REDUCING THE VULNERABILITY OF SMALLHOLDER FARMERS TO CLIMATE CHANGE THROUGH RURAL CREDIT PROGRAMS. A CASE STUDY FROM BRAZIL

By

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DEDICATION

I dedicate my thesis work to my dear family. A special feeling of gratitude to my loving parents, Theopisto Abath and Leila Montalvão who always believed in me and in my capacity to thrive through achieving successfully my goals. My wife Christina Briscoe Abath, who has support me through my Master's Degree path, being always an example of focus, determination and perseverance towards success.

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ABSTRACT

The Intergovernmental Panel on Climate Change (IPCC) confidently predicted rural areas will experience major impacts from diminished water availability, food security, infrastructure and agricultural incomes, causing shifts in crop production worldwide (2014). Latin America will be significantly affected, since more than 90 percent of the regions is vulnerable to projected changes in droughts and floods (World Bank, 2014). Extreme weather events due to climate change entail risk for large- and small-scale farmers alike, but smallholders will always be more vulnerable. This paper considers how smallholder farmers in Brazil—focusing on those in the poor Northeast region—are affected by, and respond to, climate change. Brazilian smallholder farmers represent the overwhelming majority of agricultural establishments in Brazil and, in aggregate, their production exceeds the output of large-scale farmers. They average larger yields per hectare because they make more intensive use of inputs and physical capital (World Bank, 2013).

The majority of family farmers, especially in the North and Northeast, are below the poverty line, and their household income is derived mainly from agriculture. Improving resilience and raising agriculture yields is important and the efficient use of land is critical for achieving Brazil's economic and environmental goals; however, it is not sufficient. There is a need to combine social policies (safety nets) with agriculture technology adoption, improved market access, tailored technical assistance and off-farm income generating opportunities supported by education/vocational training.

The Brazilian Government has committed itself to lifting 16 million people out of poverty. Programs such as the National Program for Strengthening Family Farming (PRONAF) represent key elements to the strategy. 2 billion Brazilian Reais (approx. 650 million US dollars) , were assigned to fund the program in 2002, reaching over R $ 8 billion (approx.. 3 billion US dollars) by 2007 (Dieese, 2008).

If well applied, credit lines available through federal programs like PRONAF are powerful tools to allow farmers to adapt to climate change. However, distribution and application of funds to the poorest remains problematic. Risks of the strategy include debt or inadequate allocation of resources, which may increase socioeconomic vulnerability rather than reducing it. PRONAF is an emblematic case of the challenges and potential benefits of microcredit programs. It provides funding for smallholder farmers or associations of smallholder farmers. Investment in their access to basic goods and services allows local adaptation to climate change.

However, the program has benefited well-organized individual farmers and associations in the south of Brazil out of proportion to their northeastern neighbors. Moreover, to qualify for the program, farmers must hold formal title to their land, a requirement that renders the poorest among them ineligible. Fund distribution has also failed to include the training and educational components needed to ensure that farmers make the most productive use of resources. Spending on these programs has reduced poverty in the short-term but it is not clear that the effect will be sustained.

In 2009, the National Institute of Applied Economics Research (IPEA) launched an assessment about the Socioeconomic Vulnerability of Brazilian smallholder family farmers due to Climate Change. This assessment analyzed the vulnerability of smallholder farmers within all five macro regions of Brazil. Additionally, the study emphasized the importance of having climate

change adaptation tools embedded in public policies to be able to avoid the impact of extreme weather events on the poor. IPEA analyzed PRONAF performance in each region. Surprisingly, even though the majority of smallholder farmers are in Northeast, only 25% in the region were able to become beneficiaries of the PRONAF resources owing to the tight eligibility requirements. On the other hand, in the South region, which has a lower concentration of smallholder farmers, 38% of this group received funding from PRONAF. According to the report, three factors contributed extensively to such results: legal rights to the land; education; and effective rural associations. This paper demonstrates that smallholder farmers from different regions of the world also struggles with such issues. Such similarity is shown through the examples of Mexico, Sri Lanka and Kenya.

Throughout this study PRONAF impacts are assessed through a literature review of several impact evaluation analyses done over the first 15 years of implementation of the project.

After presenting the main challenges posed by climate change extreme weather events in the agriculture sector, specifically targeting smallholder farmers, this paper focus on understanding the PRONAF program logic and its background. Once the background and logic is set it, this paper evaluates the impact of PRONAF in several areas such as sustainability, improvement to access to markets, and diversification.

This paper concludes by pointing out that PRONAF still has a lot of improvements ahead in order to deliver the proper type of support to smallholder farmers. This study provides recommendations so the program can best impact the livelihoods of the poorest farmers who are concentrated mostly in the Northeast region of the country.

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CHAPTER 1

SMALLHOLDER FARMING AND CLIMATE CHANGE: A GLOBAL PERSPECTIVE

1. Adaptation and mitigation in climate change

As the effects of climate change become more apparent, the phenomenon has gained more space in academic studies, government policies, private sector and non-governmental organizations actions. According to Chapter One of the Fifth Assessment Report (IR5) of the Intergovernmental Panel on Climate Change (IPCC), the literature available for assessing climate change impacts, adaptation, and vulnerability more than doubled between 2005 and 2010. The increase contributed for a more robust assessment that supports policymaking strategies and actions.. The greater prevalence of disasters caused by natural hazards such as heat waves, hurricanes, floods and sea level rising has led to greater interest in the consequences of climate change. (IPCC, 2014)

The discourse on climate change has centered on two plans of action: mitigation and adaptation. Initially, the mitigation agenda dominated Mitigation covers renewable energy sources, more energy efficient equipment and management practices or environmental consumer behavior (UNEP, 2014). Nearly two decades of international negotiation in connection with the United Nations Framework on Climate Change (UNFCCC) have led to the discussion that those nations who have failed to implement mitigation laws justify by indicating numerous challenges in the political, economic, technological, and practical perspectives which translates the difficulties in establishing a functional mitigation legal regime (Craig, 2015).

Since the Industrial Revolution, fossil fuel exploitation, poor environmental legislation and capitalist economy have contributed to increase significantly the levels of pollution. Greenhouse Gas (GHGs) emissions in the atmosphere have been shown to be one of the main causes of global

warming. Its impacts will be so enormous that it is better understood as a problem of evolution, not pollution (Nordhaus and Shellenberger, 2007). Given the context of continuous increase of pollution mainly caused by the growing usage of fossil fuels, efforts have been made to be able to shift the way humans interact with the environment that surround them. Some countries such as Brazil have taken the lead in such a direction. Brazil is a leader in climate change mitigation efforts, as seen in the figure below by the sharply decline in deforestation, that declined about 82% in Amazonia from 2004-2014 (figures in thousand square kilometers.

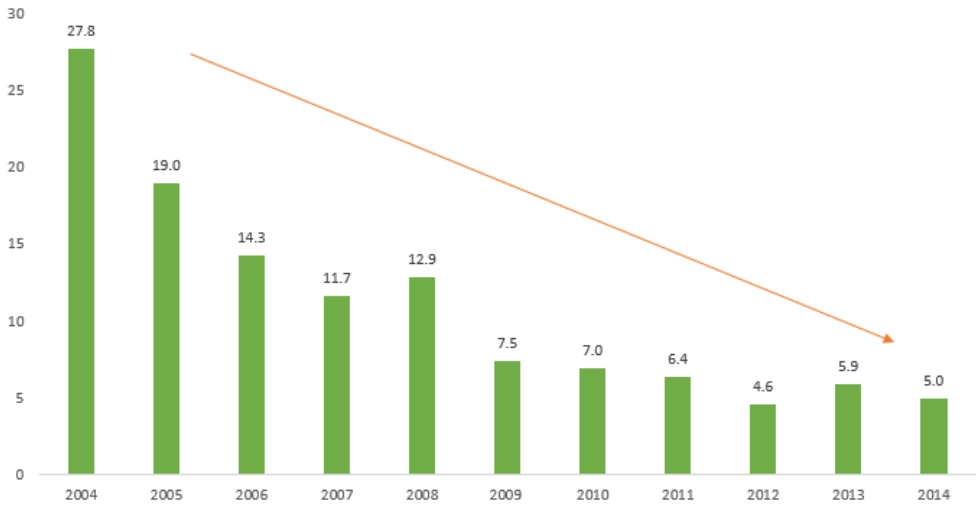

Figure 1: Decline in deforestation throughout the year - Brazil (World Bank, 2014)

