LIVELIHOOD STRATEGIES OF FAMILY FARMERS IN THE AMAZON FRONTIER OF MATO GROSSO, BRAZIL

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To my parents who taught me that I am responsible for building a better world

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CONAB	Companhia Nacional de Abastecimento
COP 21	2015 Paris Climate Conference
DAP	Declaração de Aptidão Agrícola
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GIS	Geographic Information System
HDI	Human Development Index
ICV	Instituto Centro de Vida
INCRA	Instituto Nacional de Colonização e Reforma Agrária
IOV	Instituto Ouro Verde
LCF	Less Consolidated Frontier
MAPA	Ministério de Agricutura, Pecuária e Abastecimento
MCF	More Consolidated Frontier
MDA	Ministério do Desenvolvimento Agrário
NAFA	Núcleo de pesquisa e extensão em agricultura familiar e agroecologia
NF	New Frontier
NGOs	Non-governmental organizations
PAA	Programa de Aquisição de Alimentos
PNAE	Programa Nacional de Alimentação Escolar
PRONAF	Programa de Fortalecimento da Agricultura Familiar
Prodes	Program for the Calculation of Amazon Deforestation
SEDUC	Secretaria de Estado de Educação, Esporte e Lazer

SLA	Sustainable Livelihoods Approach
VOP	Value of Production

Abstract of Thesis Presented to the Graduate School
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Requirements for the Degree of Master of Science

LIVELIHOOD STRATEGIES OF FAMILY FARMERS IN THE AMAZON FRONTIER OF MATO GROSSO, BRAZIL

By

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Chair: Stephen Perz
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Although globally family farmers constitute 98% of all farmers and produce 53% of the food supply, they also constitute the majority among the world's impoverished and hungry populations. Debate remains on how to design development programs aimed at improving this current state of family farming. Despite disagreements on specific development approaches, the tremendous diversity among family farmers across the globe indicates the need for context-specific strategies to strengthen this group.

The following research aims to understand family farming livelihoods in the context of the Amazon frontier in the Brazilian state of Mato Grosso. Data obtained from household surveys conducted among family farming communities in nine municipalities within this region were combined with secondary data to determine whether family farming livelihood strategies and scenarios varied across differing levels of frontier consolidation.

Analysis of this data reveals distinct strategies and scenarios that vary in a non-linear pattern along stages of frontier consolidation. In general, the primary strategy of risk reduction employed by farmers included diversifying their farming systems with market-oriented activities (cattle raising) and subsistence farming rather than seeking for

off-farm sources of income. The production of other food products (not cattle related) is insignificant and would require multi-scale and multi-institutional efforts to became reality. While in the less and more consolidated stages, the demands are stronger on diversification of market and governance processes, the new frontier stage needs first to solve issues related to physical assets and regulation aspects of land and farmers.

CHAPTER 1
INTRODUCTION

Many studies have indicated that the 21 century is a period when we are facing increasing unpredictability and uncertainty of the future, and that changes will continue to accelerate, especially in terms of environmental and ecological conditions (Chambers & Conway, 1991; Steffen et. al., 2011). At the same time, we also face a huge challenge of feeding a growing population and ending poverty and deprivations of all kinds, which are still concentrated in rural areas (Ashley and Maxwell, 2001). In this scenario of global changes, disputes for the access and control over natural resources are become stronger, increasing the conflicts in the rural world.

The high level of diversity and complexity in the countryside means that there is no single solution. Nevertheless, I join other scholars in arguing that the strategy for this century has to deal with equity and sustainability (Chambers & Conway, 1991), such as the end of poverty and major inequalities, while guaranteeing the quality of landscape, biodiversity, and environment. In addition, strategies must consider people's rights to construct an "autonomous perspective" of their own future (Escobar, 2007, p. 65).

To address this scenario, two global efforts are important to mention here. The first is the United Nations International Year of Family Farming (IYFF2014) which aimed mainly to increase knowledge, communication and public awareness about the diversity and role of family farmers around the world in terms of food security, poverty alleviation, and sustainable use of natural resources; and to better understand family farming needs, potential and constrains in order to design assertive policies and programs (FAO, 2013; FAO and UNDP, 2016); and the second, is the United Nations agenda for sustainable goals for the next fifteen years (2030) called the Sustainable Development Goals

(SDGs), which is a shared common vision about a sustainable, safe and fair planet (Osborn et al., 2015) and a set of goals committed by United Nations. Goal number two is to end hunger, achieve food security and promote sustainable agriculture.

> The target aims at doubling, by 2030, the productivity and incomes of small-scale producers, with explicit reference to family farmers, by guaranteeing them access to land and other productive resources and inputs, and by promoting the creation of non-farm jobs in rural areas (FAO and UNDP, 2016, p.1).

Family farmers constitute 98% of all farmers in the world and are responsible for 53% of world's food; they are also the majority of the poor and hungry population (Graeub et al., 2016; Patriota, 2016). This thesis joins others in addressing that unacceptable paradox by making visible the potential of family farmers to be central part of the solution we must to create, by addressing the growing food demand, eliminating poverty and developing sustainable farming systems, with fewer inputs and greater diversity.

Nevertheless, the debate around how to promote the development of family farming is a contested arena. Many contradictory rural development initiatives, programs and policies have been implemented by government, social movements and NGOs affecting the sustainability of rural livelihoods in a range of different ways. Some initiatives promote ideas of non-agricultural labor as a means of diversification; others seek agricultural modernization, specialization and high input systems, including insertion of farmers into commodities value chains and formal markets; and yet others pursue strategies based on the autonomy of farmers, agroecology, reciprocity and local knowledge (Niederle, 2017) producing food for local and alternative markets. As an example, in Brazil in 2015, the Ministry of Agriculture launched a program called 'Middle Class' with the goal to move 400,000 low income farmers to the middle class in four

years by addressing technological issues and rural entrepreneurship. The Ministry of Agrarian Development accused the Ministry of Agriculture of overlapping its strategies, and reducing the challenge of rural poverty as a question of access to technologies (Picolotto & Medeiros, 2017). In fact, the mere existence of these two ministries clearly expresses the conflict of antagonistic projects for rural development (Picolotto & Medeiros, 2017). More generally, the main issue support for family farming, is the idea that one approach can be applied successfully for all family farmers, as that has led to insufficient results.

One important point is to have a clear definition of who family farmers are. At global level the FAO defines Family Farming as

> a means of organizing agricultural, forestry, fisheries, pastoral and aquaculture production which is managed and operated by a family and predominantly reliant on family labor, including both women's and men's. The family and the farm are linked, co-evolve and combine economic, environmental, social and cultural functions (FAO, 2013, p.2).

But at a regional level, some countries also have distinct definitions. Nonetheless, all of them are too broad to address specific needs, interests and potentials.

> The term family farming may be used as a 'catch all' expression, but it can only be used analytically if it is systematically unpacked. Probably the most important caveat when talking about family farming is the size implication: clearly there are family farmers who are able to generate enormous agricultural surpluses, and those who are only able to eke out an existence that may barely keep the family alive (Bush, 2016, p.3).

Graeub et al. (2016) demonstrate the tremendous diversity among family farmers worldwide and the need for context-specific strategies to strengthen this group. Different understandings of family farming prevents a consensus view towards a common agenda (Belik, 2017).

This research aims to analyze what family farming means in the context of the Amazon frontier in the Brazilian state of Mato Grosso. I argue that we need to have a deeper understanding of the local conditions facing family farms as they influence farming strategies and livelihoods. With a stronger empirical foundation about family farms in Mato Grosso, becomes more feasible to design more effective government and NGOs interventions that can strengthen family agriculture change. This study includes nine municipalities chosen by NGOs, and pursues statistical analysis of secondary data and household surveys, with systematic samples from communities with family farmers in each municipality. The data analysis compares family farming across different municipalities with differing levels of frontier consolidation.

Recognition of Family Farming in Brazil

In Brazil, it was in the 1990' that discussions about family farming became evident with the creation of PRONAF – National Program for Family Farming in 1995 (Picolotto & Medeiros, 2017; Mattei, 2014; Grisa, 2017; Schneider & Cassol, 2017). PRONAF recognized the role of family farmers in the society; before they were only known as small, subsistence and low income farmers (Wanderley, 2017; Sabourin, 2017). Legitimacy grew and led to the creation of the Ministry of Agrarian Development and the Secretary of Family Farming, culminating with the institutionalization of the Family Farming Law (Lei da Agricultura Familiar N. 11.326/2006) in 2006 (Grisa, 2017).

Pedroso (2014, p. 767) argued that this institutionalization was made for three main reasons. First, social movements' brought pressure to change the term "small farmer" which suggests a type of prejudice against the value of the farmer in the economy and society (see also Wanderley, 2017). Second, there was the strategy to include "family" in the definition because it explicitly expresses social empathy for a key

population involved in food production. And the third factor was the possibility to establish objective criteria to define this group in order to develop new specific policies for it.

Another important point is that this term implies identity and livelihood, and it does not reduce the group into economic logic as “small proprieties” does. Officially identifies as family farmers, they started to be understood as a diverse social category, which perform an important role in the process of development (Schneider & Cassol, 2017).

The law 11.326 from 2006 (Brasil, 2006) defines family farmers as someone who engages in activities in the rural area and fulfill the criteria of: 1) does not legally own a land area larger than four fiscal modules (the modules varies depending of the region, which maximum of 100 hectares); 2) predominantly uses family labor in the economic activities of the establishment; 3) has a family income that originates mainly in economic activities linked to the establishment or enterprise; and 4) operates and manages the property with his/her family. The category also includes extractivists and fishers.

This definition, nevertheless, does not in itself resolve conflicts related to different models of rural development, the different views of the social actors and the need to understand the internal diversity of this group (Wanderley, 2017). Also, the people who cannot obtain sufficient income predominantly coming from their farms, were excluded from this definition since they seek to overcome poverty through non-agricultural activities (Wanderley, 2017), even though they still self-identified as family farmers. The adoption of the government’s thus undermined by the specific challenges of family farming (Wanderley, 2017) and the understanding that the diversity of farmers also is a result in differences in the access of assets, policies and market (Vitela, 2017).

The idea here it is not to question the importance of this legal definition, but instead to call attention to the need to go beyond a standardized image to consider particular context and experiences when defining priorities and strategies. Godar, et al. (2012) argue that one of the reasons for the enormous environmental and social problems in Amazon is a lack of adequate differentiation between the actors, resulting in inappropriate policies guided by generalizations about farmers. In the past, excessive diversity was seen as an obstacle for social and economic development, but nowadays it is clear that diversity is important to create resilience (Schneider & Cassol, 2017), and recognizing particularities important to design adequate policies for the needs of specific groups (Wanderley, 2017).

Research Objectives

The general objective of this research is to understand the diversity of rural livelihood strategies among family farmers in nine (9) municipalities of the Amazon frontier of Mato Grosso.

Three research questions are pursued in this study:

What differences are found in assets reported by family farmers in municipalities characterized by advanced stages of frontier development in relation to those in more recently developed settlements?

How are the livelihoods of family farmers in municipalities characterized by advanced stages of frontier development different from those in more recently developed settlements in terms of (1) degree of specialization of farming systems, (2) labor-intensity of system, and (3) diversification of livelihood strategies?

What type of assets are positively related to more diversified livelihoods, both in terms of farming systems and income sources?

By answering these questions, this research will provide valuable information to support the design and implementation of more effective policies and projects for rural development that can strengthen family farms; in turn, the findings can generate ideas for new avenues of research and practical interventions by social movements, NGOs and governments.

The National Context and the Significance of the Study

A significant part of Brazil's economy relies on the use of its immense natural resource base (USAID, 2015). Brazil has the largest land area in South America, and 33% of the Brazil's land occupied by agriculture (Knoema, 2012) and 61.6% by extensive forest cover (Knoema, 2012). These forests are in public and private lands in the form of conservation units, indigenous lands (both Protected Areas), permanent preservation areas (APPs), and legal reserves (USAID, 2010).

Recently, Brazil experienced a decade of economic and social progress from 2003 to 2014; Brazil's GDP achieved $2.3 trillion in 2011, ranking it among the world's ten largest economies. Meanwhile over 16 million people were lifted out of poverty (World Bank, 2014) from 2003 to 2014 and Brazil now is classified as an upper middle income country (World Bank, 2017). These achievements made Brazil leave the World Hunger Map in 2014 (Rousseff, 2015). Nevertheless, poverty still a reality for 10 million people, the highest number among Latin America and Caribbean countries (World Bank, 2017). Poverty is concentrated in rural areas (IFAD, 2014) where nearly 30% the population is under the official poverty line (OECD/FAO, 2015). Brazil is also among the countries with highest homicide rates in the world (World Bank, 2017) which suggests that that social insecurity and inequalities still being reality.

Brazil now exhibits a high value on the Human Development Index (HDI), but still faces significant inequality. The HDI measures the average achievement in three basic dimensions of human development—a long and healthy life, education and a decent standard of living (income). Brazil's HDI is 0.742. However, when we consider the Inequality-adjusted HDI, which accounts for inequality in the three variables, the value of HDI changes significantly, and puts Brazil with the low human development countries at 0.542 (Human Development Report, 2014). Brazil also has one of the highest levels of inequality of land distribution in the world, and land issues are the major sources of conflicts in the country (USAID, 2010). Data from IBGE (2006) have shown that 84.4% of all agricultural landholdings in Brazil are family farms, about 4.37 million farms, but they only cover 24.3% of total agricultural area. At the same time, large properties comprise 15.6% of all agriculture properties, but they occupy 75.7% of agricultural lands.

Therefore, when thinking about the Sustainable Development Goals as they apply in Brazil, we must also think about inequalities of land use and ownership. Sachs (2015) has showed that industrial agriculture is the dominant force behind many global environmental threats such as climate change, biodiversity loss, land degradation, changes in the nitrogen cycle and depletion of water resources. The limitations of natural resources, as well as the presence of poverty and inequalities and environmental degradation have made evident that increasing food production and eradicating poverty for the next century must involve fundamental changes in rural development. In this context, the importance of family farming also relates to the viability of alternative production technologies that are more ecologically sustainable. Diversified cropping systems have long been key to the resilience of family farming systems (Altieri, 2009).

Diversification also provides a basis for supporting food and nutritional security (Swaminathan, 2014; Jingzhong et al., 2010).

One of the most significant debates about the role of family farming in a new development process concerns the ability of family farms to increase food production and to be able to feed growing populations. Data from the IBGE census of 2006, showed that 70% of the food that comes to the table of Brazilians comes from family farmers. When we analyze the value of production (VOP) per hectare, the difference between family farms and large farms is strong. Findings from analysis conducted by the Institute for Applied Economic Research (2012), based on the 2006 Census, showed that the VOP for small-scale properties (less than 10 ha), even not considering non-declared VOP, was at R $ 2,700 per Hectare, while all large farms of more than 500 ha generated annual VOP of R$ 247 per hectare (Institute for Applied Economic Research, 2012, p 306 in Ramos, 2014: 674). These data contest the idea that family farming is unproductive. Ploeg (2014) also argues that peasant farms generally reach higher levels of production per unit land than on commercial farms, because of the level of diversification. The contribution of family farmers to total agricultural production is 38% of VOP and 34% of revenues, despite only occupying 24% of agricultural lands (Schneider & Cassol, 2017).

At the same time, another study (Helfand, et al. 2014) shows the high concentration of revenue and profit within Brazilian agriculture. The vast majority of properties (2/3 of total establishments), almost 3 million units, accounted for only 3.3% of total gross revenue. And less than 30,000 of the properties (0.62% of the global total) accounted for half of the total production value, measured in financial terms (Buainain et

al., 2013). All of those were properties with less than 500 hectares. But they also exhibited production above 10 minimum wages[1] and corresponded to 59% of the generated VOP. Analyzing the data from Helfand, et al. (2014), if we grouped the 'total VOP of family farmers up to 100 ha, the total VOP produced is 73,024.56 (R$ 1,000), and properties up to 20 ha produced 37,084.45 (R$ 1,000). The highest VOP is in properties of 20-100 hectares. Large-scale farms with more than 500 hectares produced 59,060,914 (R$ 1,000) of the VOP (IBGE, 2006).

The debate over the need to increase food production is often focused on expensive and/ or large-scale technological solutions, but these data show that family farms are already highly productive. Nonetheless, they have historically been neglected in development policies, which could work to better empower these 3 millions of units (60% of the farms) to be a large part of the development process. All types of farmers merit efficient support to help them develop. Family farms have been neglected in government planning process, which have promoted a separate discussion about family farming issues and expanding the country's agricultural economy, as they push in different directions (Malagodi, 2017). Beyond production of food and profit, we must recognize that family farmers constitute a significant part of the rural population and economy and support family farms is also a project for a sustainable and fair development of the country (Picolotto & Medeiros, 2017).

Graeub et al. (2016) that "one of the main issues impeding efforts to strengthen family and smallholder farmers on the policy and field level has been the effective lack of data." This research therefore aims first to provide information about family farming in

[1] R$ 937 reais, about $ 298,98 using the conversion of the day (April 13)

Mato Grosso. Second, this thesis will contribute to broader efforts to generate theoretical and practical knowledge to improve the initiatives undertaken by government, NGOs and social movements that support family farming in Mato Grosso. By linking data to action, this thesis can support initiatives to promote an integration of research, capacity building and action.

Organization of the Thesis

The thesis is organized in 6 Chapters. Chapter 2 provides a review of the relevant literature regarding the sustainable livelihoods approach. Chapter 3 describes the research design, including the study area. That discussion reviews historical elements of Amazon colonization in Mato Grosso, and overviews the municipalities included in the sample, and a discussion about frontier stages. Chapter 3 concludes with an outline of the methodology I used to collect the data. Chapter 4 presents a descriptive analysis of the livelihood systems of the family farmers in the sample. I focus on a comparative analysis of each livelihood variable across different field sites corresponding analysis of each livelihood variable across different field sites corresponding to distinct stages of frontier consolidation. Chapter 5 presents findings about the variables that influence livelihood diversity. Finally, Chapter 6 concludes the thesis by summarizing the findings, and presenting final thoughts and recommendations for future research and practice.

CHAPTER 2
SUSTAINABLE LIVELIHOODS

Development has encompassed many different paradigms and meanings. One well-known model is the 'Production Thinking' (Chambers & Conway, 1991), reflected in the Malthus's theory which argues that a hunger is a problem of food production based on population growth and environmental limits (Robbins, 2012). In a critique of that perspective, political ecology argues for the need *"*to understand the complex relations between nature and society through a careful analysis of what one might call the forms of access and control over resources and their implications for environmental health and sustainable livelihoods*"* (Watts, 2000, p. 257). Another common argument is 'Economic Efficiency' thought, which believes that problems and environmental crises are the result of "inadequate adoption and implementation of modern economic technics of management, exploitation and conservation" (Robbins, 2012, p.18). Sumner & Tribe (2008) relate it to "performance assessment", focused on outcomes with a relatively short-term view and little importance given to the historical process. Chambers & Conway (1991) called efficiency thought the "industrialized country imprint", and Sumner & Tribe (2008) described it as a "Western ethnocentric notions of development upon the Third World". Both critiques view efficiency thought as a socially constructed discourse that imply superiority of developed countries and the inferiority of developing countries.

Efficiency notions also fit together with reductionism of measurement, driven by the 'Employment Thinking' and 'Poverty-line Thinking', both of which understand poverty as a lack of employment and lack of income and consumption (Chambers & Conway, 1991). But critics have noted that such reductionism often leads to strategies of development that failed to support large segments of populations in rural areas or eliminate poverty.

In the light of such critiques, the Sustainable Livelihoods Approach (SLA) has gained attention in the rural development and poverty studies literatures (Scoones, 1998). SLA has been suggested as a more complex perspective that came from a "new generation of more optimistic household studies", showing how people are coping with and surviving economic growth (De Haan & Zoomers, 2005). SLA thought became prominent in the 1990's as a people-centered approach to poverty and sustainability in response to top-down and market-oriented approaches (Bennett, 2010). The landmark statement on SLA thought was the Chambers and Conway (1991) publication of the Institute for Development Studies (IDS) (Scoones, 2009; Morse & McNamara, 2013). That publication critiqued narrowly-conceived discussions of poverty and incorporated the ideas of capabilities, equity and sustainability (Chambers & Conway, 1991; Bennett, 2010). Chambers and Conway define a livelihood as follows:

> A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living: a livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the short and long term (Chambers & Conway, 1991, p.6).

The capabilities approach was first articulated by the Indian economist and philosopher Amartya Sen in the 1980s and is understood as the opportunities for people to do and be what they have reason to value (IEP, 2015; Scoones, 1998). Livelihood capabilities "include being able to cope with stress and shocks, and being able to find and make use of livelihood opportunities" (Chambers & Conway, 1991, p. 4). Assets refer to social and material resources which a person or household has and uses. Further, assets help to build the meaning of their world, and give them capability to struggle to be what they want be and to change what they want change (Beggington, 1999).

Therefore, SLA is a complex people-centric way to the 'being and doing of sustainable development' (Morse & McNamara, 2013), SLA seeks to understand the social, economic and ecological environments in which people find themselves, and which they must navigate in order to determine their livelihood strategies (Chambers & Conway, 1991). SLA thereby seeks to support people according to what they need and value (De Hann & Zoomers, 2005).

Sustainable Livelihood Frameworks

The Department for International Development (DFID) developed a framework (Figure 2-1) as a tool for understanding livelihoods. The framework was integrated in DFID's program for development cooperation in 1997, becoming an important theme in the UK's development policy (De Haan & Zoomers, 2005). The Sustainable Livelihoods Guidance Sheets (DFID, 1999) explain in detail the elements of the framework which are factors that affect people's livelihoods, and typical relationships between those factors. The idea was to develop a framework that could, on multiple level of scale, include the diverse elements that are related to peoples' livelihood choice, leading a more complex understanding, especially about the causes of poverty (Ashley and Carney, 1999). The framework also offered a set of principles aiming to provide a bottom-up and participatory approach (Ashley and Carney, 1999; Scoones, 2009).

The pentagon of livelihood assets (natural, social, physical, financial, and human) is mediated by transforming structures (levels of government, private sector, civil society) and processes (laws, policies, culture, institutions, power relations). These elements affect livelihood strategies and livelihood outcomes, which then produce feedbacks to assets. The sustainable livelihoods approach seeks to help us understand the factors

that lie behind people's choice of livelihood strategy, reinforcing positive aspects and mitigating negative influences (DFID, 1999).

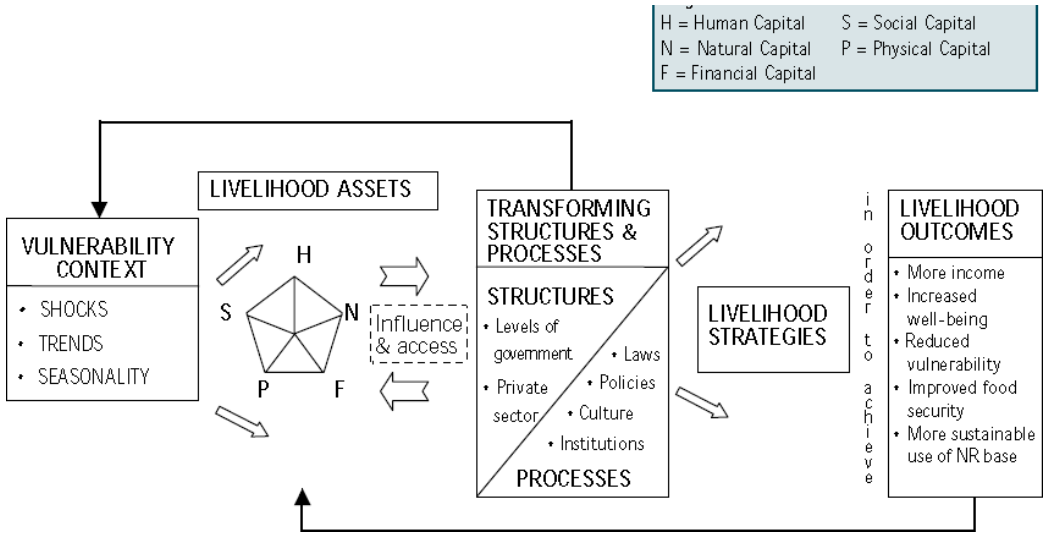

Figure 2-1. Sustainable Livelihood Framework (DFID, 1999).

The SLA has been incorporated into development studies (Carney, 2003) and has been improved by many organizations and scholars (e.g., Hamilton-Peach & Townsley, 2006; CRS, 2007; Scoones, 1998; Bebbington, 1999; Ellis, 2000; Diniz et. al., 2013). The more recent work has contributed distinct definitions of sustainable livelihoods, different assets, variants for politics and power relations and widely varying frameworks. In addition, the International Fund for Agriculture Development (IFAD) and many other institutions such as United Nations Development Program, the Food and Agriculture Organization, the World Food Programme, the British Department for International Development, Oxfam, CARE International, Society for International Development (SID), Institute of Development Studies in Sussex, and others adopted the concept of sustainable livelihoods either as an analytical tool or a planning tool and improved it via practice (De Haan & Zoomers, 2005; Scoones 2009; Mose & McNamara, 2013;

Brocklesby & Fisher, 2003). Here I provide a selective review of some notable contributions.

Beggington (1999) proposes a capitals and capabilities framework (Figure 2-2). He features the idea of how assets create meanings and capabilities that affect the access to other assets and thereby influence decisions about livelihood strategies, Beggington (1999) also highlights the idea of scale how it affects forms of engagement in livelihood actvities. In the framework, assets are “vehicles for making a living, making living meaningful and challenging the structures under which one makes a living” (Harbenas, 1971 in Beggington, 1999: p.2022).

Scoones (2009) highlighted some limitations in the SLA to engage in macro-scale dynamics such as economic globalization, long-term environmental challenges (beyond immediate shocks and stresses) and long-term shifts in rural economies. He emphasizes the challenge of multi-scale processes and tries to develop livelihood analysis that considers the economy, policies, institutions, organizations, and networks that operate on different levels (Beggington, 1999), as well as how they interact and impact each other, without losing attention on the local context.

Another important point researchers have brought up is the discussion of power relationships that play a major role in the access of assets and livelihood pathways (De Haan & Zoomers, 2005).

Scholars has discussed the influences of institutions, markets, politics, and culture (social rules and norms) in poverty and wealth. Although power relations appear in the framework, we need to be more explicit about their influences since for the most part

they stay in the secondary level (Hamilton-Peach & Townsley, 2006; Beggington, 1999; De Haan & Zoomers, 2005).

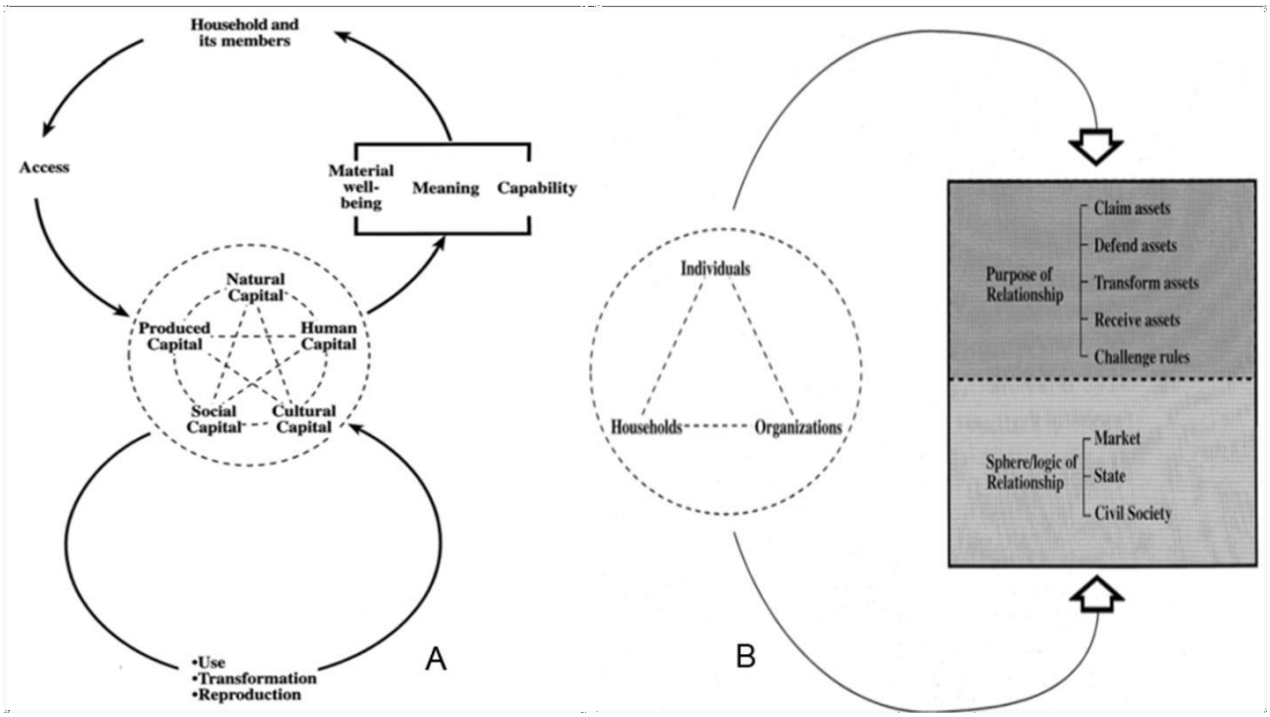

Figure 2-2. Capitals and capabilities framework (Bebbington, 1999).

Scoones (2009) explained how power relations been incorporated into frameworks through ideas such as ‘transforming structures and process’, ‘policies, institutions and processes’, ‘mediating institutions and organizations’, and ‘sustainable livelihoods governance’ or ‘drivers of change’. He claims that power actually plays a role in every component of the framework, whether in the context, in assets, in institutions and social relations. What is missing is to explore wider structures of inequalities (especially class, caste, gender, ethnicity, religion and cultural identity) and to link power relations to livelihoods and governance. Aligned with his work, Ellis (2000) proposed a definition that emphasizes the idea of access and offer a framework that clarifies the dimensions of the

social arena that regulates power and access. Ellis relates access to livelihoods as follows:

> A livelihood comprises the assets (natural, physical, human, financial and social capital), the activities and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household (Ellis, 2000, p 10)

He also developed a framework (Figure 2-3) that brings together ideas from the vulnerability approach, gender analysis, poverty-environment interactions and sustainable rural livelihoods (Ellis, 2000). It starts with assets as the basic elements that household retain and control. Ellis, 2000 defines natural assets as the natural resources such as water, land, forest that people use to generate a means of survival. Physical assets are the ones created by economic production processes such as buildings, irrigation, roads, tools, machines, power lines, and so on. Human capital means the characteristics of labor in the household, including the education, skills, age and health. Financial capital refers to the stock of money people can access such as credit or savings. Lastly, social capital refers to the social linkages, both horizontal within social groups such as associations, cooperatives, informal farmers' groups and also vertical with external authorities and organizations. Access to assets is mediated by social factors context. These interactions result in a livelihood strategy that is dynamic (De Haan & Zoomers, 2005), and thus changes and adapts over time according with peoples' needs.

Livelihood strategies themselves can be divided into two types. The first is based on management of natural resources ("on-farm activities"), whereas the second also makes use of other economic opportunities ("off-farm activities"). Whereas the first permits greater control by the household and is on site, the second may generate higher

income and permits integration into urban markets and institutions. Many rural households thus combine the two.

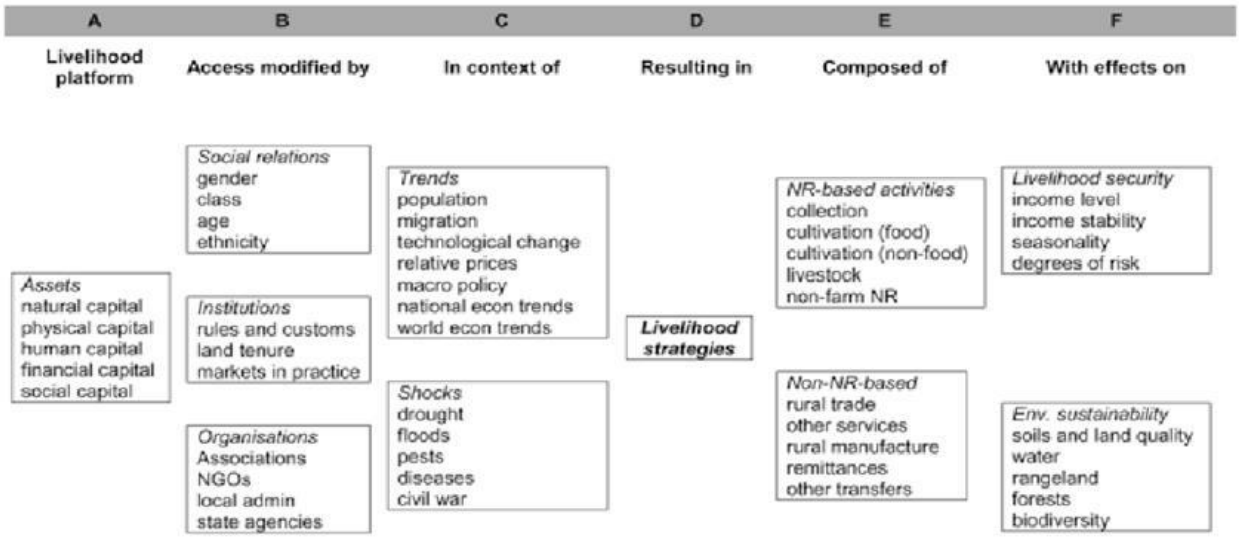

Figure 2-3. Livelihood strategies framework (Ellis, 2000).

Other authors have developed their own typologies of livelihood strategies. One includes 'agricultural intensification or extensification', 'diversification' and 'migration' (Scoones 1998). Another differentiates 'agricultural livelihoods'; 'wage employment'; and 'non-agricultural livelihoods' (Rahman & Akter 2014). A third focuses on 'accumulators,' 'diversifiers' and 'dependents' (Sallu et al., 2010). In all such typologies, the idea is to help identify contrasting strategies that compared in order to evaluate their effectiveness in terms of various outcome criteria. Such comparisons can moreover be made in different contexts.

The role of social capital has become more prominent when considering that access also depends on social relations, especially whether interacting actors are in conflict or acting cooperatively with regard to their livelihoods (De Haan & Zoomers, 2005, P.34). Research on social capital research helps to understand how the capacities

of individuals, households and communities are engaged with each other and with other stakeholders to claim their rights.

A final point concerns decision-making power. De Haan & Zoomers (2005) called attention to the fact that many studies have demonstrated that people make their own livelihood choices, but these choices are not always deliberate and conscious. In many instances, the pursuit of livelihoods does not involve strategic decision-making, but rather more incidental seizing of opportunities to secure a means of survival.

In short, the SLA aims to link assets to options in the pursuit of activities that generate incomes (Ellis, 2000) as well as non-material aspects of well-being (De Haan & Zoomers, 2005). These choices are shaped on multiscales by social, economic and environmental process. Those processes control and mediate access to those assets and the power of people to struggle and defend them, living the life they value with dignity and sustainability (Beggington, 1999).

Livelihood Studies and Research

Many researchers have used the SLA in different contexts (Chirau et al., 2014, Rahman & Akter, 2014, McKune et al., 2015; Valbuena et al., 2015; Veise et al., 2014). Prior work has mainly focused on the assessment of access, the critical links between the elements of the SLA framework, and creation of typologies of livelihood strategies that could differentiate groups of farmers which distinct needs for specific types of interventions. In Brazil, the study developed by FAO and INCRA in 1995 was crucial to define the strategies and policies of the time, by distinguing four categories of farmers: large landholders (comprising 500 thousand properties, 7.1% of the total properties in the country); consolidated family farmers (comprising 1.5 million, 21.5% of rural landholders); family farmers in transition (corresponding to 2.5 million, 35.7% of landholders); and

peripheral family farmers (also comprising 2.5 million, 35.7% of landholders) (Wanderley, 2017). With this data, the government promoted a strategy of prioritizing family farmers in transition in the National Family Farming Program (Pronaf) (Wanderley, 2017). PRONAF sought to transform transitional family farms into consolidated family farms by offering agricultural credits and technical assistance, the peripheral family farms became the focus of agrarian and social policies, as welfare programs (Grisa, 2017, Sabourin, 2017)

Other researchers have focused on understanding livelihood diversification as a new trend that has become central in the discussion on rural development due to its role to enable families to ensure their reproduction (Schneider & Niederle, 2010; Niederle, 2017). Diversification offers opportunities to pursue both agricultural and non-agricultural activities to secure family income (Darnhofer & Strauss, 2014). Although there is no doubt of its importance, there remains a need to clarify the meaning of livelihood diversification in this research.

Ellis (1999, p. 2) defines diversification as “the process by which households construct a diverse portfolio of activities and social support capabilities for survival and in order to improve their standard of living.” Others define diversification as the combination of agricultural activities with non-agricultural activities as ‘pluriactivity’ (Schneider & Niederle, 2010; Darnhofer & Strauss, 2014; Anjos & Caldas, 2002).

The focus on diversification stems from its importance for adaptation to changing circumstances. Household seek to diversify their livelihoods activities as a means of reducing the risk of the loss of a large portion of their income if an activity fail or become unviable (Perz et al., 2015). Households with more diversified livelihoods have more flexibility in increasing some activities after the loss of another. Diversification thus affects

how well the farmers can coping with risks, like seasonality, lack of credit (Aderinoye-abdulwahab et al., 2015), market failure or political or social uncertainties. Households may amplify their portfolio of income sources, especially by taking non-agricultural jobs (Valbuena et al., 2015; Schneider & Niederle, 2010; Ellis, 2000).

On-farm diversity, relates to diversification of crops and livestock in their farming systems, as well as intensifying the use of land and taking advantage of niche markets. On-farm diversity is motivated by local and regional demand for food and a good integration in commercial value chains (Valbuena et al., 2015). On-farm diversity is designed to decrease risks and take advantage of the complementarity between different farming systems (Ellis, 2000), and by reducing dependence on external inputs (Valbuena et al., 2015). On-farm diversity is also strategic in terms of food security (Ellis, 2000) and the autonomy of farmers (Schneider & Niederle, 2010). It is also linked to practices of conservation of soils and biodiversity, thus promoting ecological sustainability (Heberlê et al., 2017). Ellis (2000) argues that on-farm diversity is also strategic in terms could be a complementary or alternative livelihood strategy for off-farm diversification, since it increases labor demand and income opportunities on the family farm.

Ellis (2000) points out that off-farm diversification is not always related to on-farm diversity. The relationship could be positive when farmers use part of wages earned off-farm to invest in improvements in on-farm systems (as a substitute for lack of credit or insurance) or enabling mechanization, substituting capital for labor (Darnhofer & Strauss, 2014; Walker et al., 2009a). This is not always true, for example when the job opportunity does not provide enough earnings for on-farm investments. On the other hand, the allocation of labor to external activities, often means that farm has a debit in terms of on-

farm labor and skills, since it is normally the younger, better educated and males who leave for an off-farm job (Ellis, 2000; Rahman & Akter, 2014). Consequently, off-farm diversification can lead to the decrease of on-farm diversity or even causes the stagnation of the farm, especially when the job is far away from the community and remaining labor is limited (Ellis, 1999). These examples highlight that we should understand both on-farm and off-farm diversification, and how they interact (Ellis, 2000).

Other factors that lead to livelihood diversification are farm fragmentation, declining returns to farming comparing to other activities, and seasonality which encourages farmers to look for different opportunities in different seasonal labor markets. Sometimes it is a tradeoff between a higher income with higher risk of failure and a lower income with less probability of failure (Ellis, 2000). The important idea is to diversify among activities which does not share the same risk, in other words, to have income from activities which the factors that represent risk are different in both and thereby maintain a relatively steady income flow (Ellis, 2000; Valdivia, 1996). Ellis (1999) highlighted that the benefits of diversity are context-specific, and that understanding livelihood diversity can generate relevant knowledge to better support discussions on development (Valbuena et al., 2015).

When using SLA, it important to know that considering all elements that the approach propose can generate an enormous amount of information, and it is useful to apply an ‘optimal ignorance’ (Ellis, 2000; Scoones, 1998). Using some variables informed by the existing literature helps to research key elements of livelihood systems. The present research aims to analyze family farmers in the context of Amazon frontier changes in the light of SLA.

CHAPTER 3
METHODOLOGY

Collaboration in the Research

The objective of this interdisciplinary research program is to generate theoretical and practical knowledge that will improve the initiatives developed by public and social organizations. It is based on the systemic understanding of family agriculture, considering all the complexity within this group as well as cause and effect relationships at different scales that influence livelihood strategies and their outcomes. For this, the project involves the articulation between non-governmental organizations, universities and farmers' groups in an integrated action that, in addition to its research component, will work in the formation and strengthening of this network of organizations.

I therefore pursued a long process of discussion involving two local NGOs that work in Mato Grosso state, the Instituto Centro de Vida (www.icv.org.br) and Instituto Ouro Verde (www.ouroverde.org.br). The idea was to make this research as useful as possible for local organizations that support family farming in the region.

In order to connect practice and research in a more fluid process and to develop a bottom-up research process and a long-term commitment among institutions, the discussions around this research led to the creation of an Research Program for Resilient Family Farming in northern and northwestern Mato Grosso (http://ouroverde.org.br/resiliencia/).

To support the program, as a starting point, this research provides an overview of what is meant by ‘family farming’ in the region and what are the avenues for future research. With the involvement of local organizations, it was possible to develop the design of this research considering all local knowledge already available, the main

concerns and needs of local communities, and to hire ten undergraduate students from the local university which were trained to support the survey process. The possibility for the students to visit local farmers gave them multiple perspectives of the rural world, and offered an opportunity for critical thinking about their role as students and future professionals.

Study Area

Mato Grosso State Context

The state of Mato Grosso has had an important role in the development of Brazil, especially in the last two decades. Mato Grosso is a large state, in the central-western region of Brazil, with 903,000 km² (one of the three biggest state along with Para and Amazonas), but it has a low population density, of 3.36 inhabitants/km². Mato Grosso has 141 municipalities, and the state includes portions of three biomes: Savanna (Cerrado), Amazon Forest, and Wetlands (Pantanal) (IBGE, 2015). Mato Grosso is part of the Legal Amazon, which was set up by the Brazilian government with the goal to promote the social and economic development of the states of the Amazon region. The Legal Amazon represents 61% of Brazilian territory, encompassing the states of Acre, Amapá, Amazonas, Mato Grosso, Pará, Rondônia, Roraima and Tocantins and part of Maranhão.

Amazonian colonization policies in Mato Grosso started in Getulio Vargas's government, in the 1940's, with the creation of national agricultural colonies (1941-1944), the creation of the Plan for Economic Valorization of the Amazon (via the creation of SPVEA, a superintendency to implement this plan) and the launch of the "March to the West", a project aimed at the occupation of the region's demographic "vacuum'" in the Brazilian center-west and southern Amazonia. In the 1950's and early 1960's, there was

also an intense migratory flow of unemployed workers leaving the newly constructed capital, Brasilia, after the completion of the city's construction works. Nevertheless, it was during the military regime, in the 1970's, that the colonization process intensified (Barrozo, 2008).

The role of colonization of the center-west and Amazonia was based on a several issues. These included national security concerns to occupy and thereby secure a demographic empty space along international borders; to address agrarian conflicts in the Brazilian Northeast, led by "peasant leagues" in the 1960s; and impediments in the South to the process of agricultural modernization that was being planned, focusing on soybeans and wheat plantations. There were small farms made it difficult to adopt of industrial agriculture, and the labor force of coffee plantations which was in decay. To simultaneously address the geopolitical concern, agrarian conflicts, and impediments to industrial agriculture, the government therefore promoted Amazon colonization with advertisements to bring together "land without men for men without land" (Ribeiro, 2008; Barrozo, 2008; Schimink & Wood, 2012).

To achieve these goals, the military government launched "Operation Amazonia" with the motto "integrate so as not to give away." Several institutions were created that supported the government in this mission, such as the Amazon Development Superintendency (SUDAM); the National Institute of Colonization and Agrarian Reform (INCRA); Superintendency for Development of the Mid-West (SUDECO); and the Amazon Bank (BASA S.A.) (Joanoni Neto, 2007; Barrozo, 2008). Along with these measures, the National Integration Plan (PIN), also initiated in the 1970's, planned and constructed the federal highways of the Amazon such as the Transamazon, Cuiaba-

Santarem, Cuiaba-Porto Velho and the Northern Perimeter, which allowed the occupation and the migration many people. Two years after the creation of INCRA the government authorized private initiatives of colonization to "complement" the public agrarian reform of INCRA. A few years, later private colonization companies took over millions of hectares of public land. In Mato Grosso, colonization was carried out predominantly by the private sector. To complement the colonization effort, SUDAM and BASA offered credit, tax incentives, cheap land, and basic infrastructure such as roads and energy to foster investments by businessmen from Southern and Southeastern Brazil so they too could occupy the region (Barrozo, 2008; Schmink & Wood, 1992).

