Article

The MIAF, a viable alternative for hillsides in marginalized areas of southeastern Mexico: case study in Chiapas

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Abstract

The introduction of the maize system interspersed with fruit trees (MIAF) in the marginal areas of Chiapas represents an excellent productive option and productive reconversion in places where traditionally only the 'milpa' is cultivated, the yields obtained after the third year, have increased the expectations of the producers, even without having carried out a thorough market study, the average B/C ratio is above 2, so that this system implemented on hillside land would benefit at least 28 million Mexicans who live on condition of marginalization in southeastern Mexico, the physiographic characteristics of the lands of the producers, exceed more than 15% slope, characteristics of most of the states of the south-southeast, with the exception of the Yucatan Peninsula, which makes its establishment potentially feasible, producers would continue to produce their basic satisfactions and would have an economic activity in the short and medium term that would activate its economy.

Keywords: marginalization, MIAF, southeast of Mexico.

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Introduction

In Mexico, according to the CONEVAL (2011) it indicates that, of the 120 million Mexicans, 51% are poor and, of these, 27 million are poor and marginalized. Today that figure has increased to 28 million Mexicans living in the most depressed regions of the country and most of them are in areas that have a certain degree of marginalization, where the main economic activity is agriculture based on the system 'milpa' extensively documented since Hernández-Xolocotzi *et al*. (1994), until Lara Ponce *et al*. (2012), these authors indicate that there is a diversity of polycultures, use of edible and medicinal herbs, as well as the breeding of domestic animals to sustain and continue with their reproduction; however, it is not enough and they have the need to meet their needs with an extensive range of extra plot activities.

The state of Chiapas is considered one of the three states with the highest rate of marginalization only below Oaxaca and Guerrero, this is where environmental, social and economic conditions combine to create conditions of poverty, low productivity and fewer opportunities to create an endogenous development from the resources and the context that surrounds them. In many of the municipalities in the state of Chiapas that have outstanding above 15%, agricultural production presents several problems, such as: low yields, expensive inputs, low prices at harvest, inability to generate jobs, but the main are structural problems as: the slash-burn that causes erosion and loss of soil fertility (Camas *et al*., 2012), in addition to the irrational use of pesticides. Due to this crisis in which agricultural production is immersed, a new technological development is established for small production units, in which stands out the milpa system interspersed with fruit trees (MIAF), considered as a system that could be a solution to combat the problems mentioned.

The MIAF system is mainly oriented towards small producers in the so-called marginal areas, with the purpose of improving the labor and economic life of the producer, with the integration of several annual and perennial crop species in the same plot, such as: corn, beans, occasionally squash and a fruit tree, this system is widely documented in Cortés *et al*. (2005) and Cortés *et al*. (2010). According to Camas *et al*. (2012), there is a wide variability of farming systems, ranging from commercial to marginal systems. Cadena, (2004) mentions that, in Chiapas, 860 000 hectares of corn are cultivated, of which approximately 60% are on hillsides, where knowledge has not been generated for agricultural activity, so this has been carried out with minimal control of the effect on natural resources.

This situation makes them very susceptible to be degraded in a short time to continue with the same agricultural practices. For this reason and in view of the need to establish a sustainable soil system in plots dedicated to the cultivation of basic crops in the municipalities with high marginalization of Chiapas, this research was carried out with the objective of diagnosing and evaluating the MIAF system in the town of Manzanillo Pinabeto del municipality of Rayon, in the social, cultural, economic and biological field, in order to measure the impact that the system has generated on the farmer and the locality at a general level during the 2009-2014 period, thus detecting the benefits and limitations of the farmer under the system.

In south-eastern Mexico, the use and operation of the MIAF system dates back to the beginning of the millennium, which was achieved through the sustainable hillside management project (PMSL), in the Cuicateca, Mazateca and Mixe populations of the state of Oaxaca with the objective of reducing poverty and environmental degradation, the target population for the government were those areas of high and very high economic marginalization, characterized by the practice of hillside cultivation, through the slash-and-burn system (Sánchez, 2002).

The fundamental purpose of the PMSL was to take advantage of, preserve and improve the natural resources of the hillside, to improve the environmental conditions and the life of those farmers and producers who have made the hillsides a refuge for subsistence. As a result of this, a new production system is established, the farmers of Náhuatl origin of the state of Puebla, originated an agroforestry system, which allowed them to harvest different types of food and fodder throughout the year (Castro, 2008). To convert the traditional system to one of milpa interspersed with fruit trees (MIAF), these farmers counted on the advice of the researchers of the Postgraduate School (CP) and the National Institute of Forestry, Agriculture and Livestock Research (INIFAP), all this as part of the Plan Puebla project, extensively documented (Díaz *et al*., 1999).

