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## SUSTAINABLE LIVELIHOODS AND VULNERABILITY IN RURAL MEXICAN HOUSEHOLDS

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### Abstract

This paper identifies four different rural household profiles in Mexico, taking into account assets, income level, and other aspects related to vulnerability. The classification was done using cluster analysis and a sustainable livelihood approach. Our findings show that households diversify the ways they earn a living as one subsistence strategy to deal with the challenges of limited access to markets and physical infrastructure and weather-related damage from hurricanes and droughts. Likewise, rural Mexico is very heterogeneous across regions. This spurs reflection about the pressing need to design the right public policies to address the problems facing each household profile.

**Keywords:** Assets, sustainable livelihoods, vulnerability, rural households, cluster analysis.

### INTRODUCTION

At the moment, people living in rural areas represent 48% of the global population and 20% in Latin America. In this region, poverty has remained stable over the past three decades, proof of which is that 63% of inhabitants live on less than two dollars a day (Cepal *et al.*, 2003). Rural households draw on an array of strategies to survive, such as productive diversification, migration, and intensifying production, all while facing a broad range of risks (Ellis, 2000).

In particular, diversification is a fundamental strategy for rural households (Berhaus *et al.*, 2007; Aloba, 2015). In Latin America, between 20% and 30% of jobs are non-agricultural and account for 40% of rural income (Reardon *et al.*, 2001), although this figure may vary depending on the context or household assets (Mushonagh and Scoones, 2012). It bears mention that in Latin America, the debate on the role of the productive strategies used in rural households is nothing new. The first studies date back to the nineteen-seventies, when researchers provided extensive analysis of rural economies, emphasizing the importance of land surface area and fertility, as well as family composition (Chayanov, 1974; Stavenhagen, 1977; Shanin, 1978; Appendini *et al.*, 1983).

Later, at the end of the nineteen-nineties, the literature began to shift towards a sustainable livelihoods approach (SLA), which has been used to describe household strategies and the contexts of vulnerability they face (Ansoms and McKay, 2010). The merits of the SLA approach include its recognition of the diversity of livelihoods, the relevance of the social and institutional context, and the role that assets play (Aloba, 2015).

That is why, recently, the approach has been applied to many different countries, including Madagascar, Bulgaria, Guatemala, Peru, Philippines, Nigeria, Mozambique, China, Nepal, and Mexico (Winters *et al.*, 2002; Winters *et al.*, 2009; Morse *et al.*, 2009; Giesbert and Schindler, 2012; Orenco and Fujii, 2013; Bhandari, 2013; Hinojosa, 2013; Fang *et al.*, 2014; Ávila-Foucat, Saad and Fierros, 2014). These studies draw on a wide range of assets, although they differ across climatic, cultural, historical, and institutional conditions, and describe different stressors (Winters *et al.*, 2009; Ávila-Foucat *et al.*, 2014). The effects of stressors on households can vary depending on the characteristics of each household, and can alter daily life temporarily or cause profound commotion that requires governmental intervention (Van Den Berg, 2010; McDowell and Hess, 2012).

In Mexico, approximately 25 million people (representing 22.2% of the total population) live in rural areas, and six of every ten people (61.6%) who live in rural areas are poor (Coneval, 2012). As a survival strategy, households have diversified, and non-agricultural and non-livestock activities now represent 49.2% of total income (Cerón and Yúnez-Naude, 2015).

The SLA approach in Mexico has only been used in case studies, but not at the national level (Ávila-Foucat, 2012). Nevertheless, these studies have analyzed assets, revealing vast heterogeneity in terms of access to assets and in income (De Janvry and Sadoulet, 2001; Reardo *et al.*, 2001; Yúnez-Naude, 2010).

Accordingly, the objective of this paper is to identify, using cluster analyses, the different types of rural households in Mexico, considering their assets, monetary income levels, and other aspects related to the vulnerability they face.

