Article

Diversification of income from family farming during 2018 in Tehuatzingo, Libres, Puebla

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Abstract

Multiactivity is a current phenomenon in rural households. The objective of this work was to analyze the sources of income of peasant families in a subsistence family farming (AF) context due to the importance of meeting food needs first at home. The primary information was obtained by survey (N= 90 and n= 46) through simple random sampling with agricultural producers of maize and pumpkin in the ejido Tehuatzingo, Libres, Puebla. Two management systems were studied: the monoculture system (SMo) and the modified milpa system (SMM). More than 50% of the workforce in the two groups (58% in the SMM and 61% for the SMo) is related to family work. The activity of producers is considered multi-active (more than half of their income is derived from non-agricultural activities), such is the case of SMo producers. The opposite happens with SMM where it is estimated that 46% of its income derives from activities outside the agricultural plot, therefore, it is considered as specialized AF (more than half of its income comes from agricultural activities). It is concluded that the group with the greatest tendency to diversify sources of income is the SMM, as reflected in the Simpson Index where agricultural income is highest as a result of crop diversification and sale. This contrasts with the SMo which obtains higher economic remuneration outside the agricultural plot.

Keywords: de-peasantization, diversified income, multiactivity.

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Introduction

With the commercial opening and the different reforms, such as the privatization of land in Mexico, as of 1994 it was foreseen that family farming (AF) would disappear, as it had the idea that production would become competitive and the potential of minifundist farmers to produce food was ignored (Yúnez *et al*., 2013). Despite the persistence of rural poverty and the increase in demand for food in Latin America (Schneider, 2014) it must be recognized that this type of agriculture is the main supplier of most basic foods of human consumption (Schejtman, 2008; García *et al*., 2016).

It is essential for food security on the planet, and mostly attached to the principles of agro-ecological production (Alves and Días, 2019; Bosc and Sourisseau, 2019). In addition, this mode of agriculture claims the peasant because it highlights the practices that have been forced to carry out to ensure its social and economic reproduction (Schneider, 2003; Woods, 2014).

AF, unlike capitalist agriculture, is characterized mainly by the family nature in the organization of work and scarce access to land (Sabourin *et al*., 2015; Orsini *et al*., 2018). There is an AF classification according to the Food and Agriculture Organization (FAO) and the Inter-American Development Bank (IDB), which considers three types: subsistence family farming (AFS) where self-consumption predominates with a trend towards wage employment as a search for means of survival. Family agriculture in transition (AFT) where production is intended for sale and self-consumption, with greater land extent and can therefore diversify its primary activities.

However, farmers can be inserted into activities outside the agricultural plot to supplement their income. Finally, consolidated family farming (TFA), in which production is generally intended for sale only and is characterized by greater access to agricultural resources that allow it to generate surpluses, and the way, obtain capital that is intended for production.

For its part in Mexico, two types of AF have been classified (Yúnez *et al*., 2013; Schneider, 2014): specialized family farming (AFE), which refers to production units that earn more than 50% of their total (gross) income from agricultural activities and multi-active family farming (AFP) consisting of units that earn 50% or less of their income from agricultural activities, while the rest comes from non-agricultural activities.

This work was carried out under a context of AFS and pluriactive, so three visions will be presented within the area of diversification of rural income. Some authors argue that, within structural transformation (TE) styles, there are two that lead the producing agents of the field to diversify their activities for income generation (Rello and Saavedra, 2013).

The first style of TE is based on dual agriculture, whose features are: emergence of two agricultural subsectors, one modern linked to the industrial sector and one, with a small rural production aimed at self-consumption. Agricultural incomes are low and agents are pressured to look for other sources of income and employment, which is part of a reserve industrial army. The second style of

TE occurs in poor regions with limited resources: there is only one type of agriculture, which is very weak and contributes only 20% of household income, the survival strategy is employment in more dynamic areas, as well as self-employment and migration.

For this reason, their activities are mainly linked to industrial production areas, and service providers. According to the above, of these two TE styles, the first is characterized by dual development of the field and the second by poor agriculture. In this type of agriculture emerges, firstly, the need to join other production sectors due to the meagerness of their agricultural income, the common axis being the diversification of activities as a way of survival.