Adaptation is the alteration of human practices in preparation for the vastly changing circumstances of our world, and ultimately to sustain life on earth. Since 2007, when the Fourth Assessment Report (IR 4) was launched, there was a constant debate on adaptation and mitigation strategies. Under the scope of both of the UNFCCC and IPCC, the discussion centered around only using adaptation strategies versus complementary adaptation and mitigation strategies. In this context, the IPCC Working Group II (WGII) concluded that even though separately, Adaptation and Mitigation cannot avoid climate change impacts and risks, if combined they can reduce

considerably the impacts of climate change;. Additionally the report also portrays that Adaptation is necessary both in the short and long terms to tackle climate change impacts. High costs are often seen as critical barriers that challenge broader implementation. If no immediate action is taken, unmitigated climate change, in the long term, would likely exceed the adaptive capacity of natural and human resources. At the current stage, mitigation efforts by itself cannot postpone, or eliminate climate change impacts on the upcoming decades, increasing even more the pressure on the poorest who often do not have the necessary financial buffers to keep up minimum livelihood standards. Therefore, adaptation combined with the already undergoing mitigation strategies can be seen as the best possible strategy to mitigate social impacts worsened by of climate extreme events. (IPCC, 2007)

In 2014, the Intergovernmental Panel on Climate Change launched its Fifth Assessment Report (IR5). This report was built in the findings of the 2007 Assessment and bring more evidence in regards to the importance on combining mitigation and adaptation strategies. According to this assessment, both strategies complement each other and are crucial to reduce climate change impacts globally. More specifically, the IR5 confirmed that climate change is likely to impact negatively food security by affecting several ecosystems and biodiversity around the globe. Such impact is likely to affect several ecosystems. There is high confidence that climate change without adaptation could negatively impact production of fisheries, wheat, rice and maize in tropical and temperate regions, due to local temperature increase in global temperature of 2°C or more above late 20th century levels. It is highlighted that the combination of high temperature increases of over 2°C or more above late 21th century levels and the constant increasing demand for food, would pose large risks to food security around the globe. Climate change is projected to reduce renewable surface water and groundwater resources in most dry subtropical regions. As a result,

intensified competition for water among sectors can be expected. Adaptation can make the difference to the well-being of populations, security of assets and the maintenance of ecosystem goods, functions and services not only now but also in the future; A first step towards adaptation is to reduce vulnerability to climate variability by increasing climatic resilience especially of the poorest communities. (IPCC, 2014)

Additionally, the report conveys the importance of linking adaptation into planning, designing and decision making processes of policies. Such practice could provide synergy within development and disaster risk management initiatives. Building adaptive capacity is crucial for effective selection and implementation of adaptation options (Synthesis Report- IR 5, 2014).

Adaptation planning and implementation can be enhanced through complementary actions across levels, from individuals to governments. National governments can coordinate adaptation efforts of local and sub-national governments. Such actions include protecting vulnerable groups, supporting economic diversification and providing information, policy and legal frameworks in addition to financial support. Local governments and the private sector are increasingly being recognized as critical to progress in adaptation, given their roles in scaling up adaptation of communities, households and civil society and in managing risk information and financing.

Constraints can potentially harm adaptation planning and implementation. Some examples of common constraints to adaptation are: lack of financial and human resources, poor integration or coordination between government agencies, lack of confidence about projected impacts, different perceptions of risks, and limited tools and resources to monitor adaptation effectiveness. Another constraint includes insufficient research, monitoring, and observation and the finance to maintain them. (Synthesis Report- IR 5, 2014)

IR4 and IR5 highlighted the importance of combining mitigation into adaptation strategies. Following the trend of the latest climate change forums and dialogues, considering the importance that adaptation has been gaining in recent years, this research will focus on the adaptation perspective of climate change. More specifically, this research aims to analyze ways to increase resilience following a climate change adaptation perspective through an enhanced support on rural credit.

1.1 Extreme weather events

1.1.2 Global Warming

Since 1950, According to the Special Report about Extreme Weather Events (SREX) of the IPCC, the balance of warm and cold days has been upset in favor of warm days. On a global scale, this special report indicates that human action is responsible for such shifts in weather patterns, warming of extreme daily minimum and maximum temperatures in the atmosphere and oceans at a global scale (SREX SPM, Sections 3.2.2, 3.3.1, 3.3.2, 3.4.4, 3.5.3, IPCC).

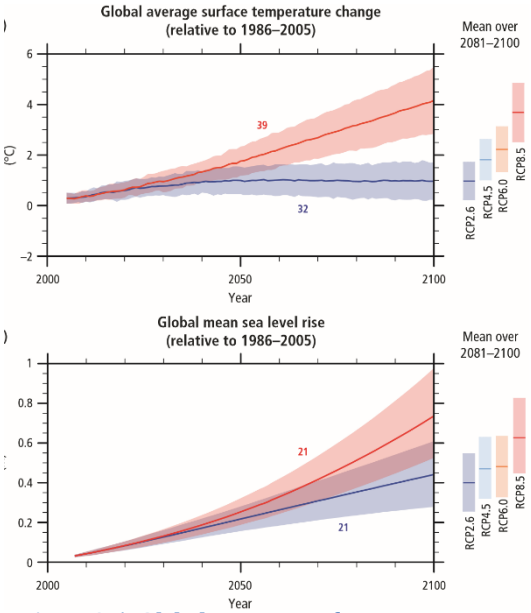

Figure 2: | Global average surface temperature change per each scenario(RCP 2 being the more optimistic and RCP8 being the more pessimist) - Figure SPM.6 page 11 SPM, 2014

The synthesis Report of IR 5 indicates that global mean surface temperature was 0.72°C warmer in 2012 than in 1951. Each of the last 3 decades (from 1983 to 2012) were progressively warmer than any previous decade since 1850 (SPM, 2014). The decade 2003–2012 was the warmest ever recorded.

Furthermore, increases in the frequency, duration, and magnitude of hot extremes along with heat stress are expected to continue.

All climatic scenarios projected under the IR 5 indicate that surface and oceans temperatures are projected to rise over the 21st century. It is very likely that heat waves will occur more often and last longer, and that extreme precipitation events will become more intense in wet regions at the same time that extreme reductions of precipitation are expected in dry regions. The ocean will continue to warm and acidify, and global mean sea level to rise.

Climate change will amplify existing risks and create new risks for natural and human systems. Risks are unevenly distributed. Even though impacts are generally greater for disadvantaged people, communities in countries at all levels of development are likely to suffer from the impact of extreme weather variations. However, poorer communities located in developing countries are likely to be more impacted as their livelihoods become unsustainable given the lack of savings to buffer crop failures. In fact, poorer communities if they were given the appropriate safety nets and systems for mutual aid, they would have the potential to be more ecologically sustainable than large-scale mono-cropping farmers, given that the land is their main source of income, it is of their interest that production should be sustainable and utilized resources optimized, to be not only productive but also long lasting. Furthermore, larger farmers have more resources to withstand shocks, in addition to the capacity of easily transit into other sectors for income production, these category is less sensitive and hence easier to adapt to climate extreme variations. Climate related impact results from the correlation between hazards and vulnerability including ability to adapt (IPCC - SPM, 2014).

The increase in global temperature is likely to impact several sectors across the globe. Recently the World Bank launched a series of reports named “Turn down the Heat,” which focus on

exploring possible impacts and results based on the scientific findings proposed in the Assessment Reports from IPCC. The first edition of Turn down the Heat indicates that agriculture will be particularly vulnerable, because extreme heat can cause severe yield losses. Tropical and sub-tropical ecosystems will be particularly vulnerable to climate change because the increase in absolute temperatures relative to past variability is larger in these regions.

1.1.3 Droughts and Floods

One of the main consequences of climate change is the increase in frequency of droughts and floods. Throughout Brazil, these climate related extreme events have been causing significant damage and impacting farmers? negatively, mainly the poorest. Even though droughts and floods areare both significant in Brazil, this paper will focus on the impact of droughts given the geographic focus and targeted audience chosen to be analyzed in this study. As will be demonstrated in the chapters to follow, droughts are one of the most common challenges faced by family farmers located in the drylands of Northeast Brazil.

