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Is Farming a Lucrative Strategy for the Rural Population in Calakmul Region, Southern Mexico?
Analysis of Diversification of Livelihood Strategies

Master thesis

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DECLARATION

I hereby declare, that I have written this bachelor thesis "*Is Farming a Lucrative Strategy for the Rural Population in Calakmul Region, Southern Mexico? Analysis of Diversification of Livelihood Strategies*" myself with help of the literature listed in references.

Prague, 24 April 2015

……

Hedvika Vašková

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ARTICLE SUBMISSION

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ABSTRACT

An understanding of the dynamics of rural livelihood strategies is a key for rural development and poverty alleviation in developing countries. The thesis attempts to define the livelihood diversification of rural households (HHs) in the Calakmul region by focusing on the types of livelihood strategies pursued by HHs and their lucrativeness depending of the influence of the Calakmul Biosphere Reserve (BCR). We randomly selected 150 HHs from three villages for a questionnaire survey. To identify HH income shares by source we used cluster analysis techniques. Five livelihood strategies pursued by HHs were classified. Using Tukey's HSD test, income sources for each strategy were compared. Our findings show that the Non-farm self-employment strategy is the most lucrative and the Informal employment strategy is the least profitable. The CART Tree Algorithm classified as significant variables: *Total income, Education of working male, Number of working members.* Using the Multinomial Logit Model we identified that these variables increase the likelihood of inclusion of HHs in non-farm strategies compared to the reference strategy - *Farm self-employment strategy*.

Key words: households, cluster analysis, logit model, income, employment, Calakmul Biosphere Reserve

ABSTRAKT

Pochopení dynamiky venkovských životních strategií je klíčové pro venkovský rozvoj a snižování chudoby v rozvojových zemích. Tato práce se pokouší definovat diverzifikaci životních strategií domácností v regionu Calakmul, se zaměřením na typy strategií obživy sledovaných domácností a jejich výnosnost v závislosti na vlivu Biosferické rezervace Calakmul (BCR). Ze tří vesnic bylo náhodně vybráno 150 domácností, které se zúčastnili dotazníkového šetření. Ke zjištění příjmů z různých příjmových zdrojů jsme použili techniku klastrové analýzy. Bylo klasifikováno pět životních strategií, do kterých se domácnosti zapojují. Použitím Tukeyho HSD testu byly porovnány zdroje příjmů pro každou strategii. Naše výsledky ukazují, že Nezemědělská samostatně výdělečná strategie je nejvíce lukrativní a strategie Neformálního zaměstnání je nejméně profitabilní strategie. Algoritmus CART klasifikoval jako významné proměnné: ce*lkový příjem, vzdělání pracujících mužů a počet pracujících členů*. Použitím Multinomial Logit Modelu, jsme zjistili, že tyto proměnné zvyšují pravděpodobnost zařazení domácností do nezemědělských strategií ve srovnání s referenční strategií - *Zemědělská samostatně výdělečná strategie.*

Klíčová slova: domácnosti, klastrová analýza, logitův model, příjmy, zaměstnanost, Biosferické rezervace Calakmul

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LIST OF ABBREVIATIONS

CBR	Calakmul Biosphere Reserve
HH	Household
HSD	Honest significant difference
DFID	Department for International Development
CART	Classification and regression tree

1. INTRODUCTION

The analysis of livelihood strategies is a key in identifying appropriate poverty-reducing interventions (Davis *et al.*, 2010). The aim of such an analysis is to deepen understanding of the causes of the dynamics of poverty and the livelihoods of target groups, the processes of increased well-being or impoverishment, HH responses to opportunities, shocks and stresses, and the outcomes of policy interventions (Rakodi, 1999).

Livelihood strategies are a set of choices which include productive activities, investment strategies and reproductive choices (Chambers and Conway, 1991). Livelihood strategies are the combination of activities that allow people to meet their needs of life such as for food, water, health care, shelter, sanitation, clothing and many others (Parisi *et al.*, 2003). The selection of livelihood strategies is influenced by many external factors from which the most important are policies and institutions that affect the livelihood of people, livelihood outcomes affecting access to capital (natural, physical, human, financial and social) and vulnerability to shocks (Kollmair and Juli, 2002).

Livelihood strategies represent a dynamic and holistic concept which includes all material and non-material aspects of human well-being (Chambers and Conway, 1991). Studies by Ellis (1999) and Barrett *et al.* (2001) show a huge diversity in livelihood strategies that people use to accomplish their goals. Livelihood strategies differ in time, in each region and between HHs. Empirical studies (Ellis, 1999; Davis *et al.*, 2010) have proved that members of rural HHs are involved in a diverse range of farm and non-farm profitable activities. However, the identification of profitable activity is difficult. According to Barrett *et al.* (2001) a livelihood strategy cannot be identified based on a single profitable activity as HH members are often engaged in various profitable activities. According to Barrett *et al.* (2001) a livelihood strategy cannot be identified based on a single profitable activity as HH members are often engaged in various profitable activities. Studies by De Janvry and Sadoulet (2001) and Winters *et al.* (2002) show a high level of diversification of HH income in Mexico. These authors claim that rural HH income is highly diversified because HHs lack access to land.

The main objective of the thesis is to define livelihood diversification and to understand the determination of the livelihood strategies of the HHs located in the *municipio* of Calakmul. To analyze lucrativeness of each rural livelihood strategies based on the annual HH income share by sources.

2. LITERATURE REVIEW

This chapter deals with the concept of livelihood strategies. It attempts to describe attributes of a livelihood and the factors influencing livelihood diversification. It provides an overview of the main determinants in the selection of livelihood strategies. This chapter serves as the conceptual framework of this thesis.

2.1. Livelihood strategy concept

Livelihood strategy concept provides an exact and realistic understanding of people's strengths and weaknesses and it is used for the understanding of different dimensions of living (see Figure 1) (Kollmair, 2002). It is a way to understand the complexities of the human living, primarily the livelihoods of the poor dwellers in rural and urban areas as the whole (Chambers and Conway, 1991; Scoones, 1998). The livelihoods concept aims to take a more comprehensive and integrated approach to poverty. It takes into account a larger range of factors influencing poverty not only on the basis of income and productivity (Barrett *et al*., 2001; Ellis, 1999; Chambers & Conway, 1991; Scoones, 1998).

The livelihood analysis provides the compact and deep picture of current situation in specific areas (policy, politics, history and socio-economic conditions) (Scoones, 1998). The analysis of rural livelihood is crucial for development research that aims on identifying suitable mechanisms for poverty reduction and describing what steps have to be chosen in order to escape poverty (Nielsen *et al*., 2013). The livelihood framework can be applied to the individual HH, group of HHs, village, region or nation (Scoones, 1998).

Livelihood strategies are the subsistence of development. People use the livelihood strategies for the creation of their HH livelihoods. Livelihood strategies represent the combination of activities determined by HHs (Davis *et al*., 2010). HHs can be involved in many different social and economical activities (farm production, non-farm activities, migration, wage work etc.). All choices of strategies are affected by HHs assets (e.g. land, crops, labour, knowledge, livestock, relationships etc.) and other external factors

(eg. political, economic and socio-cultural contexts, risks, shocks or problematic access to services.) All these factors are important during decision making process of HHs. (Chambers and Conway, 1991; Scoones, 1998; Ellis, 1999; Barrett *et al.*, 2001). The aim of all these activities is achieving HHs livelihood goals (Chambers and Conway, 1991; Scoones, 1998; Ellis *et al*., 2003).

The livelihood strategy concept is closely connected with the sustainable livelihoods. The term "*sustainable livelihood"* concerns a wide set of issues which include broader debate about the relationships among poverty and environment. The definition of sustainable livelihoods according to Chambers and Conway (1991) is as follows: "*A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks maintain or enhance its capabilities and assets, while not undermining the natural resource base.*"