### THEORETICAL FRAMEWORK

#### Sustainable Livelihoods

The sustainable livelihoods approach (SLA) has been used in numerical empirical studies in Latin America to measure the relationship between poverty and livelihood strategies (Jansen *et al.*, 2006; Diniz *et al.*, 2013; Lerner *et al.*, 2013; Ávila-Foucat *et al.*, 2014). Assets and access to assets are the foundation upon which rural households build their livelihoods. Assets become capital when they are used to generate goods, which can be divided into five types: 1) human, 2) social, 3) natural, 4) physical, and 5) financial (Ellis, 2000). The empirical evidence in Yúnez-Naude and Meléndez (2007) suggests that education, work experience, and age are several factors that drive which economic activities are chosen. Additionally, De Janvry and Sadoulet (2001) found that education is the main mechanism that allows households to move into non-agricultural activities. Similar results have been found for other parts of the world,

where human capital is a central aspect of productive diversification and welfare (Berhaus *et al.*, 2007; Ansoms and McKay, 2010; Mushongah and Scoones, 2012; Liu and Liu, 2016).

Financial capital has been widely studied, revealing that the main household assets are: access to markets, income, access to credit, and savings (Barbieri and Mahoney, 2009; Morse *et al.*, 2009; Mushongah and Scoones, 2012; Ansoms and McKay, 2010). Similarly, it has been shown that the infrastructure used in farming and means of transport are very important in defining livelihoods (Ansoms and McKay, 2010; Ulrich *et al.*, 2012).

Another asset that studies have demonstrated to be important is social capital. Cooperation between households (Barbieri and Mahoney, 2009; Mushongah and Scoones, 2012), community organization, relationships to organizations outside of the community (Bhandari), and migratory networks (Berhaus *et al.*, 2007; Mushongah and Scoones, 2012) are several key aspects of livelihood decision-making. In Mexico, the literature on social capital in forestry contexts is extensive (Rodríguez *et al.*, 2016), and has also been linked to the livelihood strategies of the *ejidos*, or community-owned lands (Winters *et al.*, 2002). Likewise, Poole *et al.* (2007), Robles-Zavala and Fiechter-Russo (2008), and Robles-Zavala (2010) have researched the role of institutions, assets, and the local environment in the diversification of rural household livelihoods in Mexico, using the SLA approach.

Land is the main variable used as natural capital (Fang *et al.*, 2014). A study of 24 small towns (less than five thousand inhabitants) in Mexico found that an additional hectare of irrigated land raised the likelihood (by 4.3%) that a household would grow commodity crops. Nevertheless, natural capital is much more than just cultivating the earth; wildlife, for example, is used as a means of daily subsistence (López-Felman, 2014), and even natural capital permits diversification, because many communities can start tourism projects related to nature (Ávila-Foucat and Pérez, 2015), or even other sorts of productive projects.

Vulnerability is driven by critical trends (population growth, economic growth, and technology trends), shocks (human health, conflicts, and climate change), and the temporary nature of certain variables (prices, production, job opportunities, to name a few), over which communities have limited control in the short and long run (Carney, 1999). This research is also interested in the effects hurricane- and drought-inflicted damage, as well as roadway infrastructure and distance from urban hubs (Finan *et al.*, 2005; Hoefle, 2016; Jansen *et al.*, 2006; Morse *et al.*, 2009).

### Typology of Households

There is a bevy of methods to categorize rural households and their livelihoods into groups (Barahona, 2006; Jansen *et al.*, 2006; Rodríguez and Meneses, 2010; Merma and Julca, 2012; FAO, 2013; Orencio and Fujii, 2013). However, Barret and Reardon (2000) asserted that three main criteria can be used to classify income sources: 1) spatial (local, national, and international); 2) functional (self-employment and wage workers); and 3) sectoral (primary, secondary, and tertiary), the latter being the most common. Recently, Orencio and Fujii (2013) developed profiles using the sectoral approach, and to do so, divided households into farming and non-farming activities. Other studies have opted to include a combination of the three criteria, and yet others have defined employment categories pursuant to temporal aspects (permanent or potential), and sectoral approaches (farming or non-farming). Other factors that have been considered include: land type, family structure, size of plots, and integration in markets (Hernández, 2000; De Janvry and Sadoulet, 2001; Barahona, 2006; Merma and Julca, 2012).

In Mexico, households have also been classified according to rural production units, which include both farmers and activities performed (De Janvry and Sadoulet, 2001; Yúnez-Naude and Taylor, 2001; Lerner *et al.*, 2013). In broad strokes, gross income is commonly used regardless of classification type (Yúnez-Naude and Taylor, 2001; Jansen *et al.*, 2006; Merma and Julca, 2012; FAO, 2013). Household profiles have also been drawn for various purposes: policymaking for smallholder farmers, describing farmers, crop productivity, and income composition (De Janvry and Sadoulet, 2001; Barahona, 2006; Rodríguez and Meneses, 2010; Merma and Julca, 2012).