Private colonization in Mato Grosso had the goal of developing the region based on “green gold” (coffee production). Colonization firms sought a very select group of small farmers from the south and southeast, creating the myth of the "ideal farmer" (Barrozo, 2008; Ribeiro, 2008). But many immigrants in the 1980’s actually came from the Northeast to Amazonia, notably to Southern Para and northern Mato Grosso. These spontaneous colonists were fleeing drought, and were attracted by the 'gold rush' (Schmink & Wood, 1992).

Is very important to highlight that migration and land settlement in the Amazon at this time was not a peaceful process. On the contrary, there were many violent conflicts among the private colonization companies and large landowners with the impoverished immigrants who were competing for land and indigenous people who were living in these territories; and further, with the in-migration of garimpeiros (placer miners). There was thus and multifaceted intense competition for control over land and other natural resources (Ribeiro, 2008; Schmink & Wood, 1992), which resulted in disputes over how

how these natural resources would be exploited (Schmink & Wood, 2012). The military government viewed any kind of defense of the peasants or indigenous people as coming from instigators of communism, and dealt with such protest severely (Schimink & Wood, 2012).

The state of Mato Grosso was thus occupied by heterogeneous and competing groups. These included people dispossessed of their land in the northeast and south of the country, and low-skilled urban workers from other regions, attracted by the discourse of a “supposedly unpopulated region where abundant land and fertile was available for those who wanted to ‘work hard’ in the first years” (translate by the author, Ribeiro, 2008, p. 219). They also included the garimpeiros, the indigenous groups, and the colonization entrepreneurs and economic interests which saw the frontier as an opportunity to expand their business (Picoli, 2006). “The result was not a single process of linear change, but instead a diversity of contested frontiers with highly varied outcomes” (translate by the author, Schmink & Wood, 2012, p. 51).

The migrants who colonized the central part of Mato Grosso, in the cerrado region prospered economically through soybean production. However, others who went to the more isolated regions of forest remained in the same economic and social condition or ended up worse off. Many colonists of forest areas then migrated to other frontier areas, or returned to the south (Barrozo, 2008; Joanoni Neto, 2007). This scenario supports what Lopes (2010) called "two Mato Grossos." One comprises the municipalities that have a growing economy sustained by modern agricultural production based on commodities, with a high per capita income, high educational attainment and life expectancies, and therefore HDI values higher than national average. As Ramos (2014)

shows, among municipalities with the highest rates of rural development in Brazil, five of the top 10 are located in Mato Grosso (Sapezal, Alto Taquari, Nova Mutum, Campo Novo dos Parecis, Sorriso and Lucas do Rio Verde). Nevertheless, Ramos (2014) also emphasizes that these municipalities present a rural desert, with no biodiversity and no people, just extensive agricultural production. In the other Mato Grosso, municipalities have high migration rates, high levels of poverty, stagnant economies, and public administrations that fully depend on state and federal transfers. They are especially in the northern part of the state, in the frontier region, and constitutes the focus of this research.

The history of land settlement in Mato Grosso led to inequalities in land tenure. IBGE data from 2006 showed that in Mato Grosso, properties of more than 2,500 ha, which are only 3.5% of the total agricultural holdings, cover 73.5% of the land available in the state. By contrast, small properties of up to 200 hectares, are 82.98% of the properties and only hold 10.43% of the land area. There are 545 INCRA Agrarian Reform settlements which occupy an area of 6,077,078 hectares, about 6% of state area and home to about 84,501 families (INCRA, 2014). This is less than the area under soybean production. Intermat is responsible for 126 settlements in the state (Midia News, 2010). Indigenous Lands occupy about 15% of Mato Grosso's territory with 134,000 km² in 68 territories with about 44 different ethnic groups (Funai, 2015). There are 73 Conservation Units that cover 4% of total state area, covering 33 thousand km.² The private proprieties are 77% of the state area, about 694,000 km.²

The economic base of Mato Grosso is founded on a model of exportation of primary goods, including grains, fibers, meat and wood. This export sector has

undergone a rapid economic expansion over the past two decades. Mato Grosso is the largest beef producer among Brazilian states, representing 16% of the total production (Beefpoint, 2013), with 28,395,205 head of cattle in 2014 (Reydon, 2014), but a low average of 0.76 heads/ ha and low productivity of 49.35 Kg/ ha / year (Instituto Mato Grosso de Agricultura Agrícola, de 2013, in ICV, 2013). In terms of large-scale agricultural production, Mato Grosso is also the largest Brazilian soybeans producer, with 9,140 million hectares covered by soybeans (Embrapa, 2016), the largest cotton producer, with 597,600 hectares, and is a significant producer of corn, with 3,416,701 million hectares, and sugar cane with 282,741 hectares (Knoema, 2013). Large farms in the region purchase inputs intensively, and are equipped with high technologies. There is also a trend of increased production of processed foods, as ten of the world's largest companies have established manufacturing plants in Mato Grosso; including JBS-Friboi, BRFoods, Cargill, Bunge, ADM and Marfrig. All were attracted by tax policies (Lopes, 2010). Under the impact of the growth of the agro-industrial commodity grown, a stereotyped view of the rural world was established. The view of mechanized agricultural interests and the government views as backward those that do not fit into of the model of agricultural modernization, which is presumed to be a one-way path for development (Mattei, 2014).

Many research investments have led to better crop and livestock technologies for rural producers (OECD/ FAO, 2015). Most of these efforts were led by EMBRAPA – the Brazilian organization for agricultural and livestock research. One reason for the "other" Mato Grosso remaining stagnant, with high rates of poverty, was due to the fact that government research and extension efforts have been concentrated on serving these

agri-business production interests, with little attention and research engaged with the improvement of family farming.

However, the growth of export-oriented mechanized agriculture has led to consequences for the environment in Mato Grosso. The large properties of the region use inputs and machinery more intensively and the result is that the state is in fifth place in the ranking of agrochemical use in Brazil (Ageitec, 2015). Further, data from Prodes (2014) show the accumulated deforestation (km²) from 1988 to 2014 (Table 3-1). Mato Grosso is the leader, with the highest deforestation rates, with peaks in 2003 and 2004.

Table 3-1. Prodes, 2014.

Accumulated deforestation (km²) -1988 to 2014	
Acre	13054
Amazonas	21651
Amapá	1493
Maranhão	24195
Mato Grosso	138316
Pará	137981
Rondonia	55455
Roraima	7022

There is nevertheless a trend for increasing commodities production in Mato Grosso. Bickel and Dros (2003) projected an increase in the soybean plantation to 40 million hectares in Mato Grosso. Also, the new Mato Grosso strategy launched in 2015 in the COP21, Paris, called “To produce, to conserve and to include” aims to increase the productivity and efficiency of commodities production in the state, to reduce the emission controlling deforestation and promoting the restauration of forests areas and to include family agriculture in the state economy (http://pci.mt.gov.br/). This very ambitious program intends to increase the participation of family farmers from 20% to 70% in the state economy, by increasing their access to credit, technical assistance, and promoting

land regularization. Key to this ambitious strategy is to encourage the amplification of grains production by increasing productivity and replacing unproductive livestock systems.

In conclusion, the history of Mato Grosso has shown how family farmers in this region have struggled to survive in a state that relies on an economic model involving extensive use of natural resources and mechanized production for export, where land is linked with political power (see Castilho, 2012). In this landscape, family farmers have struggled for recognition of their rights to claim land and build their livelihoods. Nevertheless, the dominant agribusiness model, which emphasizes monocultivation of grains, enormous use of pesticides and herbicides has attracted most all support from government research and extension agencies. Initiatives to support family farmers must to consider the landscape scale, not only at the farm level. Otherwise, family farmers will be replaced sooner or later, causing further concentration of land, and continued poverty and migration to other regions of the Amazon.

Municipalities of the Sample

I focus this study on 9 municipalities located in the northern and northwestern regions of Mato Grosso, all in the Amazon forest region. The municipalities are: Alta Floresta, Carlinda, Nova Guarita, Terra Nova, Paranaíta, Apiacás, Nova Bandeirantes, Nova Monte Verde in the north; and Cotriguaçu in the northwest. The considerations of these two regions are to involve the areas where the NGOs have been working and to include forested areas at different stages of frontier development.

In general, the municipalities in the sample have small populations, Alta Floresta is the biggest, with about 50,000 inhabitants, while the others have no more than 15,000

inhabitants. They are also young municipalities, all of them with less than 45 years since their creation.

The rural areas are important for the economy of all of the municipalities in this region. GDP data shows that except for Paranaíta (which had a big change in their economy since a hydropower dam was implemented) and Alta Floresta, in all municipalities, the agriculture sector contributes more to GDP than industries or services (IBGE, 2010). The median income per capita is low in all municipalities (Figure 3-4), and in rural areas it does not achieve R$500/ month. Nova Bandeirantes and Cotriguaçu have the lowest incomes per capita.

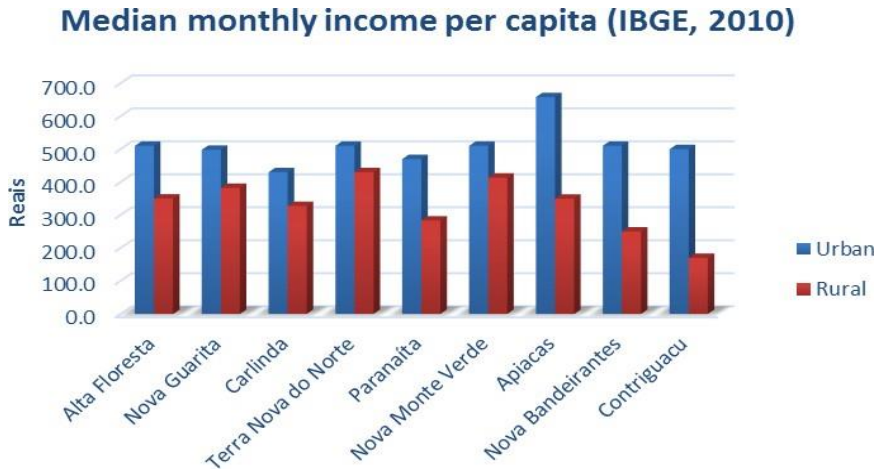

Figure 3-1. Median income rates (IBGE, 2010).

Although Apiacás has the highest income per capita, it is the municipality with the highest rate of poverty, about 40% of its population (Figure 3-5). Overall, the incidence of poverty in the region is significant.

Data about illiteracy rates and early dropouts from school, total and by gender, are also important to understand the population (Figure 3-6). The data show that although illiteracy rates are not higher than 20% of populations, the early dropouts from school is

much higher, especially in Nova Bandeirantes and Cotriguaçu where early dropouts are 70% of the school-age population.

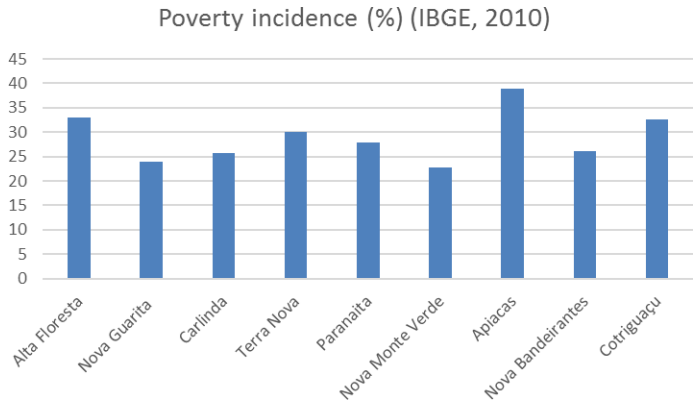

Figure 3-2. Poverty rates by municipality (IBGE, 2010).

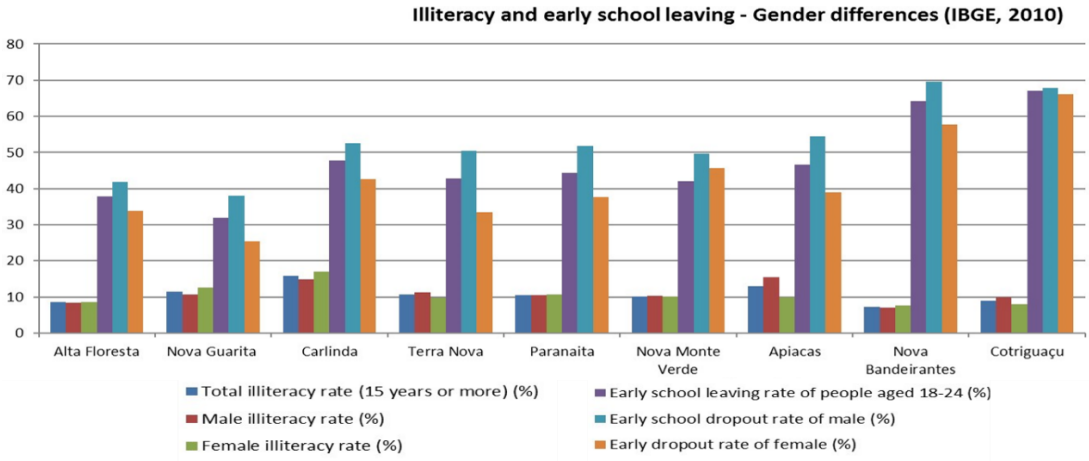

Figure 3-3. Illiteracy and early school leaving rates by municipality and gender (IBGE, 2010).

It is shocking to look at the school census from SEDUC (2014) to see how much the number of schools in the municipalities have changed from 2006 to 2014. Cotriguaçu used to have 32 schools in 2006, and that number dropped to 13 schools in 2014. In Nova Bandeirantes, 18 schools in 2006 declined to only 9 in 2014. Apiacás reports only with two municipal schools in 2014 for its 9400 inhabitants. Nova Monte Verde declined from 10 to 6 schools, and Paranaíta dropped from 22 to 8 schools. The declines in

schools reflect cost-cutting measures by municipalities. To reduce costs, the municipalities prefer to close rural schools and to provide buses to bring those kids to the city schools. This policy probably impacts early school dropouts and reflects changing values in rural areas.

With regard to agricultural holdings, Figure 3-7 shows the distribution of family farms and non-family farms across municipalities and also the percentage of area occupied by both (IBGE, 2006). The municipalities have a similar percentage of family farmers, around 70% of the farms. In Nova Guarita, 94,7% of farmers are family farms, the highest percentage. Also, different from the others, these farms occupied an area bigger than the medium and large farms (59,3%). Apiacás shows the lowest percentage of family farmers (74,2%). But overall, there is considerable inequality in terms of land distribution in all municipalities.

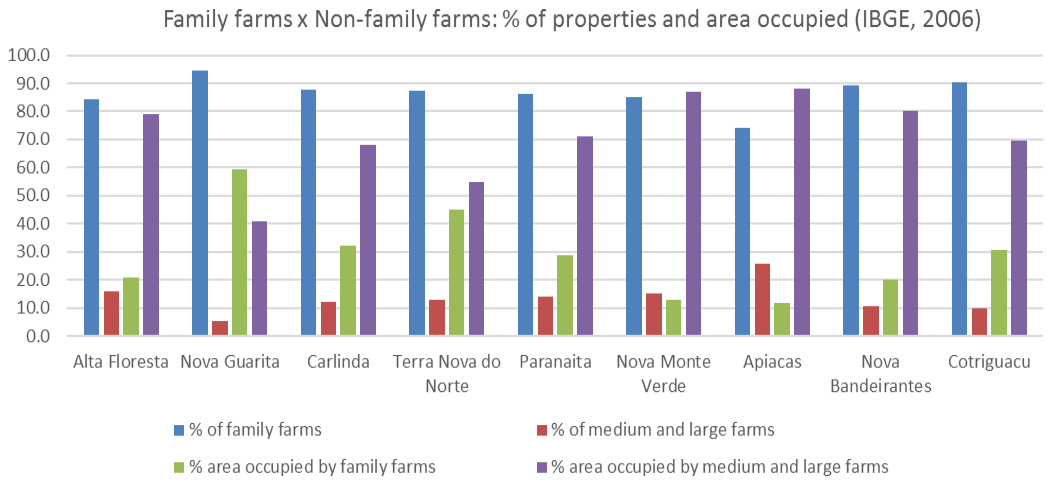

Figure 3-4. Agricultural holdings by family farming, medium and large farmers (IBGE, 2006).

Frontier Categories

To analyze the data, I divided the region in different stages of frontier occupation. This is to permit comparative analysis to understand if there is a pattern in assets and livelihood strategies across these stages. I performed a bibliographic review to identify indicators to differentiate stages of frontier occupation.

There are different theories of frontier development. In this research, a frontier is defined as a physical and temporal dimension of a forested territory with dynamic properties due to the occupation by different stakeholders leading to social, economic and environmental outcomes which change over time (Browder et al., 2008; Pacheco, 2012). The different frontier approaches include the neoclassical economic perspective (Browder et al., 2008). This approach defines 'pioneer frontiers' as a region with high rapid farm turnover and land abandonment (Schneider, 1995; Caviglia-Harris, 2013), land speculation (as the infrastructure improve settlers sell-out the properties for a second-generation) (Pacheco, 2009), and deforestation rates to indicate occupancy (Carr, 2009) more than for production purposes. The neoclassical perspective also identifies the 'consolidated frontier' which is characterized by the increase of profits due to market development and accessibility to infrastructure, which motivate capital investments to increase yields and improve productivity on agricultural lands (Schneider, 1995; Pacheco, 2012; Soler et al., 2014). Other approaches discuss Amazon frontier expansion as a capitalist strategy of using geographic movements to absorb the surplus labor of other regions (Schmink & Wood, 2012). The frontier is formed by migration waves, especially from the south of Brazil, that aimed to bring industrial and postindustrial modes of production to the north and connecting them with consumers in the south (Picoli, 2006; Pacheco, 2012), expanding capitalism by government-subsidized

fiscal incentives. As the frontier is 'improved', deforestation increases and peasants are appropriated by industrial capital, by having large-scale cattle ranching replace them, with a strong role of government investments in infrastructure shaping the frontier (Browder et al., 2008; Hoefle, 2013). This occupation process is marked by intense social conflicts. As the frontier becomes 'more consolidated', the rural population declines, deforested areas are converted from diversified production to cattle and soybeans, the number of farmers that have off-farm jobs increases (Browder et al., 2008; Picoli, 2006), and the social conflicts become less evident.

As frontiers move through stages, households also exhibit changes. The household life-cycle theory relates the household's demography with land use. As famiies age, family labor availability grows and family capabilities for land use increase (Perz & Walker, 2002; Caviglia-Harris, 2013; Walker et al., 2009a). Family thus age as frontiers pass through stages of occupation, and both impact farm production. For example, the frontier starts with the arrival of young pioneer families. Over time, as frontier occupation proceeds, the number of dependents in pioneer families rises, increasing family consumption and also production (Walker et al., 2009a). In the 'post-frontier' stage, land settlement is more consolidated, and pioneer families experience generational transitions. The second generation tends to move to a new subdivided farm, or migrate to the cities leaving the older households. With this process, the land use in the frontier change mostly from less labor-intensive but focused on subsistence farming and fast return cultivars to provide food, through more labor-intensive activities due the availability of labor, to less labor-intensive production systems such as cattle raising (Browder et al., 2008). Other authors (Hoefle, 2013; Perz & Walker 2002) also mentioned

the high migration rates typically in the frontier after the first exploration and depletion of natural resources.

In all accounts, there is no doubt about the pattern of deforestation over time. Frontier occupation begins with a high amount of forest in the initial stage (pre-frontier) and low deforestation, passing to a stage of medium forest cover and high deforestation (frontier) to more agricultural landscapes, less forest and low deforestation rates in the consolidated stage (post-frontier) (Arnauld de Sartre et al., 2016; Browder et al., 2008; Hoefle, 2013; Pacheco, 2009). Some scholars use indicators such as forest cover and rates of deforestation combined with social economic data (for example, HDI) to create categories of frontier (i.e. boom-and-bust) (Pacheco, 2012; Rodrigues et al., 2009). Pacheco (2012) added to this perspective the different rural stakeholders playing the major role (i.e. smallholder, medium and large landholders) along the different stages of frontier evolution, arguing that it goes from more diversified systems and small-scale properties to large-scale ranchers. Browder, et al. (2008) provide a household-level analysis of demographic and economic conditions over time in the frontier in Rondônia. Walker et al. (2009a) developed a model incorporating demographic factors with market-based factors (off-farm jobs, transportation and accessibility), arguing that the attributes of the families are not enough to understand changes in farming systems. Although there are some patterns, Pacheco (2012) pointed out the need to look at land use differences according with to the specific actor, because they might respond differently at different frontier stages.

To define how the municipalities of the sample would be divided into different categories of frontier, I analyzed secondary data using different indicators (Table 3-8). I

chose six variables: population density (IBGE, 2010), population change in the last 10 years, rural population, percentage of forest cover, rates of deforestation and distance to the highway (google maps). The conditions of the road are also important (Walker et al., 2009a), although not considered here. The state road (MT-208) that connects the municipalities to the main highway (BR-163) had its pavement conclude 2 years ago connecting Nova Monte Verde to Alta Floresta. Apiacás, Nova Bandeirantes and Cotriguaçu have only unpaved roads.

Municipalities	Demographic density 2010 (inhab / km²)	Population variance from 2000-2010 (%)	% of forest cover (2015)	Average rate of deforestation km2 (2010-2014)	Distance to highway – BR163 (km)	Rural population (%)
Alta Floresta	5.48	4.6	41.9	4.86	150	13.3
Carlinda	4.59	-10.6	27.4	1.28	118	58.4
Nova Guarita	4.43	-12.7	14.4	1.38	0	60.7
Terra Nova do norte	4.41	-21.5	50.3	5.34	0	55
Paranaita	2.23	4.2	51.1	16.88	223	47.1
Nova Monte Verde	1.54	18.5	54.7	4.02	304	50.9
Apiacas	0.42	28.5	83.1	14.42	340	25.6
Cotriguaçu	1.58	76.8	75.8	36.28	442	65.8
Nova Bandeirantes	1.21	67.5	63.7	46.6	370	73.1

Figure 3-5. Demographic data (IBGE, 2010) and forest and deforestation data (Prodes, 2015) by municipality.

It is evident the pattern of deforestation across the frontier type (Figure 3-6).

I ranked each municipality (from 1-9) based on its relative value for each indicator. Lower values indicate a more consolidated status for that municipality. I then summed the ranks across indicators to get index scores for degree of consolidation, again with more consolidated municipalities getting lower values. Each municipality received a score from ‘more consolidated’ (low values) to ‘new frontier’ (high values) according with each indicator, as Table 3-9 shows.

From the results, it was divided three different categories of frontier: more consolidated frontier (MCF), less consolidated frontier (LCF) and new frontier (NF).

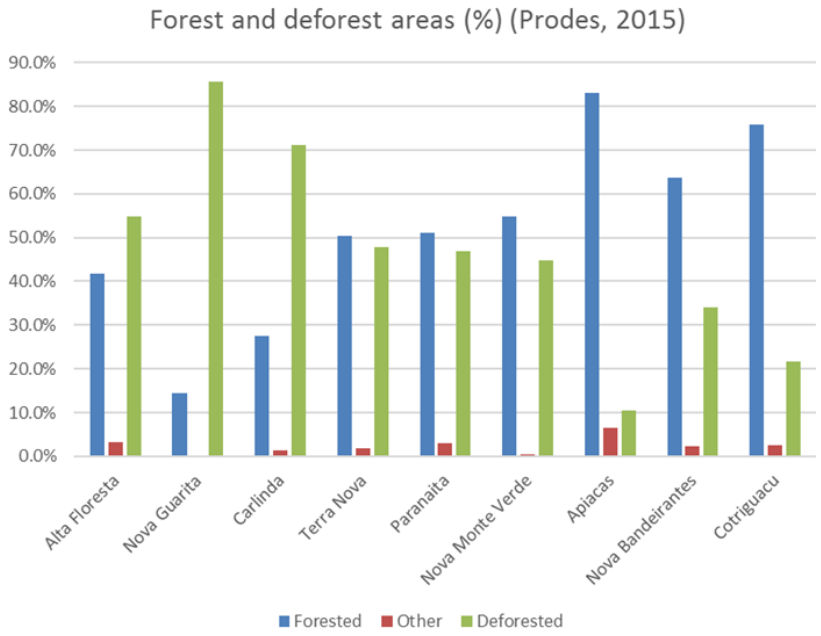

Figure 3-6. Prodes, 2015.

Municipalities	More density = more consolidate	Less variance = more consolidate	Less forest cover = more consolidate	Less average = more consolidate	More close to highway = more consolidate	Lower rural population = more consolidate	Total rank	Category
	V1	V2	V3	V4	V5	V6		
Alta Floresta	1	2	3	4	3	1	14	More consolidated frontier
Carlinda	2	3	2	1	2	6	16	
Nova Guarita	3	4	1	2	1	7	18	
Terra Nova do norte	4	6	4	5	1	5	25	Less consolidated frontier
Paranaita	5	1	5	7	4	3	25	
Nova Monte Verde	7	5	6	3	5	4	30	
Apiacas	9	7	9	6	6	2	39	New frontier
Cotriguaçu	6	9	8	8	8	8	47	
Nova Bandeirantes	8	8	7	9	7	9	48	

Figure 3-7. Score table and categories of frontier.

The more consolidated frontier refers to the municipalities with higher demographic density, less variance in the population size in the last 10 years, more agricultural and livestock landscape which mean less forest cover, lower rural population and good proximity with highways which allow farmers to be more connected to markets and increase accessibility. They are Alta Floresta, Nova Guarita and Carlinda. The new frontier includes the municipalities with highest forest cover (most the territory), a significant rural population, greater distances from highways and poor infrastructure, low population density and a big variance in its population in the last 10 years. They are

Apiacás, Nova Bandeirantes and Cotriguaçu. Finally, the less consolidated frontier encompasses the municipalities with rates in between the two categories. They are Terra Nova do Norte, Paranaíta and Nova Monte Verde (Figure 3-8).

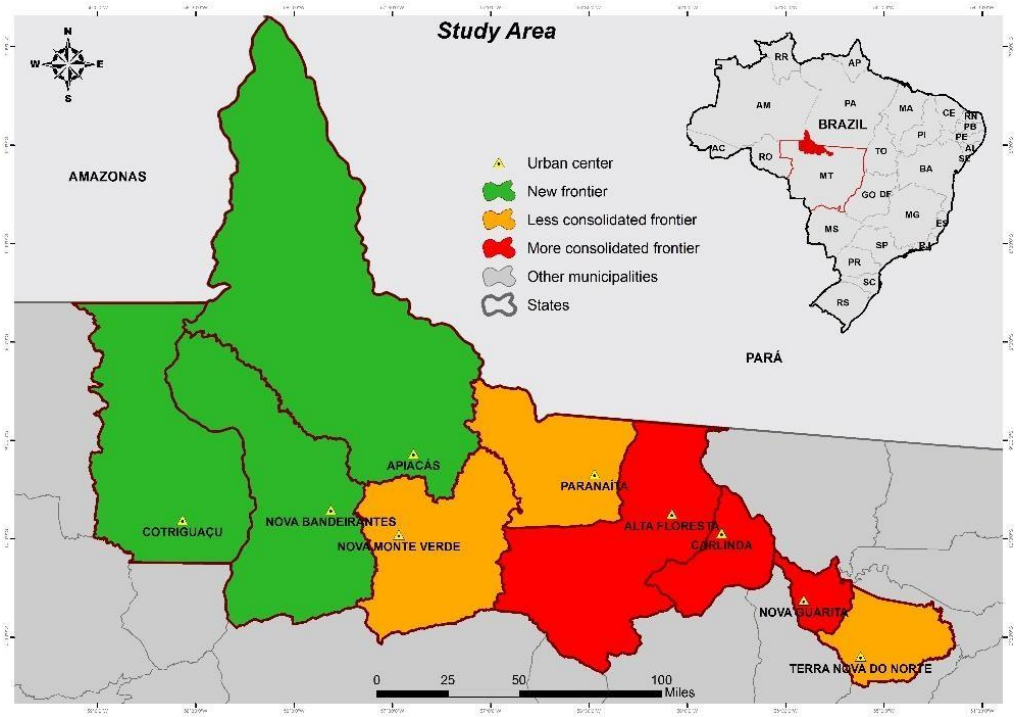

Figure 3-8. Study are with municipalities divided by category of frontier region.

According to the Sustainable Livelihoods Approach (SLA) and household life-cycle approach, the hypotheses about frontier stage and family farms are:

1. In the more consolidated frontier, access to infrastructure and services are better, permitting better education for people, better communication and information channels, stronger institutions and organizations, better regulation (of land for instance), all of which will increase livelihood security, better access to credit and higher incomes and market linkages. This context condition will lead to greater assets in general.

2. The asset-rich farmers have more ability to diversify, both on-farm and off-farm, especially because of the greater social capital, investments and education.

By contrast, other Hypothesis states that in the more consolidated frontier, families would be smaller since the second generation would move to another property or to urban centers involved in non-agricultural work. This would lead to a more specialized type of farming that demands less labor effort but is strongly linked to markets. Also, the assets-poor farmers with limited commercial opportunities needs to diversify more their farming systems to reduce vulnerability (Perz, 2005).

In sum, the process of frontier development could result either in a rise or decline in livelihood diversity. This research will analyze how assets and livelihood diversification respond to frontier development stages.

Research Design

The Sustainable Livelihood approach (SLA) provided the theoretical framework that guided this research. Based on the SLA understanding of the factors that influence livelihood choices (Figure 3-9), I collected data secondary database and household surveys. The framework aimed to incorporated more recent contributions to livelihood studies.

The secondary data were useful to find information about the broader frontier context in northern Mato Grosso and to allow for triangulation with the survey data. It will also will help to understand better the key dynamics and relationships between livelihoods and environment (Sallu et al., 2010). Besides the government database for state and municipality, I used NGOs databases maintained by NGOs, especially GIS data and internal reports. Also, I had access to an existing set of narratives from qualitative interviews from the NGOs, which I also used to design the survey questions. These sources helped to provide information about the factors that theoretically should

play major roles in livelihood strategies and wealth that were included in the surveys questionnaires.

A Livelihood resources	B Access is controlled and mediated by	C In context of	D Resulting in	E Composed of	F With effects on
Assets Natural Physical Human Financial Social	Social Relations Gender Class Age Ethnicity Religion Status Institutions Rules, norms (formal and informal) Beliefs and value systems Power structure Markets in practice Organizations Grassroots Social Movements NGOs Government agencies	Conditions and Trends History Climate Population Migration Technological trends Relative prices Macro policies National econ trends World econ trends Shocks Storm Draught Diseases	Livelihood strategies and pathways	Natural resources based activities Cultivation (food or no food) Livestock (Intensification/extensification, diversification) Non-NR based activities Rural trade Rural manufacture Services Employment Migration	Livelihood security Income level and stability Degrees of risk/ resilience Food security Well-being Capabilities Happiness Environmental sustainability Soils and land quality Water Forests Biodiversity

Feedback: opportunities or constraints

Figure 3-9. Conceptual framework (adapted from Ellis, 2000).

The survey questions were submitted to experts for review, including researchers and practitioners of both local NGOs. Afterwards, a cognitive test was performed with nine farms from two municipalities (Alta Floresta and Carlinda), including seven men and two women with different farm profiles. These tests and responses by farmers helped to improve the phrasing of questions in order to obtain valid information. A pre-test of the instrument was performed to make final adjustments to the questionnaire.

In the end, the survey had 40 questions, and it took about 30 minutes to answer (though that varied a lot depending on the farmer). The dimensions and variables considered can be seen in the Table 3-2.

The surveys were applied in a large-scale sample in nine (9) municipalities in northern Mato Grosso. I used geographic sampling to include communities close and far from the BR-163 federal highway, in order to ensure inclusion of communities at varying distances from local and regional markets. Within communities, I employed a systematic

sampling procedure, considering all small-scale farms (less than 400 ha) as determined by GIS coverage files for landholding cadastres, in order to obtain a representative sample of farms.

Table 3-2. Dimensions and variables considered in the survey.

Constructs	Dimensions	Variables
Assets	Human assets	Household size
		On- and off-farm workers Male and female on- and off-farm work Average age, on- and off-farm workers Average household age
		Household age distribution Duration of residence Origin region of households
		Percentage of farmers that took any course in the last year Number of families that experienced migration in the past 10 years and number of people who migrate, place of destination and reasons to leave
	Natural assets	Size of properties (hectares) Categories of size (IGBE categories) Titling status of land
		Availability of water sources Satisfaction with water availability Farmer perceptions of soil quality
	Physical assets	Soil preparation practices and access to agricultural inputs
	Social assets	Percentage of households that participate in associations, cooperatives and rural worker's unions
		Number of grassroots organizations farmers participate Level of participation in associations, cooperatives and rural worker's unions Perceptions about the role of community organizations Frequency of help among neighbors Interactions with external organizations at least every 3 months How much farmers feel informed about government, NGO and community organization activities in their communities
	Financial assets	Access to credit (Pronaf, other credits)
Livelihood strategies	Production	Percentage of farmers who save seeds per category Number of production systems per category
		Percentage of households engaged in different production systems per category
		Backyard production Categories of numbers of production systems Land use per category

Income	Categories of numbers of production systems that provides income Average number of production systems that generate cash income Frequency of income production per year by production system Primary source of income
	Primary on-farm source of income Number of families' off-farm sources
	Percentage of farms with different off-farm income sources Number of marketing channels
Marketing	

Table 3-2. Continued

Constructs	Dimensions	Variables
		Number of products sold in each marketing channel
		Percentage of farms using different marketing channels to sell their produce
		Number of products farmers' sell
	Food security	Average food production
		Percentage of food from different sources
	Next year's plan	Percentage of households with specific plans
		Percentage of households indicating a preference for specific government investments
Mediating process	Gender	Gender landownership status
		Decision making about production sales, organization membership, investment of money and participation in technical assistance
	Policies access	Access to policies such as PNAE and PAA, technical assistance and project benefits
	Market	Presence and distance of dairy plants and slaughters houses

There debate over the question of whether to consider properties with more than 100 hectares as family farms. Some studies have only considered properties with less than 100 hectares as family farms, arguing that even the national census has used this cut off number. Others however said that this more restrictive definition disregards farms which hold all characteristics of family operations (Godar et al., 2012). I therefore considered what is written in the law (the "4 fiscal modules" definition, equivalent to 400 hectares in Amazon) as a starting point. However, I also used the self-identification of farmers as family operators as the main criterion for their inclusion in the survey, by simply asking them at the beginning of interviews.

The analysis included quantitative methods using statistics and qualitative methods using text analysis. To portray family farming livelihoods in the region, I first performed univariate descriptive statistics on variables representing determinants of livelihoods as well as livelihood strategies. I then conducted bivariate analysis to evaluate the importance of farm characteristics for livelihood activities and income sources. This permitted evaluation of the importance of assets for livelihoods. In particular, I compare

livelihoods across municipalities in different categories of frontier regions to assess the effects of frontier stage on livelihood strategies. All statistical analysis was made using SPSS statistics analysis software. When pertinent, narrative responses to open questions were analyzed using online 'text analyzer' (https://www.online-utility.org/text/analyzer.jsp).

General Sample Data

In the original research design, 10 municipalities were involved, with a total of 15,132 family farms according to the National Census (IBGE, 2006). This served as the samping frame. A web tool (http://epitools.ausvet.com.au) was used to define a sample with desired precision of 0.035 and estimated true proportion of 0.5. The sample was divided by municipalities considering the representative percentage of family farmers in each municipality regarding to the total, as Table 3-3 shows below:

Table 3-3. Sample population and sample size before changes.

Municipality	N. family farms	% in the Sample	Sample Size
Alta Floresta	1952	12.9	96
Carlinda	1547	10.2	76
Nova Guarita	745	4.9	37
Terra Nova do Norte	1611	10.6	79
Paranaíta	1740	11.5	86
Nova Monte Verde	899	5.9	44
Nova Bandeirantes	1437	9.5	71
Apiacás	467	3.1	23
Nova Bandeirantes	1437	9.5	71
Cotriguaçu	1979	13.1	98
Colniza	2755	18.2	136
Total	15132	100	746

Systematic sampling (sample ratio=1/20) was applied to different family farming communities in the municipalities of the study area. Although the required sample provided from the model was 746 farmers, during the process, two adjustments in the

sample had to be made. One of the municipalities, Colniza, was removed from the sample, because just part of it (44 farmers) was included due to its huge size of (27,946.1 km2) and very precarious road conditions in the rain season when the survey was performed. Colniza also has many social conflicts that did not permit field teams to go into distant areas. To give a sense of the situation, in April 2017, ten family farmers were killed in a community due land conflicts with loggers and ranchers (Soares, 2017). Another important point is that in some municipalities, the sample size was lower than planned. The data from IBGE was taken in 2006, and it was used these number to calculate the sample ratio,1:20 which means I applied the survey every 20 family farms. In some municipalities, it was not possible to find the sampled farms using this systematic approach. Probably they were farmers who already migrated and small farms that became combined into a large one. Looking at the sample map (Figure 12), we can see that the sample was nonetheless geographically well distributed.

At the end, from the 12,377 family farmers that counted in Brazilian National Census (IBGE, 2006) for the nine municipalities in the sample, 560 families were systematically selected and interviewed. Among the lead interviewees, 311 were female and 249 were male. During the interview, we strongly encouraged all family members to participate together. They chose the principal respondent, normally when all family were together the male head of household took this position. Nevertheless, our sample shows that more women were interviewed and it was related with two important things, the absence of men on the property and the presence of a female interviewer. The distribution of cases among municipalities in the final sample can be seen in Figures 3-10, 3-11 and the map in the Figure 3-12.

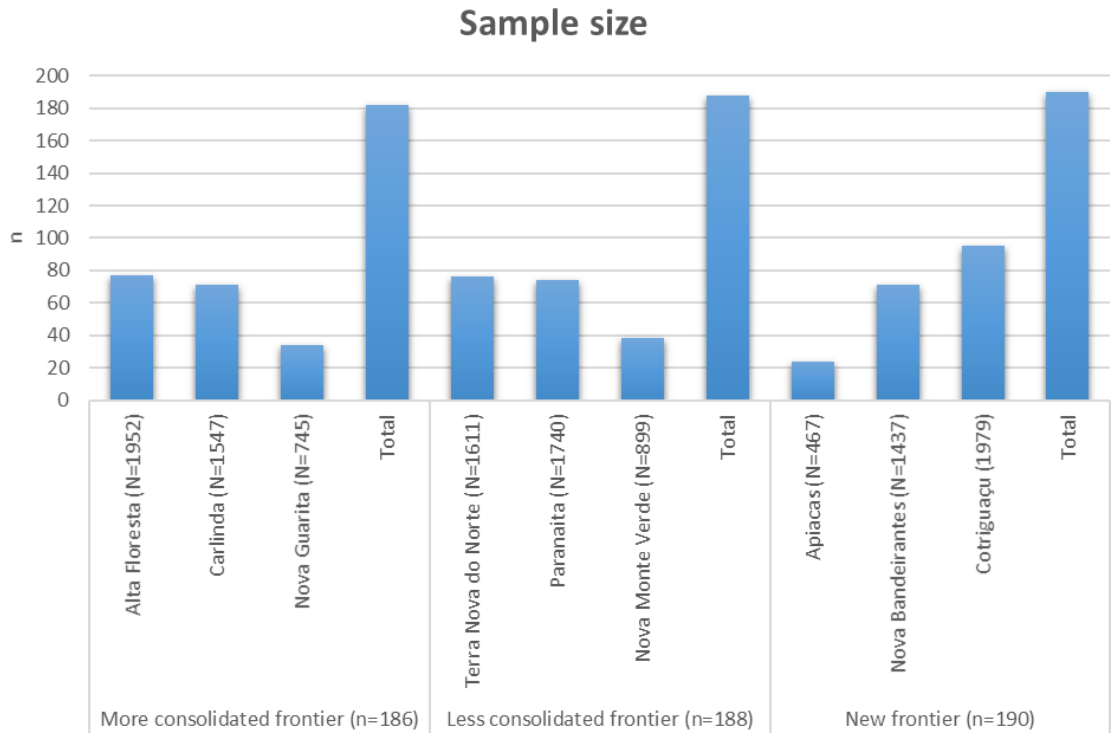

Figure 3-10. Sample by municipality and frontier region.

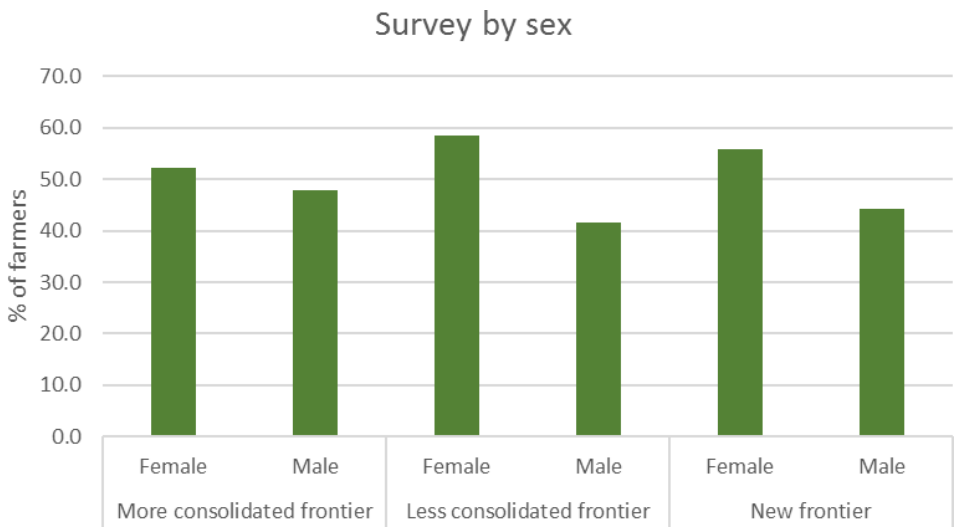

Figure 3-11. Sample by gender and by frontier region.

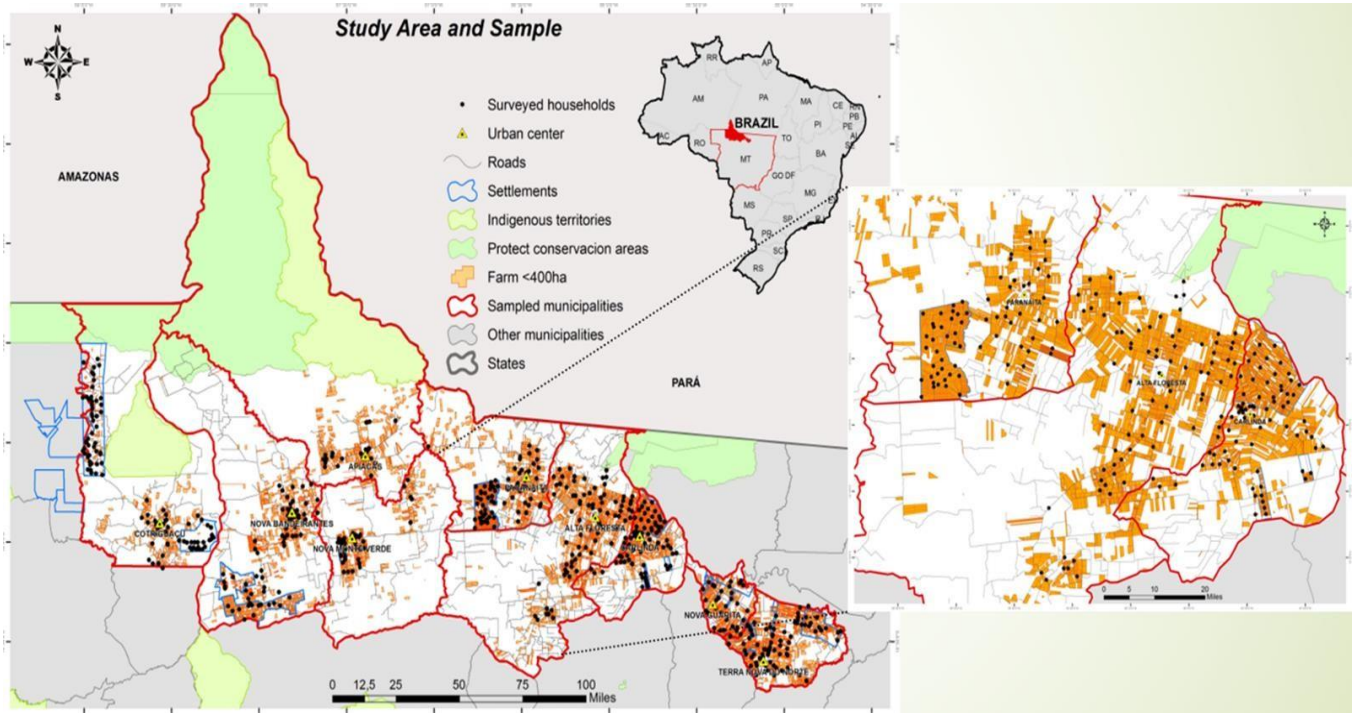

Figure 3-12. Study area and sample map.