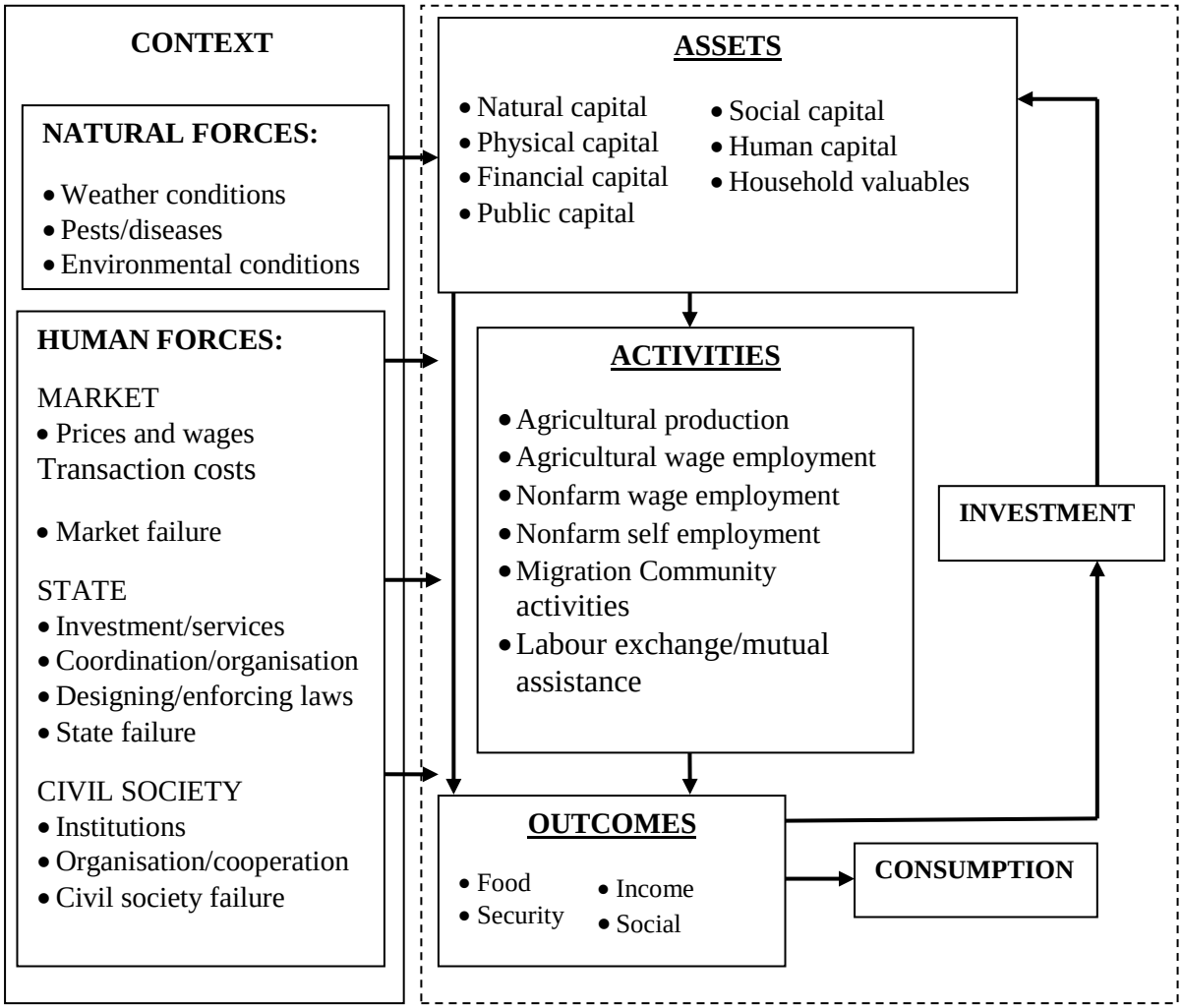

Figure 1: Household livelihood strategy framework

Source: Winters and Gordill (2001)

2.2. Sustainable livelihoods

A livelihood includes the capabilities, assets (consisting of natural, physical, social, human, and financial forms of capital) and activities needed for a well-being of HHs. Livelihood is a sustainable assuming that meets following conditions:

a) The features of vulnerability include shocks, stresses (human health, natural, economic, conflict shocks, etc.), seasonality (production, health, seasonal employment opportunities, hungry season, etc.) and trends (population, resource

trends, trends in governance, technological trends, etc.). These factors affect behaviour of HHs (Chambers and Conway, 1991; DFID, 1999). HHs are not able to control these factors directly

b) HHs are independent on external assistance (dependence on government contributions or assistance from family members).

c) Ability of HHs to maintain the long-term productivity of natural resources and ensure sustainable livelihood opportunities for the future generations.

d) HHs can not undermine or put at a disadvantage the livelihoods of other HHs. (Chambers and Conway, 1991; Holling, 1993; Davies, 1996; Scoones, 1998; Ashley and Carney, 1999).

2.3. Basic needs of rural households

The livelihood strategy concept has no a clearly defined starting point. The study by Ashley and LaFranchi (1997) deal with identifying of HHs needs. The study divides HH needs into two basic groups. The first group is *Physical needs* such as staple food, energy, water, shelter, etc. The second group covers *Livelihood needs* such as goods for barter exchange, reserves, drought cropping strategies, production inputs, cultural assets, community strength and effective local governance and resource management. Nevertheless, based on the preferences, expectations, HH size and circumstances of the HH extend of these needs differs. Some basic needs as sufficient food nutrition, shelter and clothing can be met despite the small value of assets. While others needs, such as quality and quantity of education, health care, cultural tradition and spirit, require more than that. In these cases, state policy plays an important role (Gleick, 1996; Ashley and LaFranchi 1997; Lanjouw, 1999 Furthermore, not all HHs have the same level of assets based on fulfilling their needs. Consequently, rural HHs develop different livelihood strategies (Ashley and LaFranchi, 1997).

2.4. Livelihood assets of rural households

HH livelihood strategies are depended on the access to different kinds of assets. The assets together with the socio-economic context determine the choice of livelihood strategies or ways in which HHs handle with their assets (Siegel, 2005). The asset-based approach can be used to describe relationships among assets, socio-economic context, behaviour and outcomes (Carney, 1999; Rakodi, 1999; Siegel 2005; Winters *et al*., 2002). The portfolio of assets is a stock of capital for HHs and communities that can be consumed directly and/or indirectly. HHs generate the means of survival through assets. The HHs well-being is determined by the access to the assets (Ellis, 1999; Winters *et al*., 2002).

The assets of HHs are generally defined as financial, human, natural, physical, and social capital. Dividing of assets into five categories can be a useful starting point for a HH livelihood analysis as well as a helpful guideline to gain a more complex picture of the HHs and their livelihood assets (Ellis, 2000; Jansen, 2005). The importance of assets in the livelihood strategy concept is as follows:

Human Capital reflects the stock of human skills, knowledge, ability to work and health condition available to HHs. These characteristics together enable HH to participate in different livelihood strategies and achieve their livelihood objectives *Human Capital* reflects the stock of human skills, knowledge, ability to labour and health condition available to HHs. These characteristics together enable HHs to participate in different livelihood strategies and achieve their livelihood objectives (Sayer and Campbell 2003). Human capital is a key within the livelihood strategy concept for the reason that the other assets are in many cases partly depended on the human capital which serves as a supportive factor (Kollmair, 2002).

Social capital is a very broad term with a lot of aspects. In the context of livelihood strategy concept we understand that social capital involves the social resources which the HH use for creation of livelihood outcomes such as informal social networking, membership of formalised groups, ability to cooperate, people's trust, etc. (Kollmair, 2002; Sayer and Campbell 2003). Value of social capital is affected through age, gender, place of

birth, social class; each member of the HH can dispose of different amount of social capital within the HH. Increasing social capital involves a positive effect for HHs but also can causes negative impacts that may have a negative effect on the HH development such as disadvantaging of HHs from different caste, ethnicity or religion or usurping the decision-making power by one member of the organization or a group. The study by Bebbington (1999) indicates a strong connection among social capital and poverty and claims the involvement of HHs into different kinds of organizations or groups leading to the increase of incomes.

Natural capital is the term used for the stock of natural resources such as land, water, forests, wild resources, air quality, erosion protection, biodiversity degree, etc. Natural capital presents a great value to those who derive their livelihoods from resource-based activities. High importance can be monitored particularly in rural communities, with a high proportion of poor HHs (Kollmair, 2002). Within the context of natural capital a close relationship among natural capital, the vulnerability context and the shocks and stresses exist (e.g. fires, floods, earthquakes, etc.) that negatively affects the activities of the HHs (Scoones, 1998).

Physical capital can be characterized as requirements needed to support livelihood such as basic infrastructure (e.g. transport, communications, energy, shelter and water), the production equipment and means allowing the efforts the pursuit of various livelihood strategies (Kollmair, 2002).

Financial capital represents the financial resources that HHs use to achieve their objectives. Financial capital comprises the financial resources available to HHs (e.g. savings, supplies, remittances, pensions or salary) that provide opportunity to involve the different livelihood activities (Kollmair, 2002). Financial capital can be divided into two different categories (a) available stocks in the form of cash or different assets (cash, bank deposits, livestock, jewellery) and/or (b) regular inflows of money (salary, pensions, remittances) (Ellis, 1999). Amount of financial capital is a main precondition for the increasing of other capitals (Kollmair, 2002).

2.5. The role of livelihood strategies in poverty reduction

Nowadays, poverty is commonly understood as deficiency of individuals or HHs which are not able to acquire access to materials and social services and ensure the sufficient amount of livelihood assets (Coudouel *et al*., 2002). The main indicator of poverty is the increase of inequality of well-being indicators (e.g. income, access to safe water and health care) (Ellis, 1999). Livelihood analysis can be used for a wide range of applications, such as interpretation of the causes of rural poverty and implementation of measures for poverty alleviation. Consequently, the understanding of the connection between livelihood strategies and poverty is crucial to the long-term poverty reduction (Soltani *et al*., 2012; Zrnteno *et al*., 2013).

