrani Trentadue Equal José Luis Carmona Silva Same Zoila López Cadena Igual

Acquisition of funds	Armando Volterrani Trentadue Equal José Luis Carmona Silva Zoila López Cadena