Drought is among the most damaging, and least understood, of all "natural" hazards. Although some droughts last a single season and affect only small areas, recent research from several multilateral organizations such The World Bank, UN FAO, IFAD among others have shown that droughts have sometimes continued for decades and have severely affected North America, West Africa, East Asia and Latin America. (World Bank 2014)

There is growing evidence that the frequency and extent of drought has increased as a result of global warming. The fraction of land surface area experiencing drought conditions went from 10-15% in 1970 to over 30% in early 2000s (Mannava et al, 2014). According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), a warmer climate,

combined with an increased climate variability, will increase the risk of droughts (SPM, IPCC, 2007).

As predicted, drastic reduction in precipitation in semi-arid regions have become an increasingly common phenomenon. For example, recent long droughts include: Eastern Australia (1993 to 2006), Greater Horn of Africa (2010), and Northeastern Brazil (2010 to 2013). Precipitation decreases require irrigation water, which dominate water use in most semi-arid river basins, leading to an increased demand that current systems may be unable to fulfill.

Regardless of the region, usually socio-economic impacts due to droughts arise from the interaction between natural conditions and human factors. These include changes in land and water use. Direct consequences are not limited to reduction in crops and productivity, but also result in secondary impacts such as fire hazard and reduced opportunities and income for recreation and tourism.

Responses to droughts in most parts of the world are generally reactive, responding to drought after impacts have occurred. This approach – commonly referred to as crisis management – is known to be untimely, poorly coordinated and disintegrated. As a result of such ineffective responses to drought and its increased frequency, the economic, social and environmental impacts of droughts have increased significantly worldwide. Because of their long-term socio-economic impacts,

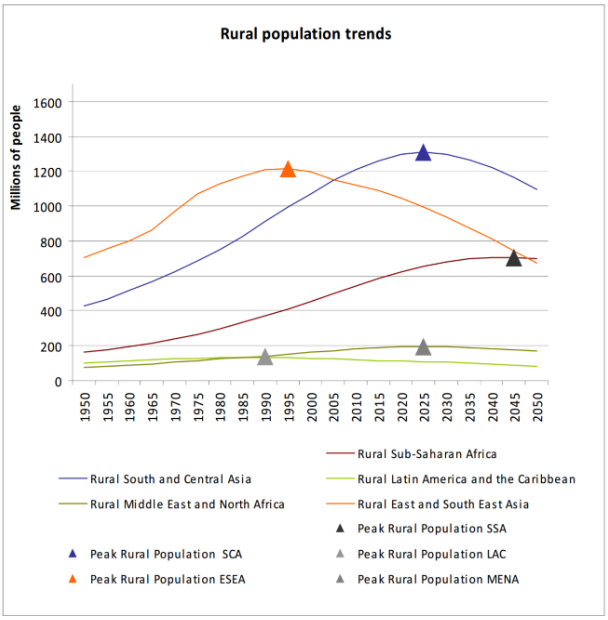

Figure 3 : Rural Population Trends from Rural Poverty Report 2011, International Fund for Agricultural Development

droughts are by far the most damaging of all natural disasters.

1.2 Climate Change sectoral impact: Agriculture in perspective

The projected increase in intensity of extreme events in the future would likely have adverse implications for efforts to reduce poverty, particularly in developing countries. Recent projections suggest that the poor are especially sensitive to increases in drought. According to the Rural Poverty Report of the International Fund for Agricultural Development (IFAD), global poverty remains a massive and predominantly rural phenomenon – with 70 % of the developing world's (1.4 billion) extremely poor people living in rural areas. (IFAD, 2011)

As a result of climate change extreme variations such as warming temperatures and lack of rainfall precipitation, farmers all over the world are experiencing reduction in crop productivity resulting in less income for them, increasing propensity for hunger, increased prices for food, higher unemployment rate, and outbound migration.

In order to avoid such a scenario rural economic growth and climate change resilience should be prioritized in the agricultural sector and rural areas. It is essential to improve the overall environment of rural areas, including infrastructure, utilities, services and governance. Such factors can help poor people manage and reduce their risk. Additionally, it is vital to enable poor rural people to manage and potentially reduce the risk faced by them. In order to succeed in such accomplishment it is necessary invest to in education to enable rural poor populations to develop the necessary skills to pursue new economic opportunities. Additionally, there is an ongoing need to strengthen the collective capabilities of rural people, particularly through their membership-based organizations. These organizations give people confidence, security and power – all invaluable attributes for overcoming poverty.

1.3 Smallholder Farmers definition and vulnerability to climate change extremes

Since Alexander Chayanov's *Theory of Peasant Economy* first defined a concept of agricultural smallholders, the idea has undergone discussion and transformation. Nonetheless, his theory that the smallholder agriculture sector relies on full operation of the farm by the family, and household income derived primarily from on farm activities. Recent scholars, such as Wiggins and Hazell, operationalize the definition of smallholder agriculture farms as 2 hectares or less (Wiggins et al., 2010; Hazell et al., 2010; IFAD, 2010). The quantification for objectivity tends to be the most commonly utilized. Nonetheless, others have recognized its limitation. According to Nagayets, the two-hectare rule fails to properly account for the quality of resources encountered, types of crops cultivable and the disparities among regions in land size proportion (2005). One region in which this holds true is for smallholder farmers in Latin America, where differences in soil fertility and farming practice make purely size-based definitions impractical. Therefore, the Brazilian legal definition of smallholder farms will be utilized for the current research, outlined in detail below.

Over half a century, family farming has undergone major transformations spurred by unprecedented weather variations and changes in their natural characteristics. According to the Global Assessment of Human-induced Soil Degradation (GLASOD) not only the size of the land available for farming is decreasing, but soil quality is deteriorating. Water resources also are becoming scarcer and water quality is deteriorating. Conscientious use of limited resources is necessary to meet challenges that the agricultural sector faces due to climate change variations.

Though planning for future climate change and better utilization of resources remain important goals, the current consequences of climate change cannot be ignored. For instance, droughts throughout the globe have already caused substantive impacts on smallholder farmers.

According to the Latin America (LAC) volume of *Turn Down the Heat*, increasing drought events may lead to problems for urban water supply or widespread cattle deaths. Smallholder farmers in arid or semi-arid areas such as Northern Mexico and Northeast Brazil may experience lower productivity or even lose entire harvests, threatening their livelihoods. A decline in agricultural productivity may cause localized famines, especially among remote indigenous communities. Smallholder farmers tend to be less resilient to weather extremes than medium to large-scale farmers given the lack of financial buffers as previously mentioned. With different patterns and quantities of rainfall, the capital of small farmers' knowledge regarding planting and harvesting decreases or disappears. Even farmers with adequate areas of land and good soils are vulnerable when changed weather patterns makes it harder to predict how much they may expect to harvest.

Recognizing the inter-farm differences in poverty (defined for the purposes of this study as the absolute measure to assess basic human needs) and vulnerability (defined the purposes of the study understood as the propensity to suffer a significant welfare shock, bringing the household below a socially defined minimum level), Soto Baquero subdivides smallholder famers in three group categories: consolidated or group A (59 hectares on average), transitional or group B (34 hectares on average) and subsistence or group C (18 hectares on average,); the latter contains the largest number (Soto Baquero et al.2007). Furthermore, it is noteworthy that small farmers who live in high precipitation areas and excellent soils can be more productive and profitable than larger farmers in a dry area with poor soils.

Group A includes smallholder farmers that have high standard of livelihood. These farmers have access to productive land, market and capital. This category usually makes substantial contributions as producers of food to be sold in domestic or international markets. Group B,

though they have some assets, there are lack of critical elements for efficient production. This group is not as attractive to the market as Group A (agribusiness). They face challenges in regards to public policies, which tend to target farms with market power or the most disadvantaged. Nonetheless, Berdegue and Escobar consider this category prime for strategies and public policy actions due to its potential for fast improvement and economic growth (2002).

The third and last category is subsistence. In this category are farmers with little resources, situated in places unsuitable for agriculture practices or economic activities. These individuals usually have most of their income derived from off-farm activities and are increasingly dependent on low income non-farming jobs. Though unlikely that agricultural development policies would be able to move the people in this category out of poverty easily, public policies need to be targeted to this category to avoid further indigence due to the high level of vulnerability (Berdegue and Escobar, 2002). Hence research has shown that this category would be better off if moved away from agriculture /rural areas. This is the case of several family farmers in Paraiba, the state with the highest concentration of outmigration in Northeast Brazil.