Secondly, it is argued that an increase in non-agricultural activities does not imply a higher income for economic operators. To improve income, agricultural productivity should be encouraged, through variables such as capital, production technologies, market prices, etc. The absence of these variables has generated uneven growth in the field, and with it the lower income households derived from agricultural activities are the ones with the most incentives to diversify (Escobal, 2001; Odoh and Nwibo, 2017).

Finally, there are findings that show that rural producers are facing a process of de-agrarianization, due to the fact that the greatest weight of their activities is found in occupations outside the agricultural plot (Mora and Cerón, 2015). These activities are related to short-term migration due to the new characteristics of the labour market (precarization of work) where the definitive establishment of employees at destination locations is limited; they are occupied as agricultural day laborers or construction workers (Escalante *et al*., 2007).

In relation to the phenomenon of income diversification or peasant multi-activity, this work defines as the combination of the different jobs, trades or businesses that can be created as part of the forms of survival and those decisions depend more on the conditions of the general labour market than on the specific market for agricultural products (Martínez *et al*., 2018); that is, the prices of maize and pumpkin seeds in the case of this work. It should be mentioned that in 2018 the peasants of Tehuatzingo sold their harvest to intermediaries who bought in their community the maize at $3 700.00 per ton and the pumpkin seed at $40.00 per kilogram.

On the other hand, at the AUDI automotive plant near this community, a worker's salary for those dates ranged from $250.00 to $780.00 per day, so it was more attractive than agricultural activity for immediate and higher incomes per day (e-consulta.com, 2017). Multiactivity may be governed by the industrialization process in the country. It should also be noted that it is a concept closely related to the process of de-agrarianization in the Mexican field; that is, to the decrease in the contribution of agricultural activities in household income generation (Jarquín *et al*., 2017).

This decrease makes according to some studies that in Mexico the main source of income in rural households no longer comes from agricultural activities, but from participation in wage labour, mainly services, manufacturing and construction (Cerón and Yúnez, 2015). Based on the above, the objective was to measure the sociodemographic characteristics and the diversity of the economic income of peasant households during 2018, in Tehuatzingo, Libres, Puebla.

Materials and methods

For the selection of the place of study, the following premises were raised: firstly, the existence of an agricultural tradition rooted in the community such as the milpa system (SM), reflecting ancestral knowledge about nature, technology and agricultural practices to ensure traditional and healthy diversified food (Sánchez and Romero, 2017). Secondly, maize production as the most important activity.

In this sense it is worth highlighting the Free Rural Development District among the most competitive in the state of Puebla, is the one with the largest area planted and the only region that does not have a deficit in maize consumption in the state (Flores *et al*., 2014).

The study was carried out in the community of Tehuatzingo, which belongs to the municipality of Libres, Puebla. This municipality is located in the north-central part of the state and comprises an area of 275 km^2, representing 0.8% of the surface of the state. It is located on the axis of the geographic coordinates between 19° 27' 52" north latitude and 97° 41' 15" of west longitude, with an average altitude of 2 378 meters above sea level, with precipitation between 400 and 900 mm per year (INEGI, 2017).

Tehuatzingo was founded from the agrarian distribution in 1929 with farmland that belonged to the San Nicolás farm. Before, they all lived on the hill called Rancho Viejo from where they were originated. Currently there are approximately 507 inhabitants (SEDESOL, 2010), of which 100 are ejido members. The community has a high degree of marginalization, which is located above the municipal average and reflects the general situation of the state of Puebla with a high marginalization rate. It is located 8 km from the city of Libres, head of the municipality with the same name, which concentrates 50% of the population (at the municipal level there are 31 520 inhabitants) (INEGI, 2017).

In early 2018, the study site was selected in accordance with the above. Local authorities (ejidal commissioner and judge of the peace) were contacted and key informants were conducted and a reconnaissance tour of the area was conducted with their support. For the collection of primary information, reference was made to the database of ejidatarios with 184 members in total, of which 100 belong to the Ejido de Tehuatzingo and where 90% grow maize.