In Chiapas there are small areas dedicated to this system and include the municipalities of Rayon, Tapalapa, Pantepec, Pueblo Nuevo, La Concordia, Chamula, Las Margaritas Trinitaria and eight municipalities of the Altos region, Chiapas. In the first four municipalities, the MIAF system was established with peach trees *Prunus persica* (L.) Stokes and avocado Hass *Persea americana* (Mill.) through a Civil Association called 'Colectivo Isitame'. While in the municipality of Ocotepec this system was driven by the INIFAP and the Organization 'World Vision Mexico'. While, in the municipality of Concordia in the Central Depression of the state of Chiapas, there are 300 hectares dedicated to this system with Persian lemon *Citrus latifolia* Tanaka, which were supported through a development program of BANCHIAPAS.

The Isitame Collective aims to experiment with sustainable technological innovations for food production, improving the use of natural resources and generating jobs, for which, this Association managed a productive project in charge of the strategic food security program (PESA) of SAGARPA, in 2009, and delivered peach trees and organic fertilizers to producers in the towns of Manzanillo Pinabeto and Ribera San Sebastián in the municipality of Rayon Chiapas. Investment made to implement the MIAF system, in order to eliminate the burning in the milpas of the producers of such localities, benefiting 67 families. The production units are less than five hectares and are located on marginal lands where the degradation of the soil has a high agro-ecological cost that affects their productivity, so that the production obtained is insufficient to satisfy the food and income needs of peasant families (Arellano and López, 2004).

On the other hand, Turrent *et al*. (2014), indicate that for the small production units a viable alternative is the MIAF system, especially in hillside and marginal areas, they conclude that this system is a multi-objective technology compatible with traditional agriculture, in which the economic engine is the fruity. However, although it is a viable option for those areas, there are some factors that can determine whether it is used or not. Orozco *et al*. (2009), indicate that there are at least 18 factors that influence the adoption of new technologies. In their study conducted in the mountainous areas of Oaxaca, they conclude that the MIAF was adopted to the extent that producers were aware of the technology and that they had greater

cosmopolitanism, as main adoption factors, indicating that this represents a good option for areas marginalized from Mexico, conclusion to which Ruiz, *et al*. (2012), where in addition to the previous ones they indicate that the training for the management of the MIAF was determinant for its adoption.

The objective of this document is: to know and analyze the impact of the establishment of the MIAF system in the municipality of Rayon, Chiapas in the social, environmental, economic and biological ambit, as well as to measure the benefits generated to producers with the application of the system. It is important to mention that the government of the state of Chiapas raised the millennium objectives to the constitutional rank as of July 2009. Chiapas is the second state with the highest degree of marginalization in the country and concentrates 14% of extreme poverty, 116 municipalities present some degree of marginalization, among them 48 of very high marginalization, 39 have high marginalization, a situation that makes them among the poorest people of Mexico (SEDESOL, 2014).

Materials and methods

The municipality of Rayon, is located in the northern mountains, hence its intricate orography, located at 17º 12" north latitude and 93º 00" west longitude. Bordered on the north by the municipality of Tapilula, on the east by Pueblo Nuevo Solistahuacan, on the south by Jitotol, on the west by Pantepec. The municipality has warm, semi-warm and humid temperate climates.

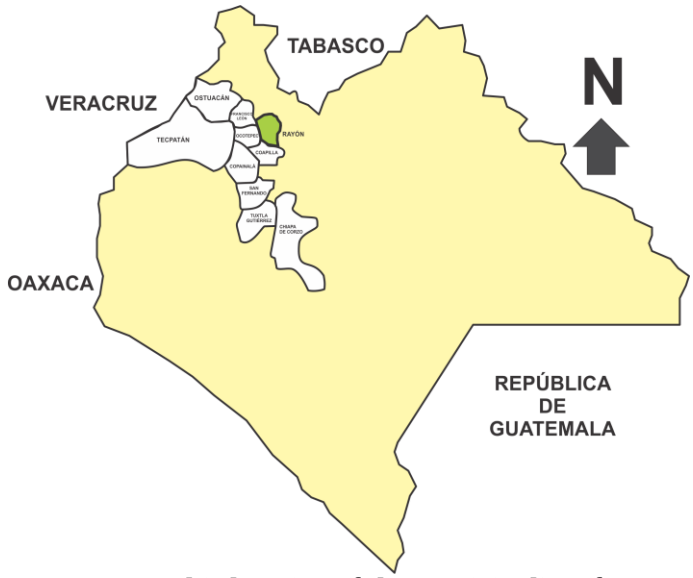

Figure 1. Geographic location of the municipality of Rayon, Chiapas, INIFAP 2016. Elaboration based on data from INEGI.