This research will target smallholder farmers in category B as the unit of analysis. This group which already has achieved the minimum conditions required to transcend poverty is likely to have the basic conditions to improve their rural credit and therefore achieve more resilience, given that the necessary support is provided to them. This topic will be discussed in greater detail in the chapters to follow.

1.4 Smallholder farmers' vulnerability to climate change: Country case scenarios

In order to illustrate the vulnerability that smallholder farmers face towards climate change induced extreme variations such as droughts some case scenarios will be described and analyzed

below. The country scenarios were chosen based on some level of similarity (climatic, social, demographic or even economic) with Brazil, the targeted country analyzed in this study. It is expected that droughts have been impacting smallholder farmers worldwide. It seems that some reaction has been taken however several different programs and initiatives that have been implemented share the same weaknesses and approach of action, yet not achieving the goals that they were created for.

1.4.1 Mexico

In Mexico, agriculture contributes only about 3 percent to gross domestic product (GDP), even though 22 percent of the population live in rural areas. Forty-four percent of the rural population is employed in agriculture. According to a recent UNCTAD report, 61% of Mexico's rural population lives below the poverty line. (UNCTAD, 2012)

Such tough reality faced by the Mexican rural population composed mainly by small farmers which represent 73% of the total of land owners can be explained by the following reasons: (a) linkage between agriculture policy and trade policies – due to entrance in NAFTA, several tariffs which would protect maize producers have been eliminated; (b) Mexican farmers are often at a disadvantage in relation to USA production due to the lack of tariffs and geographical proximity; (c) Processing market is dominated by two major players (GIMSA and Grupo Minsa have 97% of market share); (d) highly concentrated markets in the case of Mexico usually are characterized by promoting less competition having a negative impact on prices and product innovation (UNCTAD, 2012)

Mexico is the country most exposed to extreme weather events in Latin America. The country experienced 18% of all disasters in the region from 1970 to 2009 (World Bank et al, 2014).

It is likely that such extreme events can potentially increase the vulnerability of local smallholder farmers if proper policies do not take place in a priority basis.

Smallholder farmers in Mexico are highly vulnerable to climate variability and change. Their vulnerability is related to: (a) Lower than average crop yields (Mexican smallholder farmers usually produce 20% less than commercial ones) ; (b) small land tenure size (73% of farmers own less than 5 ha which is usually the range to be considered a smallholder in Mexico due to the lack of official definition); (c) Dependence on regularity of environmental conditions for production since 90% of smallholder farmers are rain-dependent, compared to 63% of commercial farmers; (d) Even though in theory there are public policies to target specifically smallholder farmers, in practice none of those have been achieving practical results to benefit the targeted audience, therefore there are lack of finances, savings healthcare, subsidies, tools, and inputs available to help cope and adapt to climate impacts. (World Bank et al, 2014)

Mexico has a remarkable record of addressing climate change challenges and is considered a global leader in the topic. The country's comprehensive strategy for climate resilient and low carbon economic growth is one of the most active in the world. Driven in part by the country's vulnerability to climate impacts, the Mexican Government has shown its commitment, long-term vision, and political will to addressing climate change through its policies and its active role in global climate forums.

The Mexican government has sought partnerships with international organizations such as IDB, The World Bank to strengthen its financial support to its nationals, especially the rural poor portion who are often the most sensitive to climate change impacts.

Programs such as the Savings and Credit Sector Strengthening Program implemented by the National Savings and Financial Services Bank (BANSEFI) with support of the World Bank

provided investment lending, development policy loans, grants, rural credit enhancement, hedging swaps, and catastrophe risk management for those public that are unlikely to receive such assistance from commercial/ private banks (Taber et al, 2004). As previously mentioned, these programs would be of great support to smallholders, however, evidence shows that most of the benefits are captured by larger farmers.

1.4.2 Kenya

Agriculture has become a key sector of Kenya's economy, employing more than 80% of Kenya's rural workforce and generating 28% of GDP and 65% of Kenya's exports. The Crop subsector accounts for 78% of total agriculture production, livestock corresponding to 20% and fisheries to 2% (Stefanović, 2015).

Despite the expansion of Kenya's agriculture sector, the country faces severe food security and productivity challenges. This scenario is magnified by the lack of inputs and irrigation. In 2012, only 0.16% of arable land was irrigated, and there was limited access to markets, market information and training/extension services, all of which thwart agricultural investments and exacerbate gender inequalities.

Smallholder farmers (owners of land with less than 10 Ha) are great majority in rural Kenya, accounting for 78% of the total agricultural output in the country. Mostly rain fed based, this system is usually characterized by mixed crop-livestock. Even though this group represents the majority in matters of population, this category occupies only one third of the country's land area.

Food insecurity is considered one of the the main challenges threatening smallholder farmers' livelihoods. This scenario is a result of the incapacity of sustaining agriculture production during

the whole year. In 2011, Kenya registered one of the driest years since 1950, this scenario of consecutive below average rainfall precipitation pattern intensified the challenges previously mentioned. As a result of climate related events such as low and unreliable rainfall patterns, many the productivity of staple crops (maize, wheat) remains below world and regional averages.

Climate change is perceived as a threat to agricultural productivity by smallholders in most parts of Kenya (Bryan et al., 2013; Tongruksawattana, 2013). Factors such as lack of resources and access to markets, limited water access, in addition to low level of education pose crucial barriers to improve smallholder farmers practices to become resilient from climate change impacts. In order to mitigate the impact of droughts and other climate related extreme events, poorer families do their best to reduce consumption, selling and borrow assets.

Kenya's smallholder farmers tend to be considered particularly vulnerable to climate change due to low levels of income and technology, in combination to the lack of access to markets and institutional support as previously mentioned (Morton, 2007). Low income producers often do not have the means to invest in adaptive technologies and strategies under increasing climatic risks (Vermeulen et al., 2012). As a result, even in an agriculture-dominated economy, the country is recipient of around 4% of the total amount of food aid given to the entire Africa continent yearly.

1.4.3 Sri Lanka

Sri Lanka has demonstrated continuously GDP growth in the past years and is considered an emerging Asian economy. Agriculture is considered one of the main drivers, representing 12% of the entire GDP. Additionally, the agriculture sector is an important source of employment for 42% of the population (World Bank et al, 2015).

Climate change represents a threat to several sectors of the Sri Lankan economy. Wet areas are becoming wetter, while the dry areas are becoming drier. Smallholder farmers, who cover the majority of the total land area used for food production in Sri Lanka, are constantly seeking to become more resilient in regards to food production systems under the scenario of increased climatic change and variability.

Despite rapid growth, Sri Lanka's agricultural sector is characterized by low levels of productivity and a lack of diversification. In order to boost the sector, major social, economic, environmental and policy-related challenges will need to be faced. Even though irrigation systems and drought-resistant varieties are widely used in the country, smallholder farmers have difficulties in accessing them. Lack of irrigation, access to markets and absence of insurance and credit programs make investment in productivity and sustainable practices especially difficult for smallholders making challenging compete with local large-scale enterprises.

Sri Lankan agriculture has already been affected by increasingly extreme droughts and floods. Climate change variations and instability will continue to impact the agricultural sector as a whole, but will be especially acute for Sri Lanka's smallholder farmers, due to several factors: (a) Lack of access to irrigation systems which will increase the susceptibility to drought (according to Climate Change specialists from the United Nations Food and Agriculture Organization - FAO and the World Bank Group drought has already reduced rice yields by 44% in the country). (b) Reliance on rain fed systems threatens staple crop productivity in a scenario of reduced and instable rainfall pattern.(c) Lack of diversified production (heavily concentrated in rice), which, given anticipated higher temperatures, may make agricultural production more risky. (d) Impact in the production of crops such as root and tuber which are mainly produced by smallholder, can be severely impacted by raising temperatures. (e) Limited access to technology (e.g., watering and

silage production techniques), which impedes small-scale livestock farmers to cope with climate-related challenges.

1.5 Analysis of global scenarios: Conclusions and comparisons.

Climate change has become a topic of major importance in the scientific and political discourse of recent decades (Niang et al., 2014). The link between climate, farm productivity and food security is widely recognized (Wheeler and von Braun, 2013). Climate change goes beyond environmental concerns and matters. Evidence has shown that climate change extreme events will not only impact multiple sectors in different parts of the globe, but also will have a direct impact as threaten to socio-economic livelihoods of the poorest.