CHAPTER 4
LIVELIHOOD SYSTEMS OF FAMILY FARMERS IN AMAZON FRONTIER OF MATO GROSSO: WHO ARE THEY?

Taking up the Hypothesis and the theory discussion, my discussion of the results aims to answer the following three questions:

- What differences are found in assets reported by family farmers in municipalities characterized by advanced stages of frontier development in relation to those in more recently developed settlements?
- How are the livelihoods of family farmers in municipalities characterized by advanced stages of frontier development different from those in more recently developed settlements in terms of degree of specialization of farming systems and diversification of livelihood strategies?
- What type of assets are positively related to more diversified livelihoods, both in terms of farming systems and income sources?

The last question was defined based in the theoretical idea that livelihood diversity is strongly related to family farmers' capabilities to cope and adapt when facing a changing context (Perz et al., 2015). Family capabilities and livelihood diversity should thus be considered in any development polices and action.

Frontier Development and Assets

Five type of assets were measured in this research: human assets, natural assets, physical assets, financial assets and social assets. As mentioned before, natural assets are the natural resources people use to generate means of survival, physical assets are created by economic production processes to increase the efficiency of means of living. Human capital means the characteristics of labor in the household, financial capital refers to the stock of money people can access, and lastly, social capital refers to the social linkages among people to organize or connect and thereby improve their livelihoods (Ellis, 2000). Again, the Hypothesis is that the conditions in municipalities characterized

as more consolidated frontiers will offer better infrastructure and services, which will allow for asset accumulation and more diversified livelihoods.

The human assets measured were: household size and age, number of household members in the labor force, regional origin of the family, migration history, and courses taken in the last year (which includes workshops, sessions with extensionists, field days, etc). It is important to qualify labor force here as the productive labor directly related to maintenance of the farming systems, for subsistence and commercial purposes.

To measure household composition, the size of each family member was recorded along with either their work status, whether on-farm or off-farm. I used that information to calculate family size and labor force. I then compared these variables for households in municipalities in the three frontier stages. The results appear in Table 4-1. The findings show significant differences in family size and on-farm labor force. Post-hoc diagnostic tests (Table 4-13) indicate that the statistical difference is between families in municipalities in the 'more consolidate frontier' (MCF) and the 'new frontier' (NF). The families are bigger in the more consolidated frontier and smaller in the new frontier, which also means smaller on-farm labor force.

It is also interesting to note that the off-farm average labor force is much smaller than on-farm average labor force, which indicates that most of the family still working primarily on-farm. When looking at the percentage of families with members working off-farm, in the MCF 44.5% of the properties have family members working outside of the farm; in the LCF they represent 55.9% of the properties and the NF 50%. There are no statistical differences among farmers from the different frontier types regarding to the percentage of farmers that have family members working off-farm.

Table 4-1. Household size and labor force (Sig. < 0.05).

ANOVA Dep variable	Ind variable	N	Mean	Std. Dev	Min	Max	F	Sig.
Number of family members	More consolidated frontier	182	3.9	2.0	1	18	4.011	0.019
	Less consolidated frontier	188	3.8	1.7	1	10		
	New frontier	190	3.4	1.5	1	9		
	Total	560	3.7	1.8	1	18		
On-farm labor force	More consolidated frontier	182	3.1	1.7	0	16	5.035	0.007
	Less consolidated frontier	188	3.0	1.3	0	9		
	New frontier	190	2.7	1.2	0	7		
	Total	560	2.9	1.4	0	16		
Off-farm labor force	More consolidated frontier	182	0.7	0.9	0	6	0.978	0.377
	Less consolidated frontier	188	0.8	0.9	0	4		
	New frontier	190	0.7	0.8	0	4		
	Total	560	0.7	0.9	0	6		

Gender differences also appear in labor force off-farm (Tables 4-14 and 4-15). Male laborers more often take advantage of off-farm jobs than female. In percentage terms, the women are working on-farm in 95,1% of MCF properties and 88,4% in NF properties. Ellis (1999) argues that male advantages to engage in off-farm work can have adverse gender effects, especially in the control of income and decision making about expenses. The study of Darnhofer & Strauss (2014) highlights the gender dimension of livelihood diversification, because it is the men who typically perform the most of off-farm work, the women stay on the farm. This not only means that women carry out additional farm-related work, they also have to cope with the majority of the work of caring for the house, and other family members, notably young children or elderly parents.

The analysis also evaluates migration across the three frontier categories.

Contrary to what was expected, no difference was found across the frontier stages, either

in terms of the number of families who experienced migration in the past 10 years or in terms of the destination of those people. From 560 families in the survey, 259 declared that one or more family members migrated in the last 10 years (46,3%). In total, there were 563 people who left their farms (an average of 2.2 people/ family that declared migration) for different reasons. Most migrants (23,1%) went to villages and towns of the same municipality.

In terms of family age differences across the frontier stages was found, both in terms of the average family age and the age of on-farm workers (Table 4-16). In the NF the families are younger and become older as one moves to the consolidated frontier categories, with older families in the MCF. The same pattern is applied in the on-farm workers, which are younger in the NF. The Tukey test showed statistical differences among the three categories (Table 4-17). The average age of off-farm workers does not present statistical difference across frontier types (Sig=0.77). However, in the MCF off-farm workers are much younger than the on-farm workers in the same category.

Because the average age can hide the age distribution in the family, I created four categories of age (equal to or more than 60 years; between 40-59; between 18-39; less than or equal to 17). Figure 4-1 shows that the age distribution changes across the categories of frontier stage. While the three younger ag categories are similar across frontier stages, Table 4-7 shows that family members with ‘more than 60 years old’ are significantly higher in the MCF to lower in the NF (see also Table 4-18 and 4-19).

In order to better understand the experience of migration and the adaptation of farmers to the frontier, I gathered information on time on property and the regional origin of the farmers. In the NF, the farmers reported less time living on their properties than

their counterparts in the MCF and LCF. There is no significant difference between MCF and LCF (Table 4-2 and 4-20).

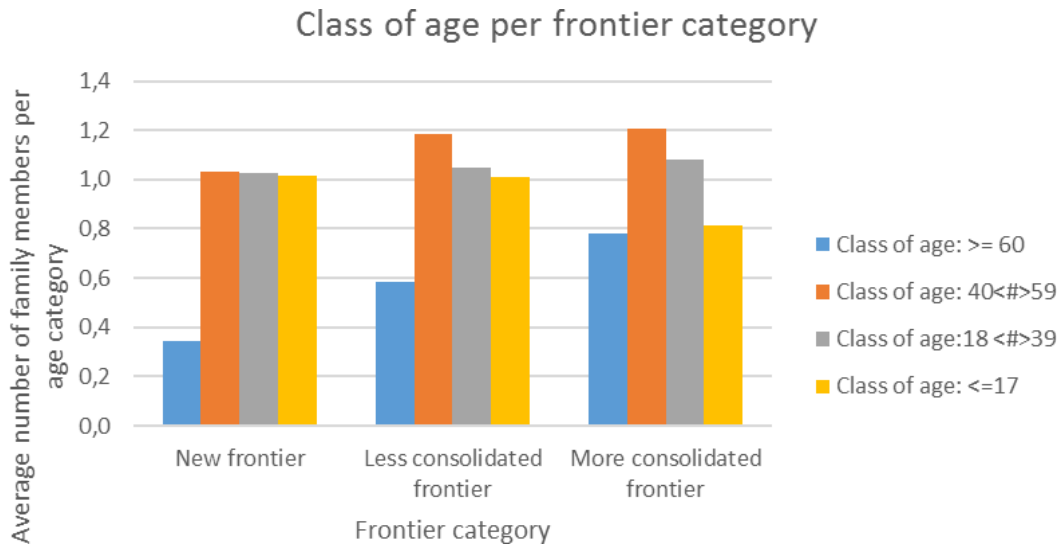

Figure 4-1. Class of age by frontier region.

Table 4-2. Average time living in the property.

ANOVA

Dep variable	Ind variable	N	Mean	Std. Dev	F	Sig.
Years in the property (P2)	More consolidated frontier	182	19.0	11.4	26.407	0.000
	Less consolidated frontier	188	17.4	10.9		
	New frontier	190	11.8	7.5		
	Total	560	16.0	10.5		

The origin of the famers is also different, in the new frontier are more people from the Northern Brazil and less influence of the South when comparing with the other frontier categories (Figure 4-2, Table 4-21). To confirm where the differences are, I calculated the adjusted residual and chi-square per dependent variable, as shown in Table 4-22.

The analysis also considers human capital via training of household members, as participation in courses varies among frontier stages. Although the percentage of farmers

who took courses in the last year is less in NF than in the other categories (Figure 4-3), differences were not statistically significant. However, the p-value was 0.06, so because it was close to 0.05, I also calculated the adjusted residual and the chi-square. Table 4-23 shows that the fewer farmers participated in trainings in the NF frontier than in the LCF.

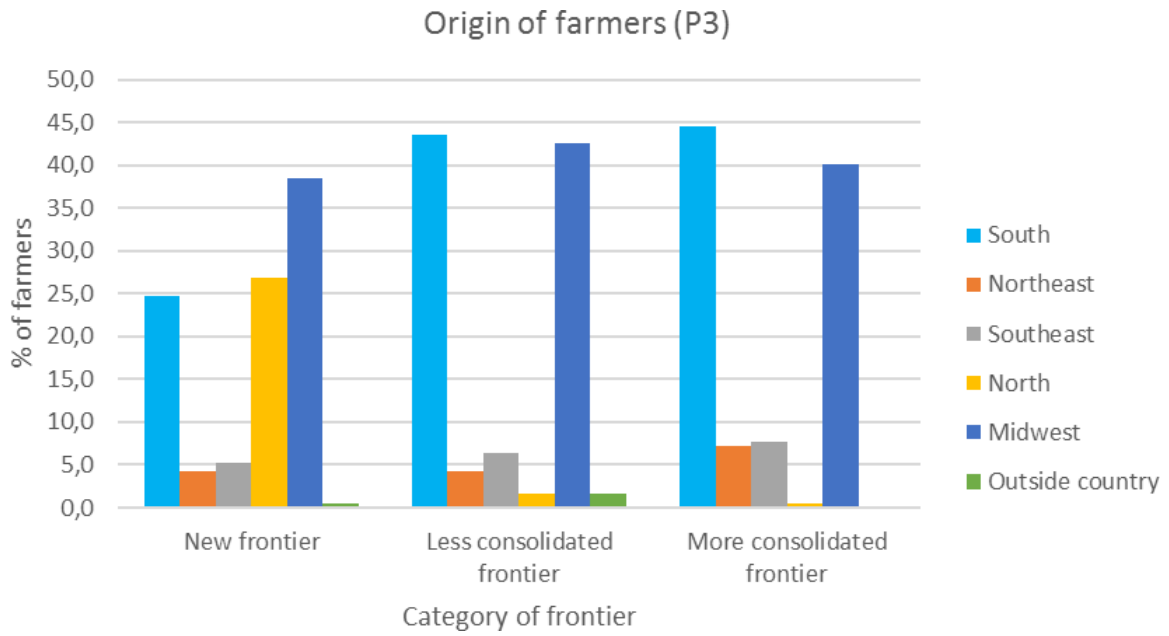

Figure 4-2. Origin of farmers by frontier categories.

Useful information that can complement the findings about access to training is farmer responses about the motivation to migrate (Figure 4-4, Table 4-24 and 4-25). I asked farmers about their perceptions about why young people leave rural areas. While in the MCF and LCF, the main reason is 'lack of income', in the NF the main reason concerns the 'lack of professional schools'. In the NF, the families are younger and wish to develop their skills and knowledge, but lack educational opportunities in this stage of the frontier.

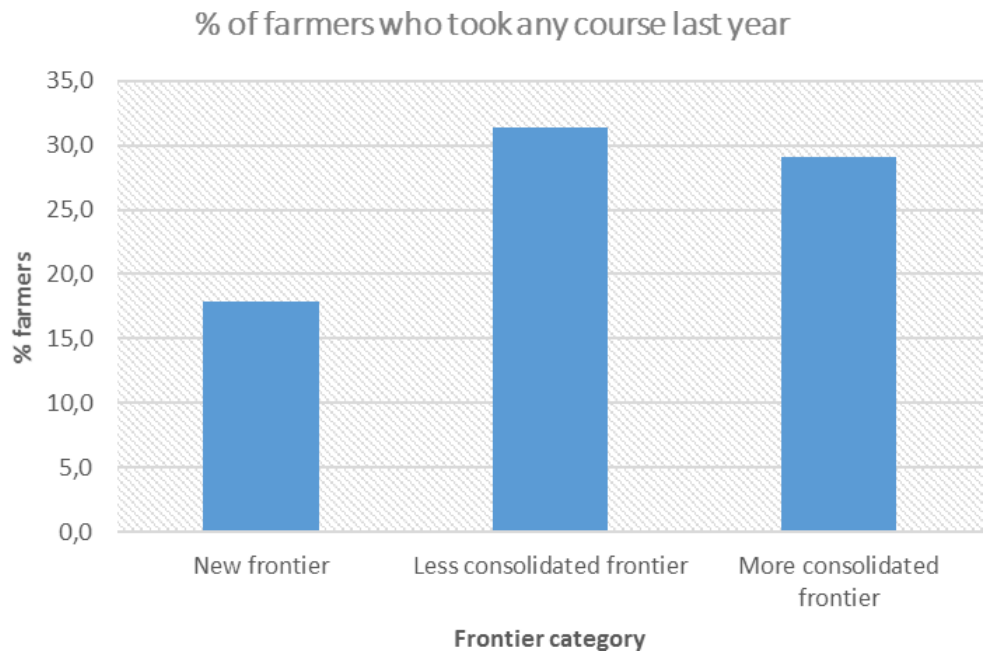

Figure 4-3. Percentage of farmers who were involved in any capacity building in the last year by frontier category.

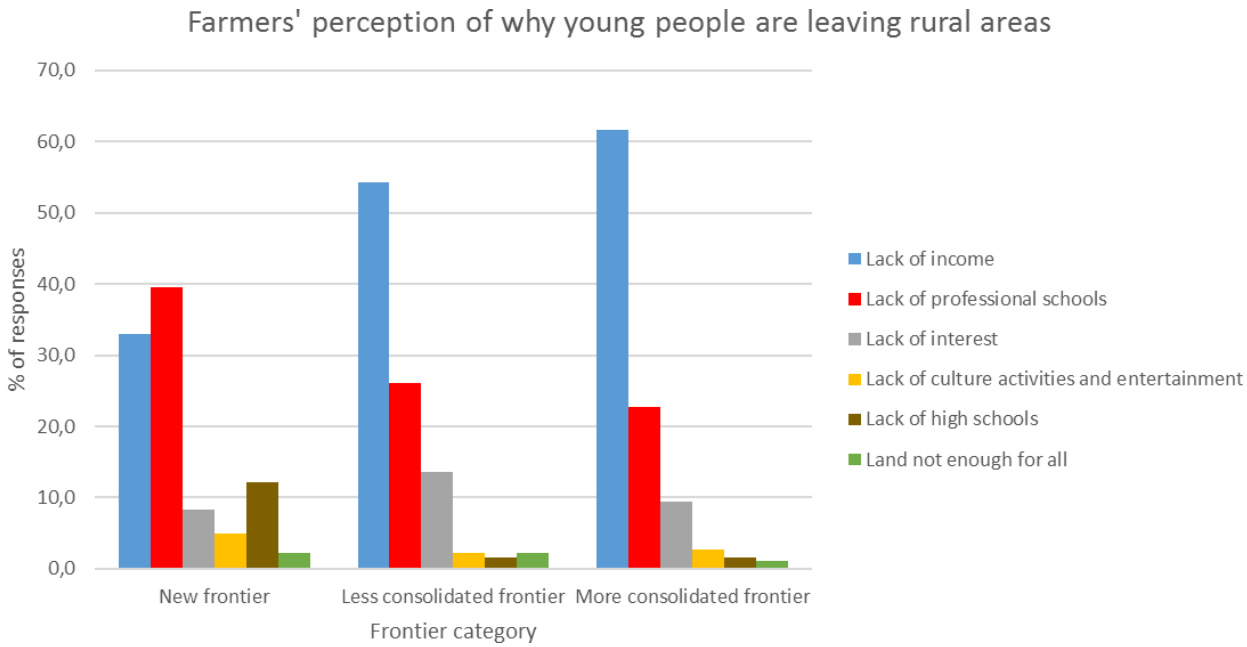

Figure 4-4. Perception of motivations to people migrate.

Another important point here is the 'lack of high schools' category in the NF. This result likely reflects the findings reported earlier about the drop in the number of rural

schools. We see that migration intentions can reflect political decisions resulting in a lack of school opportunities rather than a lack of demand for education.

The results related to human assets show that in the MCF the families are bigger, with more labor force available, contrary to expectations of theories of frontier development which would anticipates that the process of fragmentation would make these families smaller in later stages of the frontier. Also, no significant differences were found between the MCF and LCF in terms of size of families, just both related to NF. So, they represent the families which their children had entered the labor force. In the MCF, the average age of families is higher than in the NF. Although there are no differences across the frontier stages with regard to the average age of off-farm workers, when comparing off-farm age with on-farm age, mainly in the MCF there is a 7-8 years' age difference. This could demonstrate the theory that are the young family members, who normally have more skills and better health, who are performing the non-agricultural work. Splitting family members into categories of age, the data demonstrate that in the MCF, there are many more family members over 60 years old, more than the other frontier categories.

Surprisingly, the number of family members in the off-farm labor force didn't present any significant differences. Although the number of off-farm workers in the family is small, the percentage of families with any family member working outside is about a half in all frontier categories, which shows that there is a presence of livelihood diversification across all frontier stages. That said, there are gender differences. Females are less likely to work off-farm which carries implications for their work on the property and for the family, and for the control over income.

Farmers in the MCF and LCF had lived longer on their farms than NF farmers. Participation in capacity building processes was more frequent among farmers in the LCF, contrary to expectations of pattern across frontier types. Farmers in the LCF and MCF had better access to education than in the NF category.

In the NF category, there were fewer workers on farm, the families are smaller, and they had lived on their properties for less time. These findings confirm the frontier theory that describe the first stage of frontier a place where a young couple arrives and the kids are consumers but not part of the labor force. The majority of farmers migrated from the Center-west, with a significant number from the north as well.

Having discussed human capital, I now turn to natural assets of the farm households surveyed. For natural assets, I measured property size, additional properties, water availability and perceptions about the soil quality.

The average property size decreases as one goes from the young frontier (NF) to the older frontier MCF. But when we take into account the number of additional properties farmers own, those in the LCF category (especially in Nova Monte Verde) report more such properties, which raises the average total size of all properties farmers own, yielding achieving the highest overall average. In the total sample the additional properties sum 139 units, from 101 families, which means that some farmers own more than one; the maximum number was 5 additional farms. Differences in primary property size, number of additional properties, and total land area in all properties were all significant across the three frontier categories (Table 4-26).

Results from the Tukey test of the property variables show where the significant differences occur (Table 4-27). The significant difference in property size is between the

MCF and NF. The differences in the number of additional properties is between LCF and MCF (Figure 4-5). And differences in the overall size of lands claimed are among all three categories.

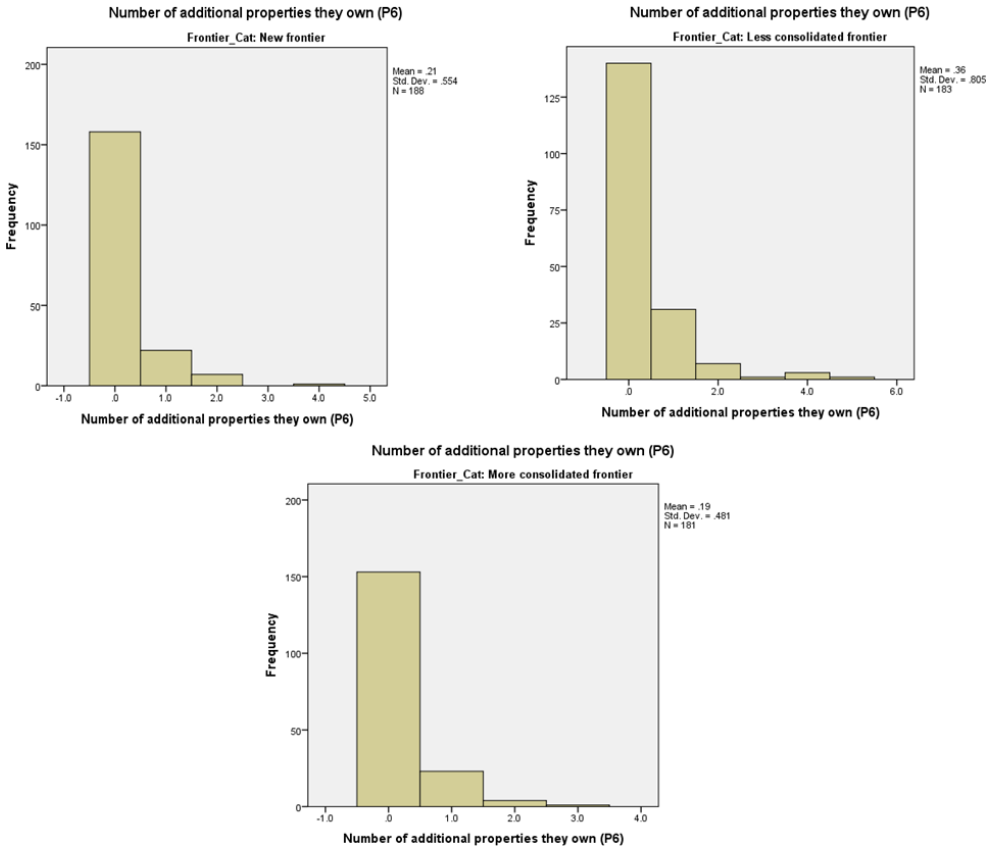

Figure 4-5. Distribution of number of properties farmers own.

To better understand these findings, I created size categories using the same classification as in the Agricultural Census (IBGE). They are seven classes of property size, shown in Figure 4-6. The chi-square test (Table 4-28) shows that there is significant difference across frontier related to categories of land size (Pearson Chi-square=0.000).

I then applied crosstabulation to the size distributions across the three frontier categories (Table 4-29) and the results verify that the main differences are in the '2<#<5 hectares' category, which is more common in the MCF category and less common in the LCF. The '20<#<50 hectares' category is more common in the MCF and less so in the

NF. In general, we can see that the majority of properties in the MCF and LCF are between 20 and 50 hectares while in the NF the majority is between 50 and 100 hectares with many properties with more than 100 hectares.

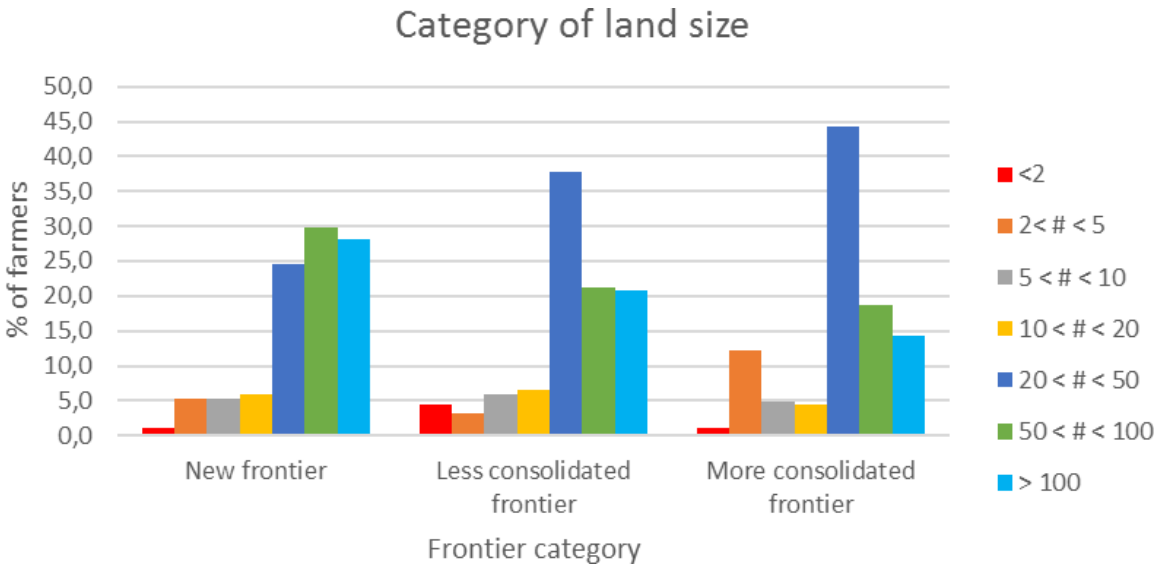

Figure 4-6. Category of land size (hectare) by category of frontier.

When comparing the findings from the survey with the IBGE (2006), the distributions across frontier categories exhibit a very similar pattern (Figure 4-7). Despite the census ten years before the survey, the similar property size distributions indicate that there were not big changes in during the intervening period. Notice however that in the LCF, it seems that properties with more than 50 hectares became more significant. Note also that this is the category where more farmers own additional properties. It might indicate re-concentration of land.

With regard to titling status, there is significant variation across the frontier categories, especially in two types of documents, title and CCU (Tables 4-30 and 4-31). The CCU (concession agreement) is a government's document that gives farmers permission to legally live and work a piece of land as a beneficiary of agrarian reform. As

we see in Figure 4-8, more lands are titled in the MCF than elsewhere, while more lands in the NF have CCFs than elsewhere. In the LCF the results of these two variables are in between, but with higher percentage of farms under 'other arrangements' category. 'Other arrangements' include mostly contract of purchase and sale (which does not provide legal rights over land).

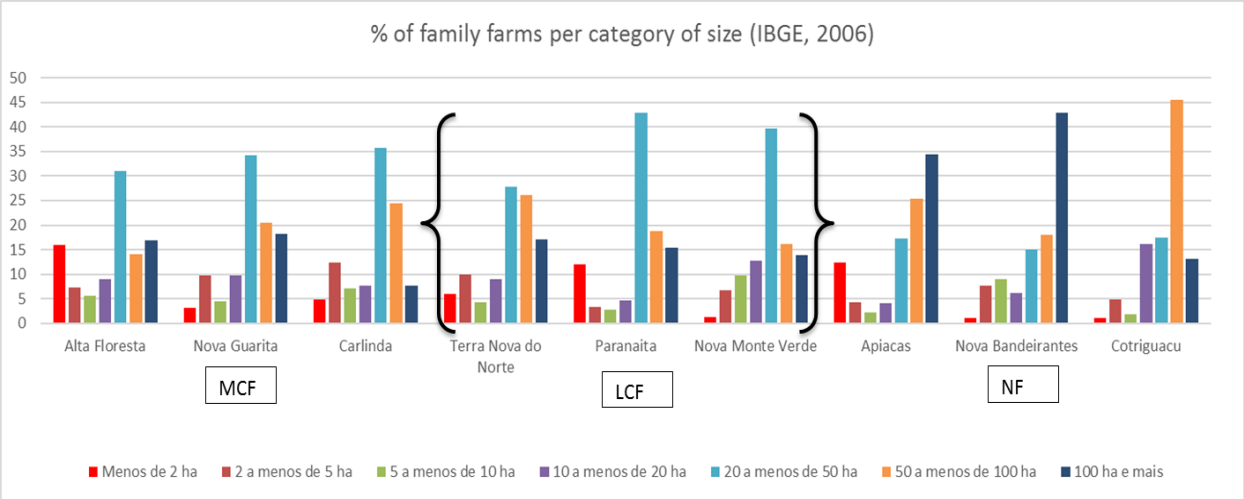

Figure 4-7. Category of size by municipality (official data from national census, IBGE, 2006).

Note that the percentage of farmers with no document is also higher in the NF. The RB (relação de beneficiários) farms related to the farmers who are in the list of beneficiaries of agrarian reform, but does not have the concession agreement yet. The differences in the distribution of land documentation are significant among the frontier stages (Tables 4-30 and 4-31).

Water resources do not seem to be a limitation for farmers. The majority of farmers have more than one water source, 80.7% reported to have stream or river in the property, 61.43% reported to have springs, 53% lake or dam, 84.4% reported to have well and just 2% declared to not have any water source. There is no difference across

the frontier stages. In the sample, 84.3% of farmers are satisfied with their water resources for the use they have.

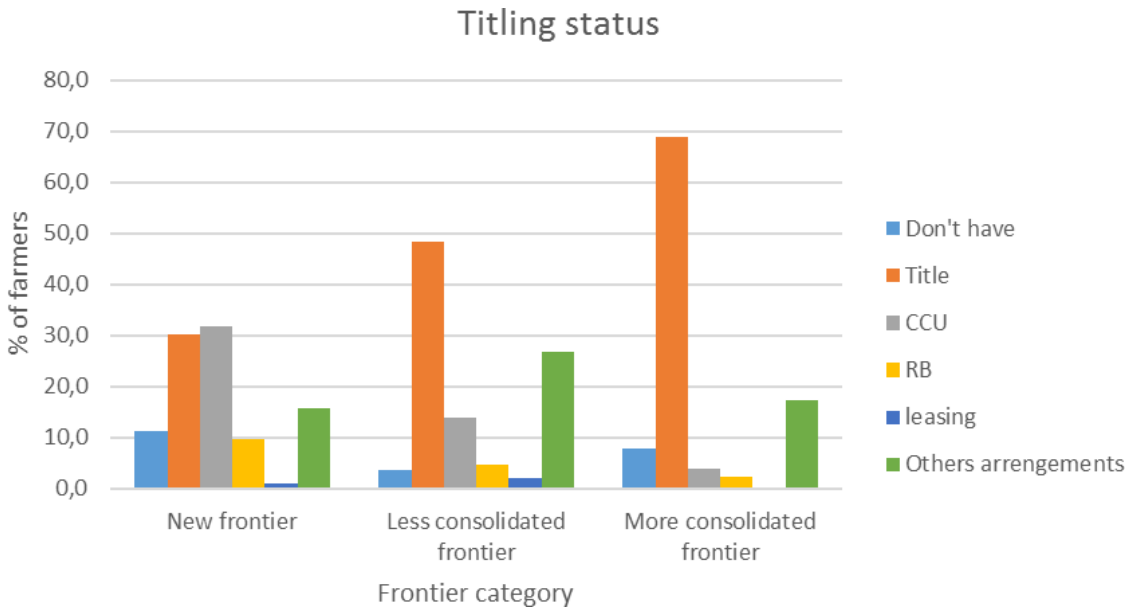

Figure 4-8. Documentation of the land by frontier region.

Lastly, regarding the perception of farmers about their soil quality, there is not significant variation across the frontier categories. The majority of farmers perceived soil quality as moderate (45%) or good (43%) for the farming systems they have worked so far.

Therefore, related to natural assets, the differences across the region are based on land size and titling. In the MCF, the properties are smaller, but the land is more secure, with higher percentage of titling farms. In the LCF, farmers reported more additional properties, raising the land average area they own, which was the biggest among the frontier categories. It seems that the LCF performs better, with more additional lands which mean higher average land size and a significant number of titled farms. It is important to point out that the additional properties mean more natural resources available for the farmer who owns it, but in a community or region scale it

could indicate re-concentration of land, which can affect negatively the family farmer's permanence in the region. It might be related to the neo-Marxist frontier approach where family farmers started to be replaced by cattle ranchers. Further study related to migration and re-concentration of land should be done in this region. In the NF, the size of primary properties is bigger, but there are more problems with titling, with just 30% of titled family farms. The higher number of lands with CCUs in the NF can also indicates a newer stage of occupation, since in the past many of the titled lands in the MCF and LCF were settlements in the first stages and became private lands and even municipalities, the case of Carlinda.

I now turn to an evaluation of physical capital across the three frontier categories. I measure physical assets in terms of farmer access to irrigation and to agricultural mechanization. With regard to irrigation, the results show an insignificant number of farmers who own any type of irrigation equipment. Related to mechanization, I asked how farmers normally prepare the soil, using a closed question with 7 choices: manual, animal traction, rented tractor, community tractor, agriculture department tractor or none (Figure 4-9). There are statistical differences among the frontier categories in terms of mechanization (Tables 4-32, 4-33 and 4-34). It seems that in the NF the local government plays a bigger role in helping farmers to establish their production systems. It was impressive that the number of farmers who owns a tractor does not change across the frontier categories.

To better understand the soil management practices, I measured nine other variables: use and frequency of use of pesticides/herbicides, biological control of diseases, burning, fertilizers, manure, lime, green manure, crop rotation and seed saving

(Figure 4-10). Except the burning practices (Table 4-35), which there is a difference in the NF and the others, all other practices do not present any difference across the frontier categories.

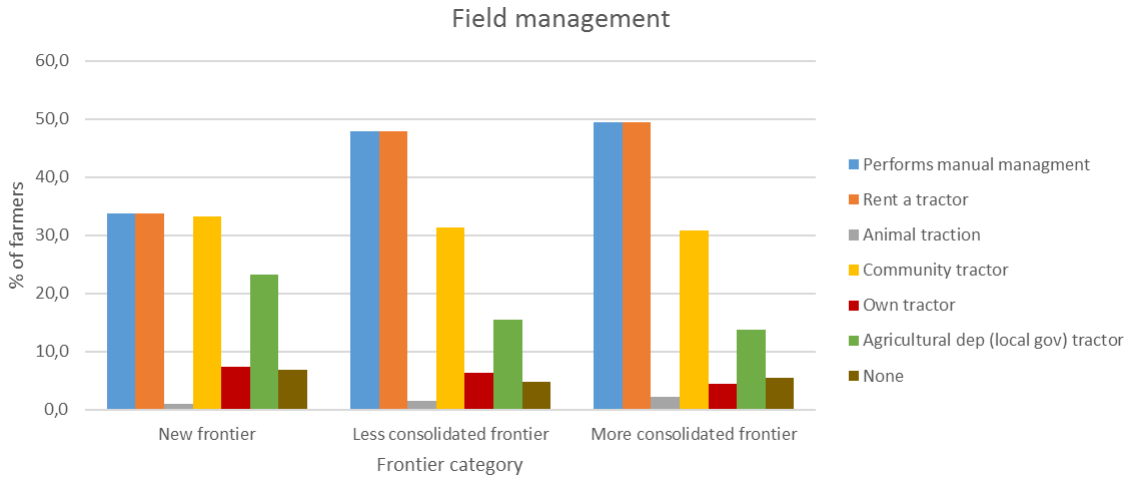

Figure 4-9. Access to mechanization of land by frontier category.

An open question about where farmers use each farming practice was also asked. Figure 4-11 shows the practices most often used by farmers, based on their farming system. The pasture system is where there is a higher level of inputs, with 79.4% of farmers using herbicides/pesticides, 58.6% applying fertilizers and 35.3% using lime. The vegetable garden is where 72.33% of the use of manure is concentrated.

I also asked about the frequency of use, according to three categories: 'less than once a year', 'once a year', and 'more than once a year'. Figure 4-12 shows the frequency of use for the most common farming practices.

Considering that about 60-70% of farmers use pesticides and herbicides, and most of it in pasture, but with a low frequency of once a year in most cases, there is evidence of a constraint for long term viability of this type of system. The presence of invasive and sometimes toxic plants demand a lot of labor or heavy use of inputs in extensive pasture systems (Walker et al., 2000).

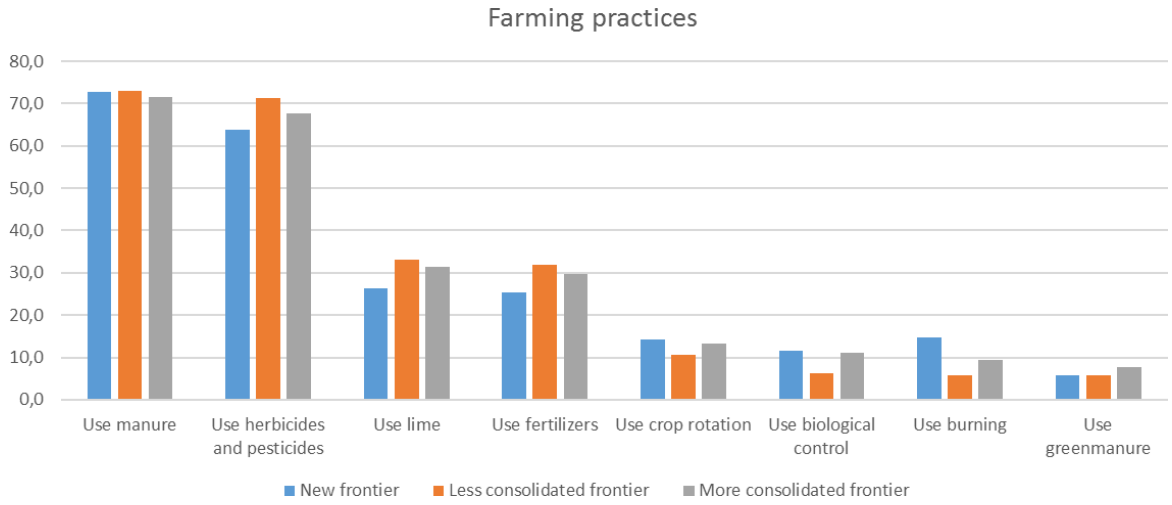

Figure 4-10. Farming practices per frontier type.

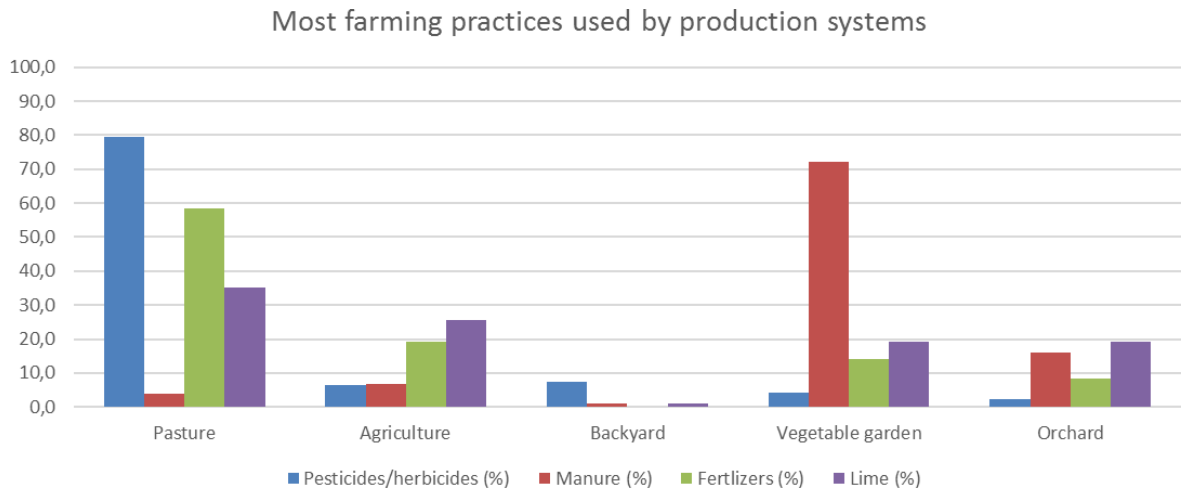

Figure 4-11. Production systems where the farming inputs are applied.

One limitation of this study was the lack of a measure of the amount of herbicides used, which could be studied in further research.

With regard to seed saving, farmers who employ this practice comprised 44.5% of the sample. However, there is no difference across the frontier categories in terms of seed saving.

Therefore, regard physical assets, the farmers in the NF are less likely to rent tractors, which limits their access to agricultural mechanization, but the local government plays a bigger role in providing the equipment. This dynamic is challenge in terms of

autonomy of farmers to prepare the soil in the right time, mostly, because there are few tractors available, farmers lose the right time of plantation as they must share and wait to use the equipment.

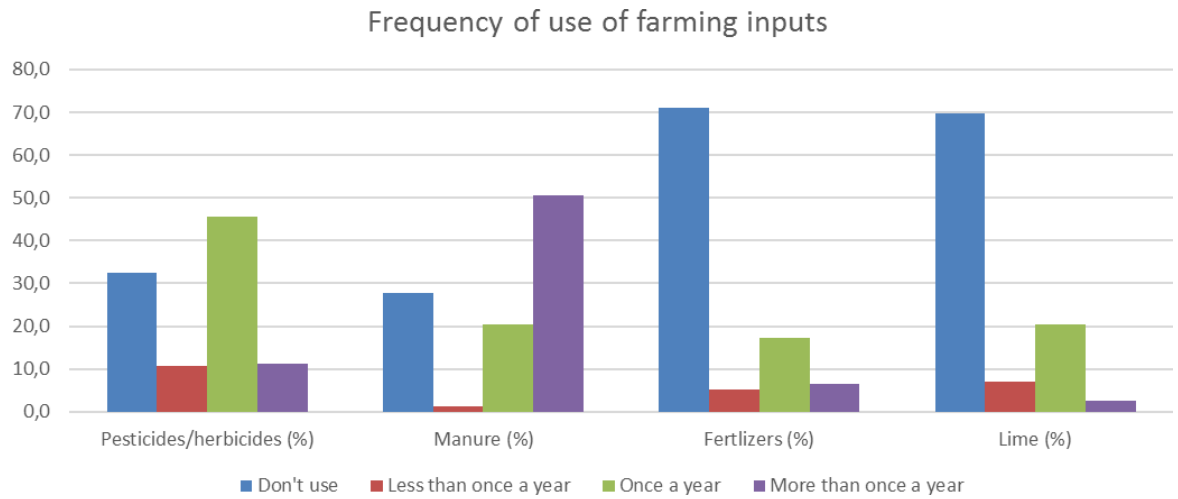

Figure 4-12. Frequency that inputs are applied.

Not surprising, NF farmers thus make more use of burning to prepare the soil. The MCF and LCF farmers reported greater physical assets. This likely reflects the shorter distance of MCF and LCF farmers to roads. Although not measured directly, in theory, it is known that in the MCF, roads are generally better maintained farmers are closer to paved roads (highways).

Financial assets are key to farming systems. One form of financial asset is access to credit. The access of farmers to Pronaf credit or other sources of credit was used as a proxy to measure financial assets (Figure 4-13). There is no difference in the access between farmers in the MCF and LCF, though access to Pronaf credit in the NF was lower (Table 4-36). Differences among frontier types become larger when considering the number of times farmers accessed credit (Figure 4-14, Table 4-37 and 4-38).

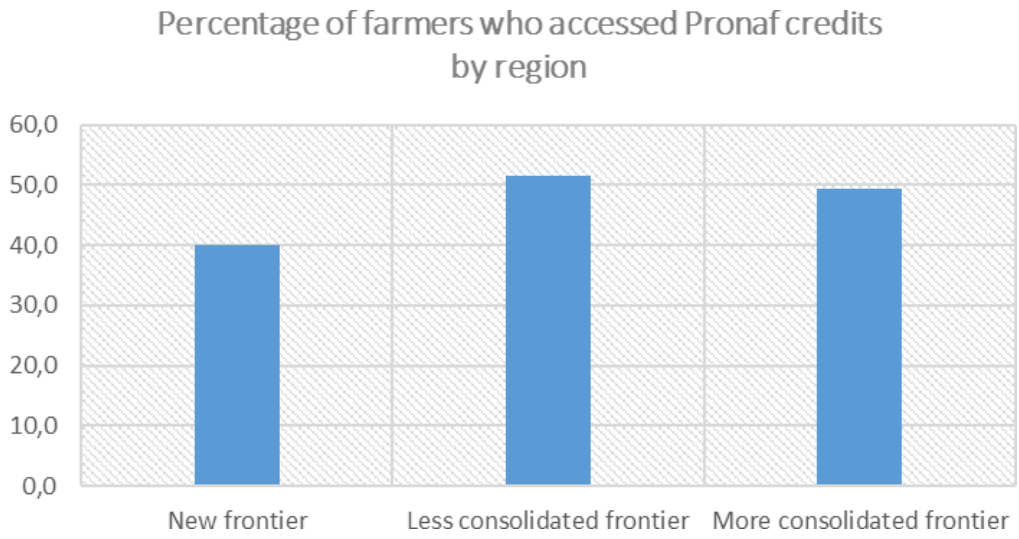

Figure 4-13. Access to Pronaf credits by frontier region.