Rural households in Mexico are very heterogeneous due to geographical and biotic diversity, access to infrastructure, and a diversity of cultural characteristics (Yúnez-Naude, 2010); this means that there is a wide array of strategies that people use to earn a living, and in some cases, livelihoods can be underestimated when they are classified based only on income.

## METHODOLOGY

### Data Gathering

The data used in this research was taken from the 2007 Mexican National Rural Household Survey (ENHRUM, in Spanish). The ENHRUM contains two components: the Community Survey (EC, in Spanish) and the Household Survey (EHH, in Spanish). The information was collected from 80 rural communities scattered throughout 14 states in Mexico, divided into five regions (1,543 households in the sample). The survey is nationally representative. The EC was used to evaluate vulnerability. To do so, we measured average distance from main urban supply hubs and the effects of weather events. The EHH was used to characterize household assets.

### Method to Create the Typology of Households

To construct the household groups, we used multivariate cluster analysis with four variables: 1) predominant source of income; 2) income level; 3) assets; and 4) context of vulnerability. Because the variables used in the cluster analysis are measured with different scales and units, a similar mixed method, with four groups ( $k=4$ ), and the Grower estimate to create distance between the variables were used (Lerner *et al.*, 2013). Analysis of variance (ANOVA) statistics were also used to ensure that the household groups created were mutually exclusive (Soltani *et al.*, 2012). The procedures used to estimate income sources, income level, assets, and context of vulnerability are described below.

### ***Income sources and activities***

First, the income sources were divided following the criteria in Barret and Reardon (2000): by spatial terms (local, regional, and national), functional terms (self-employment and wage workers), and sector. Based on these categories, the following seven sources were found: 1) agriculture, 2) livestock, 3) natural resources, 4) agriculture and livestock wage work, 5) non-agriculture and non-livestock jobs, 6) self-employment, and 7) remittances.

Second, net income for each household was estimated and production functions for each productive activity were created. Because natural resources and farm products are consumed by members of the households themselves (López-Felman, 2014), and on occasion exchanged with friends or relatives, people were asked how much money they would have earned if the products had been sold locally. Net total income is an estimate of all productive activities and remittances.

### ***Assets and Context of Vulnerability***

The assets were classified pursuant to Ellis (2000): human, physical, financial, natural, and social capital. Table 1 shows the variables used to describe the assets and the context of vulnerability.

## **RESULTS**

### **Typology of Households**

The household groups obtained from the cluster analysis were as follows: *smallholder farmers*, *farm wage-earning households*, *non-farm wage-earning households*, and *family business owners*. All of the household categories are diversified, so their names are meant only to reflect the main source of income (see Table 2).

#### ***Smallholder farmers***

The first cluster includes 20% of the sample (286 households) and is in the lowest end of the income distribution (deciles I and II), with approximately 3,390 pesos a year. Half of their income comes from farm work, natural resources, and remittances from abroad.

#### ***Farm wage-workers***

The second group includes 30% of the sample (deciles III-V), and their net annual income is approximately 20,000 pesos. Although most of their income comes from farm activities, one significant difference with respect to the above group is that this group is fairly dependent on the local labor market, because 38.5% of their income is reliant on farm wages and 23% on non-farm jobs.

Table 1. Variables of the assets used in household profiles

<i>Assets</i>	<i>Unit</i>
<b>Physical</b>	
Value of agriculture and livestock machinery and tools	Pesos
Value of other non-productive household assets	Pesos
Value of livestock herd	Pesos
<b>Natural</b>	
Type of natural resource	Name
Size of plot (irrigated and temporary)	Hectares
<b>Human</b>	
Age of head of household	Years
Education of head of household	Years
Size of household	Number of members
Indigenously-led household	1=yes, 0=no
Support for other households in case of emergency (reciprocity)	Number of people
<b>Social networks</b>	
Proportion of households in the town with migration to other parts of Mexico	Percentage
Proportion of households in the town with migration to the United States	Percentage
Number of people (friends) that could help the household in case of emergency	Number
<b>Financial</b>	
Amount of formal loans from financial institutions	Pesos
Amount of informal loans from financial institution	Pesos
<b>Context of vulnerability</b>	
Index of damage from hurricanes and droughts	0 to 1
Distance to main regional urban hubs	Kilometers
Index of road and bridge works	0 to 1

Source: Created by the authors based on data from ENHRUM 2007.