The previous section described the impact of climate change extreme events in smallholders from Latin America, Africa and Asia. Regardless of geographic location, all the examples provided (Mexico, Kenya and Sri Lanka) have similarities that enable us to draw some conclusions on the challenges faced by smallholders in a scenario where drier regions are experiencing more frequent droughts.

Comparing the challenges faced by smallholder farmers in Mexico, Kenya and Sri Lanka is possible to assess the following difficulties are presented in all the cases: (a) lack of legal definition of the concept of smallholder farmers and land size definition to be considered a smallholder (b) lack of public policies or government support with plans specifically designed to smallholders; (c) lack of education which increases the vulnerability to smallholders to climatic extreme changes since there is a problem of awareness of such climatic realities and respective alternatives available; (d) lack of access to markets and resources to invest in production (e) lack of access to irrigation leading to dependency on regular rainfall patterns.

Brazilian smallholder farmers are also facing the same challenges confronted by their peers in Mexico, Kenya and Sri Lanka. In Northeast Brazil, where the majority of the nation's smallholder farmers are located, climate change has been impacting the livelihoods of local smallholders. Even though Brazil has a legal definition of smallholders and efforts have been made to create public policies targeting specifically smallholders, such category still faces socio-economic challenges. Among several of them some examples are: lack of education, lack of land titling, lack of farm associations, lack of infrastructure, lack of access to markets and resources. This negative socio-economic scenario makes smallholder farmers from Northeast Brazil very sensitive to climatic variations. In the following chapters, Brazil and more specifically the Northeast region will be further analyzed in regards to the conditions and threats faced by local poor smallholders.

CHAPTER 2

THE VULNERABILITY OF SMALLHOLDERS IN NORTHEAST BRAZIL TO DROUGHT

2 Country and regional context

The agricultural sector plays an important role in underpinning Brazil's economic performance in matters of reduction of extreme poverty throughout the years. Brazilian agriculture has seen strong growth for over three decades even under the current context of political-economic crisis that the country has been facing for the past two years.

Total agricultural output has considerably increased if compared to outputs from 1990. It has been recognized the important contribution that the agriculture sector makes to the country's trade balance. Exports by agriculture and agro-food industries totaled over USD 86 billion in 2013, accounting for 36% of total exports. These exports end up compensating the deficits in other sectors. Therefore Brazilian agriculture has been increasing in importance as a sector that contributes positively as a receptor of foreign currency. Brazil's agricultural exports make it a major player on international markets. Brazil is among the world's largest agricultural exporter and the biggest supplier of sugar, orange juice and coffee. It is also a major producer of maize, rice and beef even though the majority of which are absorbed by the large domestic market. (OECD, 2014)

The agricultural sector is responsible for about 13% of Brazil's employment in 2012, or almost three times its share in GDP. The reality of low labor productivity compared to the rest of the economy reflects in part the dualistic nature of the rural framework in Brazil, where capital-intensive and large-scale production coexists with traditional farms, including many small and resource-poor farms producing for self- consumption or local markets. Nevertheless, the labor productivity gap in agriculture is declining, with rapid improvements in labor productivity driven

mainly by more capital-intensive production. Some of that growth occurred among small-scale farms producing high value products. The country is relatively urbanized, with 85% of the population living in urban areas in 2013 (World Bank, 2015). The majority of the poor live in urban areas and spend a significant share of their income on food. The rural poor are less numerous, but the incidence of poverty is more than double that in urban areas, at nearly 30%. (OECD, 2014).

As already described, yet there is no legal definition of smallholder farmer in the Brazilian law framework. Therefore, it is common to utilize the definition of family farming whenever approaching smallholder farmers. The family farming concept in Brazilian law shares important similarities with scholarly concepts but also differs on a number of points. According to federal law 11.326 of 2006, family farms are defined by four characteristics. First, land holdings are limited to four [1]fiscal units (*módulos fiscais*). Units vary widely in size across municipalities, according to natural resources and existing production patterns. For instance, a unit is defined as fifteen to 90 hectares in the Northeast and 5 to 40 hectares in the South (World Bank, 2013). Second, the household derives income primarily from agriculture. Third, family farms use household labor for on-farm activities, with no machinery assistance. Finally, the household manages the farm using a minority of full time employees (the amount of full time employees external to the family should be smaller than the family size) (Censo Agropecuário, 2006). Family farms gain legal recognition through the Declaration of Eligibility for the Federal Program for Family Agriculture - PRONAF (Declaração de Aptidão ao PRONAF - DAP).

[1] (*)A fiscal module is a tax-related measure based on the potential income generation from the land, ranging between 5 and 110 hectares, depending on the geographical area. Using this definition, 84% of Brazil's farms are family farms, averaging 18.4 hectares.

The legal definition of family farm is used throughout this research paper due to its importance as a reference for public policy in Brazil, but it is noteworthy as specific to this context. In many parts of the world, family farms are identified exclusively by type of management —those that are family based and operated—without considering other factors, such as work off-farm or even the size of the farm. (World Bank, 2013) This creates a discrepancy with the international literature, and even with some of the Brazilian literature, that must not be forgotten. For example, Brazilian small farms that are well-inserted into the labor market with income mostly generated from off-farm activities, are legally non-family farms. In many other parts of the world, these would be included as family farms.

Even though Brazilian family farms tend to be comparatively small, and lack physical and human capital, they represent the overwhelming majority of farm establishments in Brazil. Together, they have a higher aggregate production than non-family farms, though it is possible to argue that this is an artifact of differences in the size of the two groups. Proportionally, small farms have higher output per hectare than large farms, and family farms tend to be small. When comparing farms of the same size, non-family farms uniformly have higher land productivity. This appears to be a result of a more intensive use of inputs and physical capital, not of an inherent superiority of one type over another (World Bank, 2013).

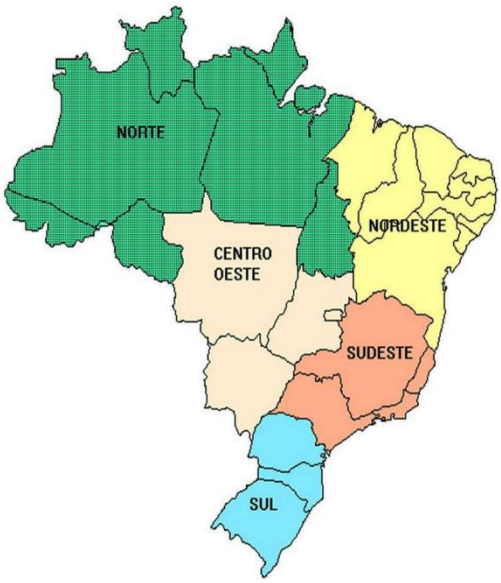

Figure 4: Brazil Map with Macro Regions

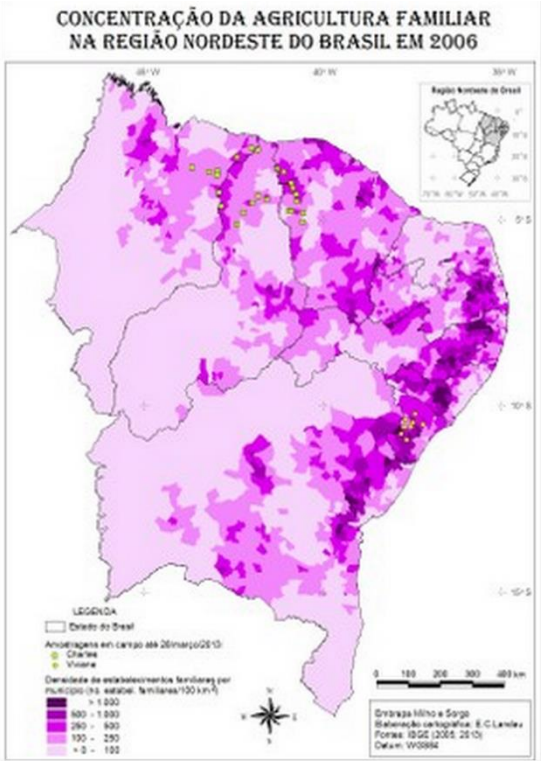

Figure 5 Smallholder concentration in NE of Brazil

The discussion about family farming goes beyond the concentration of this type of agriculture per region and how much land and other assets they own. Ability to use their assets and transaction costs faced can limit production even within a given land size and soil fertility (Soto Baquero et al., 2007).