Few farmers in the NF accessed Pronaf more than once. This is likely to be related to the time that farmers have lived on their property.

The strong difference is seen when asked the number of times farmers accessed the credits, with few farmers that accessed Pronaf more than one time in the NF. It can also be related with the time of farmers living in the property.

Other types of credits only were accessed by 5.5% of farmers in all sample, with no significant difference across the region. In conclusion the MCF and LCF showed greater financial assets comparing with LCF.

To conclude this section, I compare social assets among farmers across the frontier types. I measure social assets in terms of four dimensions: organization linkage, trust, community collaboration, and transparency. Responses were coded by assigning scores for each question regarding its importance in terms of increasing social assets. I then analyzed each dimension and overall. In addition, the responses were divided regarding different types of ties (family/neighbors' ties, community's ties, external agents' ties) in terms of their importance increasing social assets for each specific type of tie.

The results achieved did not vary among frontier types, and the summed scores across the variables were difficult to interpret. I therefore analyze scores one variable at a time. One variable, pertaining to trust, was left out due to extensive missing data.

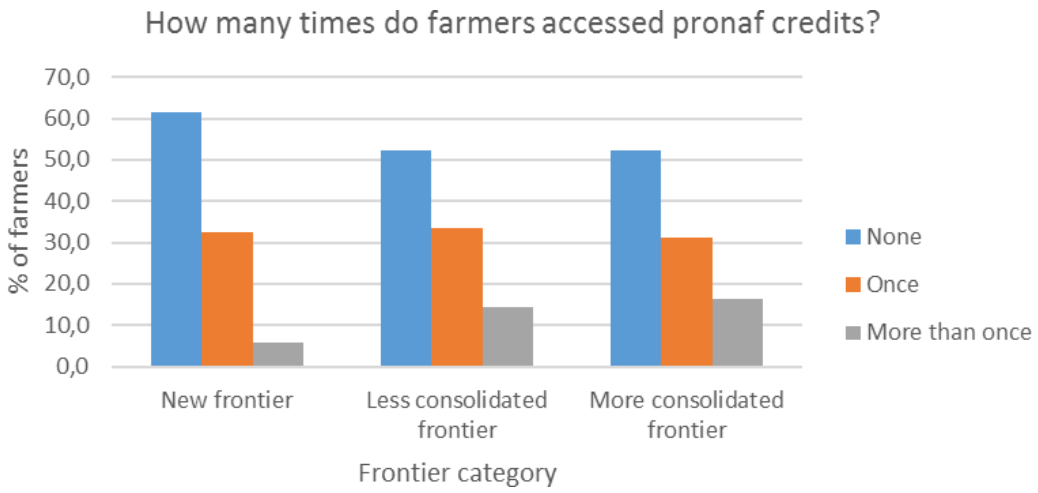

Figure 4-14. Number of times farmers accessed Pronaf credits.

Regarding organization linkages, I included questions about external and internal linkages. To measure 'external' linkages, I asked a closed question of each organization they interact at least every three months. Interviewees could choose any or all of 8 response options: NGOs, Empaer (the governmental extension service agency), local agriculture department, city hall, companies, local councils, church and "others". The average number of external institutions with which farmers interact is low. However, there is a significant different across the frontier categories (Table 4-39), with farmers in the NF having fewer external linkages when comparing to the other categories (Table 4-3).

I also asked a question about how farmers feel informed of what organizations are doing in their communities. In general, farmers most often reported that NGOs did "nothing at all" (Figure 4-15). But NGOs are also one of the external organizations with

which farmers have fewer interactions (4.9 % in the MCF; 5.9% in the LCF and 4.7% in the NF).

Table 4-3. Average number of external institutions farmers interact.

ANOVA	N	Mean	Std. Dev	Min	Max	F	Sig.
More consolidated frontier	182	1.69	1.13	0.00	6.00	10.392	0.000
Less consolidated frontier	188	1.86	1.17	0.00	6.00		
New frontier	190	1.36	0.93	0.00	4.00		
Total	560	1.64	1.10	0.00	6.00		

‘

I also asked farmers to report their perceptions of transparency of government, NGOs and community organizations. When comparing by frontier type, there were significant differences in the government and community organizations transparency (Tables 4-40, 4-41, 4-42 and 4-43). Farmers in the LCF seem to be more informed than those in other frontier types, and farmers in the NF more often lack information about what the government has done in their communities (Figure 4-16).

Looking data about community organizations, again, NF seems be less informed about their interventions and activities while MCF and LCF presented similar results (Figure 4-17).

In terms of participation in grassroots organizations, information about farmers’ participation in associations, cooperatives, rural workers’ union and other types of groups (the last with no significant amount of answer in the sample) were collected. It is notice that there is no strong difference regarding to participation in community associations, but there are differences related to participation in cooperatives (weak in the NF) and in the rural workers’ union (stronger in the LCF) (Figure 4-18; Tables 4-44, 4-45, 4-46 and 4-47).

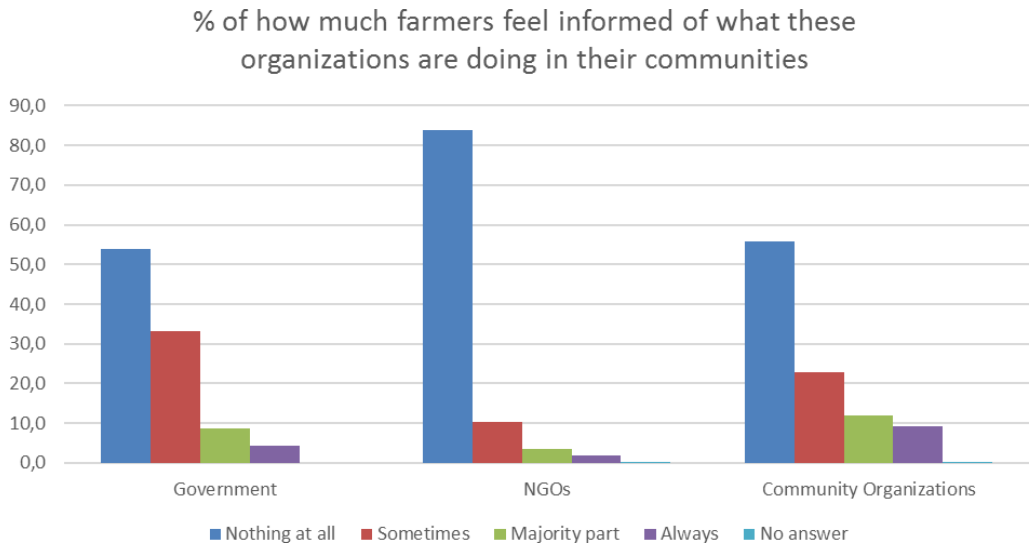

Figure 4-15. Percentage of farmers that feel informed by what the different institutions are doing in their communities.

The number of community organizations they are part of was also counted. The average number of grassroots organizations farmers participates also changes across the region with strongest difference between LCF and NF where are the highest average number and the lowest (Table 4-4 and Table 4-48).

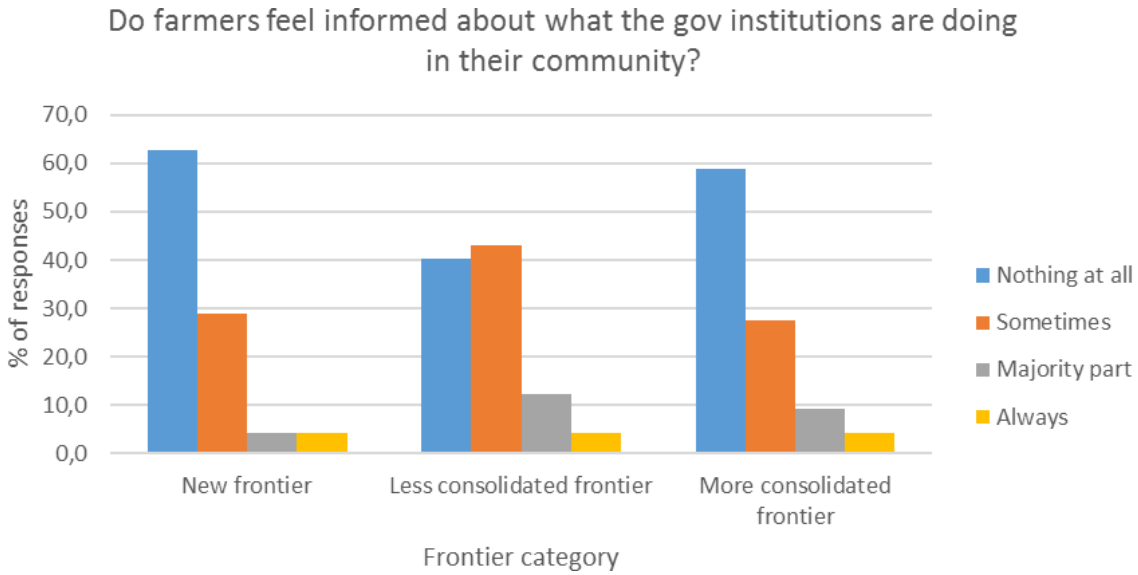

Figure 4-16. Government transparency.

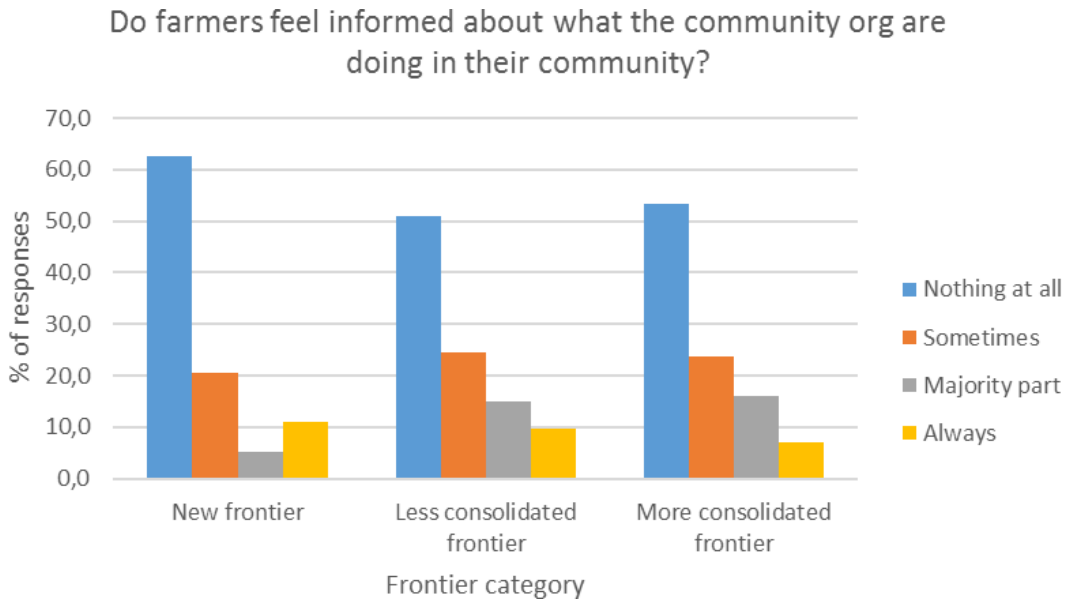

Figure 4-17. Level of community organizations transparency.

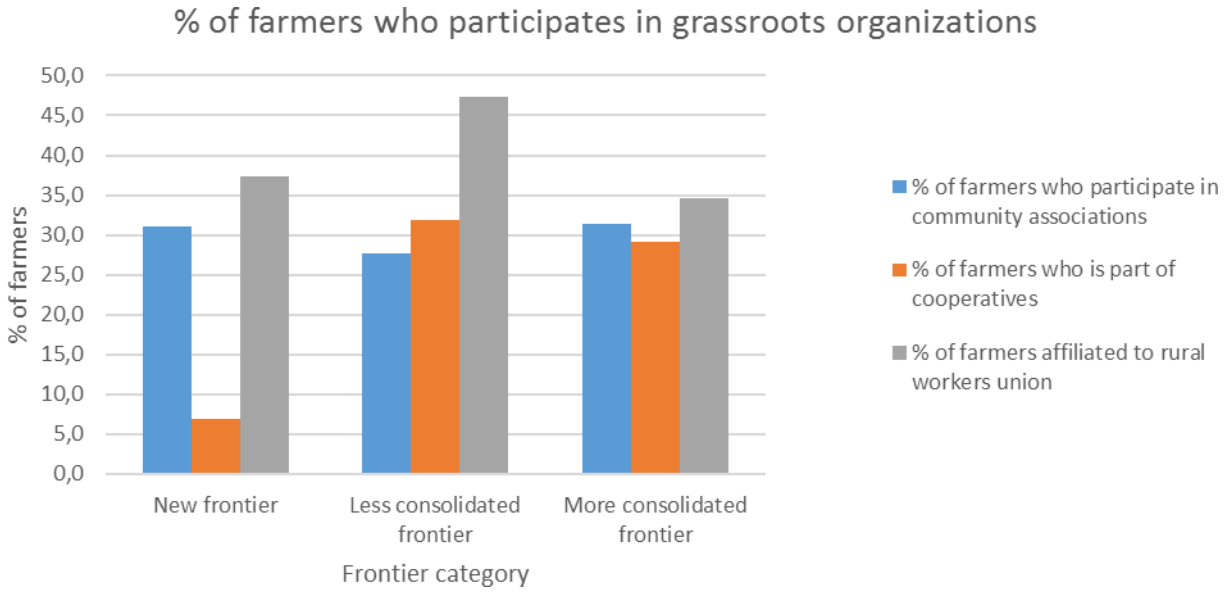

Figure 4-18. Farmers' participation on grassroots organizations.

When asked about the level of participation any significantly changes across the region was found. But, looking the data per type of grassroots organization the results for all sample shows that in the rural workers' union compile the majority of farmers who

participate but is not really engaged in the organization while in the cooperatives presented the higher level of participation of farmers (Figure 4-19).

Table 4-4. Average number of community organizations farmers participate.

ANOVA	N	Mean	Std. Dev	Min	Max	F	Sig.
More consolidated frontier	182	0.90	0.83	0.00	3.00	6.038	0.003
Less consolidated frontier	188	1.02	0.84	0.00	3.00		
New frontier	190	0.73	0.77	0.00	3.00		
Total	560	0.88	0.82	0.00	3.00		

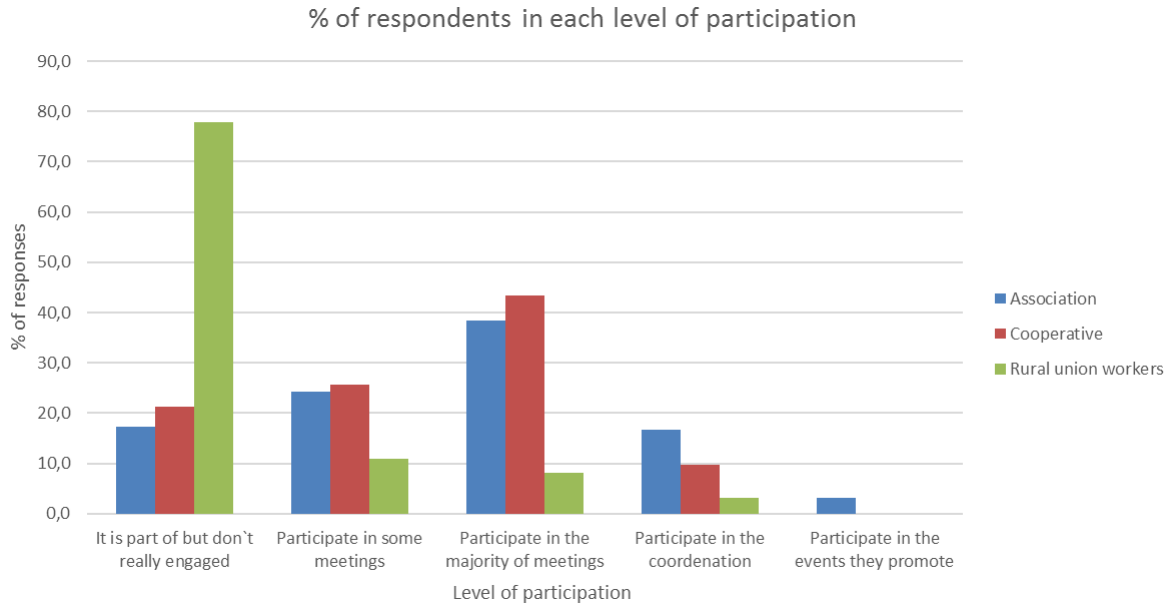

Figure 4-19. Level of engagement per category of organization.

This last section shows results about the perception of farmers on the role of community organizations. The farmers' perception changes across region with less trust in the NF is positively related with the perception that organizations just take advantage of farmers. The MCF is positive related with the perception that organizations help moderately and LCF is positively related with the perception that these organizations help a lot (Figure 4-20, Table 4-49 and 4-50).

Finally, it was asked the frequency that neighbors engaged to help each other. There is no significant difference across the frontier types. The graph (Figure 4-21) shows how it varies among municipalities and some of them present a highlight result, such as the lowest level of collaboration in Apiacás.

Thus, as the data showed farmers in the NF have fewer social linkages both with community (specially with cooperatives) and external organizations, their trust in the role of community organizations is also lower. The LCF presented greater social assets, the LCF farmers are better linked to organizations, with more community and external linkages when comparing to other categories. They also have the highest level of trust in the role of community organizations and are more informed about what organizations are doing in their communities. In the MCF the results are in between of the categories already mentioned.

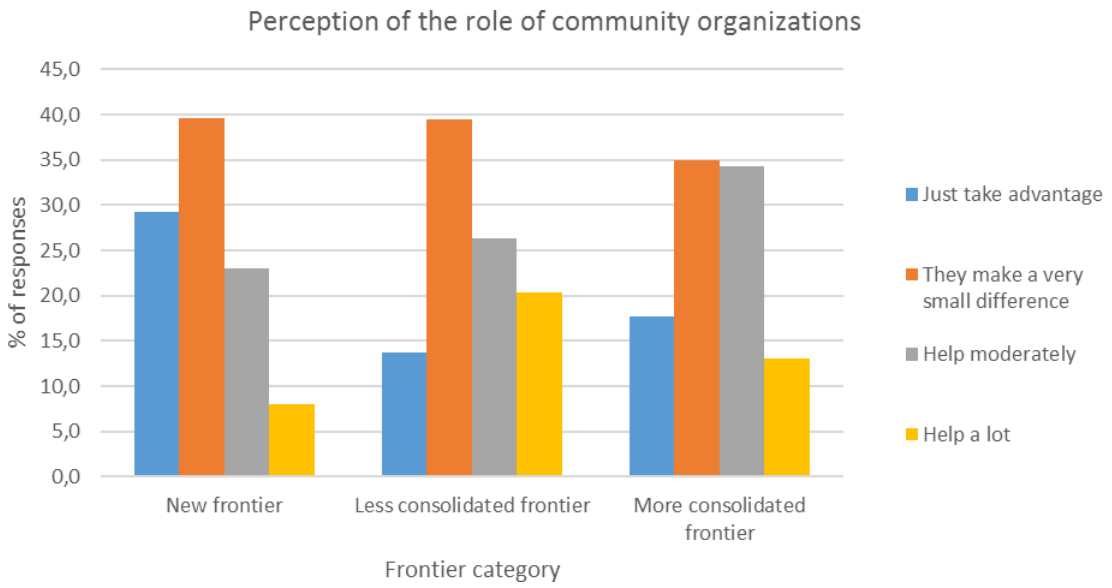

Figure 4-20. Level of trust in the role of community organizations.

The results showed that the frontier context influences the assets families own and control in different ways. Nevertheless, families in the MCF do not necessarily have

greater assets. There are close results between the MCF and LCF, and the higher results of some variables (such as capacity building, access to credits, level of transparency and level of trust in community organizations) in the LCF suggests that there are other elements (beyond the process of frontier development) playing an important role to push the assets forward. What it can be clearly stated is that the new frontier has fewer assets.

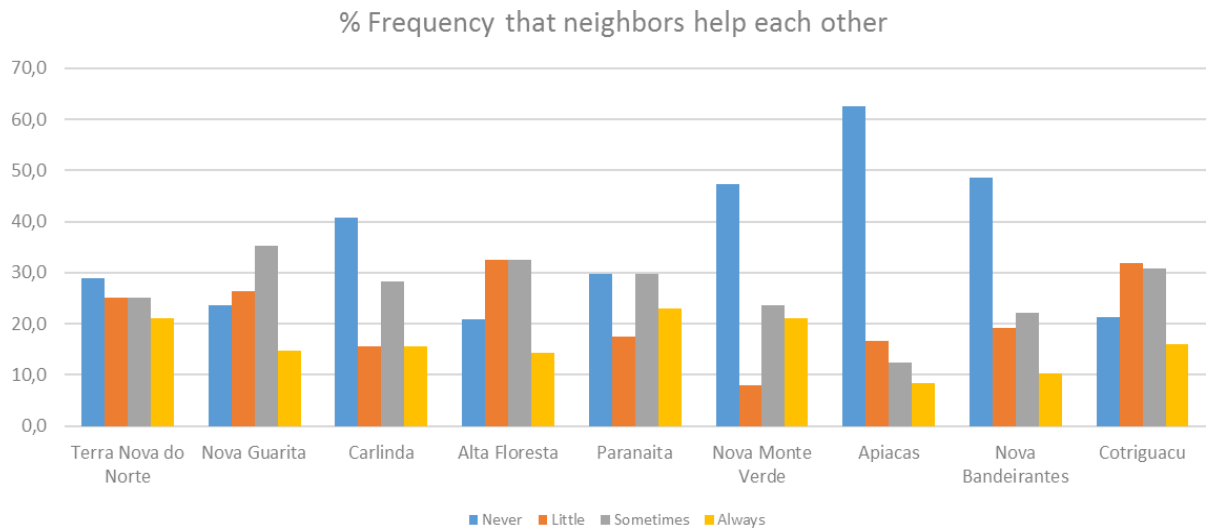

Figure 4-21. Level of collaboration among neighbors.

Frontier Development and Livelihoods Strategies

The first part of the results presented indicated that there are clearly two groups differing in terms of assets (NF and MCF/LCF). So, it is expected in theory, there will be distinct types of situations for livelihoods strategies as well. As stated based in the Hypothesis, the data on livelihood strategies aim to understand if in the more consolidated frontier farmers have more specialized or diversified livelihoods, both in terms of on-farm and off-farm activities. One of the Hypothesis explains that when the frontier develops, the farmers divide their land for the second generation, or the young people move leaving behind the oldest. This process would lead to a less intensive type

of activity, which means less diversity due to the decrease of labor in the farm. Also, the better financial assets and the proximity with urban centers could decrease the need for food production than isolated regions decreasing the need for subsistence farming systems. It might lead to specialized farming systems. But, in the other hand, the access to education and information increases, as well as market linkages which could influence more diversification of farming systems. Also, the opportunities for off-farm work grow, which could lead to more diversified livelihoods, especially in terms of non-agricultural work.

To understand livelihood strategies across the frontier stages, I evaluate five dimensions: 1) production system diversity 2) subsistence production; 3) income diversity (on-farm and off-farm); 4) marketing channels and 5) next year's plans.

In order to measure the diversity of production systems on properties, I asked about the presence of 14 production systems, already defined based on the experience of local practitioners, with an open space for any others not anticipated, there are milk cattle, calves, beef cattle, vegetable garden, orchard, coffee systems, agriculture plots, pisciculture, chicken, beekeeping, pork, processing foods, forest management and agroforestry. Because of the low report of forest management and agroforestry, they were counted as "others". Significant difference was found across the region related to the number of production systems in which farmers engage. In the MCF and LCF farmers engage in more production systems while in the NF they engage in less production systems (Tables 4-5 and 4-51). The Figure 4-22 shows the distribution of answers in each frontier category.

Table 4-5. Average number of production systems farmers engage.

	N	Mean	Std. Dev	Min	Max	F	Sig.
More consolidated frontier	182	5.88	1.984	1	12	5.047	0.007
Less consolidated frontier	188	5.86	2.140	0	11		
New frontier	190	5.26	2.362	0	14		
Total	560	5.66	2.186	0	14		

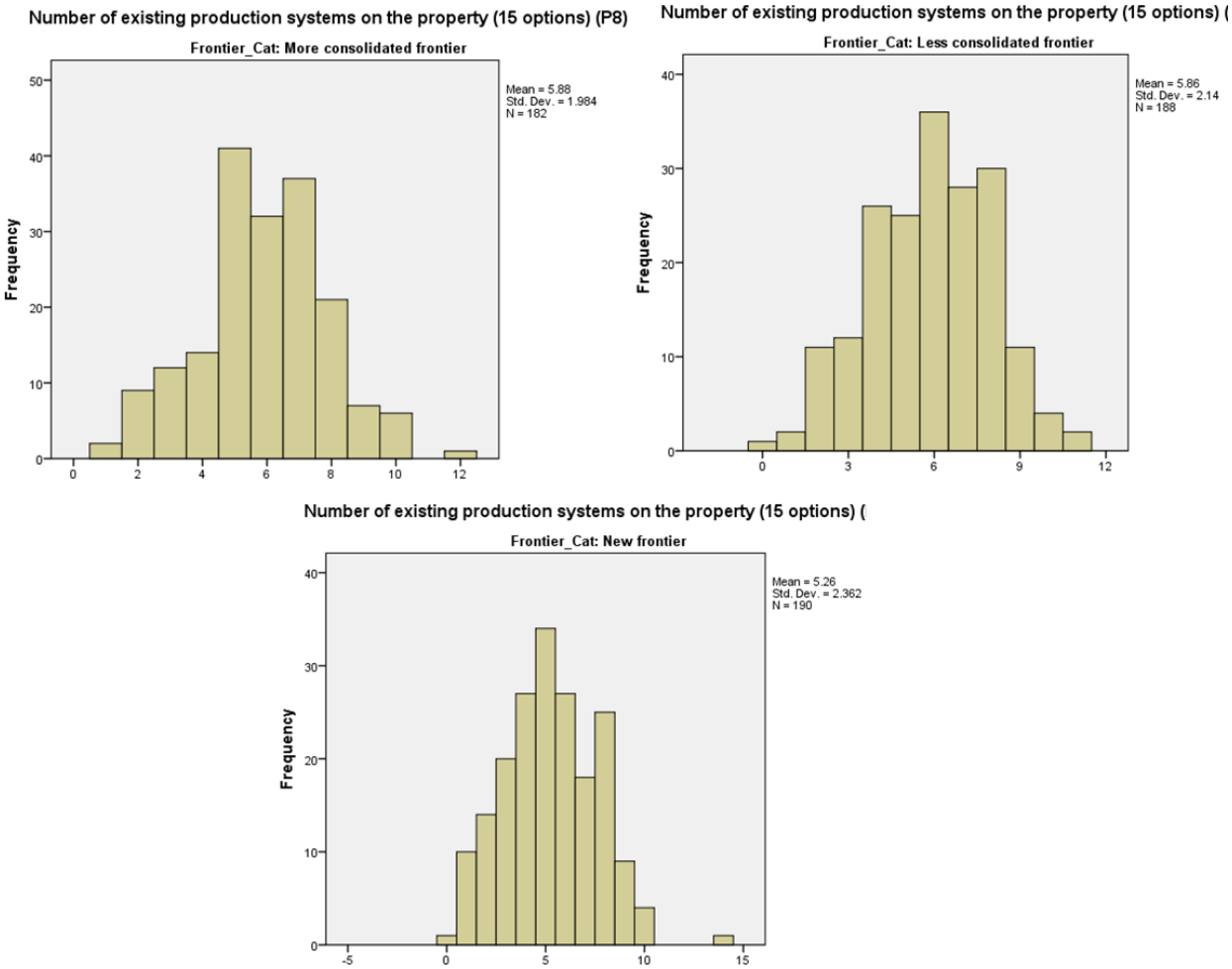

Figure 4-22. Frequency of responses about the number of production systems farmers engage.

The percentage of families carrying each production system in the property can be seen in Figure 4-23. In general, chicken, orchard, vegetable garden and calves' operation are the most reported systems among families.

In terms of type of systems farmers engage, the statistical differences are in milk less prevalent in NF and more prevalent in MCF/LCF (Table 4-52); agriculture plots less prevalent in NF and more prevalent in LCF (Table 4-53); fruits production less prevalent in NF and more prevalent in MCF (Table 4-54); chicken production more prevalent in MCF/ LCF and less prevalent in NF (Table 4-55); and coffee production less prevalent in LCF and more prevalent in NF (Table 4-56). The results demonstrate production systems differences more strongly related to the NF and the other two categories. These differences could indicate that in the New Frontier farmers are less engaged in production systems more related to families' food security. The Table 4-6 reinforces this assumption showing the number of products families consumed in the last 3 months.

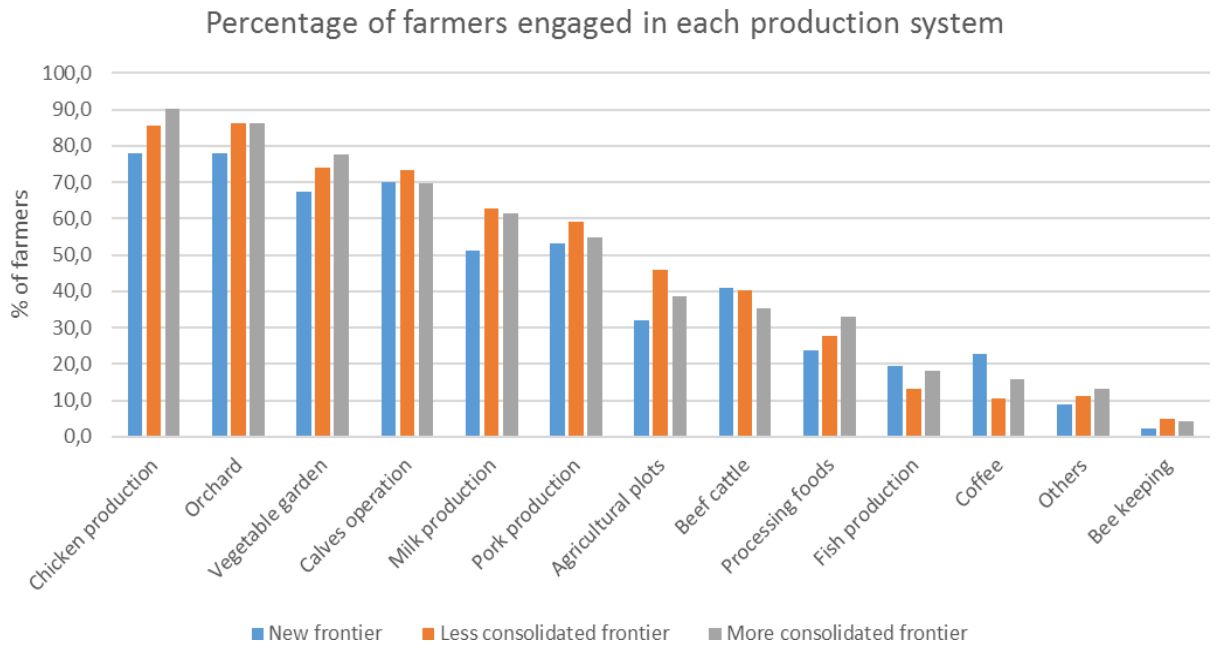

Figure 4-23. Percentage of farmers that carry each of those production systems.

It is also important to mention that if we combined cattle activities it would be one of the productive systems farmers engage most, representing 83.3% of the farmers in the MCF, 85.1% in the LCF and 82.6% in the NF. Most of farmers combine the cattle systems as the graph shows (Figure 4-24), especially milk and calves. In the work of Pereira et al. (2016) in southeastern Para, they also found out that farmers prefer to have a mixed herd rather than pure-bred cattle, since they can combine activities and the animals are less expansive.

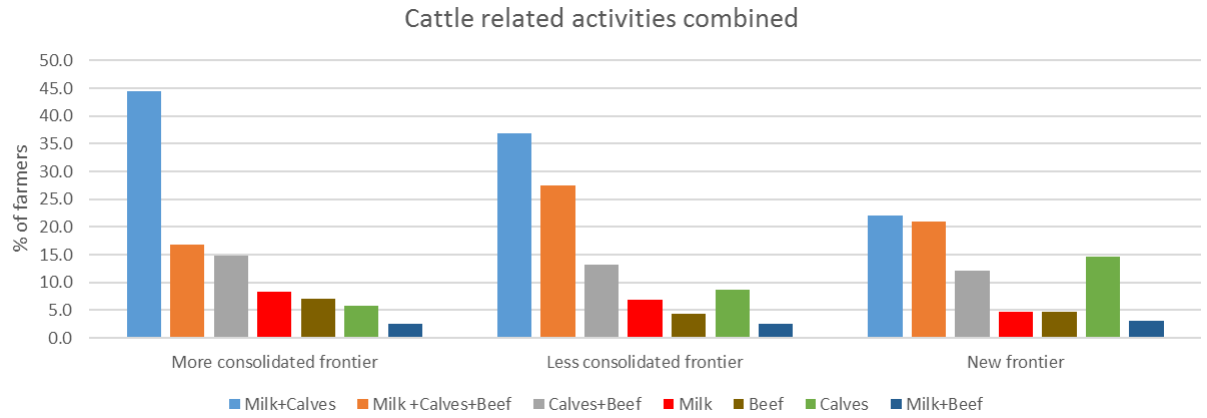

Figure 4-24. Combination of cattle related activities.

Relate to subsistence farming, a possible source of error was identified while analyzing the data. When farmers declared to have, agriculture plots they were basically referring to “lavoura branca” which is rice, beans and maize. So, many backyard agriculture plots were ignored, but they play an important role in the subsistence of families. Just to give a sense of its importance, I analyzed an open question related with the type of food farmers consumed in the last 3 months from their properties.

The results showed that backyard production is very significant, as cassava was mentioned 321 times, pumpkin or squash 125 times, potato 69 times, watermelon 40 times, pineapple 53 times, yam 12 times and peanut 6 times, in sum they represent 626 answers. The graph show the results related to percentage of responses (Figure 4-25).

The difficult to add to the production systems is that it was measure by products and not by system.

The data about the types of food families consume was also counted and quantified. The results show statistical differences between MCF/LCF and NF, which present lower average number of products farmers consumed in the last 3 months that came from their property (Tables 4-6 and 4-57).

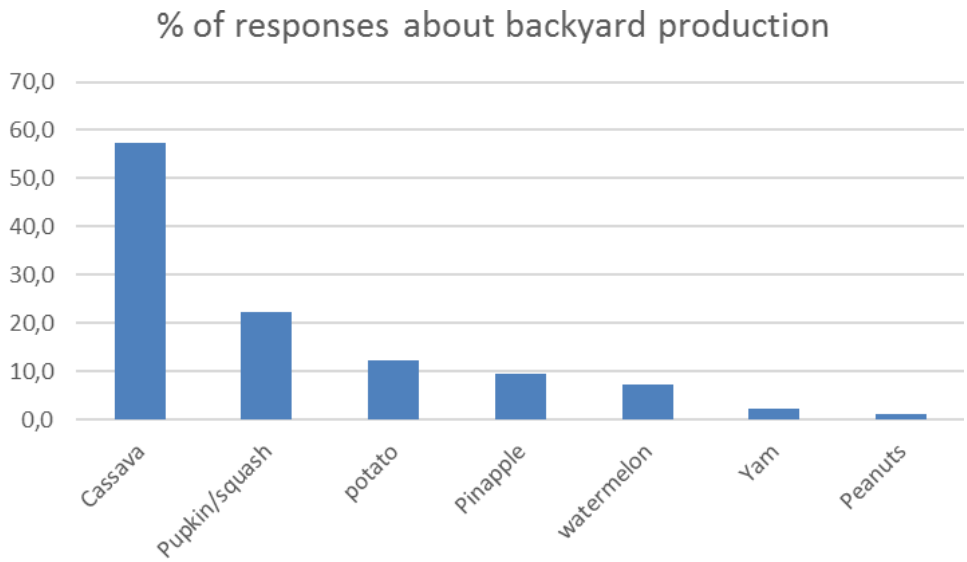

Figure 4-25. Percentage of farmers that produce each of the subsistence products.

Table 4-6. Average number of products families consumed in the last 3 months and were produced in their farms.

	N	Mean	Std. Dev	Min	Max	F	Sig.
More consolidated frontier	182	8.27	4.191	0	30	10.992	0.000
Less consolidated frontier	188	8.79	4.125	0	24		
New frontier	190	6.97	3.292	0	15		
Total	560	8.00	3.954	0	30		

Although the number of subsistence products provided by the farms was large, the majority of families still rely on the grocery store as their first source of food, with no

difference across the region (Figure 4-26). I also asked the role of neighbors and farmers' market in providing family food, with no significant number in the sample. These results could indicate also that having the grocery store as a primary source of food is not just related with the amount of food that is produced but also with availability, values and eating habits.

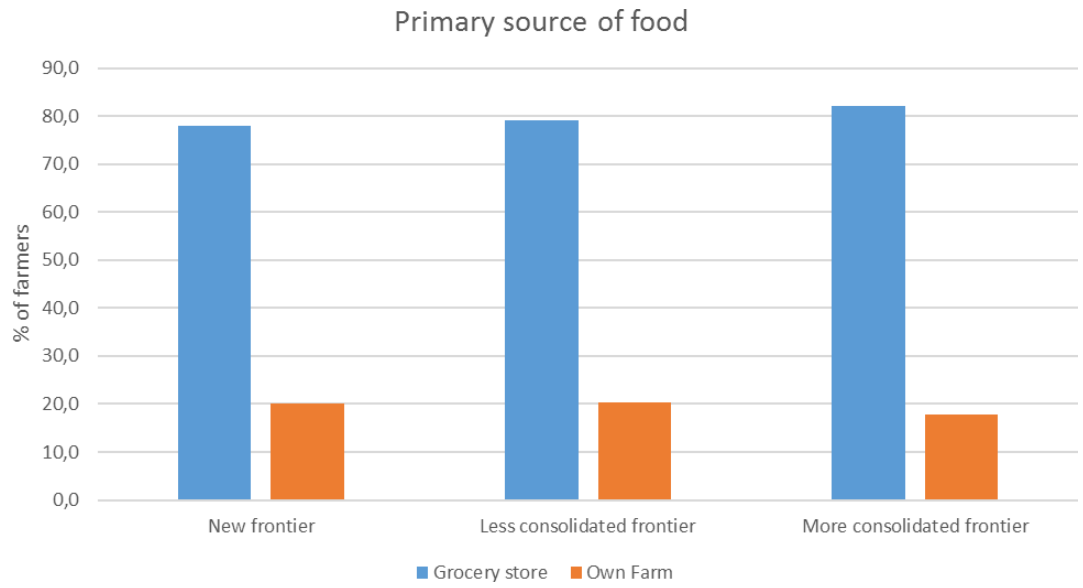

Figure 4-26. Primary source of food.

Still on production systems diversification, it was also created categories to describe the level of diversification, based on the histogram result, the 'low category' is when farmers engage in fewer than 2 productive systems, 'medium' they pursue between 2 and 8 productive systems and 'high' means they are occupied with more than 8 productive systems (Figure 4-27).

Although there are small differences across the frontier types, the results do not reach statistical significance (chi-square=0.071) and the majority of farmers are in the middle category of diversification, engaging in 3-7 production systems.

A different question was asked to understand the land use in the farm by the area farmers allocate to pasture, agriculture and others. It was also asked how much area they keep as forest. The results were not satisfactory since about 29% of the total areas was declared as “don’t know”. In general, the majority of the land use is pasture, with no difference across the region. But, there is difference in the size of the pasture across the region which become bigger as it moves from MCF to NF (Table 4-7).

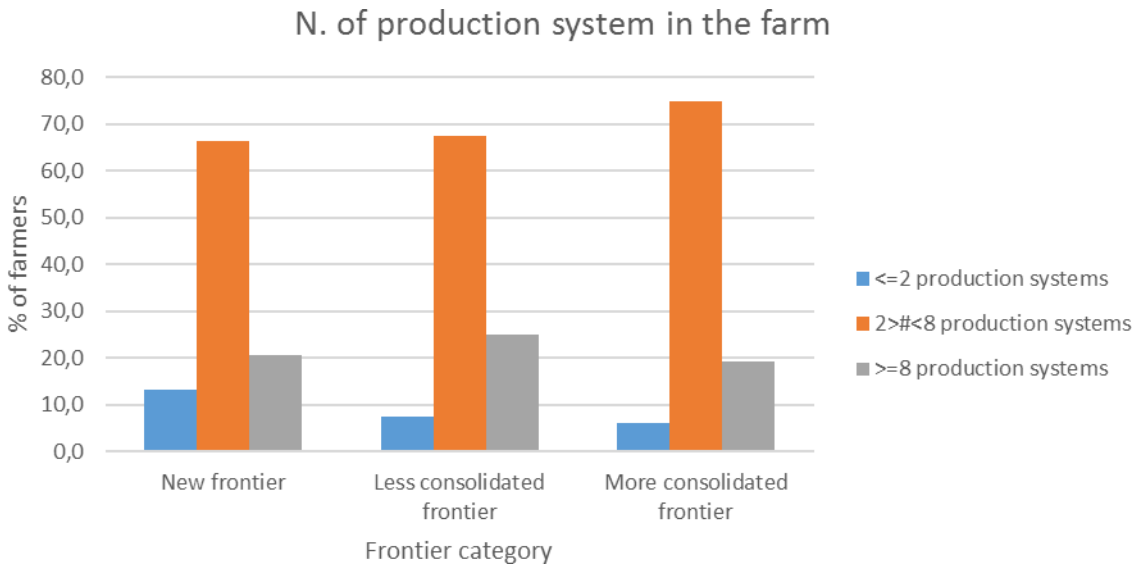

Figure 4-27. Percentage of farmers per category of farming diversification and by frontier type.

Table 4-7. Average area of each of land use.

		ANOVA – Land Use						
		N	Mean	Std. Dev	Min	Max	F	Sig.
Area of pasture (hectare)	More consolidated frontier	182	27.19	15.2	0.00	85	3.627	0.027
	Less consolidated frontier	188	33.83	20.4	0.00	130		
	New frontier	190	39.80	20.1	0.00	122		
	Total	560	33.70	18.9	0.00	130		

The percentage agricultural areas, forest areas and 'not declared' areas in the properties vary among the three frontier types (Figure 4-28 and Table 4-58). It is interesting that, although the LCF there are the highest percentage of farmers engaged in agriculture, in terms of land use, agricultural fields occupied the less percentage of areas in this category. The reasons why in the LCF are so many 'not declared' areas need to be better understood.

To measure income diversity, I looked at on-farm and off-farm sources of income. Farmers where asked which of the production systems (14 choices) generated some income. In contrast with the average systems they engage, the average number of production systems that generates income is relatively low. There is a statistically significant difference across the frontier stages, from MCF with higher mean and NF with lower mean (Tables 4-8 and 4-59). This can indicate that on-farm income diversification increases from NF to MCF, where farmers are more inked to commercial production.

The graphs show (Figure 4-29) the distribution of answers through the categories of the sample, it is seen that most farmers have 1-3 production systems that generate income in all of them, but for each category the graphs show how the curve change in this interval.

Table 4-8. Average number of production systems that generates income.