For the evaluation of the diversification of rural income, the survey was used, so a pilot questionnaire was applied for its evaluation with five producers. Finally, adaptations to this instrument were made and applied during July 2018 to a sample of 46 ejido members in a simple random manner. The sample size was determined with a reliability level of 95% and an accuracy of 5% under the following formula (Aguilar, 2005). $n = \frac{NZ^2\ p.q}{(N-1)e^2+Z^2\ p\ q}$; where: N= population size (90); Z= confidence level (95%); p= probability that the sample will be representative; q= probability that the sample will not be representative; e= maximum error (10%); n= sample size (46).

To measure income diversification, the Simpson Index (Ds) was used, which was developed by Simpson in 1949 to measure species diversity and abundance (Mora and Cerón, 2015). In this work, this index was calculated that shows the results differentiated according to the type of handling: monoculture and polyculture. Ds is measured in a range between 0 and 1, which indicates that the closer it is to 1 there is a greater source of income in rural households.

In addition, greater diversification prevails in the income generated by each of these activities, while approaching 0, the income is generated from a single activity and calculated as: $D_s=1-\sum p_i^2$; Where: P_i= proportion of category i, (in this case, income from source i) in total household income: $p_{i=y_i}\sum_{i=I}^{I} y_i$.

The variables used to make the measurement of Ds were the income obtained by the production of maize, pumpkin and bean, depending on the existence or not in each of the plots. To obtain the revenue, the total yield of each crop was multiplied by the current price of kilogram at the time of the survey. Another variable used was income from stubble, maize income (tortillas and tamal leaves), income from off-plot activities (divided into primary, secondary, and tertiary) and other sources of household income derived from work of a family member either within the community or abroad.

In addition, the impact of maize agroecosystem management systems on income diversification was quantified through a logit model, ordered where the dependent variable is categorical. The observed dependent variable (y) is the reported amount of non-agricultural income that has been converted to a *z*-score and categories have been defined: low, medium low, medium high and high, taking as limit values the first quartile, median, and third quartile as shown in Table 1.

Table 1. Classification of diversification levels, according to the z-score of the amount of non-agricultural income reported.

Diversification level	Characteristics
[y= 1] low	If z-score ≤ 25th percentile
[y= 2] medium low	If 25th percentile < z-score ≤ 50th percentile
[y= 3] medium high	If 50th percentile < z-score ≤ 75th percentile
[y= 4] high	If z-score > 75th percentile

Category 1 (low) represents a low level of non-agricultural income generation (a producer reporting this value has a high specialization in agricultural income generation and very low diversification capacity of its activities); while category 4 (high) represents the highest level of non-agricultural income generation (a producer reporting this value has a lower specialization in agricultural income generation and greater capacity to diversify its income to other non-agricultural sources). Therefore, this observed categorical variable (y) measures income diversification levels to non-agricultural sources.

The objective of the model is to estimate how the probabilities of reporting greater diversification towards non-agricultural sources change according to the management system, controlling for the effects of the variables age, education, area and management system, these being the explanatory variables. The dependent variable is non-agricultural income.

The ordered logit model (Long and Freese, 2001) assumes that the probability of observing a certain value of y (Pr [y= m]) is conditional on a set of regressors and is defined by the expression: $\Pr[^{y=m}/_{x}]= \Pr[\tau_{m-1} \leq y^* < \tau_m \mid x]$; where: y*= is an underlying variable that takes values between

(- ∞ , + ∞) and conditions the possible observed values and are linked through the following rule: y=1 if y* <τ_1; y=2 if $\tau_1 \leq y* < \tau_2$; y=3 if $\tau_2 \leq y* < \tau_3$; y= 4 if y* ≥ τ_3; The values of y* are determinate by the linear function: y*=$\hat{\beta}_1$ + $\hat{\beta}_2$ Surface + $\hat{\beta}_3$ Age + $\hat{\beta}_4$ Education + $\hat{\beta}_5$ System + e.