Currently, the predominant view is that non-farm activities play a significant role in breaking the vicious circle of rural poverty. There was found out that the involvement in non-farm activities has an important impact to reduce poverty compared to local development of agriculture (Lanjouw and Feder, 2001; De Janvry *et al*., 2005, Soltani *et al.*, 2012). On the other hand, many studies point to the fact that the conventional agricultural strategy is also important in poverty alleviation. These studies claim that improving of conditions in the agricultural sector (e.g. increasing of farmland area, improving of land productivity) can have a positive impact on rural population. Agricultural strategies are the most effective way of reducing poverty in rural areas (Reardon *et al*., 2001; Alary *et al*., 2011; Christiaensen *et al*., 2011).

2.6. Livelihood strategy diversification

Rural livelihood diversification is characterized as the process by which rural HHs extend the portfolio of their activities and assets in order to survive and to improve their well-being (Ellis, 1999). The majority of the rural HHs base their livelihood strategies on different activities in order to raise incomes, to protect the HH from risky events and thus reduce the livelihood vulnerability (Barrett *et al*., 2001). HHs is generally engaged in strategy more than year (Ellis, 1999). Another way of looking at diversification is a self-insurance as it is stated in the study by Barrett *et al.* (2001): ‘‘*Diversification is widely*

understood as a form of self-insurance in which people exchange some foregone expected earnings for reduced income variability achieved by selecting a portfolio of assets and activities that have low or negative correlation of incomes''. Livelihood diversification is related to farm activities as well as to non-farm activities (e.g. waged labour, self-employment) (Hussein, 1998; Barrett *et al*., 2001). The predominant part of HH income is generated via farm activities in rural areas. Non-farm activities generate mostly additional income (Carter, 1997; Hussein, 1998). Diversification of HH activities is affected by many factors as desperation, location, environmental changes, opportunity or risk management (Barrett and Reardon 2001). The motives can be divided into two basic categories:

(a) *Push factors* can be described as constraints that prevent HHs to diversify their income. In this case HHs generate incomes only from one or two activities and it can cause an inability to meet HH daily needs. Vast majority of poor rural HH in Latin America diversified their incomes by earning activities in order to prevent negative economic impact (Winters *et al.,* 2002). Typical *push factors* faced by farmers in rural areas of Mexico and Bolivia are seasonal droughts, lack of irrigation, market failures, lack of land or high input costs (Barrera *et al.,* 2007; Groenewald and Bulte, 2013).

(b) *Pull factors* are incentives that create labour market opportunities outside the agricultural sector and help to HHs to be engaged in multiple income earning activities (e.g. improved infrastructure, proximity to an urban area, better market access) (Ellis, 1997; Barrett *et al*., 2001; Chamberlin and Jayne, 2012). Studies by Barrett *et al.* 2001 and Winters *et al.* 2009 claim that market access is a key determinant of diversification of activities.

2.7. Livelihood strategy determinants

A decision about a livelihood strategy is directly proportional on volume of HH assets. Assets have a significant importance for choosing a livelihood strategy because they determine the profitability or unprofitability of chosen strategy (Ellis, 1999; Winters *et al*., 2002; Siegel, 2005). The study carried by Taylor and Yunez (2000) in Mexico shows that volume of HH assets has a significant effect on HH participation in income generating activities and tendency to return to those strategies. HHs can multiply their assets through investment and thus affect future livelihood strategies. The value of assets is directly dependent on ownership status and transferability (de Janvry and Sadoulet, 2000). For instance, agricultural production or self-employment income strategy can use natural, human, financial, or physical capital. Agricultural wage employment or non-farm employment uses human capital as education, social network and physical or natural capital. Studies carried out in Latin America show the importance of the broad scope of activities that integrate a livelihood strategy (Reardon *et al.* 2001). According to the study by Winters *et al.* (2002) the social variables have a significant influence to income generation from farm and non-farm activities in rural Mexico. There was found out that diversification of livelihood strategies may cause increasing migration (national or international) due to high costs of diversification (De Janvry and Sadoulet, 2000).

Land is theoretically a clear (can be easily identified as asset) and transferable asset (the property rights are clearly defined and the assets can be transferred to others for their use) (Winters *et al.*, 2002). In some cases, particularly in Ecuador, may occur such conditions when the land is not clear or transferable due to the lack of markets and property rights. The lack of transferable assets can make the selection or continuation of livelihood strategies more difficult (Samaniego, 2006). For instance, HHs that own large amount of land can be engaged in agricultural production, but they can also transfer their land (access) to financial capital and thus diversify their livelihood strategy (Lopez, 2008).

An equally important role in the livelihood decision process is played by *Human capital.* Human capital is directly influenced by the level of education. The likelihood of inclusion in non-farm wage employment increases if the individual attains at least secondary education (Corral and Reardon, 2001). The average years of schooling of HH members is an important determinant affecting HH income. The study carried out by Taylor and Yunez (2000) shows that the increase of average years of schooling of a HH head has decreased the likelihood of inclusion in staple production and furthermore has increased the likelihood of participation in wage work, and has increased the level of international migration. Based on the studies from Nicaragua (Corral and Reardon, 2001) and Ecuador (Lanjouw, 1999), it was found that the average years of schooling of HH members increases the chance of inclusion into non-farm activities and thus generate higher income.

Public assets like electrification, infrastructure and safe water are significant determinants in the process of selection of livelihood strategies in rural areas. Good access to roads has been an important determinant in implementation and diversification of livelihood strategies in rural Ecuador (Lanjouw, 1999) and Nicaragua (Corral and Reardon, 2001). Similar results were found in El Salvador, where the probability of finding non-farm wage employment was highly influenced by access to paved roads (Lanjouw and Feder, 2001).

The state policy affects livelihood activities through diverse actions such as the investment on infrastructure, provision of services, designing, implementing and enforcing laws, etc. For instance, state investment on infrastructure can decreasing transaction costs and thus adjust market prices. It is essential to provide the access to education and health care and thus increase value of human capital in the country, region or village (Corral and Reardon, 2001).

2.8. Income-generating activities of rural households

Studies from developing countries which were carried out in recently, indicate that rural HHs are dependent on the volume of their assets. The volume of assets is often directly proportional to the value of HH income. The results show that there is significant evidence about increasing importance of rural non-farm activities (Reardon *et al.*, 2001). For instance, the study by Reardon *et al.* (2001) from Latin America claim that 40% of rural HH income comes from rural non-farm activities. Moreover, the trend is leaning toward non-farm activities for rural population. These non-farm activities have played a crucial role in implementing the rural work force and generating income (Winters *et al.*, 2001). This changing situation emphasizes the significance regarding to the different activities as a whole and highlights the necessity to enhance and support livelihood strategies in order to help rural HHs to assure decent life.

Non-farm activities became an important part of livelihood strategies among rural HHs. Studies by de Janvry and Sadoulet (2001); Winters *et al.* (2001); Lanjouw and Feder (2001) and Reardon *et al.* (2001) reported an increasing share of non-farm income in total proportion of HH income. The study by Elbers and Lanjouw (2001) shows that in Ecuador non-farm activities constitute a significant share of rural employment; 36% with a growing tendency in 1994. The share of income by activities indicates that own farm employment represents 46% and non-farm self-employment around 32% in rural Ecuador. It represents the biggest share of income in comparison with other country as Peru, Mexico and Nicaragua, showing the values of 30%, 9% and 11% respectively).

As non-farm activities are considered activities outside the agriculture sector; manufacture and services (Reardon *et al.*, 2001). Non-farm activities can be divided into three basic categories (a) Self-employment includes activities as primary processing of raw materials, trade, traditional healer, transport of goods, selling goods; (b) Wage activities comprise all non-agricultural wage employment such as teacher, government worker, builder; and (c) Migration is characterized by remittances which represent income sent back by family members living in other parts of country or in foreign countries (Voedseleconomie, 2011).

Agriculture used to be the main source of income for most rural HHs for many years. It used to be common that rising outputs and incomes in agriculture sector were driving force for diversification of non-farm activities in rural areas (Ellis, 1999). In recent years, there occurs declining interest of HHs to be engaged in agricultural activities and at the same time increasing number of HHs engaged in non-farm and non-rural activities, which are resulting in enlarging the slums nearby cities etc. Table 1 shows the data on the HHs participation rates in rural income generating activities for the selected country from Latin America. The table 1 indicates the continueing importance of agricultural activities for rural HHs. The agricultural production is still remaining as a key activity. The study by Covarrubias *et al.* (2012) claims that more than one in three rural HHs are engaged in agricultural wage markets.