ANOVA	N	Mean	Std. Dev	Min	Max	F	Sig.
More consolidated frontier	182	2.31	1.478	0	9	6.208	0.002
Less consolidated frontier	188	1.91	1.185	0	8		
New frontier	190	1.88	1.238	0	8		
Total	560	2.03	1.316	0			

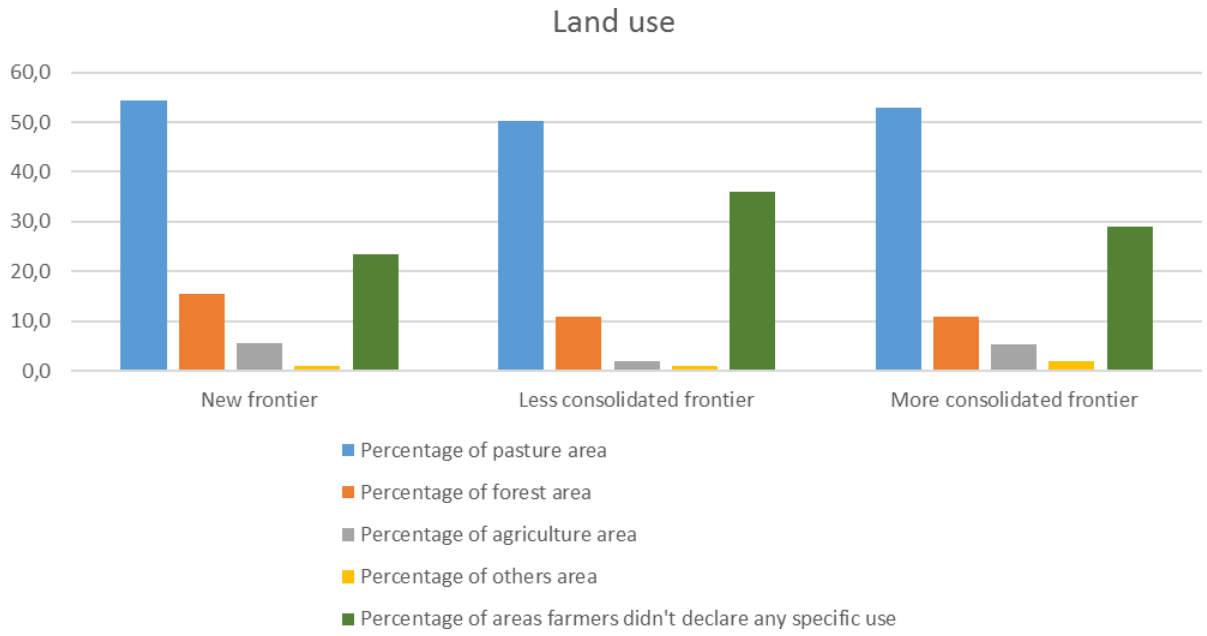

Figure 4-28. Percentage of area allocated to each land use.

The Figure 4-30 shows the primary on-farm source of income, and for all frontier regions they are cattle related (milk, beef and calves). There are three patterns, milk production decreases as the frontier goes from MCF to NF, beef production increases as the frontier goes from MCF to NF and also calves operation increases when it goes from MCF to NF. As a result, milk is the activity that most contributes in the MCF region, while calves are most important in the NF. In the LCF. 'Milk' and 'calves' are balanced (Chi-square test in Table 4-60). The number of times these systems provide income per year was asked, calves and beef cattle basically generates 1-5 times/ year while milk provides income more than 10 times/ year mostly (Figure 4-31).

Categories of income diversity (based on the histogram) were created, with 'low on-farm income diversification' when the farmers have less or equal to 2 production systems that provide income, 'medium' when is between 2 and 4, 'high' when the number productions systems that provides income are more or equal to 4 (Figure 4-32, Table 4-61).

Differently of the graph which shows the diversity of production systems farmers engage, here most farmers have two or less production systems providing income. The greater difference is specially related to MCF and NF. The MCF presents higher on-farm diversification while NF presents less. Also, an open question was asked about the types of products they sell, it was counted and confirmed the differences (sig. 0.003), the MCF sells higher average number of products (2 units) while in the NF is lowers (1,6 units).

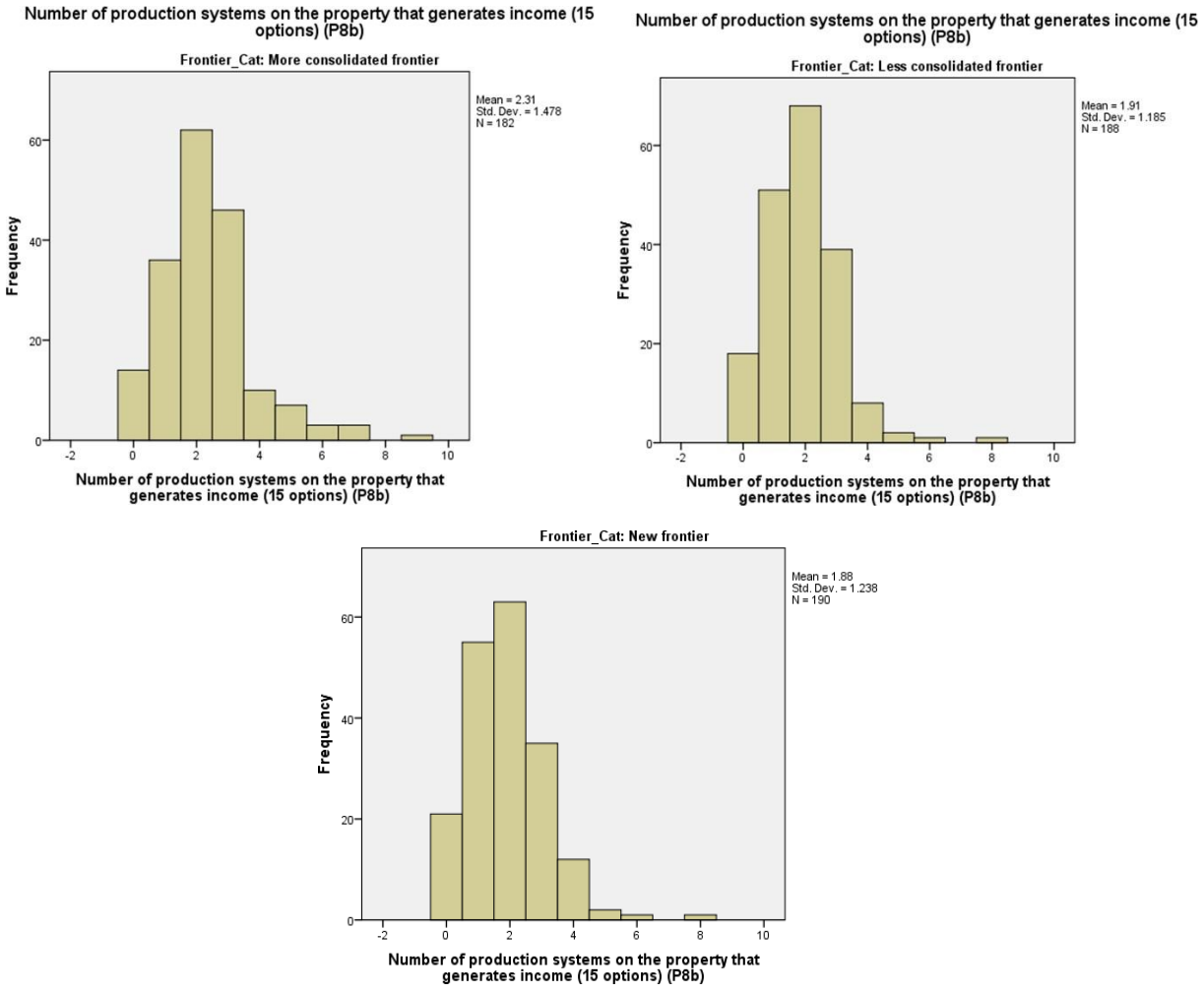

Figure 4-29. Frequency of responses related to the number of production systems that generates on-farm income in each category of frontier region

'How do they sell these products' was a closed question with 6 options: sell in the city, markets or informally; the buyers go in the community to by their products; they sell

at farmer's market; they sell to people that lives in their community; any other type not mentioned. As the graph shows the middle man plays an important role across the region, independent of the farmers' primary income source (Figure 4-33).

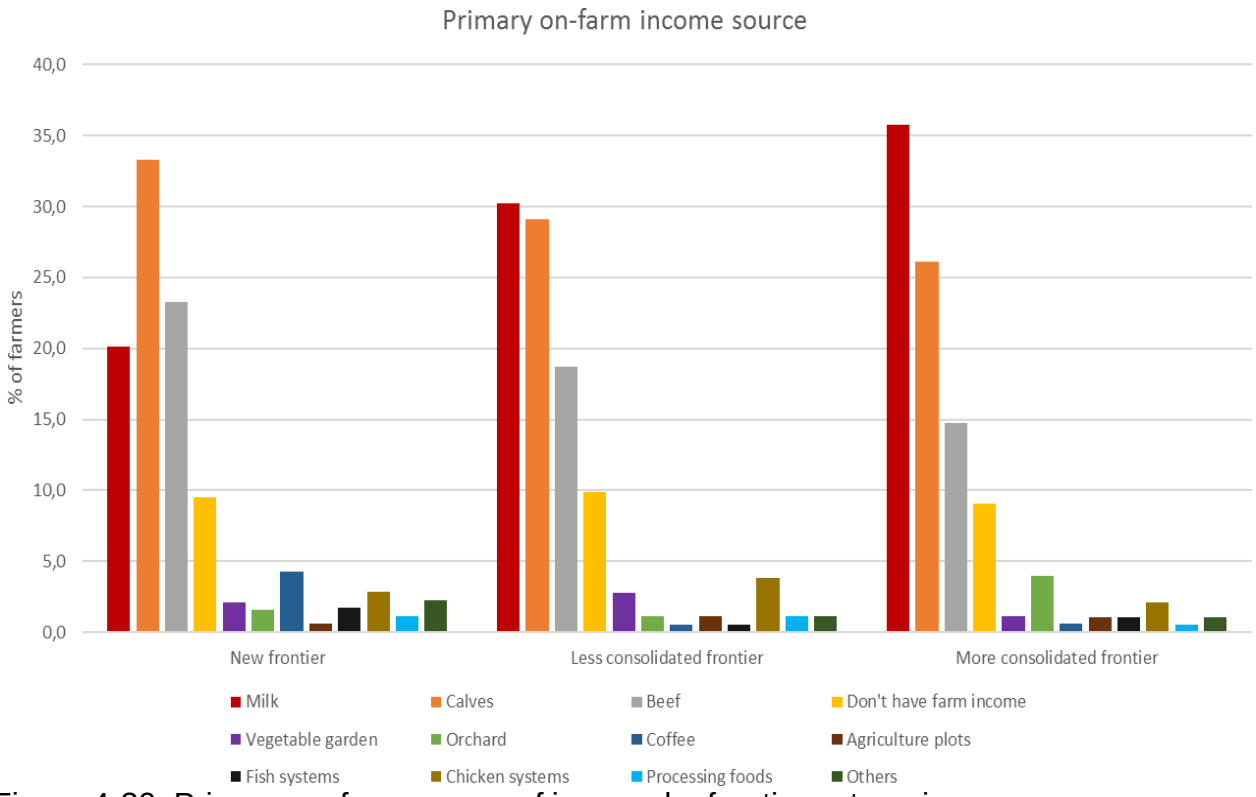

Figure 4-30. Primary on-farm source of income by frontier categories.

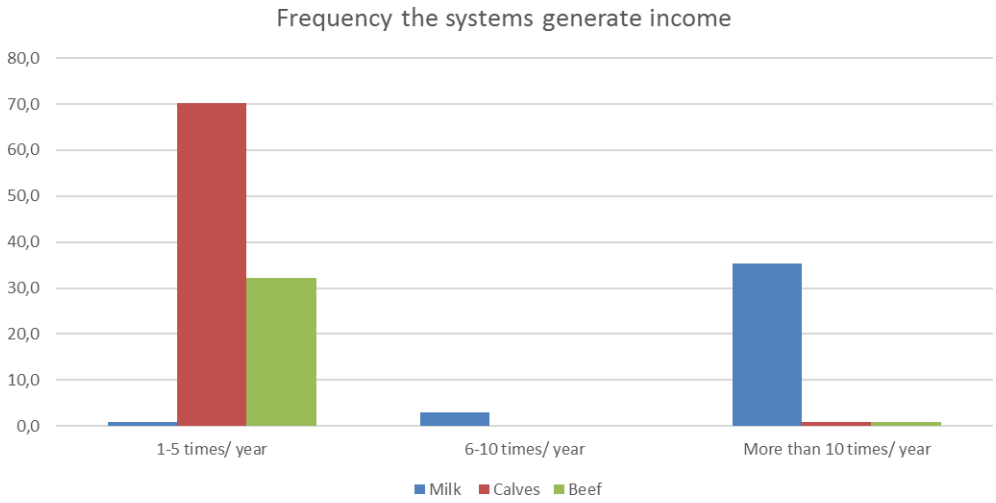

Figure 4-31. Number of times per year that cattle production systems generate income.

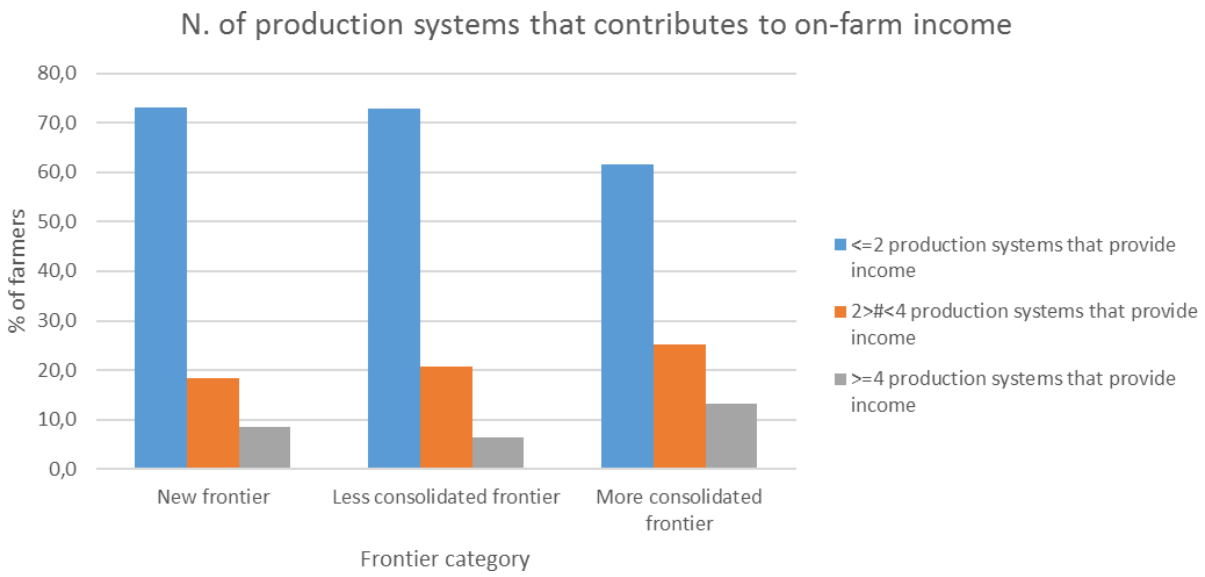

Figure 4-32. Percentage of farmers in each category of on-farm income diversification.

There are no statistical differences among the marketing channels, excepted for the 'others' in the new frontier which is impressive high. There is no information reported about what type of marketing channel is this and further research should be conducted to understand better. The number of different marketing channel farmers use changes across the region, the statistical differences is between MCF (more diversified) and NF (less diversified) (Table 4-9 and 4-62).

Regarding to off-farm sources of income that family farmers have, the presence of five different sources was asked: 1) day labor, 2) land rentals, 3) governmental or other employment, 4) retirement, and 5) welfare (cash transfer) programs. In terms of the number of off-farm income sources, the differences are between NF, which exhibits a lower average, and MCF/LCF, which show higher averages (Table 4-10, Table 4-63).

Among the categories of off-farm income (Figure 4-34) that were reported, the major difference is in the 'pension' (rural retirement) between MCF and NF, which a highest number in MCF comparing with others and benefits families most in this

category, as expect due to the number of family members with more than 60 years old. The day labor is more significant in the NF, and in the LCF both pension and day labor have similar results (Table 4-64 and 4-65).

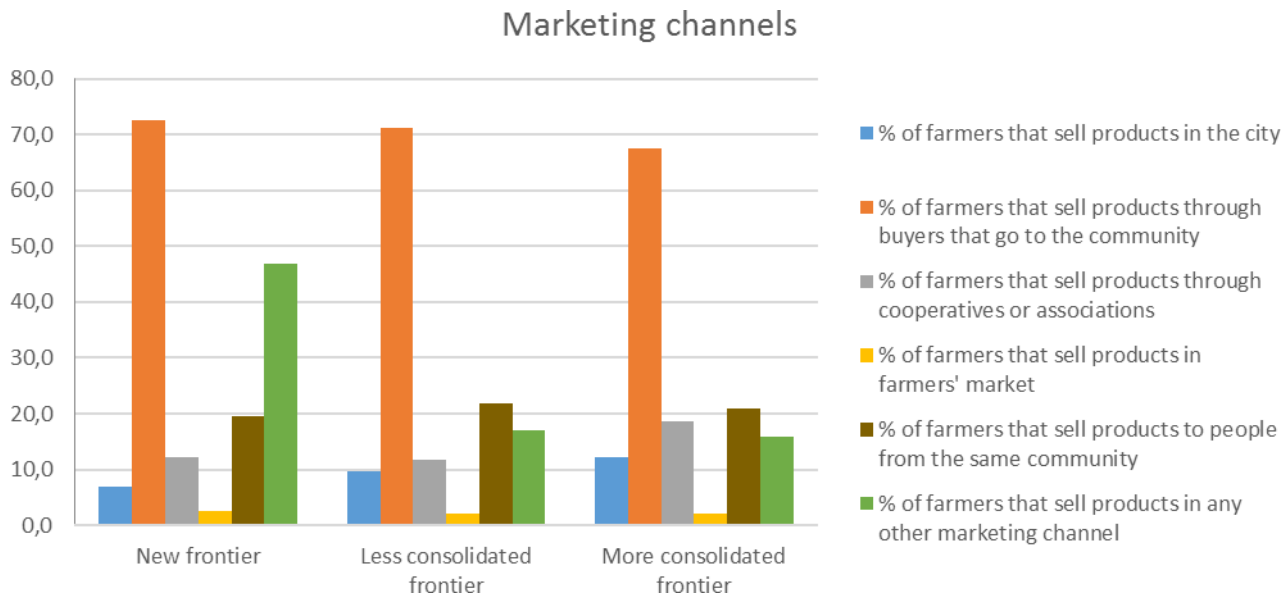

Figure 4-33. Percentage of respondents per marketing channels.

Table 4-9. Average number of marketing channels farmers use to sell what they produce.

ANOVA	N	Mean	Std. Dev	Min	Max	F	Sig.
More consolidated frontier	182	2.31	1.789	0	10	3.966	0,019
Less consolidated frontier	188	2.13	1.905	0	20		
New frontier	190	1.80	1.647	0	17		
Total	560	2.08	1.792	0	20		

It also seems highlight the percentage of farmers who are benefited from welfare programs especially in LCF and NF. Welfare programs is mostly bolsa-familia which is a governmental direct cash transfer program designed to reduce poverty, with family (small) payment tied to child vaccinations and school attendance.

Table 4-10. Average number of off-farm income sources.

ANOVA	N	Mean	Std. Dev	Min	Max	F	Sig.
More consolidated frontier	180	1.25	0.877	0	4	11.766	0.000
Less consolidated frontier	187	1.34	0.842	0	4		
New frontier	190	0.95	0.733	0	4		
Total	557	1.18	0.834	0	4		

Although off-farm sources of income increasingly are become a livelihood strategy for family farmers, the majority of the families' source of income still coming from on-farm systems (Figure 4-35).

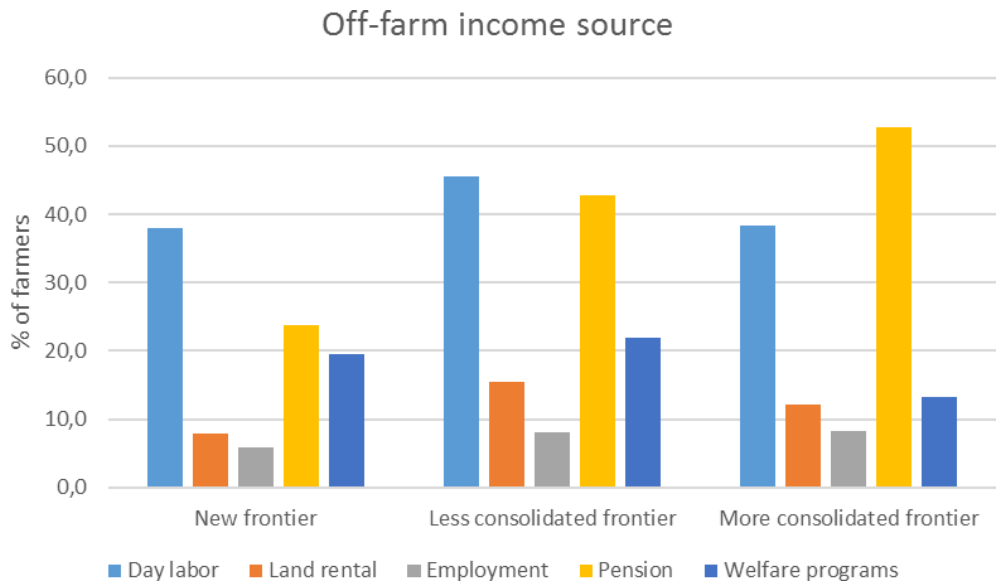

Figure 4-34. Off-farm income sources that farmers reported.

As the graph shows, dependence on government support decreases going from MCF to NF as the on-farm source of income increases. It can be related to the age of

farmers in the regions and the number of farmers who are retired. The other categories are not statistically different (Table 4-66 and 4-67).

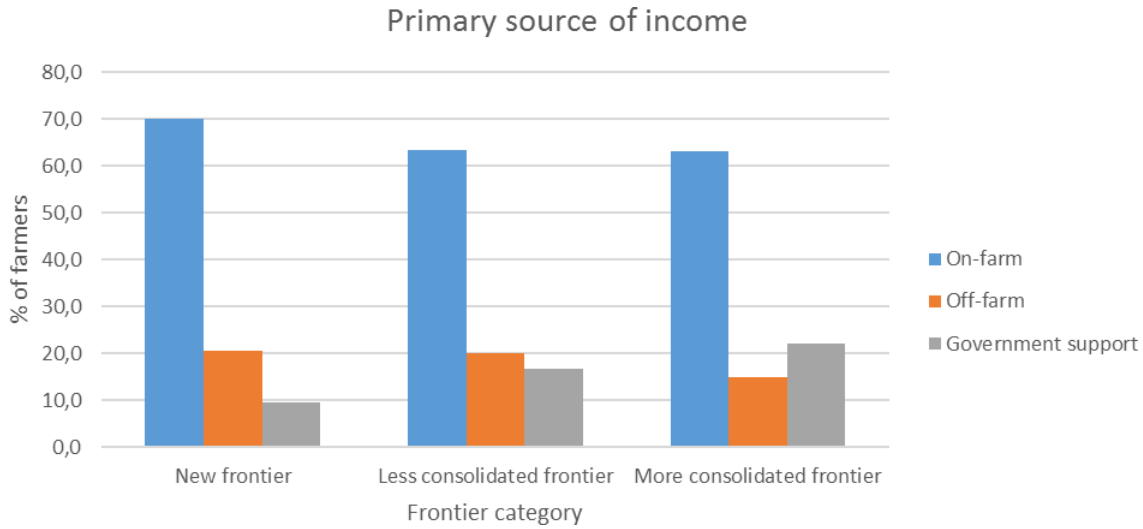

Figure 4-35. Primary source of income by frontier category.

Because the livelihood strategies are so dynamic, De Haan & Zoomers (2005) suggest characterizing farmers by their objectives and priorities. So, a closed question of what are the farmers plans for investments in the next years, with 7 choices was asked. No difference was found across the region. Livestock in the first option, with 45.5% of answers. Then, do not have plans for changes, in a second place with 25.4% (Figure 4-36).

In order to complement the question above, the opinion about what government should invest to support family farmers was also asked, they had 9 choices and could pick up three priorities (Figure 4-37, Table 4-68, 4-69). The differences are stronger related to transportation investments which seems to be a priority in NF confirming the lack of physical assets, the investments on community organizations which is lower in the NF, also in consonance with the data showing the low level of trust in the role of community organizations in this region. In general, the highest priorities are related to

credits and commercialization. Other interesting point relates to the higher need to solve legal aspects of the land in the NF and LCF than in MCF, also matches with the titling status data.

It is interesting that the highest priority was credit and the lowest was food processing. The first is a very individual type of support while the second has been the focus of many external projects carrying the idea of processing foods as a key element for rural development. However, many food processing initiatives have failed. This finding begs the question of how development initiatives are externally imposed on supporting farmers to work in a subordinate role value chains (supplying, producing, processing, packaging and selling) rather than supporting them to negotiate to participate more effectively in the value chain. Studies have demonstrated that it can aggregate value to production in a very expressive way (Niederle, 2017). Nevertheless, there are so many fail initiatives regarding to local food industries that calls attention of what is not working. A study of the labor availability, the human assets, the governance and the real needs for these plants must to be made to ensure this type of action.

The second big demand is commercialization, which is in accordance of what we have seem on these data, many production systems, few on-farm income sources. The high demand for regularization focused on environmental aspects intent mostly to allow access to formal markets and credits. Asking where government should invest rather than what is the major problem, brings a different way of seeing the needs and a good tip of the gaps in each municipality.

Summarizing, the main difference among farmers in the three frontier stages related to livelihood strategies is between MCF/ LCF and NF. of the findings for different

aspects of livelihood diversity generally show that farms in the MCF and LCF have greater livelihood diversity than those in the new frontier. Put another way, the Hypothesis that farms in the MCF would be more specialized farming was not supported.

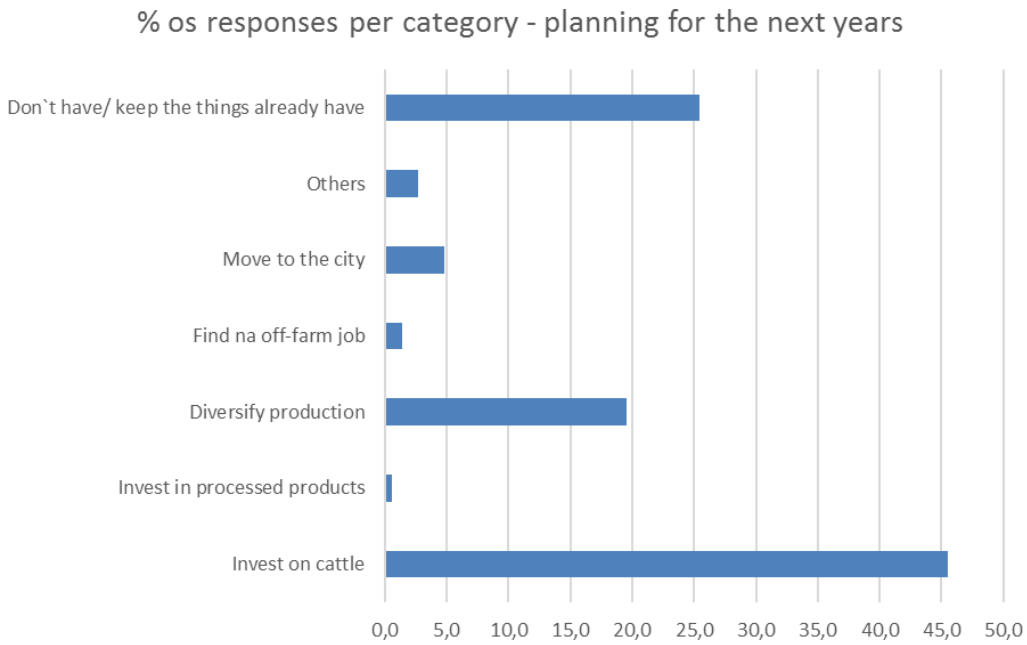

Figure 4-36. Farmers' investments plans for the next years.

These results show that assumptions about reduction of labor force availability across frontier stages do not apply to this study site in Mato Grosso. In the MCF, the higher labor force combined with greater infrastructure and market linkages to benefit on-farm diversification as well. Farmers in the MCF have higher farming diversity, and more production systems that provides income, being milk as a primary source for majority of farmers, the most of them combine milk and calves' production. They sell more types of products and they use a higher number of marketing channels. Their off-farm sources are more related with pension, probably due the higher percentage of farmers with more than 60 years old, but it doesn't impact negatively their farming diversity – the average family age is higher, but also the labor force. In the new frontier farmers have less

production systems that provides income (less diversified), and their on-farm income relies on calves' operation, with more percentage of farmers specialized in this activity, combining it less with milk or beef production comparing with the other regions. They also have less percentage of farmers working with milk, fruits, agriculture, chicken comparing with the other regions, although there are a high percentage of farmers engaging those systems across all regions. In the NF farmers also have the lower average of products the families consume from the farms. All these data do not prove the theory that in the NF farmers would engage more in food production, due to the low infra structure conditions, that could impact positively the subsistence farming (the demands to improve transportation and logistics are significantly higher than the other regions). Similar results of MCF was found in the less consolidated frontier, with primary on-farm production being both calves and milk; higher off-farm diversity of sources, being day labor and pension the most prevalent and the highlight is the food security, with the highest percentage of farmers who still doing agriculture and higher average number of products from their farms they consumed in the last three months.

As mentioned before, the low differences in livelihoods between MCF and LCF could suggest that other elements are playing important roles to influence the relationship between assets and livelihoods. In this section, I will present some analysis to better understand these influences, emphasizing that this is not a causal relationship. Rather, I seek to point out possible relationships that could be addressed in future research. Here three possible mediators' factors were selected to be analyzed: market development, access to benefits from policies, and gender.

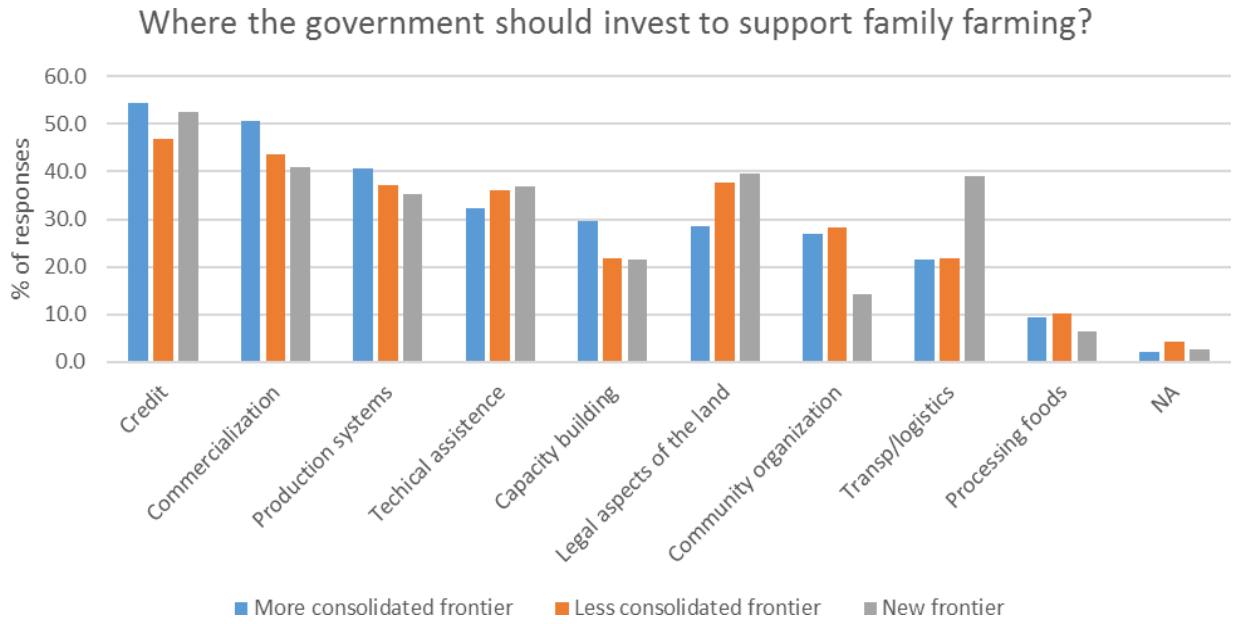

Figure 4-37. Farmers perception of where the government should invest most.

The first relates specially to the presence of dairy plants and slaughter houses in the region. Market accessibility is a relevant driver of land use/cover change in the Brazilian Amazon and can be calculated as the travel time to dairy plants (milk storage and processing) or slaughterhouses accounting for road conditions (Soler et al., 2014). There are eight slaughter houses in the region, five in the north region and 3 in the northwest of the state (MAPA, 2017); and ten dairy plants, six in the north and four in the northwest (MDA, 2017). It is not a surprise that farmers found in these value chains a secure option for their livelihoods. The distance (and road conditions) of the dairy plants in the NF also reinforces why in this region the milk production is not the primary source of farmers' income. It is about 181 km through non-pavement MT-208 from Cotriguaçu to Aripuanã (closest municipality), around 6 hours of trip in a good path. Also from Apiacás it is 184 km through non-pavement MT-206 to Alta Floresta and from Nova Bandeirantes 240 km through the MT-208 (part non-pavement) to Alta Floresta.

In terms of policy access, it relates to the technical assistance; and the access on two important government programs: PAA (Acquisition Food Program) and PNAE (National School Feed Program). The results show differences across the region just about technical assistance farmers received, the NF is negatively correlated to technical assistance while LCF is positively correlated, with the unexpected highest percentage (Figure 4-38, Table 4-70 and 4-71).

PAA (Law N. 10.696/2003) and PNAE (Law N. 11.947/2009) are government programs part of Fome Zero (Zero Hunger) program launched in 2003 in which the federal government buys food from family farmers to supply schools' food or other welfare programs that work with people in social insecurity situations, known as an institutional marketing. It was an important alignment between government programs (Graeub et al., 2016). The PNAE requires 30% of school food program budgets be utilized in purchases from local family agriculture and it is coordinated by local government. PAA is accessed through CONAB (National supply company) with a limit of R$6.500 per family/ year (Belik, 2017) and it is coordinated by federal government (still needed local arrangements).

Although PAA and PNAE are great programs and have a lot of potential of great local impact, farmer the access to them appears insignificant in the region (5% of farmers in the sample participated in PAA and 2% in PNAE). Further research should address this topic. Several studies have shown that the number of family farmers involved in the program still small, compared to other government programs (Mattei, 2014). This result could be related to lack of strong local governance to really reach the farmers (community level and local government level), Belik (2017) also pointed out the lack of

knowledge of the operation, lack of appropriate menus to local products and corruption. Also, on the supply side, there are difficulties in the preparation of documentation, production planning project, and logistical challenges.

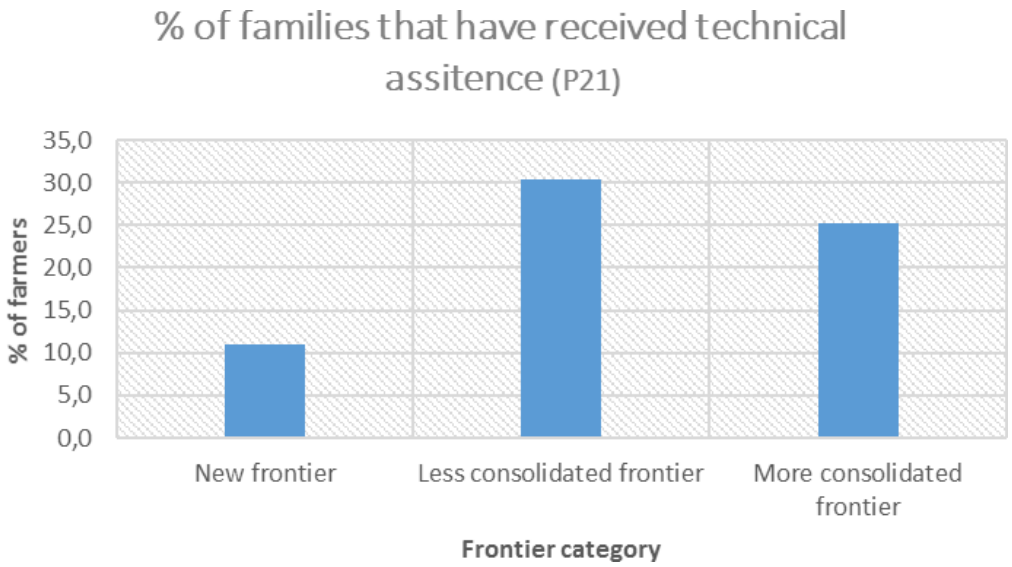

Figure 4-38. Technical assistance per frontier category.

The Figure 4-39 shows the official number of farmers who accessed the program by frontier type, the maximum achievement was about 11% of farmers in 2012.

I accessed the formal data base from the National Fund for Education (2016). The results show that in any of the three regions, in four years, the local government did not used even 50% of the budget destined for the program (Figure 4-40). The maximum was 35% surprisingly in the NF. In Carlinda and Terra Nova data showed 0% of the achievement in the program, meaning that in four years it was never done.

Another useful information is about the DAP (*declaração de aptidão agrícola*) document with is a 'statement of agricultural aptitude' with is farmers' proof document that allows them to access the main policy for family agriculture – Programa Nacional de

Fortalecimento da Agricultura Familiar – Pronaf. There is no clear pattern across the frontier categories, but it is important to note that there are gaps.

Finally, it was asked if the families were benefited (or have been) from any external projects (NGOs and Government) (Figure 4-42, Table 4-72 and 4-73). There is a strong difference in access between MCF and NF where few farmers reported participation in any project.

Another strong mediating factor is gender relations. Differentiating by gender relationship we can understand how it impact the access and control to those and the capability to pursue successfully their livelihood strategies (Chirau et al., 2014). As we already have discussed, the male labor is predominantly able to take advantage of diversification opportunities (Ellis, 1999). Two other elements researchers have studied are land ownership and agricultural decision-making (McKune et al., 2015).

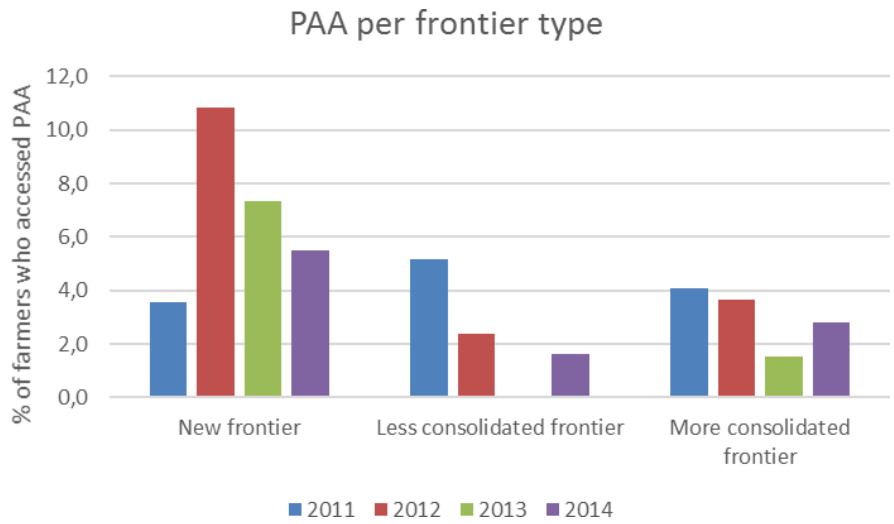

Figure 4-39. Percentage of farmers who accessed PAA per frontier type along four years (SAGI, 2016).

Regarding land ownership, in all frontier categories the males represents most of the owners (Figure 4-43), there is just a statistical difference related to the number of

lands couple owned in the LCF (positively correlated) and in NF (negatively correlated), which presents the lowest percentage (Table 4-74 and 4-75).

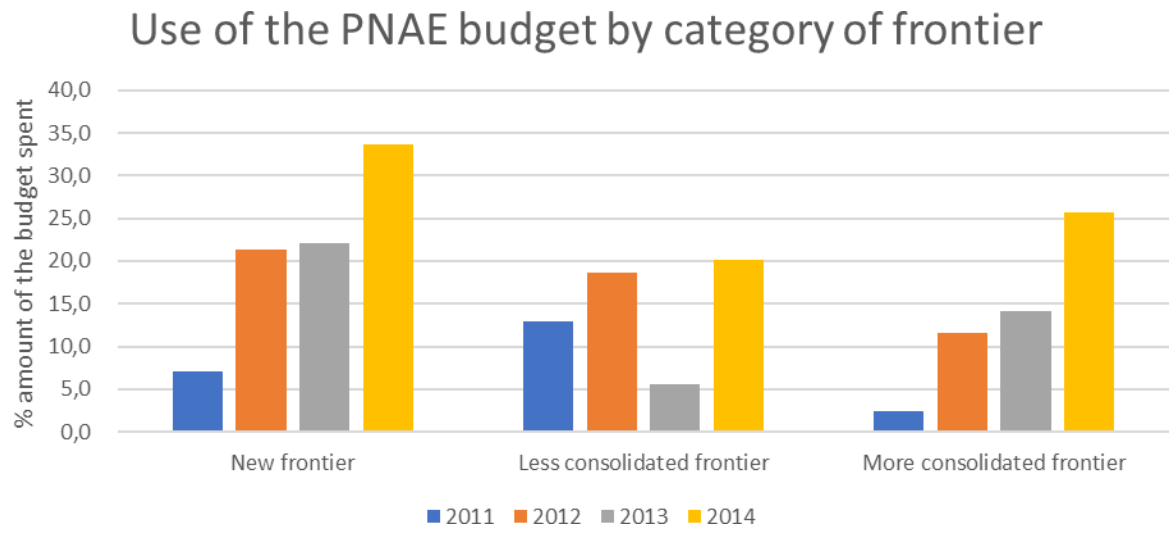

Figure 4-40. FNDE, National Education Development Fund, 2016.

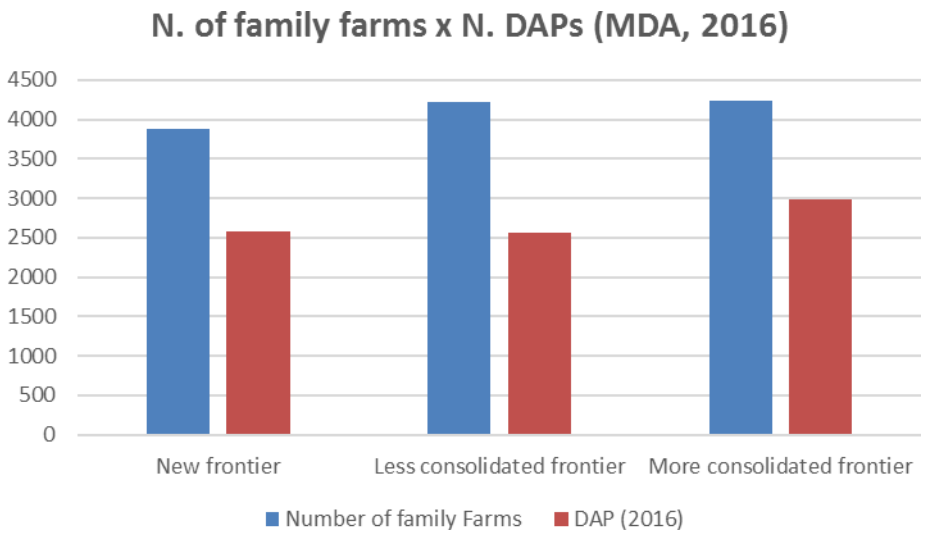

Figure 4-41. Number of family farms and number of DAP per frontier type.

When summed all sources of farmers' income, representing the level of livelihood diversity (on and off-farm sources of income) there is a significant difference between MCF and NF with higher livelihood diversity in MCF and lower in NF (Tables 4-11 and 4-76).

Land ownership could affect decision making in the property, and that will affect livelihoods. As the graphs show (Figure 4-44), the majority of decisions are also made by male members. In terms of legal documentation of land, the couple head lands are more related to government concessions (adjusted residual = 3.0) while male is positively related with titled lands (adjusted residual = 2.2). This can be related to government directions of promoting gender balance in agrarian reform benefits (Incra, 2017). The female is the most vulnerable group in terms on land security (Pearson chi-square = 0.000). It would influence many other aspects such as access to credits and policies and access to formal markets that could lead them in a vulnerable situation.