These values include the following determining factors captured by the survey so that they are validated to find out if they influence the behavior of income diversification levels. The explanatory variables of the model are: age of the interviewee, measured in years of age. Education, represented by the years of schooling completed by each of the producers. Area, area of arable land (measured in hectares). Handling system, binary variable that indicates 0= if the producer reported monoculture; 1= if the producer reported polyculture (SMM) and finally agricultural income, indicating the proportion of total income generated by agricultural activities.

Results and discussion

Monoculture corn production system (SMo)

In this group the representative sample was 16 producers (35%) of the total number of interviewees with an average age of 51 years and 6 years of schooling. Sowing maize in monoculture involves sowing a single species. Although they continue to preserve landraces varieties, occasionally in this growing system herbicides are used for the control of arvenses, although this practice was carried out only by 18% of the producers interviewed, while the rest controls the herbs through the use of traditional techniques such as cultivation tasks (weeding, furrow, etc.).

Modified milpa system (SMM)

It is called a modified milpa system because in this type of handling only two crops combine: maize and pumpkin; unlike the traditional milpa system in which maize is interspersed with some legume such as beans, broad beans or ayocote and pumpkin. In this group there are 65% of farmers of the total sample; the average age of farmers is 55 years, while on average they have 5 years of schooling (Table 2). These results are similar to what Ramos *et al*. (2013) present for the Libre region, where the prevailing age is above 55 years and the average schooling was 4 years of study.

Table 2. General characteristics by handling system.

	Monoculture	Milpa modified
Age (years)	51	55
Schooling (years)	6	5
Sex (percentage)		
Female	12	13
Male	88	87
Number of children	4	5
Average area (ha)	1.5	2

	Monoculture	Milpa modified
	Production (yield kg ha^{-1})	
Maize	2 656	2185
Pumpkin	0	201
	Other activities (percentage)	
Merchant	25	7
Construction	13	20
Cattle raising	6	13
Day laborer	6	20
Worker	6	7
Neither	44	33
Total	100	100

Prepared based on field information 2018.

In the SMo group, the most important complementary activity was self-trade, from small grocery supplies to food sales service while in the SMM the complementary work is the construction that is mostly carried out outside the community for temporary periods, and even other states of the country, as well as the work of day laborers, which unlike past migration flows they were allowed to settle in destination cities, at present it is complicated by the precariousness of available jobs.

According to the categorization, the SMM presents 57% of the total number of interviewees with a low degree of diversification (category 2), followed by 20% contemplated with high diversification (category 4). Similarly, in the SMo most producers are in category 3 which means that the diversification of their activities is average, but prone to low and very low diversification (Table 3).

Table 3. Diversification ratio by management system.

Category	Management system		Total (n= 46)
	SMM (n= 30)	SMo (n= 16)	
1	10	25	15
2	57	25	46
3	13	37.5	22
4	20	12.5	17
Sum	100	100	100

Made based on field information.

The basic characteristics of the variables used in the model and the descriptive statistics for the sample size of 46 producers are presented in Table 4.

Table 4. Summary of the variables to work on in the model.

Variable	n	Mean	Standard deviation	Min	Max
Age	46	54	14.1	25	84
Education	46	5.6	3.9	0	16
Surface (ha)	46	1.8	1	0.5	5
Handling system	46	0.4	0.5	0	1
Percentage of agricultural income	46	51.3	33.4	2.2	100

Prepared based on field information 2018.

Non-agricultural income (dependent variable) has an average of 43 675.6 which means average income outside the agricultural plot with a standard deviation of 42 736.7 and a variance of 1.8. Figure 1 shows that there is little difference between the non-agricultural income of the two management groups. The average for the SMo is 49 095 ±50 359.5 and for the SMM the average earnings outside the agricultural plot is 43 675.9 ±38 697.9.

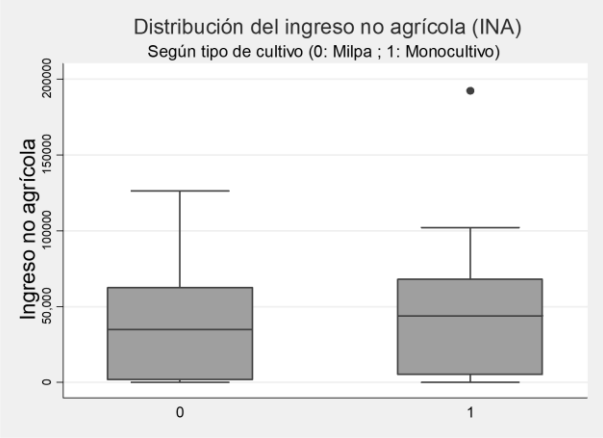

Figure 1. Distribution of non-farm income in a crop cycle.