Climate change, as evidenced by the increasing frequency and severity of droughts, can further impact the vulnerability of small farmers. With different patterns and quantities of rainfall, the capital of small farmers' knowledge regarding planting and harvesting decreases or disappears. Family or smallholders farms defined by their reliance on agricultural production who cannot predict yearly planting outcomes due to changed weather patterns, then, become uniquely vulnerable to poverty and uncertainty. This can be true even in the face of adequate land size and soil quality.

For the purposes of this study, drought will be defined as a regionally extensive occurrence of below average water availability, deviation in variables such as precipitation, soil moisture, groundwater and streamflow. Drought is usually caused by low precipitation or high evaporation rates. It is important to distinguish drought from aridity and water scarcity. Aridity is a permanent feature of

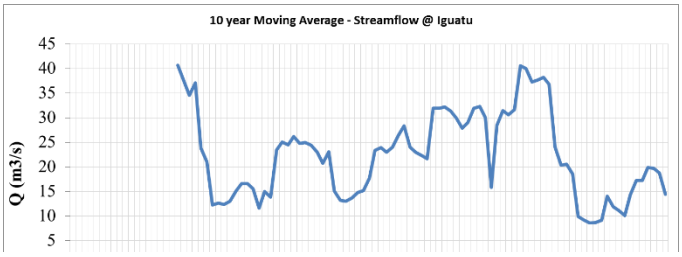

Figure 6: Natural stream flow at Ceará from 1912-2014, as depicted in the 10-year moving average, to illustrate the high climate variability in the semi-arid Northeast and its impact on water resources. Drought preparedness and Climate Resilience Report – World Bank, 2015)

a dry climate; water scarcity occurs when the shortage of water is caused by mankind using more water than naturally available.

The extreme drought that the Northeast region in Brazil faced from 2010 to 2013 revealed how vulnerable the region remains when rainfall and natural water availability are below average for several consecutive years (most severely from 2012 up to 2014). The livestock sector was put at risk, with the death of a significant number of cattle.

In addition to livestock endangerment, reservoirs are also at historically low levels in the Northeast region. This has threatened the ability of communities to maintain adequate potable water supplies and water for other uses, such as irrigation, hydroelectricity and environmental goods. The impacts of prolonged droughts are often concentrated on the rural poor located in the semi-arid area of Northeast. Ultimately, these impacts threaten the considerable gains in economic, social, and human development that the region has experienced in the past several decades, placing many at risk of slipping back into extreme poverty.

During extended periods of drought, Brazil has prioritized emergency actions to mitigate the economic losses in drought-stricken areas. Examples include, but are not limited to, increased special lines of credit, renegotiation of agricultural debts and expansion of social support programs, such as Bolsa Estiagem and Garantia-Safra. The latter are Brazilian cash transfer programs targeting poor families and farmers. In addition, policies such as Operação Carro-Pipa deliver potable water by tankers to local rural communities. In order to the community have access to these programs, it is necessary that the municipalities declare a “situation of emergency” or a “state

of public calamity," intense and serious alterations of the regular conditions beyond local capacity to respond. States and federal governments then verify and provide access to the drought-emergency resources and programs.

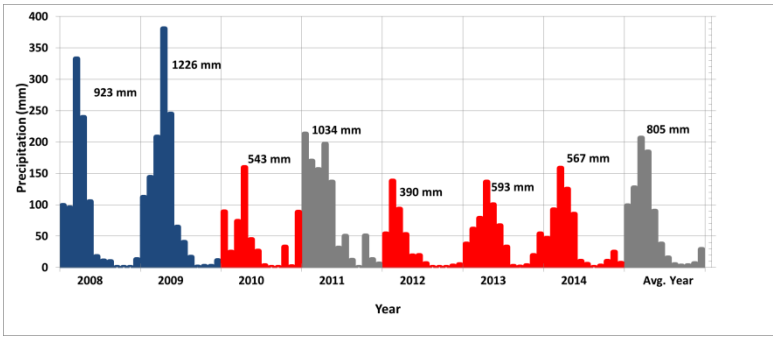

Figure 7: Monthly average rainfall and rainfall distribution (January-December) for Ceará state in Northeast Brazil, from 2008-2014. Wet years are depicted in blue, dry years in red, and the average years in grey. The average year in terms of distribution and amount is located at the far right of the figure. (E. Denys et al, 2014)

The declaration and assistance process does not involve a systematic procedure for objectively defining what should constitute an emergency or public calamity, without a specific set of scientifically informed indicators or criteria on which to base the declaration. Not only do the emergency policies fail to predict and appropriately plan for future droughts, subsequent relief measures are often slow, inefficiently targeted, and subject to political corruption. Thus, bringing objectivity into the declaration process and implementing preventative measures to reduce the future spatial and temporal impact of droughts are necessary goals to be pursued.

2.1 The institutional history and context for drought management in Brazil since the XX century

In 1934, the Brazilian government tentatively responded for the first time to a new cycle of sequential droughts during that period using a new set of interventions created to deal with drought, superceding earlier, innefective ones. The creation of the Water Code represented a benchmark for the classification and use of water resources, focused on not only the use of the country's hydraulic potential, but also in the principles for multiple water uses, with concern for water quality and economic value (De Nys et al, 2014).

Moving forward in time, in the early 1950s, when water development was treated as an economic matter for the first time, several key federal government agencies supported institutions to foster the issue of water management. A good example of such support was the creation of the Bank of Northeast Brazil (BNB) which supported the regional economic development through subsidized credit to farmers in the region. In addition, as a response to another severe drought that took place in 1958, several integrated actions for water infrastructure were institutionalized with the creation of the Superintendence for the Development of the Northeast (SUDENE). Even though such institution has been abolished years later, in 2001 it was reintroduced as Agency for the Development of the Northeast (ADENE) and then, in 2007, recreated as SUDENE under the scope of the Ministério da Integração Nacional (hereafter MI) (Malgalhães, A.R., 2011).

In the context of the reform of the Federal Constitution which happened in 1988, the transition from the end of the 20th century to the beginning of the 21st, focused on management and control of hydric resources. In this period the national system of water management and the reformulation of the criteria for granting water use rights were established. One key aspect on this regard was the installation of a National Policy of Water Resources, as well as the creation of the National System of Water Resource Management and the National Water Agency (ANA) as an implementing and coordinating institution of the National System with responsibilities that would transcend the federal domain. As per the Constitution, water is considered a limited natural resource and an inalienable public good that belongs either to the Federal or the state government.

The aforementioned steps together constituted a new approach to water management and drought policies in Brazil.. It is also noteworthy the presence of two very different perspectives in which drought is experienced in Brazil. On one hand, there are many people whose access to water is not an issue since they are located close to perennial sources of drinkable water. Within these

communities are the direct beneficiaries of the above mentioned evolution of water policies and projects, which serve as a form of drought management. On the other hand, there are the diffuse populations and rain-fed farmers who still have no reliable access to water, but instead have been heavily dependent on mechanisms to address water scarcity and droughts.

For this second group, drought management has been a reality over the years either reactively (e.g. rain-fed water cisterns construction, well drilling and recovery, dam and pumping station construction, or through social safety net mechanisms such as Operação Pipa, Bolsa Estiagem, and Garantia Safra, or to a lesser extent proactively (e.g. building resilience at the farm level, work on drought resilient crops by the Brazilian Agricultural Research Corporation (EMBRAPA),etc.). Malgalhães, A.R., 2011)

In regards to the semi-arid regions of Brazil, where a coexistence between droughts and water scarcity can be observed, it is important to notice that the above mentioned mechanisms responded to needs on new water policies that reflect changed conditions where increasing water demands and worsening drought conditions from climate change impacts have become more frequent. Since there is no adaptation in the policies to the climatic circumstances that the region faces, these programs still fail to address more specifically the impact of droughts and other weather extreme events that might affect water availability (De Nys et al, 2014). Responding efficiently to this issue is essential to meet the anticipated needs from these future natural stresses.