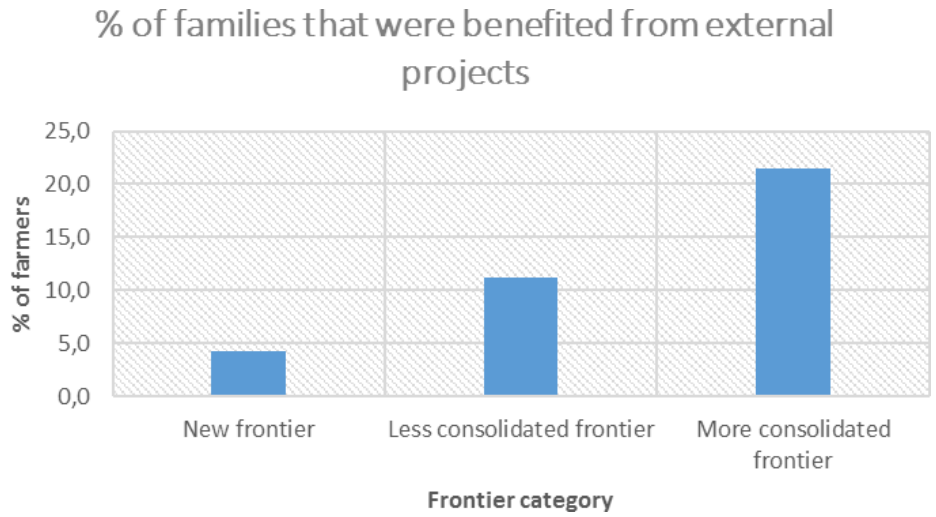

Figure 4-42. Percentage of farmers who were benefited from external initiatives.

Table 4-11. Average number of income sources (on-farm and off-farm).

ANOVA	N	Mean	Std. Dev	Min	Max	F	Sig.
More consolidated frontier	180	3.56	1.65	1	11	11.14	0.000
Less consolidated frontier	187	3.25	1.37	1	9		
New frontier	190	2.83	1.44	0	9		
Total	557	3.20	1.52	0	11		

The graphs (Figure 4-45 and Table 4-77 and 4-78) show that couple owners are more likely to diversify their farming systems and consequently the on-farm sources of income.

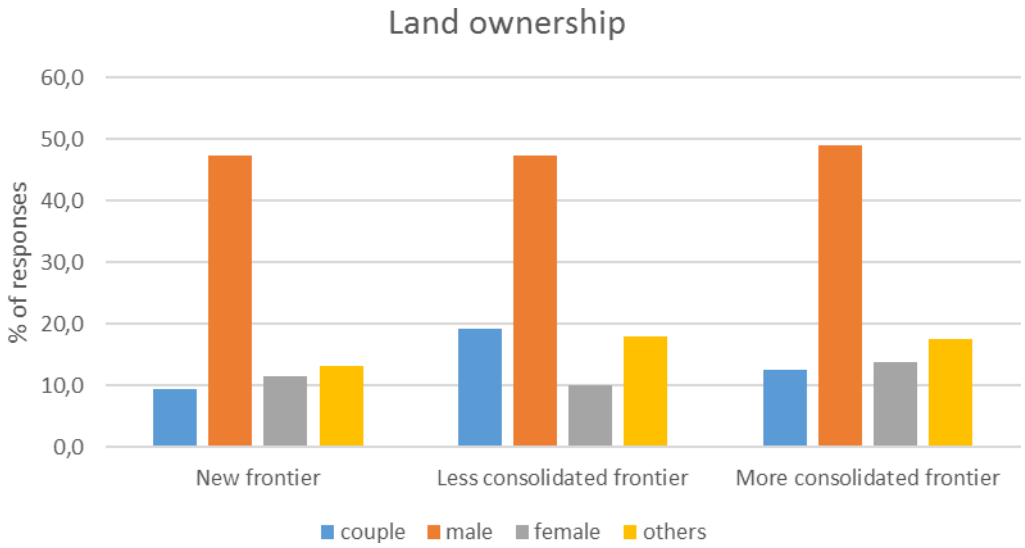

Figure 4-43. Ownership of land.

In relation to primary income source there are differences related to ownership (Pearson chi-square=0.026), the female-head farms are negatively correlated with on-farm sources as a primary income source (adjusted residual= -2.3) and positively related with government support as a primary source of income (adjusted residual=3.0); while no difference was found between the male and couple head-farms.

About the findings for markets, policies and gender indicate that they too vary across frontier stages. It shows stable cattle related market that might have effect in livelihood strategies, especially in the NF, where farmers seem more vulnerable in terms of diversity and food security, very oriented to a commodity value chain providing calves to large farmers without being really part of those negotiations.

Figure 4-44. Decision making by gender

The information about slaughters house I collected from Agriculture Ministry (MAPA) which is the ministry that look after agribusiness and medium/large owners. The information about dairy plants I collected from Agrarian Development Ministry (MDA) which just look after family farmers. This simple reference added to the contradictions already discussed here that led to the idea that family farmers and fazendeiros have antagonists and clearly different production strategies (Godar et al., 2012). However, it is not that simplistically division, actually they are interacting and (poorly) negotiating.

Finally, the technical assistance is higher in the LCF, what can influence farmers' livelihood choices, also there are higher number of couple owners. These elements might influence the level of diversification and food security in this part of the frontier, perhaps increasing it.

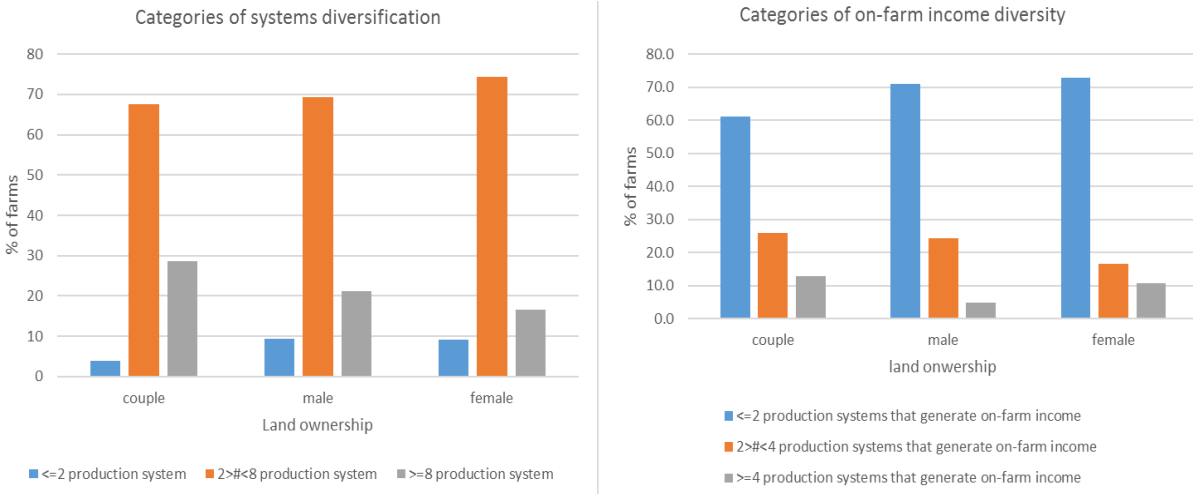

Figure 4-45. Ownership and categories of production systems diversification.

Assets and Livelihoods Diversification

Answering the first two questions this research has looked at the assets and livelihood strategies in order to understand where are the significant differences across the frontier stages. In this section, I will discuss what type of family assets are positively related to more diversified livelihoods. Family assets are the basis to give agency to farmers to create the livelihoods they value, in the context of a complex socio economic structure, including laws and regulations that constrain their capability to choose.

Seeking for expanded benefits to farmers, would be interesting to support farming diversity and livelihood diversity as well. The set of data that will follow relates assets to on-farm production systems diversity, income diversity and food security.

The first part correlates human assets to production systems and income diversity, such as family average age. A family's average age was indicated as one element that may influence livelihood diversity. However, the data for the Mato Grosso study site shows that there is no statistically significant difference (chi-square=0.798) either in terms of farming systems diversity or on-farm income diversity.

Looking at labor force, we notice that it might influences farming diversity, as increases in the labor force correspond to a rise in the number of production systems (Figure 4-46, Tables 4-79, 4-80 and 4-81), but no statistical difference was found related to on-farm income diversity (chi-square=0.247).

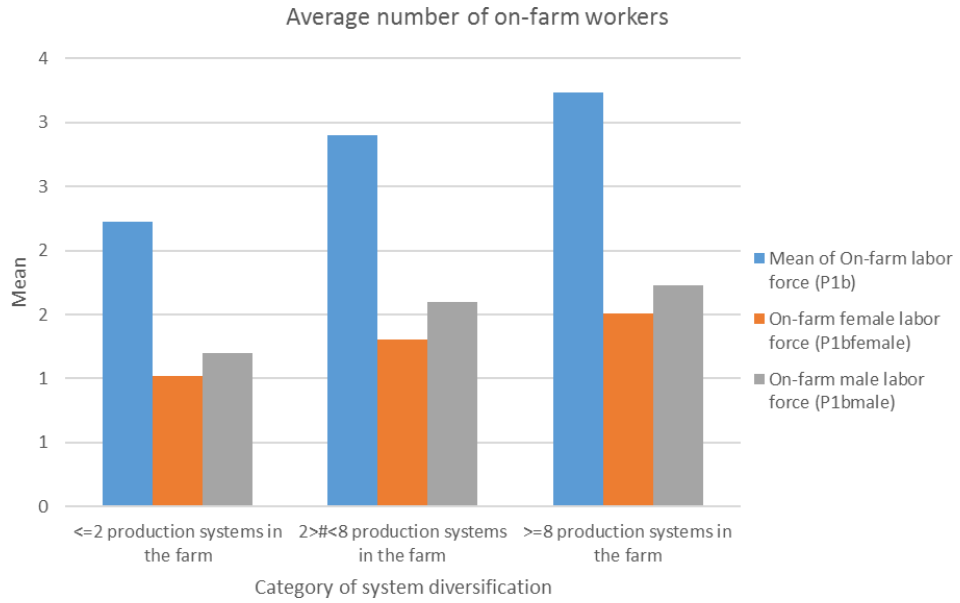

Figure 4-46. Relation between labor force and production system diversity.

Calculating by average number of production systems in the farm, it increases when the number of family members (Sig.=0.001) and labor force (Sig.=0.001) increases. The number of off-farm sources also increases when the average size of the family is bigger and when there is more labor force available (Table 4-12).

Regarding to the average size of properties, when crossing different categories of land size with categories of diversity of production systems, it is notice that diversity increases when land size increases. With positive correlations of higher land size categories, and higher number of production systems and smaller land size categories and low number of production systems (Figure 4-47, Tables 4-82 and 4-83).

Table 4-12. Average number of family members and labor force x distribution of the number of off-farm income sources.

ANOVA	N. off-farm sources	N	Mean	Std. Dev	Min	Max	F	Sig.
Number of family members	0	99	3.13	1.55	1.00	9.00	9.681	0.000
	1	308	3.54	1.58	1.00	10.00		
	2	110	4.31	1.81	1.00	10.00		
	3	33	4.24	1.64	2.00	9.00		
	4	7	5.00	1.41	3.00	7.00		
	Total	557	3.68	1.67	1.00	10.00		
On-farm labor force	0	99	2.74	1.23	1.00	7.00	5.592	0.000
	1	308	2.75	1.23	0.00	9.00		
	2	110	3.20	1.47	1.00	9.00		
	3	33	3.27	1.46	1.00	9.00		
	4	7	4.29	1.11	3.00	6.00		
	Total	557	2.89	1.31	0.00	9.00		

In terms of on-farm income diversity, the results do not present any clear pattern or statistical difference (chi-square = 0.178). The following graph checks this correlation showing that the number of on-farm diversity increases (Chi-square=0.013) while off-farm sources decrease (Figure 4-48 and Tables 4-84 and 4-85), this means the non-agricultural livelihoods are also influenced by land size (Rahman & Akter, 2014). There is an especially positive correlation between '0' off-farm sources and the properties more than 100 hectares (chi-square=0.049 and adjusted residual of 2.5). Anjos & Caldas (2002) also founded similar results stating that diversified livelihood farmers tend to have smaller farms than those that work exclusively in agriculture.

Adding to the data above, the Figure 4-49 that land size influences the primary income source since farmers who owns less than 5 hectares are more likely to rely in non-agricultural sources of income, also they show more dependence of government

support, when increasing the land size decreases the off-farm importance and the government transfers (Table 4-68 and 4-87).

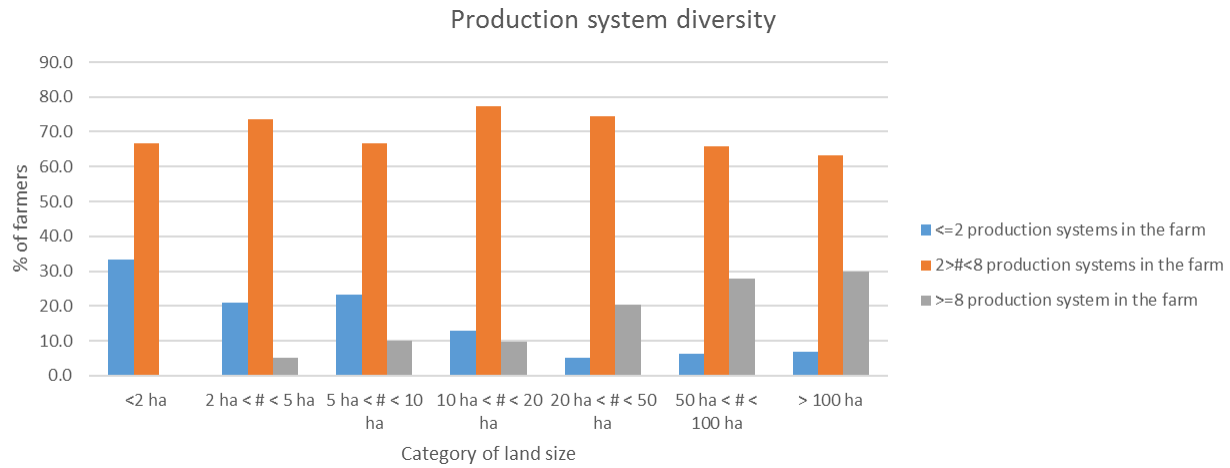

Figure 4-47. Land size categories and production systems categories.

Finally, land size has also influences on the primary on-farm income source. The graph shows the categories of size per type of farming system (Figure 4-50 and Tables 4-88 and 4-89). The most part of properties that have chicken and vegetable garden systems are less than 2 hectares. The smaller properties are also more likely to not provide any on-farm income as you can see in the first bar. The calves' production is concentrated in the bigger properties size, as well as beef production. Milk is positively correlated with properties between 20-50 hectares.

Therefore, the primary on-farm income also has relation with diversification. The graph shows a positive correlation of milk producers and the more diversified categories. As you see, the majority of farmers in the "high" diversity category, with a big difference on those in the "low" category. Coffee and chicken are more positively correlated with the "low" category of diversification, probably the size of these properties are smaller than the average (Figure 4-51 and Tables 4-90 and 4-91).

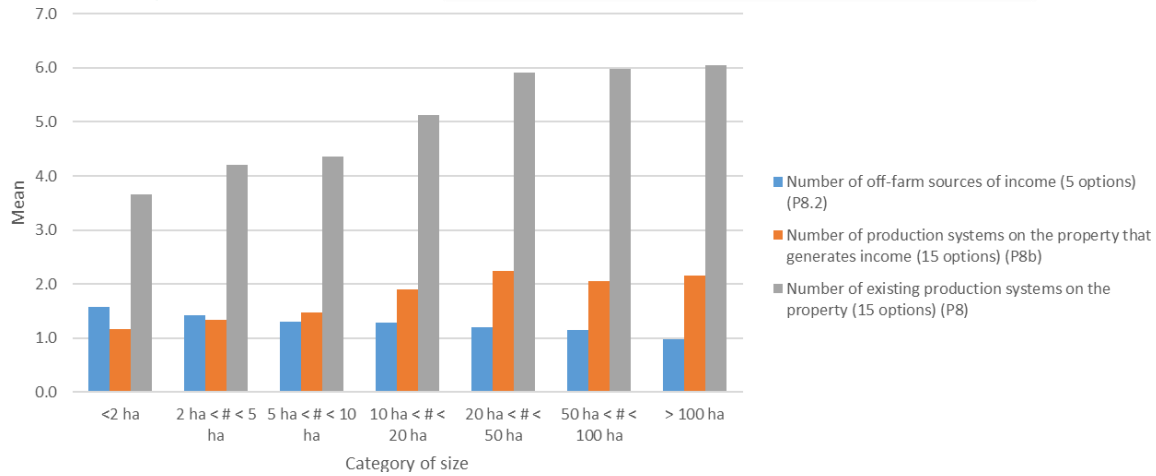

Figure 4-48. Average number of on-farm income sources, off-farm income sources and production systems.

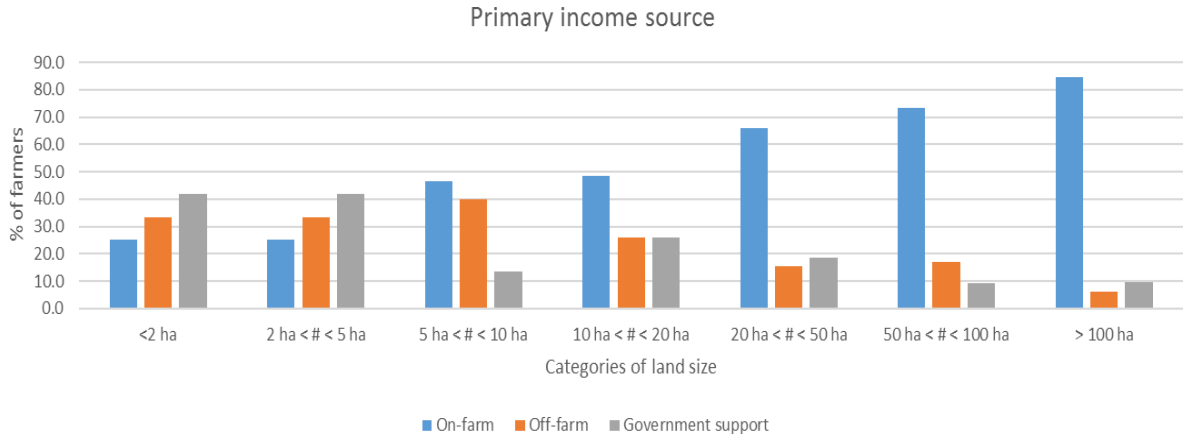

Figure 4-49. Primary income source by category of land size.

In terms of on-farm income diversification, the results show that there is a positive correlation between the farmers that have calves' operation as a primary on-farm source and the lower category of on-farm income diversification. While milk farmers are negatively correlated with this category, which mean they diversify more their on-farm income. Farmers that have orchard, processing foods and vegetable garden as a primary on-farm income source also are positively related to the higher categories on on-farm income diversity (Figure 4-52, Tables 4-92 and 4-93).

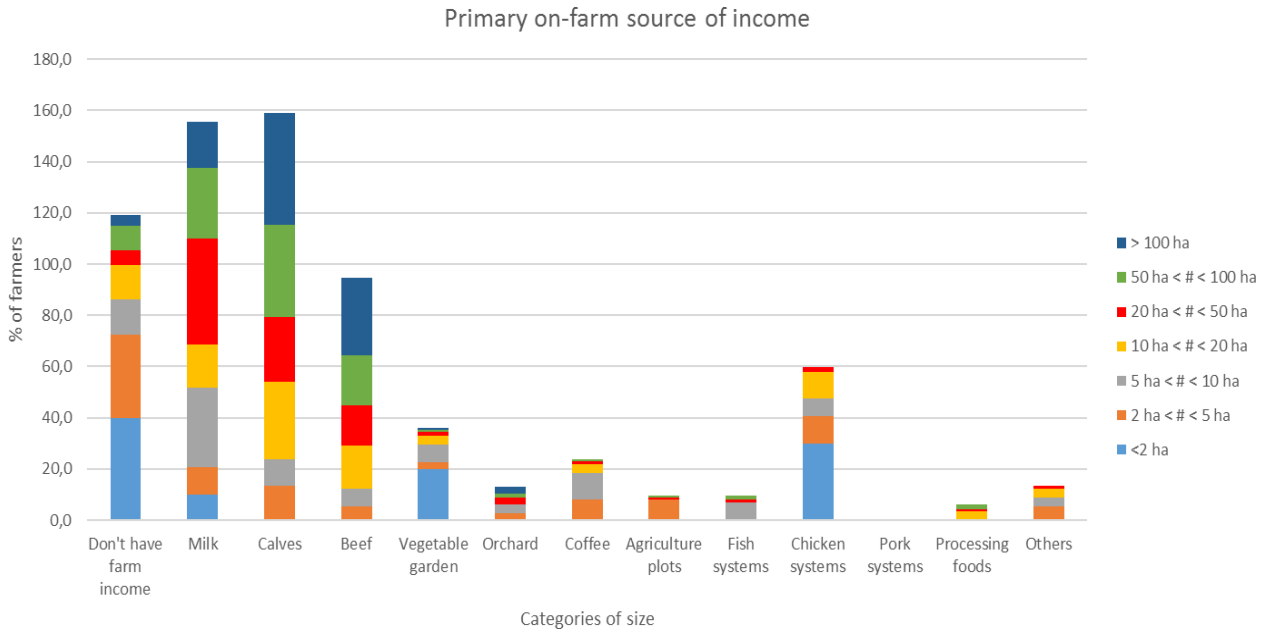

Figure 4-50. Primary on-farm income source per category of land size.

The primary on-farm income source does not present any statistical correlation with the most of categories of off-farm income source, except for the day labor which showed positive correlation with farmers that don't have any on-farm income and the coffee producers, and negative correlation with milk farmers (Table 4-94).

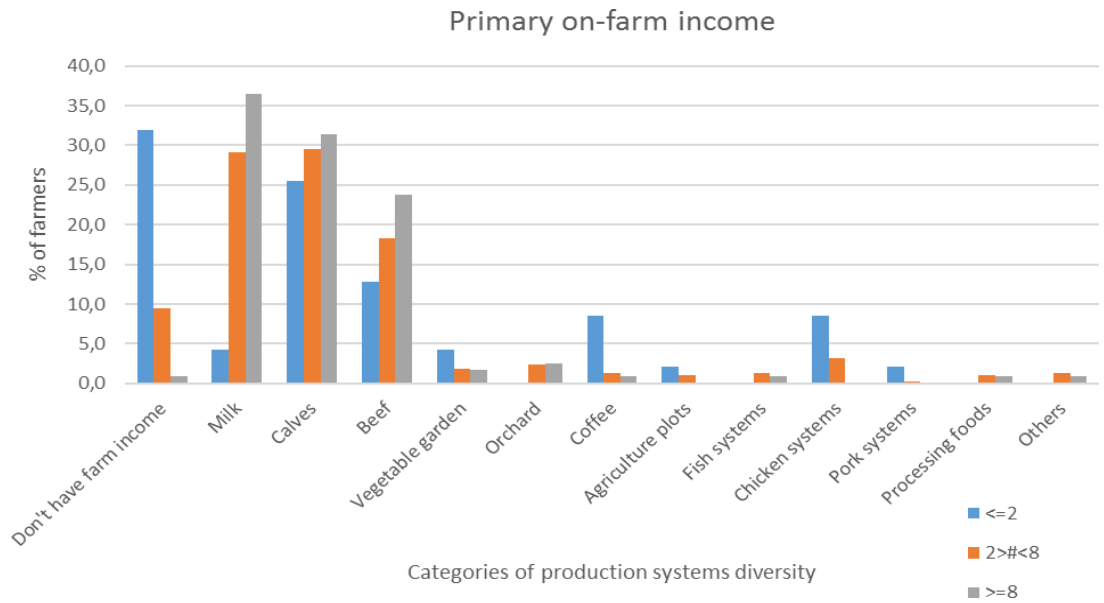

Figure 4-51. Primary on-farm income source and level farming diversification.

Other variables such as the number of on-farm income sources (F=1.23; Sig.=0.297); the number of existing production systems in the property (F=0.416; Sig.=0.797); the number of food family produced in the farm and consumed (F=2.0; Sig.=0.093); the number of products farmers sell (F=0.803; Sig.=0.523); the number of market channels they use (F=0.76; Sig.=0.549); the number of external institutions they interact (F=1.017; Sig.=0.398); the number of grassroots organizations farmers participate (F=1.23; Sig.=0.294); the number of courses taken (F=1.545; Sig.=0.188) and the number of farmers who accessed Pronaf (F=0.649; Sig.=0.628) have no statistical correlation with the number of off-farm sources.

The time in the property and the titling status (chi-square=0.182 and 0.271 for farming diversity and on-farm income diversity) does not produce any difference among the three categories of diversification in both cases (on-farm income and production systems).

Looking at the organization linkages (internal and external). It is notice that increasing participation is related with increasing farming diversity (Figure 4-53). No relationship was founded between the number of off-farm sources of income and the social linkages.

This is particularly relevant the relation of cooperatives and on-farm income diversity, and the rural workers' union affiliation and farming diversification (Table 4-95, 4-96, 4-97 and 4-98).

It is also related with more interaction with external institutions (Figure 4-54, Table 4-99).

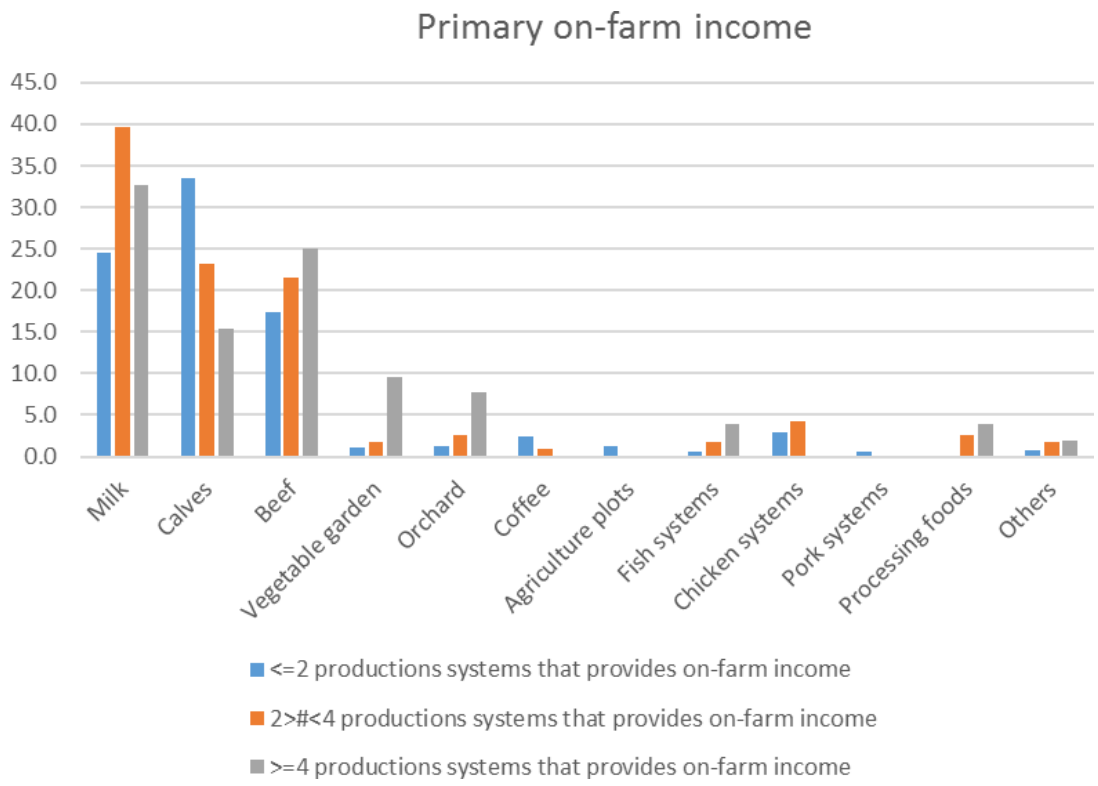

Figure 4-52. Primary on-farm income source and level of on-farm income diversification.

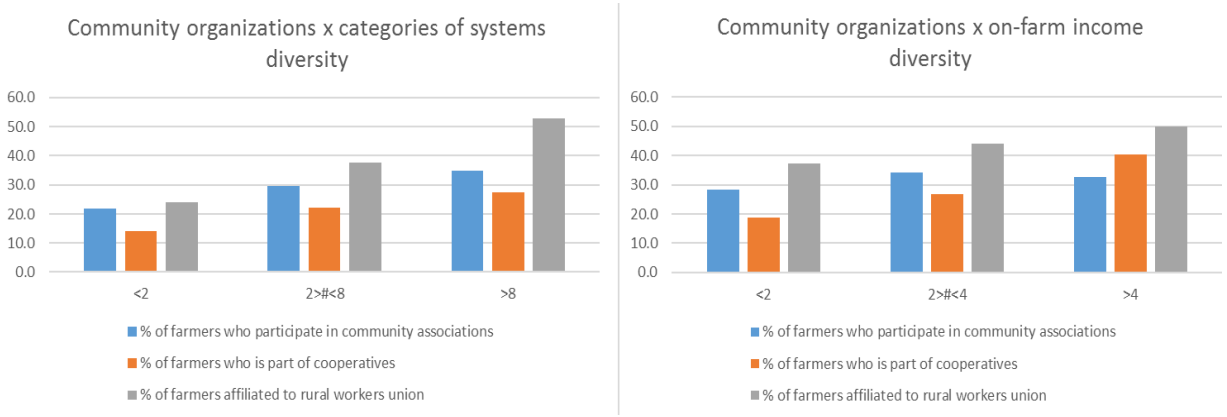

Figure 4-53. On-farm diversification and participation in community organizations.

This set of data demonstrate how assets and livelihood strategies are linked to farming and off-farm diversification. It was analyzed human assets (age, labor, time in the property), natural assets (land size, titling status), social assets (internal and external linkages), and primary on-farm income source. The results showed that the assets positively correlated to farming diversity are labor force; land size; participation in

community organizations; and milk (mainly), vegetable garden, fruits and orchard as a primary source of income.

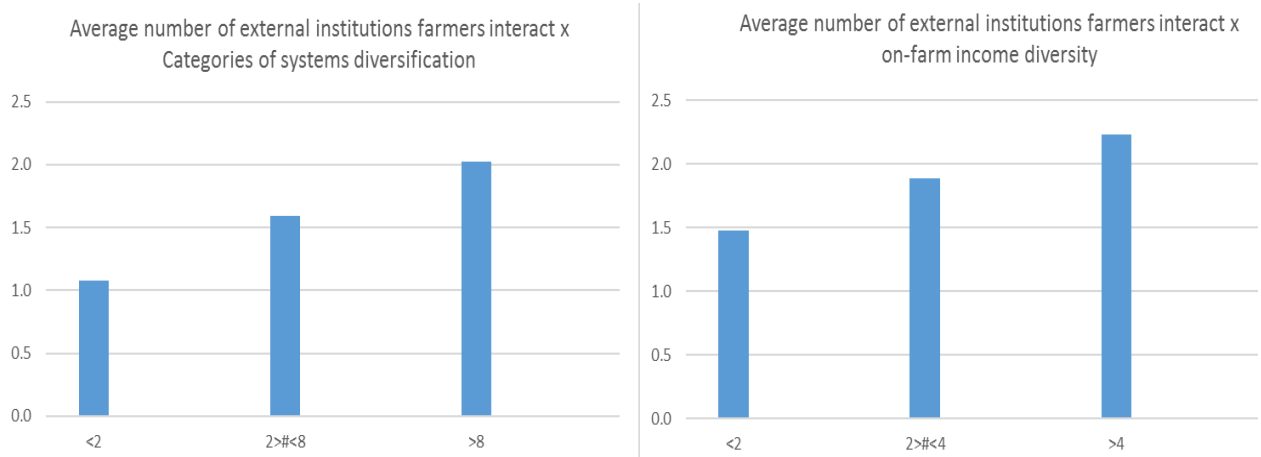

Figure 4-54. Average number of institutions farmers interact and the diversity of farming systems and on-farm income sources.

Regarding to on-farm income diversity, the correlations are less obvious, just the participation on cooperatives provided a significant correlation with higher on-farm income diversity. Also, few correlations were found regarding to livelihood diversity, the land size which is negatively correlated, indicating that smaller properties tend to diversify more their livelihoods. The data confirmed that not always the farming diversification is related to livelihood diversification as part of the same strategy to cope risks among farmers, and correlations go to opposite directions.

Table 4-13. Tukey test showing where the main differences in family size.

Multiple comparisons					
Dependent Variable	Independent variable		Mean Difference (I-J)	Std. Error	Sig.
Number of family members	More consolidated frontier	New frontier	.47409*	0.18320	0.027
	New frontier	More consolidated frontier	-.47409*	0.18320	0.027
On-farm labor force	More consolidated frontier	New frontier	.45772*	0.14651	0.005
	New frontier	More consolidated frontier	-.45772*	0.14651	0.005

*The mean difference is significant at the 0.05 level.

Table 4-14. On-farm labor force by gender.

ANOVA Dep variable	Ind variable	N	Mean	Std. Dev	Min	Max	F	Sig.
On-farm female labor force	More consolidated frontier	182	1.5	1.1	0	11	8.1854	0.0003
	Less consolidated frontier	188	1.3	0.7	0	4		
	New frontier	190	1.2	0.7	0	4		
	Total	560	1.3	0.9	0	11		
On-farm male labor force	More consolidated frontier	182	1.6	0.9	0	5	1.5528	0.2126
	Less consolidated frontier	188	1.7	1.0	0	6		
	New frontier	190	1.5	0.9	0	6		
	Total	560	1.6	0.9	0	6		
Off-farm female labor force	More consolidated frontier	182	0.2	0.5	0	5	1.2672	0.2824
	Less consolidated frontier	188	0.2	0.5	0	2		
	New frontier	190	0.1	0.4	0	2		
	Total	560	0.2	0.5	0	5		
Off-farm male labor force	More consolidated frontier	182	0.5	0.7	0	3	0.6082	0.5447
	Less consolidated frontier	188	0.6	0.7	0	3		
	New frontier	190	0.5	0.7	0	4		
	Total	560	0.5	0.7	0	4		

Table 4-15. Tukey test showing where are the main differences.

Multiple comparisons					
Dependent Variable	Independent variable		Mean Difference (I-J)	Std. Error	Sig.
On-farm female labor force	More consolidated frontier	Less consolidated frontier	.22942*	0.08990	0.029
		New frontier	.35882*	0.08966	0.000
	Less consolidated frontier	More consolidated frontier	-.22942*	0.08990	0.029
	New frontier	More consolidated frontier	-.35882*	0.08966	0.000

*The mean difference is significant at the 0.05 level.

Table 4-16. Average age of families.

ANOVA						
Dep variable	Ind variable	N	Mean	Std. Dev	F	Sig.
Families' average age	More consolidated frontier	182	43.3	14.0	8.0687	0.0004
	Less consolidated frontier	188	39.4	14.6		
	New frontier	190	37.4	14.7		
	Total	560	40.0	14.6		
Average on-farm workers' age	More consolidated frontier	181	46.8	12.6	9.2503	0.0001
	Less consolidated frontier	187	43.5	13.3		
	New frontier	189	41.0	12.8		
	Total	557	43.7	13.1		
Average off-farm workers' age	More consolidated frontier	81	39.0	10.7	0.2564	0.7740
	Less consolidated frontier	105	37.9	12.4		
	New frontier	95	38.1	9.9		
	Total	281	38.3	11.1		

Table 4-17. Tukey test showing the main differences of age.

Multiple Comparisons Dependent Variable	Ind variable		Mean Difference (I-J)	Std. Error	Sig.
Families' average age	More consolidated frontier	Less consolidated frontier	3.95975*	1.501	0.023
		New frontier	5.91699*	1.498	0.000
	Less consolidated frontier	More consolidated frontier	-3.95975*	1.501	0.023
	New frontier	More consolidated frontier	-5.91699*	1.497	0.000
Average on-farm workers' age	More consolidated frontier	Less consolidated frontier	3.35188*	1.350	0.036
		New frontier	5.77470*	1.347	0.000
	Less consolidated frontier	More consolidated frontier	-3.35188*	1.350	0.036
	New frontier	More consolidated frontier	-5.77470*	1.347	0.000

*The mean difference is significant at the 0.05 level.

Table 4-18. Farmers by class of age.

ANOVA Dep variable	Ind variable	N	Mean	Std. Dev	Min	Max	F	Sig
Class of age: >= 60	More consolidated frontier	182	0.8	0.9	0	3	15.735	0.00
	Less consolidated frontier	188	0.6	0.8	0	2		
	New frontier	190	0.3	0.6	0	2		
	Total	560	0.6	0.8	0	3		
Class of age: 40<#>59	More consolidated frontier	182	1.2	1.0	0	8	2.114	0.122
	Less consolidated frontier	188	1.2	0.9	0	3		
	New frontier	190	1.0	0.8	0	3		
	Total	560	1.1	0.9	0	8		
Class of age:18 <#>39	More consolidated frontier	182	1.1	1.1	0	6	0.133	0.876
	Less consolidated frontier	188	1.0	1.1	0	4		
	New frontier	190	1.0	1.0	0	5		
	Total	560	1.1	1.1	0	6		
Class of age: <=17	More consolidated frontier	182	0.8	1.1	0	5	1.9116	0.149
	Less consolidated frontier	188	1.0	1.1	0	4		
	New frontier	190	1.0	1.2	0	5		
	Total	560	0.9	1.1	0	5		

Table 4-19. Tukey test showing the main differences of categories in age across frontier.

Multiple Comparisons Dep Variable	Ind variable		Mean Difference (I-J)	Std. Error	Sig.
Class of age: >= 60	More consolidated frontier	Less consolidated frontier	.19511*	0.0785	0.035
		New frontier	.43811*	0.0783	0.000
	Less consolidated frontier	More consolidated frontier	-.19511*	0.0785	0.035
	New frontier	New frontier	.24300*	0.0776	0.005
		More consolidated frontier	-.43811*	0.0783	0.000
		Less consolidated frontier	-.24300*	0.0776	0.005

*The mean difference is significant at the 0.05 level.

Table 4-20. Tukey test showing the main differences related to the timing living in the property.

Multiple Comparisons Dep variable	Ind variable		Mean Difference (I-J)	Std. Error	Sig.
Years in the property (P2)	More consolidated frontier	New frontier	7.20651*	1.04472	0.000
	Less consolidated frontier	New frontier	5.58755*	1.03618	0.000
	New frontier	More consolidated frontier	-7.20651*	1.04472	0.000
		Less consolidated frontier	-5.58755*	1.03618	0.000

*The mean difference is significant at the 0.05 level.

Table 4-21. Chi-square test showing statistical difference (Pears on Chi-Square < 0.05) in origin of farmers.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	104.145[a]	10	0.000
Likelihood Ratio	106.677	10	0.000
Linear-by-Linear Association	12.660	1	0.000
N of Valid Cases	560		

a. 3 cells (16.7%) have expected count less than 5. The minimum expected count is 1.30.

Table 4-22. Adjusted residual (>1.96 or >-1.96) and chi-square results about origin of farmers (adjusted p-value=0.002).

Crosstabulation		South	Northeast	Southeast	North	Midwest	Outside country	Total
More consolidated frontier	Count	81	13	14	1	73	0	182
	Expected Count	68.3	9.4	11.7	17.9	73.5	1.3	182.0
	Adjusted Residual	2.4	1.5	0.8	-5.1	-0.1	-1.4	
	Chi_square	0.017	0.146	0.398	0.000	0.934	0.164	
Less consolidated frontier	Count	82	8	12	3	80	3	188
	Expected Count	70.5	9.7	12.1	18.5	75.9	1.3	188.0
	Adjusted Residual	2.1	-0.7	0.0	-4.6	0.8	1.8	
	Chi_square	0.034	0.483	0.975	0.000	0.451	0.078	
New frontier	Count	47	8	10	51	73	1	190
	Expected Count	71.3	9.8	12.2	18.7	76.7	1.4	190.0
	Adjusted Residual	-4.5	-0.7	-0.8	9.7	-0.7	-0.4	

Chi_square	0.000	0.459	0.420	0.000	0.503	0.705

Table 4-23. Adjusted residual (>1.96 or >-1.96) and chi-square results about farmers' participation in any capacity building activity (adjusted p value = 0.008).

Crosstabulation			No	Yes	Total
Frontier categories	More consolidated frontier	Count	129	53	182
		Expected Count	134.6	47.5	182.0
		Adjusted Residual	-1.1	1.1	
	Less consolidated frontier	Count	129	59	188
		Expected Count	139.0	49.0	188.0
		Adjusted Residual	-2.0	2.0	
	New frontier	Count	156	34	190
		Expected Count	140.5	49.5	190.0
		Adjusted Residual	3.2	-3.2	
		Chi-square	0.002	0.002	

Table 4-24. Chi-square test showing statistical difference (Pears on Chi-Square < 0.05) in motivation to migrate.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	59.683[a]	12	0.000
Likelihood Ratio	58.715	12	0.000
Linear-by-Linear Association	25.156	1	0.000
N of Valid Cases	546		

a. 6 cells (28.6%) have expected count less than 5. The minimum expected count is .33.

Table 4-25. Adjusted residual (>1.96 or >-1.96) of farmers' perceptions about the reason for young people to leave rural areas.

Crosstabulation		Lack of high schools	Lack of professional schools	Lack of leisure activities	Lack of income	Lack of interest	Land not enough for all	
More consolidated frontier	Count	3	41	5	111	17	2	180
	Expected Count	9.2	53.1	5.9	89.3	18.8	3.3	180.0
	Adjusted Residual	-2.6	-2.4	-0.5	3.9	-0.5	-0.9	
Less consolidated frontier	Count	3	48	4	100	25	4	184
	Expected Count	9.4	54.3	6.1	91.3	19.2	3.4	184.0
	Adjusted Residual	-2.6	-1.2	-1.0	1.6	1.7	0.4	
New frontier	Count	22	72	9	60	15	4	182
	Expected Count	9.3	53.7	6.0	90.3	19.0	3.3	182.0
	Adjusted Residual	5.2	3.7	1.5	-5.5	-1.2	0.5	

Table 4-26. Property size, additional properties and average size of all properties farmers own.

ANOVA Dep variable	Ind variable	N	Mean	Std. Dev	F	Sig.
Propriety size (hectare)	More consolidated frontier	179	50.84	53.58	3.865	0.022
	Less consolidated frontier	183	64.44	73.66		
	New frontier	186	68.68	62.47		
	Total	548	61.44	64.17		
Number of additional properties they own	More consolidated frontier	181	0.19	0.48	3.773	0.024
	Less consolidated frontier	183	0.36	0.80		
	New frontier	188	0.21	0.55		
	Total	552	0.25	0.63		
Size of all proprieties farmers own - hectare	More consolidated frontier	179	58.49	61.38	5.027	0.007
	Less consolidated frontier	181	82.80	94.08		
	New frontier	186	79.10	76.20		
	Total	546	73.57	78.98		

Table 4-27. Tukey test showing the main differences in property size ownership.

Multiple Comparisons					
Dep variable	Ind variable		Mean Difference (I-J)	Std. Error	Sig.
Propriety size (hectare)	More consolidated frontier	New frontier	-17.83734*	6.683	0.021
	New frontier	More consolidated frontier	17.83734*	6.683	0.021
Number of additional properties they own	More consolidated frontier	Less consolidated frontier	-.1673*	0.065	0.031
	Less consolidated frontier	More consolidated frontier	.1673*	0.065	0.031
Size of all proprieties farmers own - hectare	More consolidated frontier	Less consolidated frontier	-24.30634*	8.264	0.010
		New frontier	-20.60985*	8.209	0.033
	Less consolidated frontier	More consolidated frontier	24.30634*	8.264	0.010
	New frontier	More consolidated frontier	20.60985*	8.209	0.033

Table 4-28. Chi-square test about the category of land size per type of frontier.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	42.683[a]	12	0.000
Likelihood Ratio	42.181	12	0.000
Linear-by-Linear Association	13.219	1	0.000
N of Valid Cases	552		

a. 3 cells (14.3%) have expected count less than 5. The minimum expected count is 3.93.

Table 4-29. Adjusted residual (>1.96 or >-1.96) and chi-square of categories of size and categories of frontier.

Crosstabulation		Category of size							Total
		<2	2< # < 5	5 < # < 10	10 < # < 20	20 < # < 50	50 < # < 100	> 100	
More consolidated frontier	Count	2	22	9	8	80	34	26	181
	Expected Count	3.9	12.5	9.8	10.2	63.9	42.3	38.4	181.0
	Adjusted Residual	-1.2	3.4	-0.3	-0.9	3.0	-1.8	-2.7	
	Chi_square	0.229	0.001	0.738	0.394	0.0023	0.075	0.006	
Less consolidated frontier	Count	8	6	11	12	69	39	38	183
	Expected Count	4.0	12.6	9.9	10.3	64.6	42.8	38.8	183.0
	Adjusted Residual	2.5	-2.4	0.4	0.7	0.8	-0.8	-0.2	
	Chi_square	0.013	0.018	0.674	0.499	0.410	0.421	0.862	
New frontier	Count	2	10	10	11	46	56	53	188
	Expected Count	4.1	12.9	10.2	10.6	66.4	43.9	39.8	188.0
	Adjusted Residual	-1.3	-1.0	-0.1	0.2	-3.8	2.6	2.9	
	Chi_square	0.199	0.297	0.931	0.863	0.000	0.010	0.004	

Table 4-30. Chi-square test of titling status per frontier type.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	99.068[a]	10	0.000
Likelihood Ratio	103.946	10	0.000
Linear-by-Linear Association	4.405	1	0.036
N of Valid Cases	551		

a. 3 cells (16.7%) have expected count less than 5. The minimum expected count is 1.96.