The humid warm climate predominates with abundant summer rains, followed by the humid semi-warm climate with rain throughout the year. During the months of May to October, the average minimum temperature ranges from 9 °C to 21 °C, and the range of 15 °C to 18 °C predominates in 47.45% of the territory and from 18 °C to 21 °C at 28.74% remaining. From November to april, the average minimum temperature ranges from 6 °C to 18 °C, predominating from 9 °C to 12 °C. Rainfall in these months' ranges from 900 mm to 2 600 mm (SEGOB, 1988).

Although there are more than 70 producers in various stages of management of the MIAF system, in this study only 32 producers were interviewed, given that they were those who had more than four years of work and experience with the system.

Results

Worthy of mention is the participation of women in decision-making in this production system, however, they are also the least approached at the educational levels, given that it is they who the percentage of illiterates showed in this study, On the other hand, the fact of being on average young producers indicates that the generational change may be propitious for this system, to continue the socioeconomic conditions. It is worrisome that their inventory of productive resources is very low coupled with the percentage of slope is greater than 15%, which makes them very susceptible to being eroded and with it the loss of productive resources (Table 1).

Table 1. Social and productive characteristics of producers in Rayon, Chiapas. INIFAP. 2015

Concept	n= 32	
Age of producers (years)	38	
Members in your family nucleus	4	
Sex	69% men's	31% women
Scholarship (%)	85 with some degree of schooling up to secondary level	15 illiterate
Land tenure	69% property	31% communal
Slope of the terrain	69% from 20 to 30%	31% more than 40%
Total average area of land (ha)	3 ha	
Area dedicated to the MIAF	0.25 ha	

The producers interviewed in the town of Manzanillo Pinabeto, began to work with the MIAF system in 2009. On knowledge about the system, the first approach was through technical tours organized by the group ISITAME AC to the experimental station established in the state of Veracruz, by the College of Postgraduates (COLPOS), and the National Institute of Forestry Agricultural and Livestock Research (INIFAP). As a result of the interest shown by the producers, plots were established through the financing of the strategic program for food security (PESA) of the SAGARPA. The 100% of the producers carried out the sowing of fruit trees in 2009, while 77% applied fertilizer when it was transplanted. Being a zone of high marginalization, the costs for chemical fertilizer can be burdensome for producers, in addition to killing certain organisms that keep the soil alive, for this the use of compost based on vermicompost leachates is promoted (Bunch, 2008).

The 85% of the producers reported the presence of pests in their fruit trees and the greatest damage was caused by the aphid (*Brachicaudus* schwarzi *Myzus persicae*). Most producers apply pesticides that are not suitable for the control of pests, mixing even insecticides and fungicides due to ignorance of the handling of the products. On the other hand, 23% of producers reported diseases

in their fruit trees. The pests identified were: the gummosis caused by the fungus *Botryosphaeria dothidea* and verrucosis (*Taphrina deformans* (Berk.). For this reason, they do not carry out any control mainly due to lack of knowledge and resources.

In order to have a better control of pests and diseases, according to the manual for the establishment of the MIAF system, crops should be periodically checked to detect the presence of pests and diseases, which damage and diminish crop yields. To detect any damage by these, it is necessary to proceed to the application of the agrochemicals recommended for each species (Cortés *et al*., 2005).

Regarding the pruning of the fruit trees, the producers indicated that they have knowledge that it is a technique that is managed within the MIAF system, everyone does it from one to two times a year with the purpose of developing and shaping the tree and optimizing the production of the fruit. According to Cortés *et al*. (2005), the firing of the tree is necessary, since it determines the height and distribution of the primary structural branch.

Although all producers know and know of the need to form the runoff filter with the residues of corn and beans, as well as the branches and foliage that are obtained from the pruning, only 92% are those who perform this activity. The producers affirm that this technique works as a barrier that prevents the dragging of the floors, and maintains the humidity. The creators of the MIAF, indicated that the runoff filter is a fundamental component in the MIAF system, since it controls the water erosion and increases the water infiltration.