Even though it is clear that a lot of progress in managing and adapting to droughts in Brazil has been achieved throughout the decades, the impacts from the current Northeast droughts indicates that there is still a need to improve preparation and response measures. Due to the diversity and heterogeneity of the region a single and standardized solution it is unlikely to address all the challenges by drought events in the Northeast region (De Nys et al, 2014).Therefore it is

imperative to come up with context-specific solutions for access to water for human consumption, agriculture, animal grazing, and food security based on local inputs and targets.

2.2 The impact of Droughts to Smallholders in Northeast Drylands– Literature Review

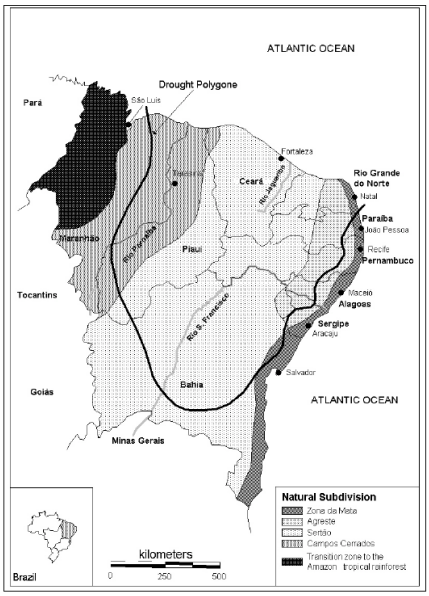

Figure 8: Natural Subdivision of NE Brazil (Sietz, D 2006)

The following section will address in detail the reality faced by smallholder farmers in Northeast drylands of Brazil. A historical-qualitative approach will give us a better sense of how the challenges posed by climate change are already affecting familiar agriculture production of crops in the different states of the region.

By analyzing regions such as the Northeast of Brazil is possible to understand the co-relation between environmental degradation and rural poverty. In states such as Pernambuco, the risks of further desertification and water unavailability, which are already high, continues to worsen due to lack of infrastructure and bad agriculture practices that increase the salinization of the land (Voerkelius et al. 2003). In addition, chances are high that the region will be affected by a reduction of annual rainfall in the course of global climate change (Gerstengarbe & Werner 2003). Therefore the region is well-suited for the purposes of this study since it is possible to analyze at the same time the heterogeneous environmental changes within a regional context, in addition to the lack of technical assistance for creating efficient strategies to reduce the environment impact and increase the droughts' resilience of local smallholder producers.

One of the most severe multi-year droughts in decades has been affecting Northeast Brazil since 2010. At the same time, studies were released indicating that the region will likely suffer even more prolonged droughts and water resources stress with climate change (IPCC, 2013).

The NE region has a long history managing and living amongst these challenging conditions, in this context initiatives to improve water storage and the creation of innovative institutions and programs to deal with water and climate variability have been taking place in the last years. These improvements in addressing long-term water needs have helped the region progress over the past decades. However, when extreme droughts occur in the Northeast, these decades of studies and all the work putted to build up structural solutions, will be proven to be insufficient to tackle these multi-year periods of shortage in rainfall. Furthermore, Brazil (like most nations) has approached the management of multi-year drought events that occur every several decades through various emergency relief and response activities. Combined with the relatively poorer socio-economic conditions of the region, this challenging situation leaves the Northeast acutely vulnerable to extreme droughts.

The drought impacts and their associated emergency response activities are likely to come at a high cost to society. However, the region lacks a robust and multi-sector analysis that accounts for these impacts and costs, especially because of the difficulty in defining the start of a drought. Historically, Brazil has not suffered with the impact of natural hazards as other countries, such as Japan, have it. This is one of the possible explanations to justify the emergency- driven approach while dealing with climate change impacts.

Much of the literature on economic impacts of drought is concerned with estimating losses in agricultural activity. The literature about the topic can be divided in two main strands, the first being more qualitative and descriptive, and the second one more quantitatively described, assessed

through econometrics models. This report will focus on the qualitative descriptive strand, which approaches case studies that document losses in agricultural production and livestock in regards to a reference year characterized by normal precipitation levels. From a qualitative perspective, studies have been built on the assumption that deviations in realized agricultural output in years characterized by abnormally low levels of precipitation (relative to a reference year) can be attributed to drought. Under this assumption, a simple before-and-after comparison of agricultural output gives an estimate of the losses imposed by the drought.

Several qualitative studies have been conducted to assess losses in agricultural production associated with drought in the Northeast of Brazil. Sarmento (2007) portrays the role of drought in explaining the evolution of agricultural value added at the state-level over the period 1970-2001. To compute the cumulative loss of agricultural GDP that can be reasonably attributed to drought, the study considers only drought years in which agricultural value added experienced negative growth (relative to the previous year). By applying this criteria to the states of the Northeast (with the exception of Maranhão), the study finds that three states from the semi-arid region (Rio Grande do Norte, Paraiba and Ceará) account for 52% of this cumulative loss. However, the study from Sarmento does not take in consideration the lost of production due to drought in years that agriculture value added grew. The author brings up a solid argument, but at the same time could understate the impacts of drought given that prices could spike or decline due to outside market pressures, meaning that growth or decline in agriculture value added was not due primarily to the amount of precipitation.

Khan et al. (2005) analyses the co-relation of the impact related to the period between 1998 and 2001 droughts on agricultural production, employment and income in the state of Ceará. The empirical analysis draws on survey data from official sources and uses the year 2000 (which was

characterized by regular precipitation levels) as reference year for computing losses for several crops (rice, beans, corn and cotton). The results show that, in 2001, in the state of Ceará, the drought was associated with losses in production revenue of about 70% relative to potential. In comparison with the 1998 drought, the one observed in 2001 was associated with larger losses in agricultural production and revenue, but with similar employment losses.

Ximenes et al. (2013) employs a similar methodology to quantify losses in agricultural output in the Northeast of Brazil since 1991. Based on historical precipitation data from INMET since 1960, they first identify drought years based on negative deviations of annual levels of rainfall from the historical mean. The following drought years have been identified from the 1990s onwards: 1992-1993; 1998; 2001-2002; 2007; 2010; and 2012-2013. Using data from the IBGE surveys Producao Agricola Municipal (PAM) and Levantamento Sistematico da Producao Agricola (LSPM), they then quantify losses in agricultural production associated with drought by computing the relative or absolute deviation of production quantities and values. In doing so, they distinguish between losses in temporary and permanent crops.

The results indicate that, relative to 2011, physical output of temporary crops would decrease by 13% per year between 2012 and 2013. These losses were clearly higher than in 2010, when output of temporary crops fell by 1.5% relative to 2009. But they were cumulatively smaller than in the 1992-93 drought, when output losses amounted to 4.6% and 40.1%, respectively (relative to 1991).

Ximenes et al. (2013) also provide evidence on the degree to which the production of specific crops was differentially affected in drought years. For dryland farming crops (beans, corn and cassava), the results provide evidence of sizable absolute losses in physical output in 2012-13.

In absolute terms, these losses were comparable to those observed in 1992-93. With regard to some of the most important permanent crops in the Northeast (banana, orange, coconuts and cashew nut), the most significant losses refer to cashew nut, whose physical production (measured in tons) experienced losses of 53% in 2010 and 66% in 2012.

2.3 Social-economic crisis: Structural adjustments in Brazil

Currently, Brazil finds itself in the middle of a painful macroeconomic and fiscal adjustment. Brazil faces the choice to address inequities in public spending and reduce transfers to the better off, or contemplate the need to unwind social programs and thus reverse some of the social gains achieved between the 1950's and 1960's, also known as the "Brazilian Golden Decade". The underlying fiscal problem of gradually rising expenditure commitments, particularly to the non-poor, was not addressed during the period of rising revenues. With the turn of the terms of trade, the adjustment has become both more necessary and more difficult as the distributional trade-offs at the heart of Brazil's fiscal policy challenge can no longer be hidden behind a rising public sector footprint. Beyond fiscal adjustment, however, to relaunch sustainable economic growth, Brazil needs to address its structural problems, including low investment, lack of adequate infrastructure, and the high cost of capital with segmented financial markets.

The Brazilian Government is implementing a strategy to eradicate extreme poverty and focus on improving opportunities for vulnerable populations. The multi-sectoral Brasil Sem Miséria program targets the 16.2 million people living in extreme poverty – i.e. with less than R$70 per capita per month (about US$1.5 per day). This implies a strong focus on the Northeast, where 59% of the extreme poor reside (Ministerio de Desenvolvimento Social webportal).