(SEE TABLE 2)

### **Non-farm wage-earners**

The third group contains 40% of the sample (deciles VI-IX) and their main source of income is non-farming wages (41%), fundamentally from temporary jobs in construction, transportation, and retail. The households in this group travel on a daily basis to the communities where they work in nearby towns, earning on average 60,000 pesos a year.

### **Family business owners**

The fourth group includes 10% of the sample and their net annual income was a little over 191,000 pesos a year. This set is in the upper income distribution (decile X) and is reliant in large part on non-farming wages (28.6%), self-employment (19%), and also agriculture (20%). These households own the largest swaths of land and have enough capital to invest in family businesses.

In short, it is clear that the first group depends on natural capital (land and natural resources) and remittances, the second two (2 and 3) survive thanks to wages (farming and non-farming), and a fourth lives off of self-employment and is less reliant on agriculture.

### **Livelihood Strategies**

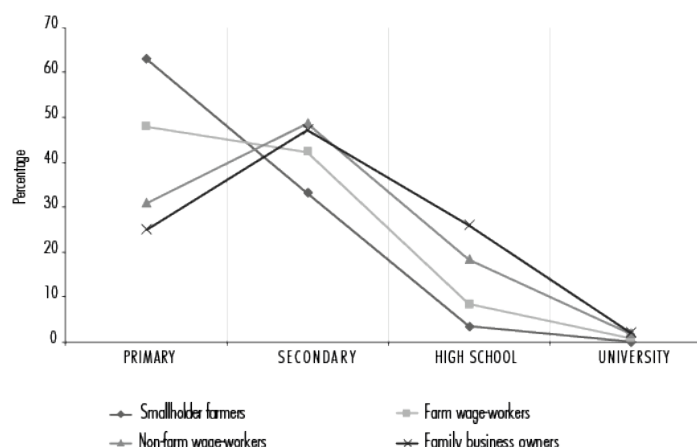
The analysis shows that practically all households do use diversification as a subsistence strategy, as 50% of household income comes from various economic activities. Productive intensification is not an essential strategy in and of itself, as households do not invest in agriculture and livestock infrastructure, and prefer to divide their time among other activities. Remittances are clearly a means of livelihood for the first group, but not for the rest, because income from remittances hovers between 15 and 19%. Accordingly, it is interesting to note that households draw on a suite of strategies at the same time, with a certain degree of emphasis on some strategies that depend on the income and assets they have, as described below.

**Human assets:** The results show that 25% of *smallholder farmers* do not have family members in the working age range (11 to 65 years old). By contrast, 77.5% of *family business owners* have three to six family members in the working age range.

Figure 1 shows level of schooling of the workforce (people aged 11 to 65 years old) for each household group. The *smallholder farmer* workforce is low-skilled, as 64% have completed only elementary school. By contrast, in the other three clusters, 50% of the family members have some secondary schooling. In addition, 3.5% of the *smallholder farmers* and 26% of *family business owners* have completed high school.

A high percentage of *smallholder farmers* are indigenous (31.8%), while only 7% of indigenous households belong to the group of *family business owners*. Poverty is tied to being indigenous, isolation, and low levels of schooling.

Figure 1. Education of the Labor Force (11 to 65 Years Old), by Household Group



Source: Created by the authors.

**Physical assets:** The composition of physical assets is very similar across the four household groups, given that non-agriculture and non-livestock assets are not the highest-value assets, even for *farm wage-earning households*. Livestock herds are another major source of investment. In other words, rural households do not invest in agriculture and livestock production; in their place, they prefer diversification or the purchase of livestock, suggesting that agricultural intensification is not the prime strategy (see Table 3).

**Natural capital:** All household groups collect firewood that they use as fuel to prepare food. Of all of the natural resources, firewood represents at least 52% of the resources used across all four household groups. Agave, the prickly pear, and other cactuses are the second-most important natural resource group, with the exception of *family business owners*, who do not use them. Medicinal plants are also important, and at least 5.6% of households use them. Wild mushrooms are important in the diet of *smallholder farmers* and, surprisingly, wildlife is essential to *small business owners* (see Table 4).