Most of the benefits offered by the system are reflected with the application of the filter based on the trees upstream. The producers assure that in a very short time they will stop buying and applying fertilizers for their plots, since the stubble has greatly benefited the soils, they have observed an improvement and greater fertility in their plots. This is most evident in tree rows since it is the area where the filter is set.

The 77% of the producers apply the thinning of fruits on their trees. This technique consists of removing the damaged, stacked and very small fruits Cortés *et al*. (2005), indicate that the most appropriate distance for fruits is between 10-13 cm. Producers who do not apply thinning, it is because they do not get used to removing the fruit of the trees for 'pity' or sentimental attachment, so you have to understand the worldview they have of nature, to see a potential product in any tree worthy of feeding or satisfying your food requirements or being able to market them.

In all cases it can be seen that yields per hectare of corn and beans under the MIAF system decrease, this in virtue of the fact that the area destined for these crops decreases to become occupied by the fruit tree; however, after the peach and avocado trees enter production, revenues start to grow well above what was obtained with the traditional system, except for the producers who obtain a very small benefit-cost ratio, the vast majority of them they have an average ratio of 2, meaning that in addition to their investment they get more weight in the first three years, which is an indication of the benefits of the system compared to what they had traditionally been doing (Table 2)

Table 2. Yields under the MIAF system compared to the traditional control and its benefit-cost ratio, in Rayon, Chiapas. INIFAP, 2015.

Producer	Control yield (kg ha^{-1})		Yield MIAF (kg ha^{-1})			Total cost of production ha^{-1}		Income ($ ha^{-1})		Ratio B/C
	Corn	Beans	Corn	Beans	Peach	Control	MIAF	Testigo	MIAF	
Marin Molina	1 156	368	900	200	1 960	2 224	6 848	9 776	26 000	3.9
Miguel Molina	1 211	257	680	200	160	2 170	7 140	8 446	7 120	1.7
Agustín Jiménez	1 267	293	800	200	860	2 435	7 280	9 173	14 600	2.4
Manuela Gómez	1 120	427	800	280	780	2 220	9 200	10 453	14 960	2.2
Crescencia Díaz	1 400	360	800	200	120	2 260	6 580	10 640	7 200	2
Marina Rodríguez	1 120	413	760	320	200	1 860	6 080	10 267	9 520	2.5
José Gutiérrez	1 014	270	870	230	1 680	2 140	8 120	7 836	23 500	3.1
Miguel Gutiérrez	900	240	480	80	180	1 220	4 680	6 960	4 840	2
Zenaida López	1 084	233	920	160	1 200	2 950	8 800	7 593	17 920	2.2
Gregorio Rodríguez	920	310	440	160	2 280	2 920	10 320	8 020	26 800	2.6
Roselino Gutiérrez	1 229	217	900	340	1 400	2 940	12 320	7 946	22 360	2
Miguel Rodríguez	1 080	180	800	100	1 956	3 680	12 680	6 840	24 160	1.9
Marcos Gutiérrez	1 135	289	880	190	1 840	3 808	13 336	8 586	24 580	1.9
Noe Gutiérrez	1 200	200	800	120	48	3 640	5 100	4 140	5 384	1.1
Enrique Laguna	1 200	200	480	120	160	3 875	5 150	5 150	5 000	1.1
Enrique Núñez	1 000	200	600	120	240	3 510	4 715	4 715	6 120	1.3
Gregorio L	1 200	400	900	320	800	5 838	7 655	7 655	14 800	1.7
Cirilo Núñez	1 000	450	800	400	500	5 388	8 475	8 475	13 200	1.6
Jesús A Gómez	800	340	400	200	800	4 413	6 085	6 085	11 000	1.6
Jorge A Ruiz	1 500	400	1252	400	500	6 188	7 075	7 075	15 008	1.7
Maclovio R	1 200	213	800	120	800	6 025	7 050	7 050	11 400	1.4
Andrés A López	1 600	160	500	120	500	4 638	6 175	6 175	7 800	1.3
Javier Laguna	1 200	200	800	120	500	4 344	6 298	6 298	9 000	1.4
Tomás R	1 400	400	1200	200	600	5 675	10 670	10 670	12 600	1.4
Albino Núñez	2 000	700	900	352	800	4 850	7 500	7 500	15 280	1.8
Claudio R	800	300	600	200	600	5 138	5 575	5 575	10 200	1.5
Jesús A Núñez	1 333	333	320	600	1 800	5 731	10 173	10 173	24 680	2.2
Santiago AG	1 250	300	1 200	200	1 000	5 319	302	302	15 800	2.9
Viviana Ruíz	1 500	380	1 120	360	2 500	6 263	13 785	13 785	29 880	2.2
Andrés Gómez	1 800	500	1 000	200	1 000	4 563	6 785	6 785	15 000	1.9
Andrés Hernández	800	200	400	100	1 000	5 194	6 557	6 558	11 100	1.5
Evaristo R	1 400	400	1 000	200	1 800	4 638	8 255	8 255	21 400	2.3
Average	1 213	317	784	222	955	4 002	7 711	7 655	14 944	2