Table 4-31. Adjusted residual (>1.96 or >-1.96) and chi-square (adjusted the p value 0.002) of titling status and frontier types.

Crosstabulation		Don't have	Title	CCU	RB	leasing	Other arrangements	Total
More consolidated frontier	Count	14	124	7	4	0	31	180
	Expected Count	13.7	88.2	30.1	10.1	2.0	35.9	180.0
	Adjusted Residual	0.1	6.5	-5.6	-2.4	-1.7	-1.1	
	Chi_square	0.924	0.000	0.000	0.016	0.086	0.262	
Less consolidated frontier	Count	7	90	26	9	4	50	186
	Expected Count	14.2	91.1	31.1	10.5	2.0	37.1	186.0
	Adjusted Residual	-2.4	-0.2	-1.2	-0.6	1.7	2.9	
	Chi_square	0.015	0.837	0.222	0.567	0.087	0.004	
New frontier	Count	21	56	59	18	2	29	185
	Expected Count	14.1	90.7	30.9	10.4	2.0	36.9	185.0
	Adjusted Residual	2.3	-6.3	6.8	3.0	0.0	-1.8	
	Chi_square	0.019	0.000	0.000	0.003	0.990	0.073	

Table 4-32. Chi-square tests for manual management.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	11.527[a]	2	0.003
Likelihood Ratio	11.687	2	0.003
Linear-by-Linear Association	9.492	1	0.002
N of Valid Cases	560		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 79.30.

Table 4-33. Chi-square tests for tractor rental.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	13.145[a]	4	0.011
Likelihood Ratio	13.530	4	0.009
Linear-by-Linear Association	3.032	1	0.082
N of Valid Cases	560		

a. 3 cells (33.3%) have expected count less than 5. The minimum expected count is .33.

Table 4-34. Chi-square tests for use of agricultural department tractor.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.559[a]	2	0.038
Likelihood Ratio	6.385	2	0.041
Linear-by-Linear Association	5.759	1	0.016
N of Valid Cases	560		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 31.85.

Table 4-35. Chi-square test for burning practices.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	8.420[a]	2	0.015
Likelihood Ratio	8.450	2	0.015
Linear-by-Linear Association	3.103	1	0.078
N of Valid Cases	560		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 18.20.

Table 4-36. Chi-square test for the number of farmers who accessed Pronaf by frontier category.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.770[a]	2	0.056
Likelihood Ratio	5.799	2	0.055
Linear-by-Linear Association	3.398	1	0.065
N of Valid Cases	560		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 85.48.

Table 4-37. Chi-square test for the number of times farmers accessed Pronaf by frontier category.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	12.051[a]	4	0.017
Likelihood Ratio	13.220	4	0.010
Linear-by-Linear Association	7.749	1	0.005
N of Valid Cases	560		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 22.10.

Table 4-38. Adjusted residual (>1.96 or >-1.96) of the number of times farmers accessed Pronaf by frontier category.

Crosstabulation		None	Once	More than once	Total
More consolidated frontier	Count	95	57	30	182
	Expected Count	100.8	59.2	22.1	182.0
	Adjusted Residual	-1.0	-0.4	2.2	
Less consolidated frontier	Count	98	63	27	188
	Expected Count	104.1	61.1	22.8	188.0
	Adjusted Residual	-1.1	0.4	1.1	
New frontier	Count	117	62	11	190
	Expected Count	105.2	61.8	23.1	190.0

Adjusted Residual	2.1	0.0	-3.3

Table 4-39. Tukey test showing the main differences of the number of external institutions farmers interact across the frontier types.

Multiple Comparisons (I) Frontier categories		Mean Difference (I-J)	Std. Error	Sig.
More consolidated frontier	New frontier	.32915*	0.11214	0.010
Less consolidated frontier	New frontier	.49854*	0.11122	0.000
New frontier	More consolidated frontier	-.32915*	0.11214	0.010
	Less consolidated frontier	-.49854*	0.11122	0.000

Table 4-40. Chi-square test of how farmers feel informed about what government institutions are doing in their communities per frontier type.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	25.477[a]	6	0.000
Likelihood Ratio	26.246	6	0.000
Linear-by-Linear Association	1.324	1	0.250
N of Valid Cases	560		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 7.80.

Table 4-41. Adjusted residual (>1.96 or >-1.96) and chi-square (adjusted p value=0.004) of how farmers feel informed about what government institutions are doing in their communities per frontier type.

Crosstabulation		Nothing at all	Sometimes	Majority part	Always	Total
More consolidated	Count	107	50	17		182
	Expected Count	98.2	60.5	15.6	7.8	182.0
	Adjusted Residual	1.6	-2.0	0.5	0.1	
	Chi_square	0.109	0.045	0.652	0.929	
Less consolidated frontier	Count	76	81	23	8	188
	Expected Count	101.4	62.4	16.1	8.1	188.0
	Adjusted Residual	-4.6	3.5	2.2	0.0	
	Chi_square	0.000	0.000	0.028	0.980	
New frontier	Count	119	55	8	8	190
	Expected Count	102.5	63.1	16.3	8.1	190.0
	Adjusted Residual	3.0	-1.5	-2.6	-0.1	
	Chi_square	0.003	0.124	0.008	0.950	

Table 4-42. Chi-square test of how farmers feel informed about what community organizations are doing in their communities per frontier type.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	17.645[a]	8	0.024
Likelihood Ratio	19.454	8	0.013
Linear-by-Linear Association	0.793	1	0.373
N of Valid Cases	560		

a. 3 cells (20.0%) have expected count less than 5. The minimum expected count is .33.

Table 4-43. Adjusted residual (>1.96 or >-1.96) and chi-square (adjusted p value=0.004) of how farmers feel informed about what community organizations are doing in their communities per frontier type.

Crosstabulation		Nothing at all	Sometimes	Majority part	Always	Total
More consolidated frontier	Count	97	43	29	13	182
	Expected Count	101.4	41.6	21.8	16.9	182.0
	Adjusted Residual	-0.8	0.3	2.0	-1.2	
	Chi_square	0.424	0.764	0.045	0.225	
Less consolidated frontier	Count	96	46	28	18	188
	Expected Count	104.7	43.0	22.5	17.5	188.0
	Adjusted Residual	-1.6	0.6	1.5	0.2	
	Chi_square	0.115	0.519	0.129	0.867	
New frontier	Count	119	39	10	21	190
	Expected Count	105.9	43.4	22.7	17.6	190.0
	Adjusted Residual	2.4	-0.9	-3.5	1.0	
	Chi_square	0.018	0.347	0.000	0.302	

Table 4-44. Chi-square test of participation on cooperatives per frontier type.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	40.846[a]	2	0.000
Likelihood Ratio	47.283	2	0.000
Linear-by-Linear Association	26.896	1	0.000
N of Valid Cases	560		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 40.95.

Table 4-45. Chi-square test of participation on rural workers' union per frontier type.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.971[a]	2	0.031
Likelihood Ratio	6.934	2	0.031
Linear-by-Linear Association	0.260	1	0.610
N of Valid Cases	560		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 72.48.

Table 4-46. Adjusted residual (>1.96 or >-1.96) and chi-square (adjusted p value=0.008) of farmers' participation on cooperatives per frontier type.

Cooperatives		Yes	No	Total
More consolidated frontier	Count	53	129	182
	Expected Count	41.0	141.1	182.0
	Adjusted Residual	2.6	-2.6	
	Chi_square	0.009	0.009	1.000
Less consolidated frontier	Count	60	128	188
	Expected Count	42.3	145.7	188.0
	Adjusted Residual	3.8	-3.8	
	Chi_square	0.000	0.000	1.000
New frontier	Count	13	177	190
	Expected Count	42.8	147.3	190.0
	Adjusted Residual	-6.4	6.4	
	Chi_square	0.000	0.000	1.000

Table 4-47. Chi-square tests and adjusted residual (adjusted p value = 0.008) related to participation on rural workers' union per frontier type.

Crosstabulation		Yes	No	Total
More consolidated frontier	Count	63	119	182
	Expected Count	72.5	109.5	182.0
	Adjusted Residual	-1.7	1.7	
	Chi_square	0.081	0.081	1.000
Less consolidated frontier	Count	89	99	188
	Expected Count	74.9	113.1	188.0
	Adjusted Residual	2.6	-2.6	
	Chi_square	0.010	0.010	1.000
New frontier	Count	71	119	190
	Expected Count	75.7	114.3	190.0

Adjusted Residual	-0.8	0.8	
Chi_square	0.395	0.395	1.000

Table 4-48. Tuckey test showing the main differences related to the number of community organizations farmers participate per frontier type.

Multiple Comparisons (I) categories	Frontier	Mean Difference (I-J)	Std. Error	Sig.
Less consolidated frontier	New frontier	.28970*	0.08378	0.002
New frontier	Less consolidated frontier	-.28970*	0.08378	0.002

Table 4-49. Chi-square test of trust in the role of community organizations by frontier type.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	25.262[a]	6	0.000
Likelihood Ratio	24.889	6	0.000
Linear-by-Linear Association	10.302	1	0.001
N of Valid Cases	510		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 22.92.

Table 4-50. Adjusted residual and chi-square (adjusted p value = 0.004) of trust in the role of community organizations by frontier type.

Crosstabulation		Just take advantage	They make a very small difference	Help somehow	Help a lot	Total
More consolidated frontier	Count	30	59	58	22	169
	Expected Count	34.5	64.3	47.1	23.2	169.0
	Adjusted Residual	-1.0	-1.0	2.3	-0.3	
	Chi_square	0.297	0.306	0.022	0.744	
Less consolidated frontier	Count	23	66	44	34	167
	Expected Count	34.1	63.5	46.5	22.9	167.0
	Adjusted Residual	-2.6	0.5	-0.5	3.0	
	Chi_square	0.010	0.631	0.599	0.002	
New frontier	Count	51	69	40	14	174
	Expected Count	35.5	66.2	48.4	23.9	174.0
	Adjusted Residual	3.6	0.5	-1.8	-2.7	
	Chi_square	0.000	0.589	0.078	0.007	

Table 4-51. Tukey test showing where are the main differences related to the average of productions systems farmers engage per frontier type.

Multiple Comparisons				
(I) Frontier categories		Mean Difference (I-J)	Std. Error	Sig.
More consolidated frontier	New frontier	.627*	0.225	0.015
Less consolidated frontier	New frontier	.604*	0.223	0.019
New frontier	More consolidated frontier	-.627*	0.225	0.015
	Less consolidated frontier	-.604*	0.223	0.019

*. The mean difference is significant at the 0.05 level.

Table 4-52. Chi-Square test of milk production per frontier type.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.435[a]	2	0.040
Likelihood Ratio	6.403	2	0.041
Linear-by-Linear Association	4.275	1	0.039
N of Valid Cases	560		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 75.73.

Table 4-53. Chi-Square test of agricultural plots per frontier type.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	7.416[a]	2	0.025
Likelihood Ratio	7.434	2	0.024
Linear-by-Linear Association	1.656	1	0.198
N of Valid Cases	560		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 70.53.

Table 4-54. Chi-Square test of orchard systems per frontier type.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	9.677[a]	4	0.046
Likelihood Ratio	10.161	4	0.038
Linear-by-Linear Association	7.382	1	0.007
N of Valid Cases	560		

a. 3 cells (33.3%) have expected count less than 5. The minimum expected count is .98.

Table 4-55. Chi-Square test of chicken systems per frontier type.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	13,810[a]	4	0.008
Likelihood Ratio	14.019	4	0.007
Linear-by-Linear Association	12.462	1	0.000
N of Valid Cases	560		

a. 3 cells (33.3%) have expected count less than 5. The minimum expected count is .33.

Table 4-56. Chi-Square test of coffee systems per frontier type.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	9.948[a]	2	0.007
Likelihood Ratio	10.033	2	0.007
Linear-by-Linear Association	3.146	1	0.076
N of Valid Cases	560		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 29.90.

Table 4-57. Tukey test showing the main differences across frontier types related to the average number of products families consumed in the last 3 months and were produced in their farms.

Multiple Comparisons (I) Frontier_Cat		Mean Difference (I-J)	Std. Error	Sig.
More consolidated frontier	New frontier	1.301*	0.403	0.004
Less consolidated frontier	New frontier	1.819*	0.400	0.000
New frontier	More consolidated frontier	-1.301*	0.403	0.004
	Less consolidated frontier	-1.819*	0.400	0.000

*. The mean difference is significant at the 0.05 level.

Table 4-58. Percentage each category of land use that have statistical significance difference per frontier type.

ANOVA		N	Mean	Std. Dev	Min	Max	F	Sig.
Percentage of forest area	More consolidated frontier	181	10.8482	15.28641	0.00	77.42	5.180	0.006
	Less consolidated frontier	184	10.8580	13.89847	0.00	68.27		
	New frontier	187	15.5938	19.37977	0.00	100.00		
	Total	552	12.4591	16.50205	0.00	100.00		
Percentage of agriculture area	More consolidated frontier	181	5.3696	17.44826	0.00	100.00	3.110	0.045
	Less consolidated frontier	184	2.0814	10.13716	0.00	100.00		
	New frontier	187	5.6221	16.92457	0.00	100.00		
	Total	552	4.3591	15.26063	0.00	100.00		
Percentage of areas farmers didn't declare any specific use	More consolidated frontier	181	28.9417	44.90910	0.00	100.00	3.747	0.024
	Less consolidated frontier	184	36.0054	47.74070	0.00	100.00		
	New frontier	187	23.3479	40.98649	0.00	100.00		
	Total	552	29.4013	44.83269	0.00	100.00		

Table 4-59. Tukey test showing where are the main differences related to the average number of production systems that generates income per frontier type.

Multiple Comparisons (I) Frontier_Cat		Mean Difference (I-J)	Std. Error	Sig.
More consolidated frontier	Less consolidated frontier	.398*	0.136	0.010
	New frontier	.429*	0.135	0.005
Less consolidated frontier	More consolidated frontier	-.398*	0.136	0.010
New frontier	More consolidated frontier	-.429*	0.135	0.005

Table 4-60. Chi-square test of the primary on-farm source of income per frontier type.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	38.559[a]	24	0.030
Likelihood Ratio	40.213	24	0.020
Linear-by-Linear Association	0.009	1	0.925
N of Valid Cases	547		

a. 24 cells (61.5%) have expected count less than 5. The minimum expected count is .64.

Table 4-61. Chi-square test of the percentage of farmers in each category of on-farm income diversification per frontier type.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	9.278[a]	4	0.055
Likelihood Ratio	9.169	4	0.057
Linear-by-Linear Association	5.751	1	0.016
N of Valid Cases	560		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 16.90.

Table 4-62. Tukey test showing major differences between MCF and NF about the average number of marketing channels farmers use to sell what they produce.

Multiple Comparisons (I) Frontier categories		Mean Difference (I-J)	Std. Error	Sig.
More consolidated frontier	New frontier	.513*	0.185	0.016
New frontier	More consolidated frontier	-.513*	0.185	0.016

*. The mean difference is significant at the 0.05 level.

Table 4-63. Tuckey test showing the main differences between NF and the other categories related to the average number of off-farm income sources.

Multiple Comparisons (I) Frontier categories		Mean Difference (I-J)	Std. Error	Sig.
New frontier	More consolidated frontier	-.303*	0.085	0.001
	Less consolidated frontier	-.390*	0.084	0.000

*. The mean difference is significant at the 0.05 level.

Table 4-64. Chi-square test related to the off-farm income sources per frontier type.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	34.010[a]	2	0.000
Likelihood Ratio	35.087	2	0.000
Linear-by-Linear Association	32.875	1	0.000
N of Valid Cases	557		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 71.10.

Table 4-65. Adjusted residual showing the main difference related to the percentage of families that receive pension (retirement).

Crosstabulation		Pension		Total
		No	Yes	
More consolidated frontier	Count	85	95	180
	Expected Count	108.9	71.1	180.0
	Adjusted Residual	-4.4	4.4	
New frontier	Count	145	45	190
	Expected Count	115.0	75.0	190.0
	Adjusted Residual	5.5	-5.5	

Table 4-66. Chi-square test showing the main difference of the primary source of income.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	12.086[a]	4	0.017
Likelihood Ratio	12.558	4	0.014
Linear-by-Linear Association	6.310	1	0.012
N of Valid Cases	557		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 28.92.

Table 4-67. Adjusted residual and chi-square test showing the main difference relate to government support.

Crosstabulation		On-farm	Off-farm	Government support	
More consolidated frontier	Count	114	27	40	181
	Expected Count	118.6	33.5	28.9	181.0
	Adjusted Residual	-0.9	-1.5	2.7	
Less consolidated frontier	Count	118	37	31	186
	Expected Count	121.9	34.4	29.7	186.0
	Adjusted Residual	-0.7	0.6	0.3	
New frontier	Count	133	39	18	190
	Expected Count	124.5	35.1	30.4	190.0
	Adjusted Residual	1.6	0.9	-3.0	

Table 4-68. Chi square tests of community organization across the frontier type where were found significance.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	12.516[a]	2	0.002
Likelihood Ratio	13.270	2	0.001
Linear-by-Linear Association	8.455	1	0.004
N of Valid Cases	559		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 42.00.

Table 4-69. Chi square tests of investments in transportation and logistics across the frontier type where were found significance.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	18.908[a]	2	0.000
Likelihood Ratio	18.385	2	0.000
Linear-by-Linear Association	14.484	1	0.000
N of Valid Cases	560		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 50.05.

Table 4-70. Chi-square test of differences in the technical assistance per frontier type.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	21.881[a]	2	0.000
Likelihood Ratio	23.588	2	0.000
Linear-by-Linear Association	11.159	1	0.001
N of Valid Cases	560		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 40.30.

Table 4-71. Adjusted residual and chi-square (adjusted p value=0.008) of differences in the technical assistance per frontier type.

Crosstabulation		No	Yes	Total
More consolidated frontier	Count	136	46	182
	Expected Count	141.7	40.3	182.0
	Adjusted Residual	-1.2	1.2	
	Chi_square	0.216	0.216	1.000
Less consolidated frontier	Count	131	57	188
	Expected Count	146.4	41.6	188.0
	Adjusted Residual	-3.3	3.3	
	Chi_square	0.001	0.001	1.000
New frontier	Count	169	21	190
	Expected Count	147.9	42.1	190.0
	Adjusted Residual	4.5	-4.5	
	Chi_square	0.000	0.000	1.000

Table 4-72. Chi-square test of the percentage of farmers who were benefited from external initiatives per frontier type.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	26.083[a]	2	0.000
Likelihood Ratio	27.044	2	0.000
Linear-by-Linear Association	25.718	1	0.000
N of Valid Cases	560		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 22.10.

Table 4-73. Adjusted residual and chi-square (adjusted p value = 0.008) of the percentage of farmers who were benefited from external initiatives per frontier type.

Crosstabulation		No	Yes	Total
More consolidated frontier	Count	143	39	182
	Expected Count	159.9	22.1	182.0
	Adjusted Residual	-4.7	4.7	
	Chi_square	0.000	0.000	1.000
Less consolidated frontier	Count	167	21	188
	Expected Count	165.2	22.8	188.0
	Adjusted Residual	0.5	-0.5	
	Chi_square	0.616	0.616	1.000
New frontier	Count	182	8	190
	Expected Count	166.9	23.1	190.0
	Adjusted Residual	4.1	-4.1	
	Chi_square	0.000	0.000	1.000

Table 4-74. Chi-square test of the ownership of land.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	29.304[a]	10	0.001
Likelihood Ratio	28.806	10	0.001
Linear-by-Linear Association	10.873	1	0.001
N of Valid Cases	560		

a. 3 cells (16.7%) have expected count less than 5. The minimum expected count is .65.

Table 4-75. Adjusted residual and chi-square test of the ownership of land

Crosstabulation		couple	male	female	Total
More consolidated frontier	Count	23	89	25	182
	Expected Count	25.0	87.1	21.5	182.0
	Adjusted Residual	-0.5	0.3	1.0	
Less consolidated frontier	Count	36	89	19	188
	Expected Count	25.9	90.0	22.2	188.0
	Adjusted Residual	2.6	-0.2	-0.9	
New frontier	Count	18	90	22	190
	Expected Count	26.1	90.9	22.4	190.0
	Adjusted Residual	-2.1	-0.2	-0.1	

Table 4-76. Tukey test showing the main difference between MCF and NF related to the average number of income sources (on-farm and off-farm).

Multiple Comparisons (I) Frontier categories		Mean Difference (I-J)	Std. Error	Sig.
More consolidated frontier	New frontier	.72953*	0.1553	0.000
New frontier	More consolidated frontier	-.72953*	0.15537	0.000

*The mean difference is significant at the 0.05 level.

Table 4-77. Chi-square test of ownership by the different categories of production systems diversity.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	19.793[a]	10	0.031
Likelihood Ratio	19.193	10	0.038
Linear-by-Linear Association	8.351	1	0.004
N of Valid Cases	560		

a. 3 cells (16.7%) have expected count less than 5. The minimum expected count is .18.

Table 4-78. Chi-square test of ownership by the different categories of on-farm income diversity.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	27.915[a]	10	0.002
Likelihood Ratio	26.987	10	0.003
Linear-by-Linear Association	2.999	1	0.083
N of Valid Cases	560		

a. 3 cells (16.7%) have expected count less than 5. The minimum expected count is .19.

Table 4-79. Chi-square test for labor force across frontier types.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	43.069[a]	18	0.001
Likelihood Ratio	42.048	18	0.001
Linear-by-Linear Association	16.402	1	0.000
N of Valid Cases	560		

a. 16 cells (53.3%) have expected count less than 5. The minimum expected count is .09.

Table 4-80. Chi-square test for on-farm female labor force across frontier types.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	24.022[a]	12	0.020
Likelihood Ratio	25.024	12	0.015
Linear-by-Linear Association	11.055	1	0.001
N of Valid Cases	560		

a. 11 cells (52.4%) have expected count less than 5. The minimum expected count is .09.

Table 4-81. Chi-square test for on-farm male labor force across frontier types.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	22.050[a]	12	0.037
Likelihood Ratio	21.897	12	0.039
Linear-by-Linear Association	9.673	1	0.002
N of Valid Cases	560		

a. 9 cells (42.9%) have expected count less than 5. The minimum expected count is .18.

Table 4-82. Chi-square test of land size and production systems diversity.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	46.177[a]	12	0.000
Likelihood Ratio	44.508	12	0.000
Linear-by-Linear Association	33.889	1	0.000
N of Valid Cases	552		

a. 5 cells (23.8%) have expected count less than 5. The minimum expected count is 1.07.

Table 4-83. Adjusted residual of land size and production systems diversity.

Crosstabulation			<2	2< # < 5	5 < # < 10	10 < # < 20	20 < # < 50	50 < # < 100	> 100	Total
Categories for diversity of production systems	<2	Count	4	8	7	4	10	8	8	49
		Expected Count	1.1	3.4	2.7	2.8	17.3	11.5	10.4	49.0
		Adjusted Residual	3.0	2.7	2.9	0.8	-2.3	-1.2	-0.9	
	2>#<8	Count	8	28	20	24	145	85	74	384
		Expected Count	8.3	26.4	20.9	21.6	135.7	89.7	81.4	384.0
		Adjusted Residual	-0.2	0.6	-0.4	1.0	1.8	-1.0	-1.7	
	>8	Count	0	2	3	3	40	36	35	119
		Expected Count	2.6	8.2	6.5	6.7	42.0	27.8	25.2	119.0
		Adjusted Residual	-1.8	-2.5	-1.6	-1.7	-0.4	2.0	2.5	

Table 4-84. Chi-square test and adjusted value related to the number of off-farm income sources.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	36.523[a]	24	0.049
Likelihood Ratio	41.664	24	0.014
Linear-by-Linear Association	13.068	1	0.000
N of Valid Cases	549		

a. 13 cells (37.1%) have expected count less than 5. The minimum expected count is .15.

Table 4-85. Chi-square test and adjusted value related to the number of off-farm income sources per category of land size.

Crosstabulation		Number of off-farm sources of income (5 options) (P8.2)					Total
Categories of land size		0	1	2	3	4	
<2	Count	0	7	3	2	0	12
	Expected Count	2.1	6.6	2.4	0.7	0.2	12.0
	Adjusted Residual	-1.6	0.2	0.5	1.6	-0.4	
2< # < 5	Count	1	24	9	4	0	38
	Expected Count	6.8	21.0	7.5	2.2	0.5	38.0
	Adjusted Residual	-2.5	1.0	0.6	1.3	-0.7	
5 < # < 10	Count	3	17	8	2	0	30
	Expected Count	5.4	16.6	6.0	1.7	0.4	30.0
	Adjusted Residual	-1.2	0.2	1.0	0.2	-0.6	
10 < # < 20	Count	3	21	3	3	1	31
	Expected Count	5.5	17.1	6.2	1.8	0.4	31.0
	Adjusted Residual	-1.2	1.4	-1.5	0.9	1.0	
20 < # < 50	Count	35	99	49	6	4	193
	Expected Count	34.5	106.5	38.3	11.2	2.5	193.0
	Adjusted Residual	0.1	-1.4	2.4	-2.0	1.2	
50 < # < 100	Count	26	70	22	10	1	129
	Expected Count	23.0	71.2	25.6	7.5	1.6	129.0
	Adjusted Residual	0.8	-0.2	-0.9	1.1	-0.6	
> 100	Count	30	65	15	5	1	116
	Expected Count	20.7	64.0	23.0	6.8	1.5	116.0
	Adjusted Residual	2.5	0.2	-2.1	-0.8	-0.4	

Table 4-86. Chi-square test for primary income source by category of land size.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	82.266[a]	12	0.000
Likelihood Ratio	81.440	12	0.000
Linear-by-Linear Association	54.906	1	0.000
N of Valid Cases	549		

a. 3 cells (14.3%) have expected count less than 5. The minimum expected count is 1.95.

Table 4-87. Adjusted residual for primary income source by category of land size.

Category size		Primary source of income			Total
		On-farm	Off-farm	Government support	
<2	Count	3	4	5	12
	Expected Count	7.9	2.2	1.9	12.0
	Adjusted Residual	-3.0	1.4	2.4	
2< # < 5	Count	8	17	13	38
	Expected Count	24.9	6.9	6.2	38.0
	Adjusted Residual	-6.0	4.4	3.1	
5 < # < 10	Count	14	12	4	30
	Expected Count	19.7	5.5	4.9	30.0
	Adjusted Residual	-2.2	3.2	-0.4	
10 < # < 20	Count	15	8	8	31
	Expected Count	20.3	5.6	5.0	31.0
	Adjusted Residual	-2.1	1.1	1.5	
20 < # < 50	Count	128	30	36	194
	Expected Count	127.2	35.3	31.4	194.0
	Adjusted Residual	0.1	-1.2	1.1	
50 < # < 100	Count	83.9	23.3	20.8	128.0
	Adjusted Residual	2.1	-0.3	-2.4	
> 100	Count	98	7	11	116
	Expected Count	76.1	21.1	18.8	116.0
	Adjusted Residual	4.8	-3.8	-2.2	

Table 4-88. Chi-square test of the primary on-farm income source per category of land size.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	240.457[a]	72	0.000
Likelihood Ratio	192.596	72	0.000
Linear-by-Linear Association	20.865	1	0.000
N of Valid Cases	539		

a. 69 cells (75.8%) have expected count less than 5. The minimum expected count is .02.

Table 4-89. Adjusted residual of the primary on-farm income source per category of land size, showing the significant differences.

Categories of size (Hectares)		Don't have farm income	Milk	Calves	Beef	Veg garden	Coffee	Agric plots	Fish	Chicken	Others	Total
<2	Count	4	1	0	0	2	0	0	0	3	0	10
	Expected Count	1.0	2.9	3.0	1.8	0.2	0.2	0.1	0.1	0.3	0.1	10.0
	Adjusted Residual	3.3	-1.3	-2.1	-1.5	4.1	-0.4	-0.3	-0.3	5.1	-0.3	
2< # < 5	Count	12	4	5	2	1	3	3	0	4	2	37
	Expected Count	3.6	10.6	11.1	6.8	0.8	0.7	0.3	0.4	1.1	0.4	37.0
	Adjusted Residual	4.9	-2.5	-2.3	-2.1	0.3	2.9	4.7	-0.7	2.9	2.6	
5 < # < 10	Count	4	9	3	2	2	3	0	2	2	1	29
	Expected Count	2.8	8.3	8.7	5.3	0.6	0.5	0.3	0.3	0.9	0.3	29.0
	Adjusted Residual	0.8	0.3	-2.4	-1.6	1.9	3.5	-0.5	3.1	1.3	1.2	
10 < # < 20	Count	4	5	9	5	1	1	0	0	3	1	30
	Expected Count	2.9	8.6	9.0	5.5	0.6	0.6	0.3	0.3	0.9	0.3	30.0
	Adjusted Residual	0.7	-1.5	0.0	-0.2	0.5	0.6	-0.5	-0.6	2.3	1.2	
20 < # < 50	Count	11	79	49	30	3	2	1	2	4	2	191
	Expected Count	18.4	54.6	57.4	35.1	3.9	3.5	1.8	2.1	5.7	2.1	191.0
	Adjusted Residual	-2.3	4.9	-1.7	-1.2	-0.6	-1.0	-0.7	-0.1	-0.9	-0.1	
50 < # < 100	Count	12	35	45	25	1	1	1	2	0	0	126
	Expected Count	12.2	36.0	37.9	23.1	2.6	2.3	1.2	1.4	3.7	1.4	126.0
	Adjusted Residual	-0.1	-0.2	1.6	0.5	-1.1	-1.0	-0.2	0.6	-2.2	-1.4	
> 100	Count	5	21	51	35	1	0	0	0	0	0	116
	Expected Count	11.2	33.1	34.9	21.3	2.4	2.2	1.1	1.3	3.4	1.3	116.0

Adjusted Residual	-2.2	-2.8	3.7	3.7	-1.0	-1.7	-1.2	-1.3	-2.1	-1.3

Table 4-90. Chi-square test of primary on-farm income source and the level of farming diversity.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	81.360[a]	24	0.000
Likelihood Ratio	81.289	24	0.000
Linear-by-Linear Association	2.074	1	0.150
N of Valid Cases	547		

a. 24 cells (61.5%) have expected count less than 5. The minimum expected count is .17.

Table 4-91. Adjusted residual showing the significant differences of primary on-farm income source and the level of farming diversity.

Primary on-farm income source			Don't have farm income	Milk	Coffee	Chicken systems	Pork systems	Total
Categories of production systems diversity	<2	Count	15	2	4	4	1	47
		Expected Count	4.5	13.4	0.9	1.4	0.2	47.0
		Adjusted Residual	5.5	-3.9	3.6	2.4	2.1	
	2>#<8	Count	36	111	5	12	1	382
		Expected Count	36.3	108.9	7.0	11.2	1.4	382.0
		Adjusted Residual	-0.1	0.4	-1.4	0.5	-0.6	
	>8	Count	1	43	1	0	0	118
		Expected Count	11.2	33.7	2.2	3.5	0.4	118.0
		Adjusted Residual	-3.6	2.2	-0.9	-2.1	-0.7	

Table 4-92. Chi-square test of the primary on-farm income source and the level of on-farm income diversification.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	90.393[a]	24	0.000
Likelihood Ratio	99.563	24	0.000
Linear-by-Linear Association	9.582	1	0.002
N of Valid Cases	547		

a. 24 cells (61.5%) have expected count less than 5. The minimum expected count is .19.

Table 4-93. Adjusted residual showing the correlations related to the primary on-farm income source and the level of on-farm income diversification.

Primary on-farm income			Don't have farm income	Milk	Calves	Vegetable garden	Orchard	Fish systems	Processing foods
Categories of income diversity	<2	Count	52	93	127	4	5	2	0
		Expected Count	36.0	108.1	112.2	7.6	8.3	4.2	3.5
		Adjusted Residual	5.0	-3.1	3.0	-2.4	-2.1	-1.9	-3.4
	2>#	Count	0	46	27	2	3	2	3
	<4	Expected Count	11.0	33.1	34.4	2.3	2.5	1.3	1.1
		Adjusted Residual	-3.9	3.0	-1.7	-0.2	0.3	0.7	2.1
	>4	Count	0	17	8	5	4	2	2
		Expected Count	4.9	14.8	15.4	1.0	1.1	0.6	0.5
		Adjusted Residual	-2.5	0.7	-2.4	4.1	2.8	2.0	2.3

Table 4-94. Adjusted residual showing the main correlations between day labor and primary on-farm income systems.

Crosstabulation			Day Labor		Total
			No	Yes	
What of those production systems contributes more to families' income	Don't have farm income	Count	21	31	52
		Expected Count	30,6	21,4	52,0
		Adjusted Residual	-2,9	2,9	
	Milk	Count	103	53	156
		Expected Count	91,9	64,1	156,0
		Adjusted Residual	2,1	-2,1	
	Coffee	Count	2	8	10
		Expected Count	5,9	4,1	10,0
		Adjusted Residual	-2,5	2,5	
	Chicken systems	Count	6	10	16
		Expected Count	9,4	6,6	16,0
		Adjusted Residual	-1,8	1,8	
	Pork systems	Count	0	2	2
		Expected Count	1,2	0,8	2,0
		Adjusted Residual	-1,7	1,7	
	Others	Count	0	6	6
		Expected Count	3,5	2,5	6,0
		Adjusted Residual	-2,9	2,9	

Table 4-95. Chi-square test related to participation in cooperatives and on-farm income diversification.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	13.756[a]	2	0.001
Likelihood Ratio	12.599	2	0.002
Linear-by-Linear Association	13.374	1	0.000
N of Valid Cases	560		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 11.70.

Table 4-96. Adjusted residual showing where are the correlations between participation in cooperatives and on-farm income diversification.

Crosstabulation			% of farmers who is part of cooperatives		Total
			Yes	No	
Categories of income diversity	<2	Count	73	315	388
		Expected Count	87.3	300.7	388.0
		Adjusted Residual	-3.1	3.1	
	>4	Count	21	31	52
		Expected Count	11.7	40.3	52.0
		Adjusted Residual	3.2	-3.2	

Table 4-97. Cho-square test showing correlation between participation in the rural worker's union and on-farm income diversification.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	14.520[a]	2	0.001
Likelihood Ratio	14.679	2	0.001
Linear-by-Linear Association	14.475	1	0.000
N of Valid Cases	560		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 19.91.

Table 4-98. Adjusted residual showing where are the correlations between rural workers' union and farming systems diversity.

Crosstabulation			% of farmers affiliated to rural workers' union		Total
			Yes	No	
Categories of production systems diversity	<2	Count	12	38	50
		Expected Count	19.9	30.1	50.0
		Adjusted Residual	-2.4	2.4	
	>8	Count	64	57	121
		Expected Count	48.2	72.8	121.0
		Adjusted Residual	3.3	-3.3	

Table 4-99. Chi-square test showing correlation between the average number of institutions farmers interact and the diversity of farming systems.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	30.191[a]	12	0,003
Likelihood Ratio	33,761	12	0,001
Linear-by-Linear Association	28,537	1	0,000
N of Valid Cases	560		

a. 8 cells (38.1%) have expected count less than 5. The minimum expected count is .18.

CHAPTER 5
DISCUSSION

The Sustainable Livelihoods Approach helped to understand which types of assets influence the livelihoods strategies pursued by family farmers in a frontier region. It is an interesting diagnostic and analytical tool (Chirau et al., 2014). The results demonstrated more complexity than a simple pattern across the region. It highlights the understanding that development is not a linear process, neither spatially nor temporally. Also, it reinforces the idea of Pacheco (2012) that generalization related to the process of development cannot be extended to all social groups. Farmers in different frontier stages face different situations that, according with their background make them respond differently and create diverse livelihood strategies. The idea of linearity, when adopted by institutions and organizations, can limit their capacity to innovate.

Summarizing the findings, regarding to assets the results showed greater human assets in the MCF (and similar to LCF) related to labor force, time of permanence, age and education. They have higher labor force, higher average age due to multigenerational members living together in the farm, with more experience, not only because of the age but also because of the longer time living in the property. Capacity building seems to be more accessible also in the MCF and LCF. In terms of natural assets, there is no clear results regarding to MCF and greater natural assets, each frontier type reported advantages (land security, land size or extra land ownership). But what is remarkable is that the natural assets are not a constraint in any of those regions. Although it is always important to keep in mind that natural assets are still a cause of conflicts and disputes in the rural world and need to the more secure.

In terms of physical assets, farmers in the MCF and the LCF exhibited higher values. In terms of mechanization, the differences are in the tractor rental which is higher in the MCF and LCF, showing also higher income level which allows them to rent the machines. The proximity to highways and roads also could indicate better assets in the MCF. The access to credit as an indicator for financial assets also is greater in the MCF and LCF. The greater social assets are more linked to LCF than to MCF. LCF have more external institutional linkages, farmers feel more informed about government interventions than in the other regions, and reported a similar result with the MCF regarding transparency of community organizations. In terms of participation, all regions have the same level of participation in farmers' associations. The participation in cooperatives also showed similar numbers in the MCF and LCF, while in the NF it dropped drastically. Regarding affiliation in rural workers' unions, the LCF showed the highest rate. The level of engagement in these organizations does not change across the region, but changes regarding the type of organization, with the rural workers' unions have the least engagement. In terms of number, the LCF and MCF showed higher numbers of community organizations they are part of. The NF reported the weakest results for human, physical, financial and social assets.

To conclude, there are not clear differences between the more consolidated frontier and the less consolidated frontier in relation to assets; what can be stated is only that the new frontier farmers have fewer assets.

Regarding to the second question related to the diversification of livelihoods, when all sources of income (on-farm and off-farm) are summed the highest average number of income sources is in the MCF (but LCF presented similar number); the Hypothesis of a

possible specialization of farming systems was not verified. The MCF showed the higher average number of farming systems that farmers engage comparing to the other regions.

Despite engaging in other non-agricultural activities, the land remains the main source of rural livelihoods in all frontier types; and as Chirau et al. (2014) and Pacheco (2009) found in their research, the availability of the natural capital (especially land and water) has enabled farmers to diversify their farming systems, more than seek for off-farm diversification and they still adopted this as a first strategy of risk reduction. Most of the families' income come from on-farm systems (more than 60% of farmers in all categories). The off-farm income seems to reflect the emergence of the families to guarantee any source of income (Valbuena et al., 2015), rather than a strategy to consolidate farming activities. As we expect after the assets assessment, the major differences among production systems are between the NF and the other two categories.

In all frontier categories, , cattle related activities are very prominent, with more than 80% of farmers engaging. This is also reflected in terms of the higher percentage of pasture in the land use of farms. Also in all frontier categories, farmers aim to invest in cattle, which is not surprising since it performed the major role in their livelihoods. In terms of primary on-farm source of income, there are three patterns: milk production increases as the frontier goes from NF to MCF, while both beef production and calf operations decrease as the frontier goes from NF to MCF. In all cases the middle man plays the major role in the market process, with no differences across the region.

Nevertheless, in the MCF farmers use a higher average number of marketing channels (and only slightly lower numbers in LCF) while in the NF they use fewer marketing channels. This is in accordance with the idea that on MCF the marketing linkages would

be greater. In the New Frontier, farmers are less engaged in production systems related to families' food security when compared to the other frontier types, disproving the assumption that they would be more engaged in food production to cope with context constraints (Walker et al., 2009a). The number of food types consumed and produced on farm is higher in the MCF and LCF; as well as the farming diversity (number of production systems). The grocery stores in all regions are still the major source of food, independent of the differences regarding to food production.

Off farm income diversity is higher in the LCF. The lower off-farm income diversity was found in the NF, confirming the idea that there are less livelihood diversity opportunities in the new frontier types. Regarding the type of off-farm income source that most contributes to families' income, in the MCF it is pension while day labor is more significant in the NF. In the less consolidated frontier, both pension and day labor had similar results.

Data about market, policies and gender added to the understanding of family farming livelihoods. There is a consolidated market (cattle value chain) available with strong demand, which probably is driving changes in livelihood systems. This is especially true when farmers faced constraints to access public policies. In the NF, farmers have less labor force available, and are more vulnerable in terms of diversity and food security; when they see a well-consolidated chain for selling calves to large farmers, they convert their production even without credit, without technical assistance (Pereira et al., 2016) and without being really part of those negotiations. Large farmers and family farmers have been understood as having antagonistic strategies, but in fact they are strongly linked through the beef value chain, which increased in price and demand when Brazil

became an emergent beef supplier (Godar et al., 2012; Pereira et al., 2016). Schneider et al. (2002) discuss the power of economic forces to influence land use in the frontier areas. With local and regional interests supporting these trades and an absence of government intervention, these conditions would lead to predatory types of land use with a short-term view, such as logging and cattle ranching, in opposition to any sustainable economic growth and long-term interests of the communities.

The higher access to technical assistance and higher percentage of couple-owned farms (related to high diversification level) in the LCF might explain the result of similar diversification rates as MCF. Thus, better strategies to support female-headed farms are needed; these are disadvantaged by more constraints related to ownership, access to credit and livelihood security.

Regarding the last question, about how family assets influence the level of livelihood diversity, results suggest that various types of family assets are important. To better understand diversity, it was correlated with family life-cycle variables such as age, labor, time in the property; land size and titling status; social linkages; and primary on-farm income source. As some other studies suggest (Walker et al., 2009a; Pacheco, 2009; Browder et al., 2004), the results from household structure and land use are ambiguous: age, time in the property and titling do not correlate with farming or livelihood diversification. Related to human assets, family labor force clearly affects livelihood choices. The higher average number of labor force relates to higher farming diversity, but not to on-farm income diversity. It also relates to higher number of off-farm income sources. The relation of diversity with labor force, as Perz (2005) describes, means that farmers are a moving target, since in some the children grow up or the adult children

move out, changing all family labor dynamic and these families will respond differently to diversification over time.

In terms of natural assets, the land size is a variable that correlates with diversity. When the land size increases, it also increases farming diversity, but no relation was found with on-farm income diversity. In contrast, the number of off-farm income sources decreases when land size increases. A similar result was found in the work of Rahman & Akter (2014), where land-rich farmers presented more farming diversity and less livelihood diversity (non-agricultural). Adding the theory that low infrastructure leads to more dependence of on-farm systems, the bigger properties normally are far away from the urban centers. A geographical analysis using the GIS information of the data would help this discussion in the future.

Land-size also influences the choice of the primary on-farm income source. In terms of primary income source, farmers with less than 5 hectares are more likely to depend on government transfers. It demonstrates that the diversification of livelihoods can be related with natural resources constraints, in this case land, more than household characteristics as was expected. The smaller properties are also more likely to not provide any on-farm income or to rely on chicken and vegetable garden systems. Both beef and calf production are concentrated in the larger property sizes. Milk is positively correlated with properties of intermediate size, between 20-50 hectares.

Milk producers are also positively correlated to farming diversity and on-farm income diversity; this also could explain the level of diversification in the MCF. On the other hand, calf operation is positively correlated with low on-farm income diversification. There is no clear relation among the categories of off-farm sources (day labor, employee,

pension, welfare programs, rental) and other assets or livelihoods. The day labor was the only one that pointed correlation with coffee producers and farmers who do not have on-farm income (also concentrated in the smaller farms), while milk producers are negatively correlated with day labor.

Other limiting factor for diversification in the NF could be the limited work force, the high-risk aversion related to low income flow (Walker et al., 2009a); and the limited access to policies and credits as Aderinoye-abdulwahab et al. (2015) pointed out as one of the major challenges to livelihood diversification (see also Martins & Pereira, 2012). Age also could be an element that influences diversification; Rahman & Akter (2014) argue that older farmers could mean more maturity to making decisions and younger farmers are more oriented to modern technologies and farming systems (see also Valdivia, 1996). In this case, it also could be related to activities that provide more social status (calves against milk, for example).

Finally, community participation increases farming diversification (in the case of rural workers' union) and on-farm income diversification (in the case of cooperatives), which also helps to understand the low level of diversification in the NF. The importance of social assets was also mentioned by Chirau et al. (2014) as essential to maintain and secure livelihoods.