Table 3. Value of Physical Assets (Pesos)

	<i>Smallholder farmers</i>		<i>Farm wage-earning households</i>		<i>Non-farm wage-earning households</i>		<i>Family business owners</i>	
	\$	%	\$	%	\$	%	\$	%
Total	15 206	100	23 338	100	42 335	100	102 928	100
Value of livestock herd	6 057	39.8	8 995	38.5	15 525	36.7	40 140	39
Value of agriculture and livestock assets	1 411	9.3	2 971	12.7	6 109	14.4	17 854	17.3
Value of non-agriculture and non-livestock assets	7 738	50.9	11 372	48.7	20 702	48.9	44 934	43.7

Source: Created by the authors based on data from ENHRUM 2007.

Table 4. Use of Natural Resources (Percentage)

<i>Name of natural resource used</i>	<i>Smallholder farmers</i>	<i>Farm wage-earning households</i>	<i>Non-farm wage-earning households</i>	<i>Family business owners</i>
Tree timber	3.1	1.5	1.4	1.5
Firewood	59.4	62.2	53.5	52.3
Coal	2.9	1.3	0.5	0.0
Wild fruit	2.0	3.0	2.2	2.3
Medicinal plants	6.3	5.6	7.9	6.2
Edible plants, vegetables, crops	2.0	2.6	4.0	2.3
Wild mushrooms	3.4	1.1	1.6	0.8
Agave, prickly pear, and other cactuses	8.9	9.9	13.5	0.0
Materials gathered to make artisan crafts	0.3	0.4	0.3	12.3
Land for plants and leaves	3.7	4.1	4.0	5.4
Wild animals, like rabbits, iguana, and birds	1.7	1.7	1.7	4.6
Fish, seafood, and/or shellfish	3.7	3.7	4.5	6.9
Sand, gravel, and/or stones	2.3	2.4	3.9	4.6
Other	0.3	0.7	0.9	0.8
Total	100.0	100.0	100.0	100.0

Source: Created by the authors based on data from ENHRUM 2007.

On average, the vast majority of household groups has less than two hectares of land, which means that they cannot even produce enough food to survive all year (Cepal, 1982). *Smallholder farmers* have the largest percentage of land, between two and five hectares, and *family business owners* tend to have larger plots (five hectares or bigger).

*Financial assets:* In general, amounts are low and rise in relation to income. The amount of formal credit is highest among *smallholder farmers* and *non-farm wage-earning households*, and the majority of informal loans go to *farm wage-earning households* and *family business owners*. *Social networks:* Findings show that at least 17% of households have members that have immigrated to the United States, and 11.8% have members that have moved to other parts of Mexico. It also emerged that at least one person would be able to make a loan to other households in case of emergency. It is also clear that *smallholder farmers* can get more money in case of contingency situations, for an amount of 2,500 pesos, while *family business owners* would be able to get only half that amount (1,193 pesos).

*Context of vulnerability:* Table 5 shows that households with a greater share of non-agriculture income are close to regional development hubs, giving them greater job opportunities, while *smallholder farmers*, who are more reliant on natural resources, are more isolated. Thus, diversification is tied to proximity to cities and access to regional labor markets. Likewise, all rural households have suffered climate-related damage, due to hurricanes and droughts. Similarly, there are no major differences in terms of access to roadway infrastructure.

In short, assets exhibit similar conditions in terms of access to primary education, investment, natural resources and land size, informal loans, and migration. Damage from hurricanes and drought are similar across all households, but there are differences pursuant to proximity to urban hubs, the highest levels of schooling, and access to loans and credit.

Table 5. Variables of Vulnerability and Effects on Households

<i>Name of natural resource used</i>	<i>Smallholder farmers</i>	<i>Farm wage-earning households</i>	<i>Non-farm wage-earning households</i>	<i>Family business owners</i>
Index of damage from hurricanes and drought	0.2	0.2	0.2	0.1
Distance from regional hubs (km)	44.3	41.4	37.3	29.4
Index of public works, roads, and bridges	0.3	0.4	0.3	0.3

Source: Created by the authors based on data from ENHRUM 2007.