Table 1: Household participation in rural income-generating activities

Country and year	Agricultural total (%)	Non-agricultural total (%)	Agricultural wage employment (%)	Non-agric. wage employment (%)	Non-agric. self-employment (%)
Ecuador (1995)	93.0	85.3	39.1	34.4	38.8
Nicaragua (2001)	95.0	72.8	39.4	35.2	26.2
Guatemala (2000)	92.6	84.1	42.6	34.5	30.7
Panama (2003)	86.6	86,5	35.4	31.9	25.7

Source: Covarrubias *et al.*, 2012

2.9. Livelihood outcomes of rural households

Livelihood outcomes are the goals which HHs want to achieve and they represent result of pursuing the livelihood strategies. HH activities influence the outcomes (e.g. increasing income, access to food, health, reduced vulnerability). Livelihood outcomes can be evident immediately or evident only over time. For example, agricultural production can bring immediate increases in income. Activities such as communal work or networking do not ensure immediate income but they can lead to future social benefits. Diversifying activities is a method how to reduce variability of outcomes (Winters *et al.*, 2001; Babulo *et al.*, 2008). Livelihood outcomes are not just dependent on access to assets or affected by the vulnerability context. The outcomes are also shaped by the environment, structures (public and private sector organizations) and processes (laws, regulations, policies, societal norms) (Serrat, 2008).

Income is the main variable for analysis for majority of studies. However, the measurement of HH well-being based *only* on income is incorrect for a broad variety of reasons. Firstly, HHs tend to be underestimated due to strategic reasons (financial or material support). Secondly, rural income is especially irregular over the time and vulnerable to shocks. It can adversely affect the indicator of economic status of HHs. Thirdly, earnings are suggestible to temporary fluctuations due to the temporary events. Fourthly, income can incorrectly reflect disparities in consumption that result from differences across HHs in the accumulation of assets or savings. For HHs that face poverty and high extent of material need, income is insufficient and not reliable criterion for outcome analysis (Meyer and Sullivan, 2003).

2.10. Quantifying rural livelihood strategies

The vast majority of studies dealing with income diversification strategies have used total income as a main criterion (Reardon, 1997, Cavendish, 2000). The disadvantage of this approach is susceptibility to seasonal fluctuations over the years. For example, income from crops can indicate considerable yearly fluctuations due to climatic changes. Therefore, obtained results may be inaccurate or flawed. The study by Ellis (1999) uses

multiple criteria to account for different income strategies. For instance, the proportional contribution of several income sources to group of HHs into income strategy categorization. Another approach is based on the multiple HH activities and the casual nature of their outcomes. Rather than using relative shares of income component. It means that livelihood strategies are quantified according to assets divided into different income generating activities (Jansen *et al*., 2006).

3. OBJECTIVES OF THE THESIS

Rural HHs in the *municipio* of Calakmul live in a close contact with the Calakmul Biosphere Reserve. Livelihood strategies of HHs are directly or indirectly affected by the reserve and have an impact on socio-economic development of the local HHs. To understand the decision-making process and the behaviour of HHs it is necessary to analyse their livelihood strategies, assets and income diversification.

The main objective of the thesis is to define livelihood diversification and to provide a quantitative as well as qualitative assessment of the characteristics of the Calakmul HHs. We focus on the determination of the livelihood strategies pursued by Calakmul HHs and on an analysis of the lucrativeness of these strategies depending on the influence of the establishment of the Calakmul Biosphere Reserve and governmental restrictions on farming.

4. DATA AND METHODS

This chapter presents a brief description of the study area. It deals with an overview of methods needed to meet the objectives of this research and used literature. It describes the methods used for data collection and classification of HH income generating activities.

4.1. Location of the study area

This research was carried out in the *municipio* of Calakmul primarily in the three villages Becán, Hilberto Jara, Valentín Gómez Farías (Fig. 2). The villages are in close proximity to Calakmul Biosphere Reserve (CBR). The *municipio* of Calakmul is located in the peninsula of Yucatan in southern Mexico (Abizaid and Coomes, 2004) Calakmul is the smallest administrative and territorial unit in Mexico and it is one of the most isolated and least populated regions of Mexico. The population reaches a total of 22,480 inhabitants; with a density of 14 inhabitants per square kilometres (Alayón-Gamboa and Ku-Vera, 2011).

The *municipio* of Calakmul was once an important part of the Maya civilization (Turner *et al.*, 2001). Therefore several Mayan archaeological sites are located in and close to the territory of CBR contributing to the development of a local tourism industry and eco-tourism (Hanson, 2008).

In the early 1900s the *municipio* of Calakmul was an important source of the natural chewing gum called *chicle* (*Manilkara zapota*) and the extraction of tropical woods such as mahogany (*Swietenia macrophyla*) and tropical cedar (*Cedrela odorata*) (Turner *et al.*, 2001). The 1960s and 1970s witnessed an industrial and agricultural upswing in Calakmul. In 1970s the Escarcega-Chetumal highway was completed helping so to connect the Yucatán Peninsula with the rest of the country (Farfán, 1996). The federal government promoted the establishment of new *ejidos* which attracted farmers from different states mostly from Tabasco, Veracruz and Chiapas (Alayón-Gamboa and Ku-Vera, 2011) and Michoacán (Murphy, 2003). An *ejido* is a kind of land tenure that combines collective

ownership with individual use (Siembieda, 1996). The land distributed generally ranges from 20 hectares to 100 hectares. Currently *ejidos* represent 60 percent of Mexico's cultivated land (Valsecchi, 2014).

Recently, the importance of agriculture has started to increase in the region. This has resulted in deforestation and a decline in fauna and flora populations (Wood *et al*., 2013). In 1989 the Calakmul Biosphere Reserve was established (Ericson *et al.*, 1999). The large portion of the CBR is located on communally-owned or *ejidos* lands (49.6%) (Sánchez-González 1993). Calakmul was transformed from a frontier for agriculture, hunting, *chicle* harvesting and timber extraction to an internationally protected area. Activities such as agriculture, hunting, and the extraction of wood that were previously supported by the government have suddenly become restricted or completely prohibited (Hanson, 2008).

As a consequence, agriculture nowadays remains only on a small scale (Wood *et al.*, 2013). Despite these government restrictions most of the inhabitants are still characterised as farmers (Alayón-Gamboa and Ku-Vera, 2011). Quasi-subsistence farming provides an important source of income for most of the HHs. HH incomes come primarily from the sale of agricultural and forestry products and wage labour (offices, restaurants, shops, labour on other farms etc.) (Wood *et al.*, 2013). Nevertheless, smallholder agriculture is now less profitable and more risky. Thus HHs are forced to diversify their livelihood strategies. HHs are currently engaged more in Non-agricultural activities (Radel *et al.*, 2012).

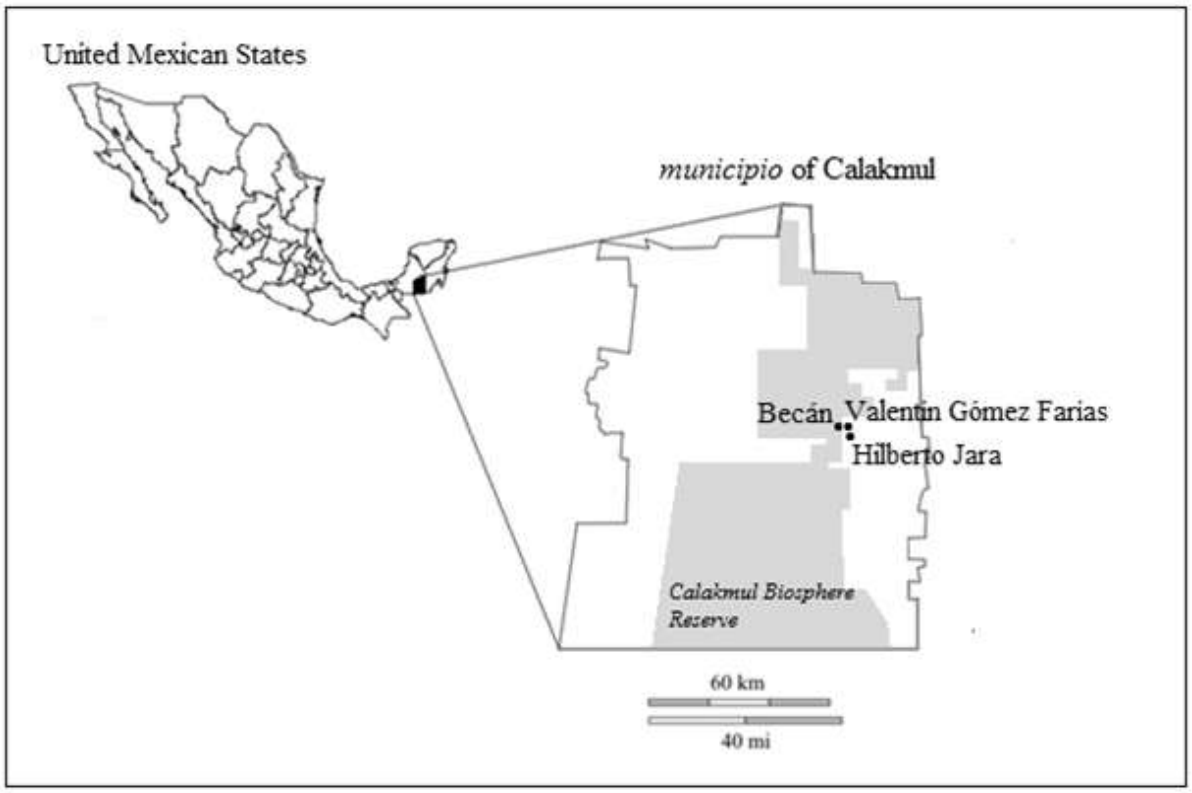

Figure 2: Location map of study area

4.2. Data sources

For the elaboration of the work primary and secondary data were used. As a source for the secondary data was used reviewing literature. The literature was reviewed before and during the questionnaire survey in order to understand the livelihood strategy concept. The main sources of secondary data were scientific journals such as: *World Development, Journal of development economics, Agriculture and Human Values, Journal of Rural Studies, Agricultural Economics*. Data were searched through database *Web of Knowledge*. For the primary data collection several methods were used.