The distribution of lower non-agricultural incomes occurs between the 26-50% percentile. While higher non-agricultural incomes are in the 76-100% percentile. There is also an atypical data which is found in the polyculture group (SMM). Using an ordered logit model, the value of $chi^2 = 0$ which indicates that the coefficients are jointly significant. While Pseudo $R^{2,}$ close to traditional r^2 indicates that 27% of the dependent variable (diversification of rural income) can be explained by variations in independent variables (Table 5).

Table 5. Basic results of the model: ordered logistic regression.

Variable	Coefficient	z	P>[z]	Standard error
Age	-0.0543**	-2.08	0.038	0.0261
Education	-0.0806	-0.57	0.572	0.1426
Surface	2.3213**	3.88	0	0.5977
Handling system	-0.7715	-1.22	0.222	0.6319
Percentage of agricultural income	-0.0721**	-3.9	0	0.0185

Prepared based on field information 2018. N= 46; Pseudo R^2= 0.2755; **= significant at 1%.

The level of schooling does not explain that producers diversify or not due to their statistical significance greater than 0.05, this result may vary depending on the sample size. In addition, it contrasts with literature that considers education as a favourable aspect for the impetus to households in the conduct of non-agricultural activities (De Janvry and Sadoulet, 2004; Yúnez and Meléndez, 2007).

On the other hand, De Grammont (2009a) found that the level of education is not sufficient to achieve an increase in incomes of producers, as cases have been found at the lowest levels of income where farmers have high levels of education; the level of education is not a determining factor in increasing the economic income of the producers. Similarly, there is no significant difference between management systems, since there is very little variation between the income of each of the groups.

On the contrary, age and surface size variables are determining factors for producers to choose to diversify their activities. With regard to the variable age there is a negative relationship in terms of the diversification of non-agricultural income; that is, older people are less likely to tend to do other activities, which resembles the work done by Andersen and Valencia (2010) where they conclude that older people tend to limit themselves to agricultural work.

The size of the cultivated area influences the likelihood of diversification of rural activities, so the smaller the area of crops, the greater the probability of participating in non-agricultural activities (Andersen and Valencia, 2010). On the other hand, it was found that the higher the proportion of agricultural income less incentives it has to report other non-agricultural activities, this relates to what is mentioned by De Grammont (2009b) where it refers that the dynamics of multiactivity change according to the level of income.

In other words, the lower the economic incentives, the greater are the practices in rural households to supplement their income. This trend of diversification of activities in the Mexican countryside is accompanied by the fall in corn prices, as well in wages. Among the age and education variables, negative and significant correlation was detected with a significance level of 5% (rho= -0.8198), this linear association between explanatory variables creates a problem of high collinearity in the econometric model. In order to avoid bias in the estimating of the variances of the beta coefficients of the logit model, it is necessary to eliminate this correlation between regressors.

For this reason, the problem was addressed by debugging the correlation with an auxiliary regression, where it is obtained the pure component of age variations that was not linearly dependent on education, once that component was extracted the correlation between the two variables has been eliminated (Gujarati and Porter, 2010).

An illustrative analysis was carried out to delve into the correlations that are significant (Figure 2), in the first group corresponding to the monoculture, the high diversification of non-agricultural activities tends to decrease as age increases, it can also be observed that in this group the type of diversification it dominates is the medium-low rate between 40-60 years and the closer to 20 years the agricultural activities carried out are more diverse.