## DISCUSSION

The spatial, functional, and sectoral criteria used by Barret and Reardon (2000) were useful in identifying the rural household profiles. The results show that remittances are an international source of income (spatial criteria), wages and

self-employment represent a functional difference, and the agricultural and non-agricultural sectors reflect the main sectoral difference. Net income also has an influence on the profiles and elucidates the inequalities of rural Mexican households.

Diversification is the main livelihood strategy for low-income households, where *farm wage-earning households* focus their efforts on agriculture and livestock activities, while other household groups are concentrated on non-agriculture and non-livestock activities (except the *smallholder farmers*). Diversification in *smallholder farmers* is meant for remittances. In the other household groups, diversification tends towards non-agriculture wages or self-employment. The importance of wages is a sign of the reliance on activities derived from use of land and commerce. This means that diversification requires a minimum amount of income and asset accumulation, as indicated in previous studies (Ávila-Foucat, 2012), and also depends on access to labor markets. In effect, *family business owners* live the closest (29 kilometers away) to cities, giving them easy access to markets and reducing transaction costs.

These results match other studies that have demonstrated the importance of infrastructure in livelihood decisions (Finan *et al.*, 2005; Jansen *et al.*, 2006; Ansoms and McKay, 2010). The household groups obtained in this study are consistent with the findings of other research on the rural economy in Mexico, where agriculture and non-agriculture wages account for 49.2% of total rural household income (Cerón and Yúnez-Naud, 2015). It has also been shown that migration and remittances play an important role in poor communities, but are not enough to spur development (Stefoni, 2011; Cohen and Rodríguez, 2005). In fact, it is hard to say, based on these results alone, that non-agriculture and non-livestock income has fueled rural economic development or has mitigated extreme poverty (World Bank, 2008). Scoones (1998) defines productive intensification as a better use of natural resources, like land, wildlife, or forests.

Because cross-section data was used in this paper, it is difficult to analyze the process of economic intensification in detail. However, the results suggest that it is not an essential strategy, as households do not invest in agriculture and livestock infrastructure, signaling that agriculture is not a priority in the sample of households used. This finding is because irrigation-driven production is concentrated in specific districts and states throughout Mexico, such as Sinaloa. In summary, livelihood strategies are similar across households, but there is a different emphasis on agriculture and non-agriculture activities and in the categories where assets play an important role in these variations.

The precarious conditions ailing rural households can in part be attributed to limited access to credit (De Janvry and Sadoulet, 2011). *Smallholder farmers* and *non-farm wage-earning households* apply for formal loans in amounts less than 4,000 pesos, likely from local institutions. By contrast, informal loans are used by *family business owners*, who look for higher loan amounts. All of this spotlights the challenges involved in accessing large formal loans.

Nevertheless, the social networks analysis reveals that all households would be able to go to someone else for help in case of an emergency; what is surprising is that *smallholder farmers* can access higher loan amounts than higher-income households. Namely, the poorest households are more reliant on their social networks (close friends and relatives) than on formal credit. Other papers have demonstrated cooperation between households (Barbieri and Mahoney, 2009; Mushongah and Scoones, 2012); however, the findings of this study suggest that cooperation happens through loans and not only by interchanging assets.

Education is a widely-analyzed variable in Mexico, and its importance for development and diversification has been demonstrated in empirical studies (Yúnez-Naudé and Taylor, 2001; Bandhari *et al.*, 2013). The results show that all of the households have low levels of schooling, but that secondary education is more common in *non-farm wage-earning households*. Inequalities in schooling are also possibly due to distance from urban hubs and unequal access to labor markets.

*Family business owners* have the greatest endowment of physical capital, which means that they have the highest potential to invest, which gives them a deeper tool chest with which to confront stress factors. The livestock herd and non-agriculture and non-livestock infrastructure are the most important investments that all of the households make. The livestock herd is an important source of savings and families resort to it in case of problems (Berhaus *et al.*, 2007). Investments in cars and other non-agriculture and non-livestock investments are mainly in transportation needs, because public transportation in rural zones is sparse (Adato *et al.*, 2006; Giesbert and Schindler, 2012).

Agriculture and livestock infrastructure has a significant percentage share of the investments made by *family business-owning households*, in spite of farming not being their main economic activity. The minimum plot size for subsistence is four hectares, according to the ECLAC (1982), and as is the case for the majority of households in the sample, it is unsurprising that diversification into non-farming activities is the main strategy, implying that this diversification is a way to get out of poverty.