4.3. Primary data collection

Primary data were collected through a questionnaire survey which was carried out from July to October 2013. The target group included the rural population of age ≥18 years permanently living in the *municipio* of Calakmul. In total 150 respondents were selected based on *simple random sampling*; 50 from each village under our survey. The questionnaire was prepared in Spanish and pilot questionnaires were tested among 15 HHs, subsequently modified and simplified. The final version of the questionnaire involved 43 questions divided into six categories following the methodology of previous studies (Messer and Townsley, 2003; Steimann, 2005; Durham *et al.*, 2011; Jagger *et al.*, 2012;) (see Annex I.):

i. Socio-demographic data - This part of the questionnaire is focused on basic information such as name of the village, age and gender. Data is used for basic classification of questionnaire.

ii. Human capital - This part provides the picture about the structure and characteristics of HHs such as number of HH members, age and level of education of HH members, gender and age of HH heads.

iii. Natural capital - Analysis of the natural characteristics provides a comprehensive picture of the ownership of land, utilization of land, cultivated crops and cash crops and the natural conditions in *municipio* of Calakmul. It was also examined how respondents perceive and utilize the BCR.

iv. Social capital: This section examines the membership of HHs in formalised groups or organizations and participation in social networking.

v. Physical capital: This section examines tangible assets owned by HHs such as machinery, transport equipment, buildings or animals.

vi. Financial capital: This chapter describes the financial situation of HHs. It examines the type of employment and income of each HH member. Moreover it examines other financial incomes as loans, micro-credits, collateral or governmental subsidies.

By using questionnaires we collected quantitative data on HH livelihood assets, the economic activity of HHs and livelihood outcomes. The data from the questionnaire was supplemented with additional qualitative data collected through personal interview and observations.

4.4. Data analysis method

This study used an annual HH income share by sources as the criterion for the classification of livelihood strategies. The same approach was used in previous studies by Reardon, 1997; Nielsen *et al.* (2013) and Tuyen (2013). Income to HHs comes from diverse sources; therefore, it is appropriate to use a clustering vector of income share variables. Cluster analysis is a multivariate statistical method that is used to classify objects – to sort units into groups (clusters). Units belonging to the same group are more similar to each other than to units of other groups (Anderberg, 1973). Cluster analysis is a widely used technique for the classification of livelihood strategies (e.g. Brown *et al.*, 2006; Lerner *et al.*, 2013; Nielsen *et al.*, 2013). To obtain a detailed picture of livelihood strategies and HH capital, individual clusters were described using descriptive statistics.

We used the k-means clustering method, which minimizes the sum of squares of the distances of all elements from the centres of clusters in the redefinition of the number of clusters. As the first step it is important to predefine the number of clusters *k* and select *k* points at random as cluster centres. The second step is to specify objects to their nearest cluster centre according to the Euclidean distance function. The third step is to determine the distance of each object to the centroids. All these steps are repeated until same points are specified to each cluster in consecutive rounds (Chen *et al*., 1998; Jing, 2007).

$$J = \sum_{j=1}^{k} \sum_{i=1}^{n} \left\| X_i^{(j)} - c_j \right\|^2$$

- J – objective function
- k – number of cluster
- n – number of cases
- x_i- case *i*
- c_j – centroid for cluster j
- $\left\| x_i^{(j)} - c_j \right\|^2$ – Euclidean distance function

The comparison of HH income shares was carried out by using Tukey's HSD tests, similarly to the study by Sujithkumar (2007). Tukey's HSD test works by defining a value Honest Significant Difference (HSD). The aim of the test is to find out means that are significantly different from each other and to compare all possible pairs of means. Firstly, it is necessary to arrange the sample means from the smallest to the largest. Then, by using the test criterion minimum and maximum sample means are compared on the level of significance. If the test does not demonstrate a statistically significant difference between these means then others means are not significantly different (Wilkinson, 1999; Abdi and Williams, 2010).

$$qs = \frac{Y_A - Y_B}{SE}$$

- Y_A - the larger mean
- Y_B - the smaller mean
- SE - the standard error

The Multinomial Logit Model modelled the determinants of HH livelihood strategy choices. This model used a set of equations each of which indicate the impact of selected variables on the log-odds ratio

$$\ln\left[\frac{x_j}{P_{ik}}\right] = x_i \beta_j$$

for each unit change of x_i, the coefficients β_j show the change in the log-ratio among the likelihood of inclusion to livelihood strategy j and the likelihood of inclusion of

livelihood k (Greene, 2011). Since agriculture generates a large proportion of income and is important for subsistence in the *municipio* of Calakmul (Wood *et al*., 2013), we selected farm work-based livelihood strategy as the reference strategy. Livelihood variables as being important to the choice of livelihood strategy were selected based on the literature (Table 2). For the selection of appropriate variables for the Multinomial Logit Model we applied a classificatory CART Tree Algorithm. This technique is used for finding the tree structure that best discriminates the classes (Breiman *et al.*, 1984). The subsequent analysis was carried out in MS Office Excel 2007® and IBM SPSS 22®.

Table 2: Livelihood platform variables

Variables	Definition	Literature
	Natural Capital	
Farm size	Size of land for agriculture	Carney (1999); Ellis (1999), Jansen *et al.* (2006); Zhao (2014)
Home garden size		Ellis (1999)
		Human Capital
HH size	Number of people in HH	Jansen *et al.* (2006); Zhao (2014)
Number of working members	Number of HH members older than 15 and younger than 80 years	Ellis (1999)
Number of male working members	Number of males in the HH older than 15 and younger than 80 years	Ellis (1999)
Age of working members		Ellis (1999); Winters (2009)
Education of working members	Average years of schooling completed by HH members older than 6 years	Carney (1999); Ellis (1999); Jansen *et al.* (2006)
Education of working female members	Number of years of schooling completed by working female HH members	Ellis (1999); Winters (2009)
Education of working male members	Number of years of schooling completed by working men HH members	Ellis (1999)
HH head's gender	Gender of the HH head	Ellis (1999); Zhao (2014)
HH head's age	Age of the HH head	Jansen *et al.* (2006); Zhao (2014)
HH head's education	Number of years of schooling completed by the HH head	Ellis (1999)
Age of male working members	Age of male working members	Ellis (1999)
Age of male working members	Age of male working members	Ellis (1999)
	Social capital	
Membership of *ejido**	Number of institutions (formal, informal) that any of HH members have been members of.	Ellis (1999); Scoones, 1998
	Physical capital	
Total assets per working member	Farm equipment or a sewing machine	Ellis (1999)
	Financial capital	
Access to credit	Access to credit	Ellis (1999)
HH income	Total annual HH income	Nielsen *et al.* (2013); Tuyen (2013).

Note: *Common land tenure that combines individual and cooperative use.

4.5. Classification of HH income generating activities

Based on the survey and literature (Vijveberg, 1995; Seyfang, 2001; Barrett *et al.*, 2001; Covarrubias *et al.*, 2012; Jütting and de Laiglesia, 2009; Winters *et al.*, 2009) we divided the main income-generating activities of HHs into five categories:

(A) *Informal employment strategy* - is the set of income-generating activities that are not regulated or protected by the Government. Informal employment can be defined as a low paid employment often without the necessity of education and an employment contract. This category includes employment such as a seasonal worker or a home help.

(B) *Non-farm self-employment strategy* - is the set of income-generating activities from a trade or business. It does not include farm businesses and trade.

(C) *Formal employment strategy* - is regulated or protected by the Government. It is characterized by a regular wage, sickness leave, certain rights etc. This category includes employment in factories, offices, and enterprises.

(D) *Farm self-employment strategy* - is characterized as self-employment in agriculture. This category includes crop and livestock production and other farm activities.