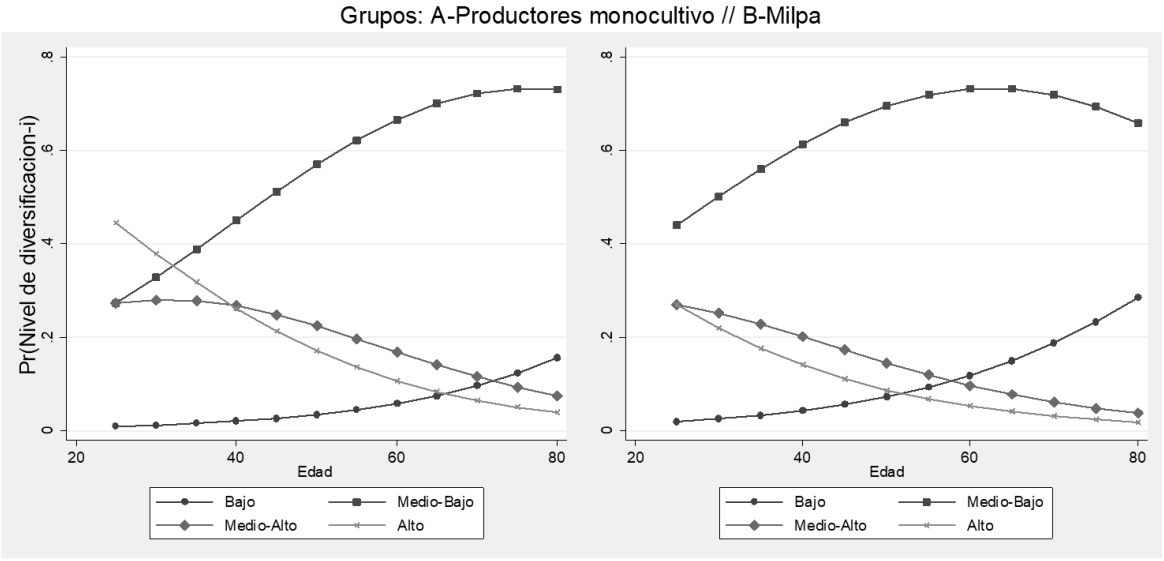

Figure 2. Estimated probabilities of reporting each level of diversification by age.

As for the group corresponding to the modified milpa system, the diversification of non-agricultural activities is also concentrated at a medium-low level, which reaffirms that the probabilities to be reported for high diversification in activities outside the agricultural site are scarce and almost zero as it approaches an age of eighty years in both producer groups. Figure 3 shows the results obtained through the model of the probabilities of non-agricultural income diversification levels, considering that the variable that is now changing is the percentage of income from agricultural activities.

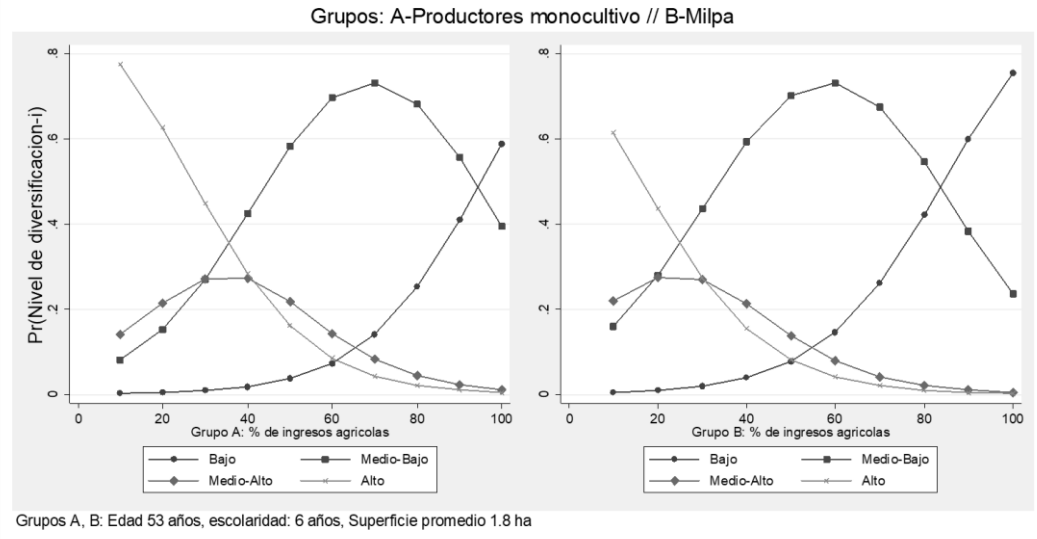

Figure 3. Probabilities of reporting each level of diversification according to percentage of agricultural income.