If we continue with only the corn and bean crops, the risk of not harvesting anything is very high, given that they are in an area where the inclement weather may not allow them to harvest any of the two crops and this facilitates migration to other markets. work to offer their workforce, either

in the work of the field or in another branch of economic activity. Something similar was found by Rodriguez *et al*. (2015) in red tomato *Lycopersicum esculentum* L. in a marginalized municipality of Oaxaca, and later Salinas *et al.* (2016); Cadena *et al*. (2016), who when evaluating the MIAF system with avocado under conditions of marginalization, the B/C ratio was 4.89.

With the presented data and the expectations of the producers, as well as the growth of their plantations, it is possible to do agribusiness in areas of high and very high marginalization, given that in the medium and long term the production of fruit trees is avocado or peach, they can generate more profits for producers than continue to sow only their satisfactions. As found by Ruiz *et al*. (2012) and Orozco *et al*. (2009), who identified the awareness of producers as necessary to have a permanent technical advisor, in such a way that they can guarantee the final quality of the fruit demanded by the market.

Table 3. SWOT analysis of the MIAF system, in Rayon, Chiapas. INIFAP, 2015.

Strengths	Opportunities
• Emotion for the fruit and work for the trees • Joy for the fruits • Continue persevering, even if no immediate result is seen, but with the hope of seeing results • They take the work seriously • They want to get ahead • They look prosperous, think big • With more potentially resources • Goodwill for the land • The family benefits because it diversifies the income • Change of producer and family mentality	• Advising and training • Local-regional market • Good prices • Purchase of the local product • Take advantage of Government Programs
Weaknesses	Threats
• Distrust in counseling • Not attending the consultancies • Lack of peach and avocado cultivation • Ignorance of use in agrochemicals to fight new pests, diseases, weeds	• Theft in the plots • Damages in the plots • Diseases • Rodents • Burns or keeps neighbors scratches • That everyone sow the same • Price for competence and quality • Other producing regions • Internal disorganization • Improve the organization • Do not let us help • Low fruit price • Intermediaries • Lack of family support in the work with the fruit

Source: elaboration based on field work. INIFAP, 2015.

In the SWOT analysis, according to Ramírez (2002), the process of strategic planning of an organization is supported, its importance is the evaluation of the strengths and weaknesses within the internal and external environment of an organization, in order to have with a diagnosis of their operating conditions. In this case, from the statements made by the producers, it is possible to notice the importance that must be placed when incorporating a new system to their traditional system of self-consumption and the importance of advising and looking for potential niche markets for products.

Although the expectations indicated by them about a new relationship between the producers and the same terrain where their source of consumption is, and although they currently do not have any contingency plan for the threats, it is certain that the weaknesses shown are feasible to overcome with the presence of a technical advisor.

The 85% of the interviewees stated that the standard of living of them and their families has improved economically, family and work, since the income has increased with the sale of their crops, now they no longer have the need to go out in search of work outside their homes, and above all reaffirmed that, with this system, the work in the plots has increased. On the other hand, the remaining 15% did not detect any change, possibly due to the fact that the peach tree has not been produced in previous years, due to not providing them with adequate attention and management, given that the greatest benefits are seen with the sale of the peach.

Conclusions

The MIAF system for marginalized areas of Mexico represents an acceptable productive option and productive reconversion, given that it offers the possibility of obtaining income from the third or fourth year on the fruit selected without affecting the production for self-consumption, and the yields average obtained and the B/C ratio, by the introduction of the system has not changed the attitude of producers to the field and an advantage of the system has been the inclusion of women in decision making.

The yields in the first three years of the establishment are lower than those traditionally obtained by the producers, but the B/C ratio is on average of 2, which is why producers have been interested in the system for the conditions in the region of the region north of Chiapas.

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