4.6. Limitation of the study

The major limitation of this work was language barrier. Almost all survey participants spoke only Spanish or *Ch'ol* language (the original language of the Indians coming from the area of Chiapas), and thus questionnaires were completed with the assistance of family members, who translated from *Ch'ol* to Spanish. Any other interpreter was not available. Some incorrect interpretations due to the language barrier could affect final results.

5. RESULTS

This chapter describes the livelihood strategies pursued by HHs in the *municipio* of Calakmul in southern Mexico. The first part of the chapter shows main characteristics of the HHs. Second part compares HH income of each livelihood category (A - E). The third part of this chapter deals with determinants affecting the selection of each strategy.

5.1. Livelihood Strategy Classifications

Using cluster analysis we classified four livelihood strategies based on income (A - D) and one non-income-strategy (E) (Table 3). The main characteristics of the HHs surveyed are shown in Table 3 and Table 4.

Table 3: Household livelihood strategies (N=150)

	Categories of Livelihood Strategies				
	A Informal employment strategy	B Non-farm self-employment strategy	C Formal employment strategy	D Farm self-employment strategy	E Non-Labour strategy
Number of HH	8	6	101	33	2
Proportion of total HHs (%)	6	4	67	22	1
Income sources	**Income share by source per HH (%)**				
Informal employment	95 (14)	0 (0)	1 (3)	6 (14)	0 (0)
Non-farm self - employment	5 (14)	69 (26)	1 (3)	2 (8)	0 (0)
Formal employment	0 (0)	25 (28)	96 (8)	2 (8)	0 (0)
Farm employment	0 (0)	6 (14)	2 (7)	90 (16)	0 (0)
Non-Labour	0 (0)	0 (0)	0 (0)	0 (0)	100 (0)

Note: Standard deviations are in parentheses

Livelihood strategy A was pursued by 6% of HHs. These HHs generate their income mainly from informal employment (95%) such as seasonal and casual work, ancillary construction works etc. A small proportion (5%) of these HHs generates income from Non-farm self-employment (Table 3). As indicated in Table 4 these HHs are characterized by the lowest HH farm size (5 ha), the highest average age of working members (44.1 years) of all the categories.

Livelihood strategy B is represented by a small amount of the HHs surveyed (4%). The income is mostly generated from Non-farm self-employment (69%) (Table 3). This HH business is mainly related to local shops, businesses involving transportation, restaurants, buying up raw material from farmers and then reselling these materials to companies (*chicle*). These HHs' businesses are mainly located in their homes. These HHs consist on average of 5.3 members which is the highest number out of all the livelihood strategies identified. The working members have the highest average schooling (9 years) and they are the youngest (33 years). An interesting finding is that female family members in group *B* had achieved the highest average education of working females of all categories (8.9 of schooling years) (Table 4). HH in category *B* own the largest farmlands (20 ha); nevertheless, only a small percentage of income is generated from farm activities (Table 3).

Livelihood strategy C is represented by the largest percentage of the HHs surveyed (67%). HH income is mainly generated from formal employment (96%) (Table 3); from tourism and services, in particular. The vast majority of working HH members must commute to work, in many cases more than 20 km per day, or have to leave home and live in a place of work during the week or month. Due to this fact, 22% of the HHs in this category own a car. The HHs following this strategy have better access to credit (23%) than other categories (Table 4).

The HHs in *livelihood strategy D* represented 33% of the sample. The HHs generate their income mainly from farm employment (90%) (Table 3). This strategy is characterized by crop (corn, beans, squash, oranges, lime) and livestock production (poultry and pigs). The HHs following this livelihood strategy have a larger size of a farm (13.3 ha) then categories *A* (5 ha) and *C* (8.9 ha). The education of HH members was at a lower level (7.1

years of schooling) compared with *A* (8.6 years), *B* (9.0 years), *C* (8.5 years) (Table 4). *Livelihood strategy E* is represented only by 1% of the sampled HHs (Table 3). The HHs following this livelihood strategy show zero income. The HHs are dependent on relatives. HH members are old and poorly educated or illiterate. This livelihood strategy is not included in the analysis because of insufficient sample size.

Table 4: Household livelihood assets (N=150) (average in ,000 USD)

Assets	Categories of Livelihood Strategies					
	Total	A	B	C	D	E
			Human capital			
HH size	4.8	3.9	5.3	5	4.8	1,5
	(1.7)	(1.5)	(0.8)	(1.6)	(2.0)	(0.7)
Gender of HH head - male (%)	132	5	6	90	29	2
	(88)	(63)	(100)	(89)	(88)	(100)
Age of HH head (year)	40.9	43.8	39.8	39.3	44.2	61.5
	(10.3)	(14.7)	(9.8)	(9.0)	(10.9)	(17.7)
Education of HH head (year)	8.5	7.7	8.4	8.6	8.1	0
	(2.2)	(2.4)	(2.5)	(2.3)	(1.6)	(0)
Average age of working members (year)	36.5	44.1	33.0	35.6	36.4	68.5
	(8.8)	(14.1)	(6.1)	(7.1)	(8.0)	(8.8)
Average age of working females (year)	35.7	35.0	36.7	34.2	36.6	74.0
	(10.1)	(0)	(11.0)	(8.0)	(10.4)	(0)
Average age of working males (year)	36.9	43.0	32.3	35.8	37.4	68.5
	(8.9)	(14.9)	(4.0)	(6.9)	(9.0)	(7.8)
Average years of schooling of working members (year)	8.5	8.6	9.0	8.5	7.1	0
	(2.2)	(2.3)	(1.1)	(|2.2)	(1.7)	(0)
Average years of schooling of working females (year)	8.4	8.6	8.9	8.6	7.6	0
	(2.2)	(2.3)	(0.2)	(2.4)	(1.7)	(0)
Average years of schooling of working males (year)	7.9	6	9.3	8.7	6.5	0
	(2.1)	(0)	(2.5)	(2.1)	(1.4)	(0)
			Natural Capital			
HH farm size (ha)	10.7	5.0	20	8.9	13.3	50
	(20.0)	(9.3)	(40.0)	(20.6)	(12.0)	(0.00)
Home garden size (ha)	0.0014	0.0015	0	0.0014	0.0016	0
	(0.0047)	(0.0035)	(0)	(0.0054)	(0.0027)	(0)
Farm land per member of HH (ha)	2.8	2.5	3.9	1.9	3.2	37.5
	(6.2)	(4,6)	(8.0)	(4.6)	(3.2)	(17.7)
			Social capital			
Member of *ejido* - yes (%)	44	2	2	23	15	2
	(29)	(25)	(33)	(23)	(45)	(100)
			Physical capital			
House ownership - yes (%)	115	6	4	74	29	2
	(77)	(75)	(67)	(73)	(88)	(100)
Ownership of means of transport - yes (%)	33	0	4	22	7	0
	(22)	(0)	(67)	(22)	(21)	(0)
			Financial capital			
Total annual HH income per adults – average (USD)	2,613	740	3,824	3,227	14,111	0
	(4,598)	(190)	(2,778)	(5,369)	(965)	(0)
Access to credit - yes (%)	0	2	2	23	5	0
	(0)	(33)	(33)	(23)	(15)	(0)

Note: A: Informal employment strategy; B: Non-farm self-employment Strategy; C: Formal employment Strategy; D: Farm self-employment strategy. Standard deviations are in parentheses, (1 USD is equal to 14.62 MXN, El Banco Nacional de México, 21.1.2015)

5.2. Comparison of household income

Results on HH income are reported in median differences between livelihood strategies. Because of the small sample size (N=150), median better describes the real value of HH income. The categories are compared on the basis of these variables: *Total annual HH income* and *Annual HH income per adult* (Table 5). Differences of each variable were investigated by Tukey's HSD tests (Table 6).

Table 5: Composition of household income by livelihood strategy (N=150) (median values in ,000 USD)

Variables	**Categories of HH Livelihood Strategies**			
	A Informal employment strategy	B Non-farm self-employment strategy	C Formal employment strategy	D Farm self-employment strategy
Total annual HH income	0.855	10.131	3.970	2.029
Annual HH income per adult	0.670	3.585	2.378	0.707
Income sources	**Annual HH income by source**			
Informal employment	0.855	0	0.164	0.575
Non-farm self-employment	0.103	5.579	1.369	1.150
Formal employment	0	6.845	3.559	2.053
Farm employment	0	0.684	0.684	1.971

Note: (1 USD is equal to 14,62 MXN, El Banco Nacional de México, 21.1.2015)

The lowest level of HH welfare can be observed in *livelihood strategy A*. HHs in this strategy had got the smallest total annual HH income and annual HH income per adult (Table 5) in comparison with other categories. As we can see in Table 6, between strategies A – B there is a statistically significant difference in total annual HH income and annual HH income per adult. HHs in *livelihood strategy B* earned a significantly higher income in both variables than *strategy A*. Another statistically significant difference is between *strategies A - C. Strategy C* generates higher total HH income than *strategy A*. Livelihood strategy A is the least lucrative strategy for HHs.