This research contextualized the importance of family farming as part of the strategy to grow food in a sustainable way. It showed how concentrated the production of food is in Brazil, even among family farmers. Instead of just thinking about technology and productivity to address food challenges, we must to consider developing participation, linkages and empowerment that could involve millions of farmers that are

out of the system. This research demonstrates the enormous diversity among family farmers and calls for context-specific strategies, that can address specific challenges, potentials, and interests. It used the livelihood framework to analyze the different elements influencing livelihood strategies among farmers, and based the analysis in the context of frontier development.

A remarkable finding is the percentage of farmers working as calves' suppliers, integrated with large-owners, in the beef value chain. In fact, cattle-related activities are at the core of their strategies and should be addressed, as Pacheco (2012) states that these are central family farming systems in 'frontier' and 'post- frontier' regions. Other studies have indicated that livelihood systems of the family farmers have changed in the past decades, from mostly subsistence farming to small-scale ranching tied to the global economy (Pereira et al., 2016). This research shows that farmers are focusing on market-oriented activities (cattle raising), but still strongly working in subsistence farming, mixing the strategies, and it is not only a linear process. As Pacheco (2009) demonstrates, simplistic understanding is not appropriate to describe the development of family farmers such as from subsistence to specialized or low-income to high-income status. This pattern was also identified by Walter et al. (2009a): farming systems with high diversification, but a single product integrated in the market. The organizations that want to support family farmers in this region but avoid working with cattle and pasture systems or connecting their work with those value chains are not working with farmers' reality. Making generalization about the role of farmers to produce food and ignoring their role in commodity value chains also does not help. In this region, the supply of other food products (not cattle related) is insignificant and multi-scale and multi-institutional efforts

are needed to make this a reality. There is potential to better engage on this type of production and it is needed in terms of food security and especially thinking about long-term development and environmental sustainability.

The descriptive analysis performed in this research does not allow precisely identifying what motivates a household to choose among various livelihood options (Rahman & Akter, 2014). Other limitations of this research were the lack of information related to income flow and wealth, the time labor of each activity (on-farm or off-farm work) and a better understanding of the migration flow that would help to better characterize farmers and their needs and to visualize future scenarios. All these elements could be explored in future research.

This research provides insight on the livelihood strategies of family farmers in these regions and contributes to the dialogue on how organizations can develop better strategies for supporting these farmers. Rather than providing simple solutions, my intent is to promote an informed debate and emphasize key elements that can bolster the role of such organizations in promoting rural development.

As discussed in the introduction of this thesis, rural development programs must address poverty and inequality while protecting the quality of the natural environment and ensuring food security (Jingzhong et al., 2010). It goes beyond the debate of the long-term existence of family farmers in the rural world, debate that has been on the discourses of developers for decades, to an understanding that family farmers are part of the agrarian structure of rural Brazil. In facing many constraints, these farmers have developed resilient strategies by transforming and adapting their livelihoods and ensuring their social reproduction. As for any other agricultural sector, these farmers need

consistent policies and support as administered by effective democratic institutions (Malagodi, 2017; Schneider & Cassol, 2017). In this dynamic process of transformation, many expressions of their identity were developed leading to a great livelihood diversity, which demand different strategies and approaches, respecting their logic and autonomy (Malagodi, 2017). I attested in this research differences across the frontier types, but also within each type.

As was mentioned before, most farmers are engaged in different types of cattle production (beef, calf and milk), a known trend. The Brazilian herd has grown significantly in the last 20 years with 83% of this expansion occurring in the Amazon, especially in Rondonia, Mato Grosso and Para (Bowman, et al. 2012). This result complements other studies (Walker & Moran, 2000; Pacheco, 2009; Godar et al., 2012) that have demonstrated that cattle ranching is part of both large-scale farmers and family farmers' strategies. Furthermore, approximately 80 percent of agricultural lands in the Amazon are currently devoted to cattle production (Schneider et al., 2002). Factors that make ranching a more successful and resilient livelihood include the low level of risk, stable prices and demands, increased market development and incentives, low transportation costs and access to credit (Martins & Pereira, 2012; Pereira et al., 2016; Pacheco, 2009). At the same time, cattle ranches have been pointed as the major driver of deforestation in Amazon (Walker & Moran, 2000; Pacheco, 2009). Therefore, although a resilient livelihood strategy, cattle ranching is not likely ecologically sustainable.

Although cattle production is unlikely to decrease in the coming decades, institutional support of diversifying farmer livelihoods might mitigate its negative environmental impact. This research also showed that farmers might respond to market conditions,

modifying their livelihoods to what is securely available. The labor and land are assets that favor family farmers to rely in farming livelihoods, but there is a lack of political and market power (Poulton et al., 2010).

Just a small part of these farmers is producing other types of food, and probably the majority of urban center foods are coming from outside of the region. This puts the region in a position of commodities supplier (to other regions) at the same time food consumers are demanding outside suppliers (from these other regions). This contradiction is also an opportunity.

The rural development process in the MCF and LCF should focus on consolidating the existing markets and building new markets which involve new products, new circuits and new transactional mechanisms, not only focused on agricultural products but also on services (Jingzhong et al., 2010). These regions presented elements indicating likelihood to address food production strategies and farmers presented characteristics linked to diversity. This also calls for a change to research efforts that have operated with limitation and little incentive for technological development of other value chains (Viera Filho, 2013). In addition, the social linkages in these regions are stronger, which could be invested in, supporting local organizations, creating spaces for them to contribute to policy making. Training inputs strengthen organizations that will make a difference for most family farmers (Poulton et al., 2010), but this is not easy and not fast to achieve.

We must support grassroots organization with a clear purpose. Jingzhong et al. (2010) emphasized that rural development processes become stronger if they are rooted in social capital and, at the same time, in new markets and new connections.

The NF should not be addressed the same way, since farmers there have fewer assets and ambitious programs that assume high farmer capabilities could lead to frustrating results. But a starting point would be to consolidate and improve the existing markets structures. The agency of farmers to negotiate in the beef value chain, where the role of family farmers has been neglected and hidden, should be supported. By participating actively in the market negotiations, farmers will have a chance to choose staying in these value chains or moving forward, in their own path. In addition, their commodity strategies need to be complemented by food security and farming diversity to ensure less risk and more well-being for families. It should be recognized that the consumption of meat and other nutritionally significant animal products, such as milk, is very valuable for food security of those families (Schneider & Niederle, 2010; McKune et al., 2015). Also in this region supporting local government is strategic to help farmers build basic elements to ensure livelihood security, such as land tenure security, road conditions, market opportunities, education and so on.

In all frontier types, improved marketing is a key element to distribute to farmers an important value generated from this part of the process. When not engaged, the farmers submit their production to a third party and receive almost no information of price variability and market conditions (Belik, 2017; Schneider & Cassol, 2017). Markets have to be seen not as an abstract and distant entity, but instead as concrete spaces built by social relations between people and institutions, where the products are qualified by different types of being, living and producing in the land, in dynamic processes that can be negotiated (Heberlê et al., 2017; Niederle, 2017). This type of approach highlights

strong territorial and local roots (Niederle, 2017) that meet a growing consumer demand for health, agroecological and local products (Niederle, 2017).

The recognition of family farming diversity is also related to the need to support multiple markets and address the challenge of organizing a complex network of producers and consumers (Niederle, 2017). Social organizations must engage in the governance of these arrangements, which are mostly commanded by powerful actors of the value chain (Jingzhong et al., 2010), so that farmers are not left at the mercy of expropriating market mechanisms with free intermediaries having advantages over production, and poorly designed policies (Malagodi, 2017). This governance means coordination at different levels, between actors in the supply chain, vertically and horizontally, facilitating transactions, encouraging dialogue and creating transparency (Poulton et al., 2010).

Family farmers need a strong political support and protection to be able to compete in the market (Bush, 2016). This support would require that government agencies support by defining policies that guarantee market prices and regulate taxes. Although Brazil has its ‘minimum price policy’, the government face difficulties in its implementation the due to a lack of resources (Belik, 2017). At state level, Mato Grosso through the State Secretary of Family Farming in partnership with the National Supply Company have been working since 2016 to create an information system that informs publicizes all family farmers about the market value of their products, which would then provide them the opportunity to negotiate (SEAF, 2017). Improving farmers’ access to market information is also an important aspect of improving farmers’ access to marketing services (Poulton et al., 2010). NGO assistance or farmer organizations can help to

reduce some of the transaction cost disadvantages faced by family farms and facilitate links between farmers and formal hierarchies of markets (Poulton et al., 2010). These organizations also could initiate studies of informal economic activities in place. The private sectors (i. e. food markets and restaurants) should engage in supporting the capacity of small and undercapitalized farms to meet their requirements and deliver fresh, local and quality products (Poulton et al., 2010).

In terms of policy, the civil society (i.e. NGOs and social movements) should engage in guaranteeing the applicability of policies, the access to information and improvement of bureaucratic aspects, making what already exists work in the field, and to foment the discussion around what must be improved, transformed or created. There are so many policies at the national level for family farmers such as National Program for Strengthening Family Agriculture (Pronaf); Food Acquisition Program (PAA); National Biodiesel Program (PNB); National Policy on Technical Assistance and Rural Extension (Pnater); Family Agriculture Insurance (SEAF); Family Agriculture Law; Organic Law of Food Security; Price Guarantee Program for Family Agriculture (PGPAF); National Program for the Sustainable Development of Rural Territories (Pronat); 'Mais alimentos' Program; National School Feeding Program (PNAE); Minimum Price Guarantee Program (PGPM-Bio); National Policy on Climate Change (PNMC); National Rural Housing Program (PNHR), Rural Development Sustainable Development Program (PDSTR), Family Agriculture Agro-industrialization Program, National Land Credit Program (PNCF), "Luz para todos", "Arca das Letras", National Program for Access to Technical Education and Employment (Pronatec), National Policy on Agroecology and Organic Production (Pnapo) and the National Plan for Agroecology and Organic Production (Planapo)

(Heberlê et al., 2017; Picolotto & Medeiros, 2017). Nevertheless, Pronaf is the only well spread policy. Local level capacity, participation and engagement in the implementation of those policies is missing, as well as a monitoring process to ensure the understanding of the barriers faced.

Another challenge is the creation of links between these policies. As an example, the Mato Grosso state government recently called on the civil society to build the State Plan of Family Farming up to 2030. This call extended to seven municipalities in MT to get inputs for the plan, supported by Empaer (technical assistance) and the State Rural Sustainable Development Council, which are both related to the State Family Farming secretary, and local NGOs. Some of the strategies include drafting and enacting legal procedures for processing foods, supporting sustainable food production, applying agroecological methods, diversifying and building new markets, enacting legally binding regulation on the use of agrochemicals, and promoting capacity building. However, the extent to which this plan connects with national policies and plans and improves their functioning is unknown. And, at state level, it is unknown whether this plan is articulated with the PCI (to Produce, to Conserve and to Include) state program or the Sustainable Municipalities State Program. What contributes to this lack of connection is also the lack of a shared view of the role of family farmers in rural development that those policies and programs would support (Vitela, 2017).

Research on rural livelihood strategies can help to define priorities that can support the implementation of these policies and programs. For example, this research showed the vulnerability of the smallest-scale farmers which reported low diversity and dependence of off-farm sources, with just part time of their labor dedicated to their own

land. But, they havethe advantages of their close proximity to the urban center which provides logistical and infra structure benefit. What policies could promote intensive types of production, such as agroforestry, which can increase diversity and food production, for example? Would other policies, PNAE and PAA already discussed in this research that never gained scale (Belik, 2017), be interesting to them? If these policies were successfully applied they would just be able to embrace a small percentage of farmers, about 230,000 farmers, far fewer than those three million out of the market (Belik, 2017). This means that these policies can be addressed to just a group of farmers and the assessment of which group to target is important to better define efforts. Another vulnerable group are the female-headed farms. How all policies are looking at this group, recognizing their constraints to better develop approaches that can decrease the existing gaps? Women's needs, interests, and constraints must be identified and supported with appropriate strategies that may vary from men's (McKune et al., 2015).

In 2000, micro-credit specifically addressed the peripheral farmers was created for investment in agricultural and non-agricultural activities (Wanderley, 2017). It was a way forward since Pronaf (as commented) privileged just the farmers in transition, this micro credit recognizes these family farmers and redesigned coherent mechanisms to support them (Grisa, 2017). Nevertheless, the results of this research showed minimum access, less than 10%, which demonstrates that at local level it needs to be improved.

Schneider & Cassol (2017) analyzing IBGE data found similar results than this research and described family farmers as three groups. The first group of farmers represents the majority whose properties depend heavily on the income of the farm, but some flexibility with regards to off-farm activities, but their main strategy of social

reproduction is agriculture and livestock; The second group of farmers have multiple sources of income which includes agricultural income, as well as, non-agricultural activities and pensions, which provide significant income flow. The third group of family farmers live in rural areas, but agriculture and agricultural production no longer have a significant economic contribution. In such cases, farms might simply serve as their residence or provide subsistence food sources Therefore, different policies would be addressed to whom the natural resources available are not enough to ensure income (Schneider & Cassol, 2017; Valbuena et al., 2015) and to the ones who depend on agricultural activities. Geographical analysis would aid these analyses.

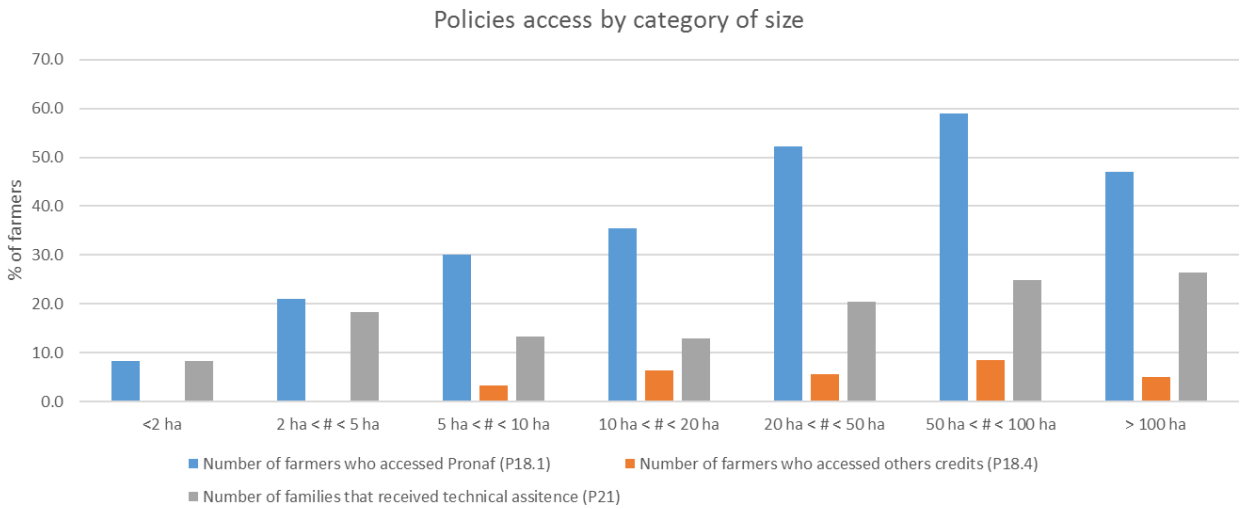

Figure 5-1. Access to credits by category of size.

Finally, I want to mention the need to overcome sectored thinking and actions. Rural communities should be considered dynamic spaces for living and working, producing and consuming , for social interaction and leisure, and as a space of culture and innovation (Niederle, 2017). Currently, European societies are promoting the countryside as a ‘space for consumption’ that they brand as ‘a living countryside’ with new markets for agro-tourism, what kind of care facilities, nature and landscape preservation and for establishing new connections between existing markets through

their patterns of pluriactivity (Jingzhong et al., 2010)However, for this kind of community and economic development, we also need to recognize that the complexity inherent to these systems must be addressed by interdisciplinary work and research. We must extend beyond the agrarian background of technical assistance. And we must utilize the plurality of knowledge therein that can serve to create solutions, that improve our understanding of the different and newly emerging scenarios and dimensions of this space (Heberlê et al., 2017).

In a practical way, each territory should have its physical space of knowing, interacting and sharing. These spaces can support policies and research about family farming, getting contributions from different actors and connecting ideas (Heberlê et al., 2017), also creating positive interactions among initiatives and with government. The family farming information needs to be decentralized, being generated in each location, not just from IBGE and the national databases, where the information is often hard to find and to put together. Municipal databases could be linked to the process of environmental regulation. It would allow each agricultural secretary to really know family farmers needs and reality.

Local organizations waste efforts disputing their strategies and a unique way of doing rural development, but by focusing on proving their own value they miss the learning opportunity of communicating with each other. The process of innovation happens through multi-stakeholders' interaction, also outside the regular partners, because farmers also are shaped by how society frames them. We should not just look at farmers and at rural, but look at farmers-society interactions. The diversity of livelihoods calls for multiple approaches and collaborative work. The solutions should be

territorially rooted. The government, social movements, grassroots organizations, research institutes and NGOs need to clearly define their role on rural development, especially NGOs which role is not so clear and change case to case. I believe that in this context, NGO's would have a strong role of supporting capacity building processes for local government and grassroots organizations, to support fair market governance, to make accessible good and reliable information, performing policy monitoring, and to promoting the social value of family farming in each territory.

LIST OF REFERENCES

Aderinoye-Abdulwahab, S.A., Nwachukwu, S.C., Salawu, O.L.and Popoola, P. O. (2015). Assessment of livelihood activities of rural farmers in Kwara State, Nigeria. Ethiopian Journal of Environmental Studies & Management 8(2):120–129. https://doi.org/http://dx.doi.org/10.4314/ejesm.v8i2.2

Ageitec, (Agência Embrapa de Informações Tecnológicas). (2015). *Agrotóxicos no Brasil*. Retrieved from http://www.agencia.cnptia.embrapa.br/gestor/agricultura_e_meio_ambiente/arvore/CONTAG01_40_210200792814.html

Altieri, Miguel A. (2009). Agroecology, Small Farms, and Food Sovereignty. Monthly Review an Independent Magazine 61: 03. Retrieved from http://monthlyreview.org/2009/07/01/agroecology-small-farms-and-food-sovereignty/

Anjos, F. S and Caldas, N. V. (2002). Pluriactivity and family farming in Brazil: the case of Rio Grande do Sul. Retrieved from http://books.google.com/books?hl=en&lr=&id=NLT1mijjgmcC&oi=fnd&pg=PA7&dq=CEPAL+Review+93&ots=Rd2CLwf31R&sig=2ZCTAGJGvVtny_0CzmkmHteLw1I

Arnauld de Sartre, X., Oszwald, J., Veiga, I., Castro, M., de Assis, W. S., Michelloti, F., … Lavelle, P. (2016). Sustainable development policies and the spread of land-sharing practices - A statistical assessment in a frontier region of the Brazilian Amazon. Journal of Rural Studies, 48, 65–76. https://doi.org/10.1016/j.jrurstud.2016.09.009

Ashley, C., & Carney, D. (1999). Sustainable livelihoods: Lessons from early experience. Development, 64.

Ashley, C., & Maxwell, S. (2001). Rethinking Rural Development. Forests, Trees and Livelihoods, 12(3), 155–161. https://doi.org/10.1080/14728028.2002.9752420

Barroso, João Carlos. (2008). Políticas de Colonização: As políticas públicas para a Amazônia e Centro-oeste in J. C. Barrozo, *Mato Grosso: do sonho à utopia da terra*.15-26. Cuiabá: EdUFMT.

Bebbington, A. (1999). Capitals and capabilities: A framework for analyzing peasant viability, rural livelihoods and poverty. World Development, 27(12), 2021–2044. https://doi.org/10.1016/S0305-750X(99)00104-7

BeefPoint. (2015). *Mato Grosso registrou o maior volume de produção de carne bovina entre todos os Estados em 2014*. Retrieved from http://www.beefpoint.com.br/cadeia-produtiva/giro-do-boi/mato-grosso-registrou-o- maior-volume-de-producao-de-carne-bovina-dentre-todos-os-estados-em-2014/

Belik, Walter. (2017). Circuitos de comercialização e familiar no brasil: notas para discussão in Agricultura familiar brasileira: desafios e perspectivas de futuro Brasília: Ministério do Desenvolvimento Agrário, 221-242.

Bennett, N. (2010). Sustainable livelihoods from theory to conservation practice: An extended annotated bibliography for prospective application of livelihoods approaches in protected area community research, 55. Retrieved from http://dspace.library.uvic.ca:8080/handle/1828/4461

Bickel, U., & Dros, J. M. (2003). The Impacts of Soybean Cultivation on Brazilian Ecosystems. WWF, 1–28.

Brocklesby, M. a., & Fisher, E. (2003). Community development in sustainable livelihoods approaches - an introduction. Community Development Journal, 38(3), 185–198. https://doi.org/10.1093/cdj/38.3.185

Browder, J. O., Pedlowski, M. A., Walker, R., Wynne, R. H., Summers, P. M., Abad, A., … Mil-Homens, J. (2008). Revisiting Theories of Frontier Expansion in the Brazilian Amazon: A Survey of the Colonist Farming Population in Rondônia's Post-Frontier, 1992-2002. World Development, 36(8), 1469–1492. https://doi.org/10.1016/j.worlddev.2007.08.008

Buainain, Antônio Márcio, Eliseu Alves, José Maria Da Silveira, and Zander Navarro. (2013). Sete Teses Sobre O Mundo Rural Brasileiro. Revista de Política Agrícola 22 (2): 1–25.

Bush, R. (2016). Family Farming in the Near East and North Africa. International Policy Centre for Inclusive Growth (IPC-IG), Working Paper N. 151.

Carney, D. (2003). Sustainable Livelihoods Approaches: Progress and Possibilities for Change. Secretary, 2008(02.05.), 67. https://doi.org/ISBN 1 86192 491 7

Carr, D. (2009). Population and deforestation: why rural migration matters. Progress in Human Geography, 33(3), 355–378. https://doi.org/10.1177/0309132508096031

Castilho, A. L. (2012). *Partido da terra: como os políticos conquistam o território brasileiro*. São Paulo: Contexto.

Caviglia-Harris, J. L., Sills, E. O., & Mullan, K. (2013). Migration and mobility on the Amazon frontier. Population and Environment, 34(3), 338–369. https://doi.org/10.1007/s11111-012-0169-1

Chambers, Robert; Conway, G. (1991). Sustainable rural livelihoods: practical concepts for the 21st century. Ids Discussion Paper, 296(Brighton: Institute of Development Studies, University of Sussex), 29. https://doi.org/ISBN 0 903715 58 9

Chirau, T. J., Nkambule, S., & Mupambwa, G. (2014). Rural Livelihoods in Zimbabwe: Heterogeneity, Diversification and Vulnerability. International Journal of Innovation and Applied Studies, 5(1), 5–15.

CRS, (Catholic Relief Services). (2007). Zambia Livelihood Assessment and Analysis. Retrieved from http://www.crs.org/our-work-overseas/research-publications/zambia-livelihoods-assessment

Darnhofer, I., & Strauss, A. (2014). Resilience of family farms: understanding the trade-offs linked to diversification. Paper Presented at the 11th European IFSA Symposium, on “Farming Systems Facing Global Challenges: Capacities and Strategies”, Held 1-4 April 2014 in Berlin (Germany), (April), 1–10.

De Haan, L., & Zoomer, a. (2005). Exploring the Frontier of Livelihood Research. Development and Change, 36(1), 27–47.

Dfid, Departement for International Development. (1999). Sustainable Livelihoods Guidance Sheets. Context, 26. https://doi.org/10.1002/smj

Diniz, F. H., Hoogstra-Klein, M. a., Kok, K., & Arts, B. (2013). Livelihood strategies in settlement projects in the Brazilian Amazon: Determining drivers and factors within the Agrarian Reform Program. Journal of Rural Studies, 32, 196–207. https://doi.org/10.1016/j.jrurstud.2013.06.005

Ellis, F. (1999). Rural Livelihood Diversity in Developing Countries: Evidence and Policy Implications. ODI Natural Resource Perspectives, 40(40), 1–10. Retrieved from http://www.mendeley.com/research/rural-livelihood-diversity-developing-countries-evidence-policy-implications-10/

Ellis, Frank. (2000). *Rural Livelihoods and Diversity in Developing Countries*. New York: Oxford University Press.

Embrapa. (2016). *Soja em números (Safra 2015/2016)*. Retrieved from https://www.embrapa.br/soja/cultivos/soja1/dados-economicos

Escobar, A. (2007). Whose Knowledge Whose Nature? Biodiversity Conservation and the Political Ecology of Social Movements. Journal of Political Ecology, 5, 53–82.

FAO, (Food and Agriculture Organization of the United Nations). (2013). *International Year of Family Farming 2014: Master Plan*. Retrieved from http://www.fao.org/fileadmin/user_upload/iyff/docs/Final_Master_Plan_IYFF_2014_30-05.pdf

FAO and UNDP, (Food and Agriculture Organization and United Nations Development Programme). (2016). Regional perspectives of family farming.

FUNAI, (Fundação Nacional do Índio). (2015). Terras Indígenas. Retrieved from http://www.funai.gov.br/index.php/indios-no-brasil/terras-indigenas

FNDE, (Fundo Nacional de Desenvolvimento da Educação). (2016). PNAE: Repasses financeiros. http://www.fnde.gov.br/programas/alimentacao-escolar/alimentacao-escolar-consultas/repasses-financeiros

Godar, J., Tizado, E. J., Pokorny, B., & Johnson, J. (2012). Typology and Characterization of Amazon Colonists: A Case Study Along the Transamazon Highway. Human Ecology, 1–17. https://doi.org/10.1007/s10745-012-9457-8

Graeub, B. E., Chappell, M. J., Wittman, H., Ledermann, S., Kerr, R. B., & Gemmill-Herren, B. (2016). The State of Family Farms in the World. World Development, 87, 1–15. https://doi.org/10.1016/j.worlddev.2015.05.012

Grisa, Catia. (2017). A agricultura familiar nas políticas para a agricultura familiar in G. C., Delgado & S. M. P. P. Bergamasco, (ed), *Agricultura Familiar Brasileira: Desafios e Perspectivas de Futuro* (290-311). Brasília: Ministério do Desenvolvimento Agrário.

Hamilton-Peach, J., & Townsley, P. (2006). An IFAD Sustainable Livelihoods Framework, 1–6.

Heberlê, A. L. O.; Sicoli, A. H.; Silva, J. S.; Borba, M. F. S.; Balsadi, O. V.; Pereira, V. F. (2017). Agricultura familiar e pesquisa agropecuária: contribuições para uma agenda de futuro in G. C., Delgado & S. M. P. P. Bergamasco, (ed), *Agricultura Familiar Brasileira: Desafios e Perspectivas de Futuro* (131-148). Brasília: Ministério do Desenvolvimento Agrário.

Helfand et al. (2014). Pequenos e médios produtores na agricultura brasileira: situação atual e perspectivas in A. M. Buainain, E. Alves, J. M. Silveira, & Z. Navarro. *O mundo rural no Brasil do século 21: a formação de um novo padrão agrário e agrícola* (658-690). Brasília, DF: Embrapa.

Hoefle, S. W. (2013). Beyond carbon colonialism: Frontier peasant livelihoods, spatial mobility and deforestation in the Brazilian Amazon. Critique of Anthropology, 33, 193–213. https://doi.org/10.1177/0308275X13478224

IBGE, (Instituto Brasileiro de Geografia e Estatística). (2006). *Censo Agropecuário*. Retrieved from http://www.ibge.gov.br/home/estatistica/economia/agropecuaria/censoagro/2006/

IBGE, (Instituto Brasileiro de Geografia e Estatística). (2010). Economia por município. Retrieved from https://cidades.ibge.gov.br/

IBGE, (Instituto Brasileiro de Geografia e Estatística). (2015). *Mato Grosso*. Retrieved

from http://www.ibge.gov.br/estadosat/perfil.php?sigla=mt

IEP, (Internet Encyclopedia of Philosophy). (2015). *Sen's Capability Approach*. Retrieved form http://www.iep.utm.edu/sen-cap/

IFAD, (International Fund for Agricultural Development). (2014). *Investing in rural people in Brazil*, 2–8. Retrieved from https://www.ifad.org/documents/10180/efe6c7c0-298c-4646-b7f6-4d2e7440f164

INCRA, (Instituto Nacional de Colonização e Reforma Agrária). 2014. *Projetos de Reforma Agrária Conforme Fases de Implementação - SIPRA*. Ministério do Desenvolvimento Agrário – MDA. 161–179.

INCRA, (Instituto Nacional de Colonização e Reforma Agrária). (2017). Reforma Agrária. Retrieved from http://www.incra.gov.br/reforma_agraria

ICV, (Instituto Centro de Vida). (2013). Boas práticas são a saída para aumentar a produtividade da pecuária. Retrived from http://www.icv.org.br/wp-content/uploads/2014/05/edi%C3%A7%C3%A3o_outubro_web.pdf

Jingzhong, Ye; Schneider, Sergio; Vanh Der Ploeg, J. D. (2010). Rural development reconsidered: building on comparative perspectives from China , Brazil and the European Union. Rivista Di Economia Agraria, 65(2), 163–190. https://doi.org/http://www.inea.it/public/it/pubblicazioni.php?action=1&scat=90

Joanoni Neto, V. (2007). *Fronteiras da crença: Ocupação do norte de mato grosso após 1970*. Cuiabá: Editora da Universidade Federal de Mato Grosso -- EdUFMT.

Knoema. Brasil | Data and Statistics. (2015). Retrieved from http://pt.knoema.com/atlas/Brasil

Lopes, Vivaldo. (2010). *Mato Grosso, Território de Oportunidades*. Cuiabá, MT: Entrelinhas.

Malagodi, E. (2017). Por que a questão agrária é uma questão da agricultura de base familiar e Camponesa? in G. C., Delgado & S. M. P. P. Bergamasco, (ed), *Agricultura Familiar Brasileira: Desafios e Perspectivas de Futuro* (40-62).

Brasília: Ministério do Desenvolvimento Agrário.

Martins, P. F., & Pereira, T. Z. (2012). Cattle-raising and public credit in rural settlements in Eastern Amazon. Ecological Indicators, 20, 316–323. https://doi.org/10.1016/j.ecolind.2012.02.031

Mattei, L. (2014). O Papel e a importância da Agricultura Familiar no Desenvolvimento Rural Brasileiro Contemporâneo. Rev. Econ., 45, 83–91.

McKune, S. L., Borresen, E. C., Young, A. G., Auria Ryley, T. D., Russo, S. L., Diao Camara, A., … Ryan, E. P. (2015). Climate change through a gendered lens: Examining livestock holder food security. Global Food Security, 6, 1–8. https://doi.org/10.1016/j.gfs.2015.05.001

MDA, (Ministério do Desenvolvimento Agrário). (2016). *DAPs ativas por município*. Retrived from http://smap14.mda.gov.br/extratopf/PesquisaMunicipio.aspx

Midia News. (2010). *Quinze assentamentos serão criados pelo Intermat em 2010*.

Retrieved from http://www.midianews.com.br/cotidiano/quinze-assentamentos-serao-criados-pelo-intermat-em-2010/15569

Morse, S., & McNamara, N. (2013). Sustainable Livelihood Approach, a critique of theory and practice. https://doi.org/10.1007/978-94-007-6268-8

Niederle, P. A. (2017). Afinal, que inclusão produtiva? A contribuição dos novos mercados alimentares in G. C., Delgado & S. M. P. P. Bergamasco, (ed), *Agricultura Familiar Brasileira: Desafios e Perspectivas de Futuro* (166-194). Brasília: Ministério do Desenvolvimento Agrário.

OECD/FAO, (Organization for Economic Co-operation and Development; Food and Agriculture Organization of the United Nations). (2015). OECD-FAO Agricultural Outlook 2015. Paris. https://doi.org/http://dx.doi.org/10.1787/agr_outlook-2015-en

Osborn, Derek; Cutter, Amy; Ullah, F. (2015). Universal Sustainable Development Goals: Understanding the Transformational Challenge for Developed Countries. Stakeholder Forum.

Pacheco, P. (2009). Smallholder livelihoods, wealth and deforestation in the Eastern Amazon. Human Ecology, 37(1), 27–41. https://doi.org/10.1007/s10745-009-9220-y

Pacheco, P. (2012). Actor and frontier types in the Brazilian Amazon: Assessing interactions and outcomes associated with frontier expansion. Geoforum, 43(4), 864–874. https://doi.org/10.1016/j.geoforum.2012.02.003

Patriota, T. C & Pierre, R. M. (2016). An increasing recognition of the role of family farming in achieving sustainable development. International Policy Centre for Inclusive Growth (IPC - IG).

Pedroso, Maria T. M. (2014). Experiências internacionais com agricultura familiar e o caso brasileiro in in A. M. Buainain, E. Alves, J. M. Silveira, & Z. Navarro. *O mundo rural no Brasil do século 21: a formação de um novo padrão agrário e agrícola* (728-753). Brasília, DF: Embrapa.

Pereira, R., Simmons, C., & Walker, R. (2016). Smallholders, Agrarian Reform, and Globalization in the Brazilian Amazon: Cattle versus the Environment. Land, 5(3), 24. https://doi.org/10.3390/land5030024

Perz, S. G. (2005). The Effects of Household Asset Endowments on Agricultural Diversity among Frontier Colonists in the Amazon. Agroforestry Systems, 63(3), 263–279. https://doi.org/10.1007/s10457-005-4164-8

Perz, S. G., Caldas, M. M., Arima, E., & Walker, R. T. (2007). Unofficial road building in

the Amazon: Socioeconomic and biophysical explanations. Development and Change, 38(3), 529–551. https://doi.org/10.1111/j.1467-7660.2007.00422.x

Perz, S. G., Leite, F. L., Griffin, L. N., Hoelle, J., Rosero, M., Carvalho, L. A., … Rojas, D. (2015). Trans-boundary infrastructure and changes in rural livelihood diversity in the southwestern Amazon: Resilience and inequality. Sustainability (Switzerland), 7(9), 12807–12836. https://doi.org/10.3390/su70912807

Perz, S. G., & Walker, R. T. (2002). Household life cycles and secondary forest cover among small farm colonists in the Amazon. World Development, 30(6), 1009–1027. https://doi.org/10.1016/S0305-750X(02)00024-4

Picoli, Fiorelo. (2006). *O Capital e a Devastação da Amazônia.* São Paulo: Expressão Popular.

Picolotto, E. L. & Medeiros, L. S. (2017). A formação de uma categoria política: os agricultores familiares no Brasil contemporâneo in G. C., Delgado & S. M. P. P. Bergamasco, (ed), *Agricultura Familiar Brasileira: Desafios e Perspectivas de Futuro* (342-366). Brasília: Ministério do Desenvolvimento Agrário.

Ploeg, Jan Douwe van der. (2014). Peasant-Driven Agricultural Growth and Food Sovereignty. The Journal of Peasant Studies 41 (6): 999–1030. doi:10.1080/03066150.2013.876997.

Poulton, C., Dorward, A., & Kydd, J. (2010). The Future of Small Farms: New Directions for Services, Institutions, and Intermediation. World Development, 38(10), 1413–1428. https://doi.org/10.1016/j.worlddev.2009.06.009

PRODES. (2015). *Monitoramento da Floresta Amazônica por Satélite*. Retrieved from http://www.obt.inpe.br/prodes/index.php

Rahman, S., & Akter, S. (2014). Determinants of Livelihood Choices: An Empirical Analysis from Rural Bangladesh. Journal of South Asian Development, 9(3), 287–308. https://doi.org/10.1177/0973174114549101

Ramos, P. (2014). Uma história sem fim: a persistência da questão agraria no Brasil rural contemporâneo" in A. M. Buainain, E. Alves, J. M. Silveira, & Z. Navarro. *O mundo rural no Brasil do século 21: a formação de um novo padrão agrário e agrícola* (658-690). Brasília, DF: Embrapa.

Reydon, B. P. (2014). Governança de terras e a questão agrária no Brasil in A. M. Buainain, E. Alves, J. M. Silveira, & Z. Navarro. *O mundo rural no Brasil do século 21: a formação de um novo padrão agrário e agrícola* (728-753). Brasília, DF: Embrapa.

Ribeiro, J. D. (2008). Colonização e garimpos: expropriação e violência no norte do MT in Barroso, J. C. (Ed), *Mato Grosso: do sonho à utopia da terra* (205-230). Cuiabá: EdUFMT.

Robbins, P. (2012). *Political Ecology: A critical Introduction to geography* (2nd ed). Political versus Apolitical Ecology (p11-24) (12–24). UK: Wiley-Blackwell Publishing Ltd.

Rodrigues, A. S., Ewers, R. M., Parry, L., Souza Jr., C., Verissimo, A., & Balmford, A. (2009). Boom-and-bust development patterns across the Amazon deforestation frontier. Science, 324(5933), 1435–1437. https://doi.org/10.1126/science.1174002

Rousseff, D. (2015). *Speech at 70th UN General Assembly*. Retrieved from http://www.voltairenet.org/article188874.html

Sabourin, E. (2017). Origens, evolução e institucionalização da política de agricultura familiar no Brasil in G. C., Delgado & S. M. P. P. Bergamasco, (ed), *Agricultura Familiar Brasileira: Desafios e Perspectivas de Futuro* (263-289). Brasília: Ministério do Desenvolvimento Agrário.

Sachs, J. D. (2015). *The Age of Sustainable Development*. New York: Columbia University Press.

SAGI, (Secretaria de Avaliação e Gestão da Informação). (2016). *PAA Data*. http://aplicacoes.mds.gov.br/sagi/paa/visi_paa_geral/pg_principal.php?url=abertura

Sallu, S. (2010). Resilient or Vulnerable Livelihoods? Assessing Livelihood Dynamics and Trajectories in Rural Botswana, 15(4).

Swaminathan, M S. (2014). Zero Hunger. Science. New York, N.Y. 345 (6196): 491. doi:10.1126/science.1258820.

Schmink, M. & Wood, C. H. (2012). *Conflitos Sociais e a Formação da Amazônia*. Belém: Ed. UFPA.

Schmink M. & Wood, C. H. (1992). *Contested Frontiers in Amazonia*. New York: Columbia University Press.

Schneider, R. R. (1995). Government and the economy on the Amazon frontier. World Bank. https://doi.org/10.1596/0-8213-3353-4

Schneider, R., Arima, E., Veríssimo, A., Júnior, C. S., & Barreto, P. (2002). Sustainable Amazon. Limitation and opportunities for rural development. World Bank Technical Paper, 515, 68. https://doi.org/10.13140/RG.2.1.4977.8084

Schneider, S. & Cassol, A. (2017). Diversidade e heterogeneidade da agricultura familiar no Brasil e algumas implicações para políticas públicas in G. C., Delgado & S. M. P. P. Bergamasco, (ed), *Agricultura Familiar Brasileira: Desafios e Perspectivas de Futuro* (82-107). Brasília: Ministério do Desenvolvimento Agrário.

Schneider, S., & Niederle, P. A. (2010). Resistance strategies and diversification of rural livelihoods: the construction of autonomy among Brazilian family farmers. Journal of Peasant Studies, 37(2), 379–405. https://doi.org/10.1080/03066151003595168

Scoones, I. (2009). Livelihoods perspectives and rural development. Journal of Peasant Studies, 36(1), 171–196. https://doi.org/10.1080/03066150902820503

Scoones, I. (1998). Sustainable rural livelihoods: a framework for analysis. IDS Working Paper, 72, 22. https://doi.org/10.1057/palgrave.development.1110037

SEAF (Secretaria de Estado de Agricultura Familiar e Assuntos Fundiários). (2017). *SEAF divulga cotação de preços da agricultura familiar.* Retrieved from http://www.seaf.mt.gov.br/-/6223377-seaf-divulga-cotacao-de-precos-da-agricultura-familiar

SEDUC. (2014). *Censo Escolar*. Retrieved from http://www.seduc.mt.gov.br/Paginas/censo-escolar-indicadores.aspx

Soares, D. (2017). *Corpos de 9 pessoas assassinadas em área rural de MT são levados para perícia.* Retrieved from http://g1.globo.com/mato-grosso/noticia/corpos-de-9- pessoas-assassinadas-em-area-rural-sao-transportados-para-colniza-mt.ghtml

Soler, L., Verburg, P., & Alves, D. (2014). Evolution of Land Use in the Brazilian Amazon: From Frontier Expansion to Market Chain Dynamics. Land, 3(3), 981–1014. https://doi.org/10.3390/land3030981

Steffen, W., Persson, Å., Deutsch, L., Zalasiewicz, J., Williams, M., Richardson, K., … Svedin, U. (2011). The Anthropocene: From Global Change to Planetary Stewardship. Ambio, 40(7), 739–761. https://doi.org/10.1007/s13280-011-0185-x

Sumner, A. & Tribe, M. (2008). *International Development Studies: Theories and Methods in Research and Practice.* London: SAGE publications Ltda.

United Nations. (2014). Human Development Report 2014.

USAID. (2010). Country Profile Property Rights and Resource Governance. 1–20.

USAID. (2015). *Brazil*. Retrieved from http://usaidlandtenure.net/brazil

Valbuena, D., Groot, J. C. J., Mukalama, J., Gérard, B., & Tittonell, P. (2014). Improving rural livelihoods as a moving target: trajectories of change in smallholder farming

systems of Western Kenya. Regional Environmental Change, 15(7), 1395–1407. https://doi.org/10.1007/s10113-014-0702-0

Valdivia Corinne. (1996). Diversification as a Risk Management Strategy in an Andean Agropastoral Community. American Journal of Agricultural Economics, 78(5), 1329–1334. https://doi.org/Doi 10.2307/1243516

Veisi, H., Liaghati, H., & Vaninee, H. S. (2014). Participatory assessment of the sustainability of livelihoods in the agroecosystem of Abesard, Iran. Sustainability Science, 9(3), 347–359. https://doi.org/10.1007/s11625-014-0241-0

Vieira Filho, J. R. E. (2013). The structural heterogeneity of family farming in Brazil. CEPAL REVIEW, 111, 99-115.

Vilela, Sérgio Luiz de Oliveira. Perspectivas para a agricultura familiar brasileira: elementos de um projeto político de desenvolvimento rural, para além de uma "questão tecnológica" in G. C., Delgado & S. M. P. P. Bergamasco, (ed), *Agricultura Familiar Brasileira: Desafios e Perspectivas de Futuro* (244-262). Brasília: Ministério do Desenvolvimento Agrário.

Wanderley, Maria de Nazareth Baudel, "Franja Periférica", "Pobres do Campo", "Camponeses": dilemas da inclusão social dos pequenos agricultores familiares in in G. C., Delgado & S. M. P. P. Bergamasco, (Ed), *Agricultura Familiar Brasileira: Desafios e Perspectivas de Futuro* (64-81). Brasília: Ministério do Desenvolvimento Agrário.

Walker, R., Moran, E., & Anselin, L. (2000). Deforestation and cattle ranching in the Brazilian Amazon: External capital and household processes. World Development, 28(4), 683–699. https://doi.org/10.1016/S0305-750X(99)00149-7

Walker, Robert; Perz, Stephen; Caldas, Marcellus; Silva, L. (2009). Land use and land cover change in forest frontiers: the role of household life cycles, 56(4), 1387–1397. https://doi.org/10.1177/016001760202500202

Watts, M. J. (2000). Political Ecology, in Sheppard, E. & Barnes, T., *A Companion to Economic Geography* (p 257). Blackwell, Oxford.

World Bank. (2017). Atlas of Sustainable Development Goals.

World Bank. (2017). *Brazil Overview*. Retrieved from http://www.worldbank.org/en/country/brazil/overview

BIOGRAPHICAL SKETCH

Camila Horiye Rodrigues was born in São Paulo, Brazil. She attended the Universidade Estadual Paulista where she graduated in 2007 with a degree in forest engineering. She was also involved with social movements in São Paulo, especially the Movimento dos Trabalhadores Rurais Sem Terra (MST), participating in many of their political activities. After finishing her undergraduate studies, she moved to the Amazon where her work with family farmers began in Alta Floresta, Mato Grosso. For the next seven years, she worked at Instituto Centro de Vida (ICV) as an extentionist and later as a program manager.

Since 2014 Camila has been affiliated with Coopernossa, a cooperative of workers for family farming. She works as a consultant of rural development issues, with family farmers, indigenous groups or government. After participating in a capacity building course led by the Amazon Leadership Initiative Program, she came to the University of Florida, where she pursued her master's degree in interdisciplinary ecology. She also earned a minor degree in tropical conservation and development. Her master's degree fieldwork was conducted in 2016 and included extensive travel throughout the northern municipalities of Mato Grosso. This research aimed at better understand the livelihood strategies of family farmers along the frontier of this region.