In the monoculture group as in the modified milpa, the level of diversification decreases when the percentage of income from agricultural activities increases, that is, at a higher level of income generated on the agricultural plot, producers tend not to look for other sources of income, which coincides with De Grammont (2009c) where it mentions that multiactivity differs depending on income level, so at the highest levels, the diversification of activities disappears. It is also found that the level of diversification in activities outside the agricultural site is higher in the monoculture production system.

Simpson index

The Simpson index for the modified milpa system reports a greater number of activities that contribute to the entry of the peasant unit compared to the monoculture system, because the Ds is close to 1 (Table 6).

Table 6. Comparison of Simpson Index between the two management systems.

System	Simpson Index
Monoculture	0.912
Milpa modified	0.958

Prepared based on field information 2018.

Agricultural income is higher in the SMM since it represents 54% of its total income, which is consistent with the Ds because they carry out activities that are mostly linked to the plot to ensure livelihoods, while diversifying their crops by combining maize with pumpkin. The opposite happens in the SMo because the proportion of income that does not depend on agricultural activities is higher in this type of management, because it amounts to 56% while in the SMM non-agricultural income represents 46%.

Of the total sample of producers (n= 46), 29 are engaged in activities other than agriculture, which in percentage terms represents 63%. If the results are broken down by management system, in the monoculture system 56% of producers carry out another activity, and in the modified milpa system 67 % is engaged in other activities besides work on the agricultural site. According to Magdaleno *et al*. (2014) this reflects the adjustment to the practices that peasant families carry out to continue their forms of subsistence, as a result of the lack of attention in Mexican agro.

According to the above, Table 7 shows the main sources of income outside the farm plot in the SMo, which come from self-employment, followed by wage employment, both derived from non-agricultural activities. While in the SMM there is an income from wage employment in the agricultural branch such as those who do work with the yunta and day laborers. It should be noted that in this group of producers dominates the non-agricultural wages employment, where mainly the construction sector or the working industry is located, being the main company in the region the automotive luxury cars AUDI.

Table 7. Diversification of employment in Tehuatzingo.

Production system	Self-employment (%)		Wage employment (%)	
	Agricultural activities	Non-agricultural activities	Agricultural activities	Non-agricultural activities
SMo	11	45	11	33
SMM	20	10	30	40

Prepared based on field information 2018.

At least 55% of total income in the peasant household comes from non-agricultural activities that are the support to support the family and to be able to plant their crops, this coincides with what was found by Janvry and Sadoulet in a study in 2004 where they mention that the income generated by activities carried out off the farm represents more than half of the income of peasant households in Mexico.

Multiactivity is a peasant practice that they use to continue planting, they use their labor in temporary employment, agricultural day laborers, in construction and self-employment such as commerce. This matches what describes Magdaleno *et al*. (2014) as well as Escalante *et al*. (2007) where families supplement their agricultural income with non-agricultural activities. Thus, there is a decline in the activities that were traditionally carried out in the Mexican field, where factors such as manufacturing and the services sector impact on the reduction of agricultural production.

Conclusions

Peasant families use different practices to maintain maize planting in order to obtain sustenment for the family. Farmers who diversify their crops tend to generate higher agricultural incomes compared to those engaged exclusively in just one crop. More than half of producers in both groups carry out activities other than agriculture as mechanisms to ensure the permanence and reproduction of the family.

The SMM has a higher rate of agricultural income diversification than the SMo according to Simpson Index. In addition, the most likely age to diversify their income is between 20 and 30 years, while older producers diversify less. With regard to non-agricultural income, the main source comes from participation in the wage labour market, which is also a current trend in the Mexican countryside. In Tehuatzingo peasants are temporarily employed as day laborers or in the construction industry. Currently working conditions are precarious and unsafe, unable to guarantee economic stability to the surplus labor from the field.

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