Livelihood strategy B is the most lucrative strategy and has much higher levels of welfare than the other categories *A, C, D* (Table 5). Results in the Table 6 show that between *strategies B - D* there is a statistically significant difference in total annual HH income and annual HH income per adult. *Livelihood strategy B* generates a significantly higher income in both variables than *strategy D.*

Livelihood strategy C is the second most lucrative strategy (Table 5). There is no statistically significant difference in the variables of *strategy C* compared to the other *strategies A, B, D* (Table 6).

Livelihood strategy D is the second least lucrative strategy compared to the other *strategies A, B, C* (Table 5). As indicated in Table 6 between *strategy D* and *other strategies (A, B, C)* there is no statistically significant difference.

Table 6: Comparison of HH income by source (N=150) (median in ,000 USD)

Livelihood Strategy Comparison	Total HH income	Annual HH income per adults
A vs. B	-9,275*	-2,914*
	(0.16 x 10^{-3})	(0.22 x 10^{-2})
A vs. C	-3,114*	-1,707
	(< 0.1 x 10^{-3})	(< 0.1 x 10^{-3})
A vs. D	-1,173	-0,036
	(0.02)	(0.59)
B vs. C	6,160	1,206
	(0.03)	(0.37)
B vs. D	8,101*	2,877*
	(0.12 x 10^{-3})	(0.15 x 10^{-3})
C vs. D	1,940	1,671
	(0.9 x 10^{-2})	(0.1)

Note: Values of income in ,000 USD (1 USD is equal to 14.62 MXN, El Banco Nacional de México, 21.1.2015), *Statistically significant parameters P-values below 5% (p< .05)

5.3. Determinants of livelihood strategy choice

From the selected variables listed in Table 2 we can identify variables that significantly contribute to the classification of HHs in individual clusters. *Strategy E* is not included in the model for reasons of small sample size. In the selection of significant variables we applied a classification CART Tree Algorithm. As the reference strategy we selected D - Farm self-employment strategy as the reference strategy.

The results of applying the CART Tree Algorithm show as significant the following variables: *Total income, Education of working males, Number of working members*. These selected variables were then used in the Multinomial Logit Model. The results (Table 7) show the influence of assets on the likelihood of the strategy selection compared to the likelihood of choosing the reference strategy *D* – the *Farm self-employment strategy*.

Higher values of total HH income significantly increase the likelihood of inclusion of the HH in *strategy C* – the *Formal employment strategy* compared to the reference *strategy D* – the *Farm self-employment strategy*. The same is the case with higher levels of *Education of working males*, which reduces the likelihood of the HH being included in the reference *strategy D*. The higher the number of working members the greater the likelihood of inclusion in *strategy C* – the *Formal employment strategy* compared to the reference *strategy D* - The higher the value of total HH income and the higher the education of working men the greater the likelihood of inclusion of the HH in *strategy B* – the *Non-farm self-employment strategy* compared to reference the *strategy D*.

Table 7: Multinomial Logit Estimation for determinants of livelihood strategy choice

Explanatory variables	**A vs. D**		**B vs. D**		**C vs. D**	
	Coef.	SE	Coef.	SE	Coef.	SE
Total HH income	-0.11×10^{-3}	0.13×10^{-3}	0.48×10^{-4}*	0.18×10^{-4}	-0.26×10^{-4}*	0.10×10^{-4}
Education of working men	-3.24	5.15	-1.52	1.06	-1.36*	0.47
Number of working members	0.29	0.89	0.97*	0.42	0.71*	0.24
Pseudo R2			0.595			

Note: A: Informal employment strategy; B: Non-farm self-employment Strategy; C: Formal employment strategy;

D: Farm self-employment strategy; *statistically significant parameters at level of 5%

6. DISCUSSION

Based on our results, the least dominant and poorest livelihood strategy is *strategy A* – the *Informal employment strategy*. This finding can be classified as a positive phenomenon in rural development of the region as Jütting and de Laiglesia (2009) states that a high proportion of informal employment is associated with poverty in developing country. Most people working in informal employment are vulnerable to various risks such as exploitation, unsafe working conditions, health problems, loss of earnings etc. (Biles, 2008; Jütting and de Laiglesia, 2009). The HHs following this strategy are vulnerable due to having no regular income. Money earned often covers only basic needs and there is no opportunity to create financial reserves. Another threat is the lack of HH income diversification. In case of job loss, a HH cannot replace its income. As Ellis (1999) and Minot *et al.* (2006) claim in their studies, income diversification is one of the essential assumptions of increasing revenue, welfare and decreasing the vulnerability of HHs. Another risk factor is the fact that all of these threats also affect the food security of the HHs. HHs are primarily dependent on subsistence agriculture because financial conditions do not allow them to buy enough food. In the case of poor natural conditions and natural hazards (drought, rain, pests) HHs are not able to produce sufficient amounts of food. As families do not have sufficient income to repay loans, this can lead to the collapse of the HH. On the other hand, we can see as positive the fact that this strategy is modestly represented in the surveyed region, because, especially in developing countries and in poorer regions, it is an important source of employment opportunities for unskilled and semi-skilled workers who otherwise would be unemployed; it also contributes to the diversification of HH incomes (Onyenechere, 2011).

Barrett *et al.* (2001) state that in developing countries positive relationships between non-farm activity and welfare exist. Studies by Ellis (1999); Jütting and de Laiglesia (2009) state that non-farm employment contributes to the growth of national income. In our study *strategy B* – the *Non-farm self-employment* is the most profitable out of all strategies, even though represented by the smallest number of the HHs surveyed. According to a study by Reardon *et al.* (1997) non-farm income represents 42 % and 40% of total rural income in Africa and Latin America respectively. Non-farm activities play

an important role in rural HH incomes and livelihoods. All HHs surveyed generate at least a small part of income from *Non-farm self-employment* activity (Table 4). This fact indicates that people are aware of its lucrativeness. HHs following this strategy had relatively high income diversification (Table 4). HHs generated income mainly from the *Non-farm self-employment* and *Formal employment*, which can be considered as the most lucrative source of income (Table 4). Income diversification decreases the financial vulnerability of HHs in case of job loss. An important characteristic of this group is the relatively high average of schooling years of working HH members (8.6 years) (Table 3). The importance of education is undeniable. The ability to manage the assets of HHs effectively is closely linked with levels of education (Rakodi, 1999). Using the Multinomial Logit Model we identified the education of working males as a significant variable which increases the likelihood of HHs engaging in *strategy B*. This fact corresponds to the current situation in Mexico. Men dominate the major portion of society and power structures. There is a considerable inequality between the genders. Men earn more money, have decision-making power in the HHs and are the main breadwinners (Frias, 2008).

The *formal employment strategy* is the most frequent strategy by HH in the *municipio of* Calakmul and the second most lucrative strategy. HHs following *strategy C* are less prone to vulnerability due to high diversification of HH incomes (Table 4). The average education of men and women in category C is almost the same. Only HHs following *strategy C and B* have university-educated members. Both strategies are characterized by a relatively high level of education. HH heads are younger and more educated compared to the other *strategies A* and *D*. These characteristics of HH heads and members facilitate the involvement of the HH in *strategy B,* and *C (*the *non-farm or commercial strategies)*. HHs with higher education of members have a better chance of finding a well-paid job (Table 4). The same trend was found in Mali by Abdulai and CroleRees (2001) and in Peru by Swinton and Quiroz (2003). These findings suggest that younger heads of HHs display greater tendencies to engage *in non-farm (B* and *C) strategies.* This finding is consistent with the increasing importance of labour migration in the *municipio of* Calakmul (Cohen, 2004). To a large extent this is national migration but in recent years increasingly international migration, mostly to the USA, has increased (Radel *et al.*, 2012). The reasons for migration are mainly recurrent poor harvests caused by climatic conditions (droughts

and hurricanes) and insufficient local labour markets (Schmook *et al.*, 2013). Migration can represent a big problem for the region in the form of a large outflow of people to other parts of Mexico or abroad.

The *farm self-employment strategy* is the second most frequent strategy in our sample; nevertheless, it generates the second lowest total annual HH income compared to *strategies A, B* and *C*. It may be caused by governmental limitations and restrictions preventing both the expansion of farming and the use of modern agricultural practices (Ericson *et al.*, 1999). HHs engaged in *strategy D* are characterized by a low level of education compared to other strategies (Table 4.). As mentioned above, education is important. Education brings development, new knowledge and experience to HHs. Higher levels of education can help farmers adopt new agricultural techniques that are in compliance with the rules of the Calakmul Biosphere Reserve (CBR). Despite this low income and low level of education, *strategy D* has a very important and positive feature - diversified and balanced incomes (Table 4). Income diversification is important not only for farmers but also for other HHs because Calakmul is a region with high rates of natural disturbance such as droughts (CENECAM, 2010), hurricanes and tropical storms (Alayón-Gamboa and Ku-Vera, 2011) hence HHs are more vulnerable. This claim is confirmed in studies by Eriksen and Silva (2009) and Alayón-Gamboa and Ku-Vera (2011). On the basic of this finding we can state these HHs are less prone to lack of income thanks to income diversification and their basic food security is partly ensured.