Natural resources are an important income source (Shana and Sundriyal, 2012) and a significant component of the diet (Belcher *et al.*, 2005). Other studies have demonstrated that natural resources are important to survival, especially for the poorest households (López-Felman, 2014), but it is interesting to note that the benefits that nature gives to rural households is independent from whether they participate in agriculture and livestock activities or not. Dependence on firewood is due to poverty, but also to culture and culinary traditions. In Mexico, 27.8% of power for households, stores, and public roads comes from wood kindling (Sener, 2011). Medicinal plants are used to cure disease and wild mushrooms are part of the diet for the first three household groups. The wealthiest households hunt wildlife (like bush meat), likely due to the cost of the firearms necessary for hunting.

*Family business owners* live closest to the cities (29 kilometers away) as compared to *smallholder farmers*, who face higher transaction costs and challenges in accessing regional markets.

Looking at climate change-related hurricanes and droughts, it is clear that all of the household categories are affected (Van Der Berg, 2010), but vulnerability is exacerbated in certain cases when families have limited resources. For example, *smallholder farmers* are the most vulnerable because they face the greatest challenges in accessing regional markets and have the lowest education levels. These households also have few agriculture and livestock physical assets (1,411 pesos) to augment productivity or their supply of agriculture and livestock products (milk, eggs, and crops). Moreover, the vast majority of these households have lands (less than two hectares) that are seasonally vulnerable to climate change and suffer from limited access to credit (1,293 pesos).

In Mexico, recent case studies have analyzed livelihoods and vulnerability (Eakin, 2005; Robles-Zavala, 2010; Giesbert and Schindler, 2012; Winters *et al.*, 2009). However, few studies have examined the relationship between income and family assets (Winters *et al.*, 2002). Moreover, most of the research on livelihood strategies has drawn on case studies, and few have provided nationwide empirical evidence.



The results of this study can be used to understand the regional heterogeneity of income, assets, and the contexts of vulnerabilities facing communities, providing a holistic overview to maximize the livelihood strategies that rural households adopt and the decisions they make (Carter and Barrett, 2006; Giesbert and Schindler, 2012). The relevance of education, age of the workforce, and size of land has also been addressed in the literature, but natural resources, access to informal credit, social networks, and context of vulnerability have received less attention in Mexico with the SLA.

In terms of the limitations of this research, the main limitation is that the survey used was not conducted with an SLA, but it does offer a wealth of data, which make it possible to create proxy variables for each capital. Other approaches have been used to analyze productive activities, diversification, poverty, and the rural environment (World Bank, 2001; Carter and Barret, 2006; Winters *et al.*, 2009; FAO, 2013), but asset-based analysis is the most important tool to understand households' capabilities and skills (Winters *et al.*, 2002). Structural aspects, like education and poverty, are undoubtedly crucial to development. However, development policies derived from this study can also be directed at diversification, markets, remittances, credit, and social networks.

Diversification is a major strategy that households use, and sectoral policies have tended to support productive activities, but they are not consistent with each other. Accordingly, in order to support diversification, it would be necessary to have an efficient and coordinated policy that considers sustainable development. Likewise, policies designed for diversification seem to be a better strategy than remittances for rural development, as Stefoni (2011) demonstrated.

Access to markets, and especially to jobs, is an important aspect to which close attention should be paid; likewise, household organization may decrease transaction costs (FAO, 2013). For example, household loans must become more accessible in terms of administrative requirements, the guarantees required, and interest rates. Finally, social networks are essential to accessing credit and remittances.

## CONCLUSIONS

Based on income availability, family assets, and the context of vulnerability, we identified four household profiles: one tied to natural capital and remittances; another two to agriculture and non-agriculture wages, respectively, and the fourth to self-employment. Productive diversification is the main livelihood choice made in response to exogenous factors and the best development strategy as compared to ramping up remittances. Access to elementary school education, investments, natural resources, size of land, and access to formal loans are all very similar across the different household groups. Likewise, damage from droughts and hurricanes affects every level, but proximity to cities is different, as is level of schooling, and access to loans and credit. Structural aspects, like education and poverty, are undoubtedly crucial to development; however, other development policies derived from this study are also important to consider: sustainable diversification, access to markets and commercialization, and access to formal credit.

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