A small number of HHs diversified livelihood strategies by the production of *chicle* (nature chew-gum). The production of *chichle* has a long tradition in Calakmul. *Chicle* has great potential in international trade due to the increasing popularity of Fair trade and Bio products. Other such activities include honey production, the cultivation of allspice and charcoal production. Only a small proportion of respondents (4.5%) use these alternatives as income activities. It is to be expected that the percentage of HHs engaged in these activities will grow in the future due to programs of local and international organizations (eg. Productores Forestales de Calakmul AC, Fondo para la Paz etc.), which organize public workshops and presentations. Nevertheless, it is important to consider that even the careful handling of local sources can have a devastating effect.

Tourism and eco-tourism have also big potential in Calakmul due to the CBR, the rich history and many preserved Mayan ruins (eg. Becán, Xpujil, Calakmul ruins etc.). Compared to other archaeological sites (eg. Chiapas, Oaxaca etc.) the *municipio* of Calakmul is visited by small numbers of tourists. Nevertheless, the importance of tourism in recent years is steadily rising. As of now, HHs are not ready for the onslaught of tourism. The question is, whether HHs will be able to react in time and take advantage of local potential in the future.

The involvement of the CBR in the livelihood strategies of HHs poses difficulties. A major problem is the different interpretation of laws and regulations at various levels of government. Indirect linkage of national policies and local responses lead to the conscious or unconscious violation of laws. It is not clear which activities are permitted or prohibited, and to what extent (timber extraction). This lack of clarity leads to corruption, poor understanding of the rules and conflicts between different levels of government. It is very difficult and costly to monitor and punish the violation of laws (Wood *et al.*, 2013). The current situation prevents the development of the region and increases the vulnerability of the CBR.

7. CONCLUSION

Using cluster analysis techniques the study provides a detailed picture of rural HH strategies in the *municipio of* Calakmul in southern Mexico. We identified four main types of livelihood strategies based on income activities and one HH strategy based on non-income activities. The results from applying Tukey's HSD tests indicate that the *informal employment strategy* is the least profitable strategy. HHs engaged in this strategy are highly vulnerable and are not able to ensure their food security. A positive fact is that only 6% of the HHs surveyed follow this strategy.

The *Non-farm self-employment strategy* is the most profitable strategy compared to all other ones (A, C and D). HHs' Incomes are relatively diversified. HHs are less prone to vulnerability due to the high diversification of HH incomes. Formal employment strategy is the most followed strategy by the Hhs surveyed in the *municipio of* Calakmul and the second most lucrative strategy. It is a positive phenomenon as it is closely connected with growth and human development. HHs in *strategies B and C* demonstrate a higher potential to engage in non-farm activities. The *farm self-employment strategy* generates the second lowest total annual HH income and the lowest level of education compared to *strategies A, B and C*. As a positive feature found is that only this strategy has highly diversified and balanced incomes.

Multinomial Logit estimation showed that HHs that generate higher total income are less likely to be included in the strategy *Farm Self-Employment*. HHs are more likely to engage in lucrative strategies and generate more money. The level of education of working men was found to be an important factor in the selection of a strategy. The education of working men reduces the possibility of inclusion in *Farm Self-Employment*. It was also found that the greater the number of members who currently work the greater inclusion in *Farm Self-Employment*.

According to our information, it is evident that the *Farm self-employment strategy* is highly risky and unprofitable for HHs in the *municipio* of Calakmul. The HHs not involving the CBR in their livelihood strategies are rather engaged in Non-farm activities. For the development of the region it is necessary to unify policies at all governmental levels and allow HHs to take full advantage of the potential benefits of the CBR.

It is important to government of Mexico consider priorities. The BCR creates potential economic benefits but on other hand blocks the access to resources (farmland and forests), and thus indirectly aggravates poverty in the *municipio* of Calakmul. We should think about who will obey the rules and invest in the conservation of the CBR: poor and vulnerable HHs or HHs living well with a secure income?

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ANNEXES

Annex 1 The questionnaire used during the survey

Preguntas general

1. Nombre del pueblo / ejido
2. Edad
3. Sexo a) hombre b) mujer
4. Número de miembros de la familia que viven en su casa. Y sus edad y sexo.

El capital natural

5. ¿Usted es propietario o renta la tierra agrícola? a) propietario de la tierra agrícola b) renta la tierra agrícola c) No tengo/ rento tierras agrícolas d) otro
6. Cuantas hectares tiene o área que usted alquila de tierras agrícolas (m^2).
7. Que cultivos tiene sembrado en su parcela ?
8. ¿para que cultiva?
   a) Ventas (donde) c) autoconsumo d) el intercambio e) otro
9. Usted transforma un cultivo a otros productos?
   a) no b) sí
10. ¿Qué productos están transformando a otro?
11. ¿Usted vende sus productos transformados? a) Sí b) no
12. ¿Donde usted vende estos productos?
13. ¿Usted tiene acceso todo el año con el agua?
    a) Sí, tengo acceso al agua. A distancia tiene para la obtencion (h, Km)?
    b) No, no tengo acceso al agua. ¿Cómo resolver este problema?
14. ¿Utiliza alguna reserva de la biosfera? (Colección de madera, producción de carbón, la recolección de plantas ...)
    a) Sí (como) b) No (¿por qué no?)
15. ¿que beneficio les hace estar cerca de la reserva de la biosfera (financiero, el turismo)
16. ¿que riesgo tiene en vivir en su comunidad? (enfermedad, el crimen, los animales)

El capital financiero

17. Menciona el empleo y los ingresos de los miembros de la familia que contribuyen al presupuesto familiar.
    a) el ingreso:
    b) el ingreso:
    c) el ingreso:
18. ¿la familia cuenta con ingresos secundarios ?
19. ¿Ingreso total de la familia? (pesos)
20. ¿Usted tiene una cuenta bancaria?
21. ¿ la familia cuenta con algunas obligaciones? (préstamos bancarios, arrendamientos, otros préstamos, hipotecas)
22. ¿objetivo del prestamo?
23. Gastos mensuales de la familia. (Pesos)
24. Estructura de los gastos.
    a) El hogar (alimentos, energía, equipamiento del hogar)
    b) Salud (asistencia sanitaria, los seguros, la vacunación)
    c) Educación (cursos, uniformes, manuales)
    d) Ahorros
    e) Ayuda (en el campo, en el hogar)
    f) Alquiler (edificio, lugares, campo)
    g) insumos (plántulas, herramientas)
25. ¿usted piensa que los ingresos cubren todos los gastos de la familia?
26. ¿Cómo usted estima su ingreso?
    a) Muy bueno
    b) Bueno
    c) Bastante bien
    d) Malo
    e) Muy mal
27. ¿En el caso de dificultades financieras en su familia realizan empeños? (Metales Preciosos, joyas, bienes raíces)?
28. ¿Usted ha recibido apoyos del Estado, o en la organización de la sociedad?

El capital técnico / físico

29. ¿Usted tiene en su parcela cabezas de ganado?
30. ¿cual es el uso que le dan a los animales ? A) alimentacion b) venta c) reserva financiera d) otro
31. ¿Es propietario de su vivienda y tiene otro apartamento u otra inmueble?
32. ¿el tipo de tranporte que tiene en su casa es propio ?
33. ¿Usted es dueño de mecanización? a) manual b) mecánico

Capital humano

34. Nivel de Educaciön
    a) Sin educacion
    b) Primaria
    c) Secundaria
    d) Preparatoria/ bachiller
    e) Escuela superior
35. Usted tiene un acceso a los servicios de salud?
36. Distancia, del Centro de Salud.
37. ¿Cuál es la accesibilidad del centro de salud?
38. ¿Usted contrata a trabajadores para su parcela o hogar?

Capital social

39. ¿Es usted miembro de alguna organización, cooperativas, asociaciones, Ejido?
40. ¿Cuánto tiempo ha sido un miembro de las cooperativas, asociaciones, Ejido
41. ¿cual es su ocupacion en la organización de cooperativas, asociaciones, Ejido?
42. ¿cuantos ańos dura tu posicion en la organización de cooperativas, asociaciones, Ejido
43. ¿que beneficio tiene el ejido al estar cerca de la reserva?

Annex II. The lookout tower in CBR close to village Valentín Gómez Farías.

Annex III. The Mayan ruin of Becan. In the distance is seen village Valentín Gómez Farías. These ruins are a popular tourist attraction in *municipio* of Calakmul.

Annex IV. Traffic in the CBR during the rainy season is complicated.

Annex V. Workshop for the local community organized by *Productores Forestales Calakmul Ac.*