Ceará has made solid progress in improving both economic and social indicators in recent years and is the third largest economy in the Northeast region. Between 2007 and 2010 the State's GDP (currently ranked 12th out of 27 States in Brazil) grew by an accumulated 58%, well above Brazil as a whole (25%). Notwithstanding this recent progress, the State faces significant challenges: poverty levels are still unacceptably high in Ceará, with 13% of its population living below the regional extreme poverty line2 and almost a third of the people (31%) are below the regional poverty line. It is evident that to sustain social inclusion gains made and substantially reduce current poverty levels will require more rapid and inclusive economic growth.

2.4 New ways to tackle Poverty through Agriculture: The Rural Productive-inclusion approach

Despite substantial gains over the last decade, poverty in Brazil remains high, and more than one person out of five lives below the poverty line. According to the National Institute of Applied Economics Research (IPEA), extreme poverty reached 7.3% in 2009, down from 15.2% in 2003; while moderate poverty declined to 21.4% from 35.8%. Despite these impressive gains, there are still a large number of people who remain poor in monetary terms and who lack access to basic services. Reaching these people, and more importantly, establishing the conditions for their productive inclusion into the Brazilian economy, remains a challenge.

As a response to the problem previously described The Brazilian Government committed itself to lifting 16 million people from poverty through a three-pronged approach that included a productive inclusion component promoting activities in rural and urban areas, and aimed at increasing the productivity of families in extreme poverty towards employment and income

[2] 'Extreme poverty line' is defined as the required income to consume the minimum intake (2,000 calories/day) according to the World Health Organization (WHO).

generation. Programs such as the Brazil Sem Miséria are key to an effective response to the challenging situation. Inside the umbrella of the Brazil Sem MisériaPlan, the Food Acquisition Program (PAA) ; One Million Cisterns; the National Program for Strengthening Family Agriculture (PRONAF); Garantia Safra are all important projects to improve livelihoods of Brazilian farmers, specially smallholder farmers who can beneficiate from these initiatives.

This research will focus on PRONAF due to the general scope of the argument presented. Emphasis will be given to rural credit initiatives and its link to climate change as an adaptation tool to improve Brazilian smallholder farmers' livelihoods climate resiliency.

2.4.1 Increasing water availability through 1 Million Cisterns and One Land to waters Program

One of the main problems for smallholders located in the Northeast is lack of access to water. This is particularly true in the Semiarido, which extends throughout almost the entire Brazilian Northeast and through the northern portion of the Southeastern region. In 1999 it was created the Brazilian Semiarid Association (Articulação no Semiárido Brasileiro, ASA), a network of over one thousand organizations. They developed the Program of Social Development and Mobilization for Living with the Semiarid (Programa de Formação e Mobilização Social para Convivência com o Semiárido). Within that overall program, they created the One Million Cisterns Program (Programa Um Milhão de Cisternas, P1MC) and the One Land, Two Waters Program (Programa Uma Terra e Duas Águas, P1+2), which rely on the capture and storage of rain water for human consumption and food production. Both cistern programs were started by civil society organizations and adopted by the federal government and scaled up massively through federal funding. They are based on innovative water storage technologies, adapted for the local environment and for small scale use.

Water shortages are one of the region's many problems associated with—and contributing to— poverty. Like semiarid regions throughout the world, the Brazilian Semiarid has highly irregular rainfalls and long periods of drought. Though it receives more rain than many other semiarid regions, its evaporation rate is high, leaving the region with a net water deficit. The length of the rainy season varies, but it generally accounts for four or five months per year, leaving seven to eight months of drought. During this period, known as the seca, there is a lack of water for domestic consumption, forcing long hikes—often of several kilometers—to the reservoirs, particularly by women and children.

According to Brazilian Agricultural Research Corporation (Embrapa), during the drought period, a family with five children spends a monthly average of three days per person obtaining water. Water in the region is often unfit for human consumption, either from salinization from minerals in the rocks and soil or from pollution from pesticides, fertilizers, and bacteria. It has also been documented that five weeks per person per year are lost due to diarrhea contracted following the consumption of contaminated water. Based on data from the Brazilian Ministry of Health, UNICEF reports that one out of every four children who die in the Semiarido will lose his or her life as a result of diarrhea after ingesting water unfit for human consumption

The P1MC has the goal of expanding access to drinking water for 5 million people via the construction of 1 million cement cisterns. Once families are guaranteed access to drinking water, the One Land, Two Waters Program (P1+2) seeks to ensure water for farming, respecting the regional food culture and the knowledge of local farmers.

The P1+2 program is intended for families that already have access to water for human consumption, meaning families that are already benefitting from a cistern. It expands small scale water collection technologies and teaches water conservation and water use, so that cistern-stored

water is available for both consumption and farming. Participating families take part in a set of social programs, including training through farmer-to-farmer exchanges, collecting experiences and sharing best practices, and construction.

2.4.2 A new focus on Brazilian Public Policy: Rural Development and Food insecurity. The Food Acquisition Program (PAA)

Although there are efforts by the Brazilian government to eradicate extreme poverty through robust social programs, poverty and the related problem of hunger remain issues; According to the Brazilian Institute of Geography and Statistics (IBGE) there are 16 million people in Brazil (out of about 200 million people) who live on an income of less than $35 per month, making them much more vulnerable to hunger and nutritional insecurity.

The issue of hunger and secure access to food in Brazil began to receive more attention in the 1990s, due to the work of civil society actors who created the movement Citizen Action against Hunger, Poverty, and for Life (Ação da Cidadania contra a Fome, a Miséria e pela Vida) to mobilize Brazilian society to fight hunger and malnutrition. Numerous local and state committees were created to collect food, clothing, and building materials, which were then donated to civil society organizations that served low-income populations, in particular families and people facing food insecurity and malnutrition. This movement for essentially charitable purposes helped to build organizations that were capable of pressuring the government to take the issue of food security more seriously.

In this context, the Food Acquisition Program (Programa de Aquisição de Alimentos, PAA) was created in 2003 in order address issues of rural poverty, hunger, and food insecurity by guaranteeing demand in local markets for small producers through local government purchases of agricultural products. The program provides funding to cooperatives and associations to build food

reserves, where foodstuffs can be stored for post-harvest periods when supply is lower and the market price is more favorable, and to buy food for use in government institutions and programs, like the School Meals Program (Federal program that provides food through lunch meals in Brazilian public schools). This new agenda in the Brazilian public policy - that gained form since 2002 when Lula da Silva (Labor Party) won the elections and became the new Brazilian president- is proof that if given the proper conditions smallholder farmers can improve their livelihoods. Throughout this study the impact of this program and the ones described next will be assessed.

2.4.3 Accessing markets while becoming more resilient through PRONAF.

Launched in 1996 the National Program for strengthening Family Agriculture (Programa Nacional de Fortalecimento a Agricultura Familiar (PRONAF) is a national program which aims to support the sustainable development of the Brazilian rural areas, based on strengthening family agriculture, recognizing the central and strategic role that small farms play in promoting food security, employment and income creation. This program operates in decentralized way an as a partnership among private sector, public sector in a federal and municipal level.

In 2012 the Garantia Safra program is created. Under the umbrella of PRONAF, this program came to support smallholder family farmers to become more resilient to extreme weather events such as droughts. This program aims to support exclusively smallholder family farmers' inhabitants of the Northeast, more specifically the semiarid portion also called Sertão or Drought Polygon.

Garantia Safra is unique for the following reasons: (a) It acknowledges that droughts are cyclical events moving from an emergency approach to a continuous approach, allowing room to a permanent and institutionalized support in case of drastic lost in crops productivity due to extreme droughts; (b)The program brings importance and incentive to local market insertion and

production. It supports small producers, helping them becoming more competitive in local markets; (c) Unifies Federal, municipal, farmers, civil society and private sector in a same goal and focus to support crop production of smallholders. Because of its main goals which are evaluate and strengthen access to credit, financing, and investment of smallholders, these last two public policies will be further assessed throughout this study.

As demonstrated Brazil has been utilizing public policies as main strategy to tackle issues such as extreme poverty, food insecurity and lack of water availability. This model has proven to be functional and bring positive results in matters of development to the country. This research will further discuss more specifically the case of PRONAF and its related programs in the chapters to follow.

From an economic perspective family farming can be seen in two different approaches. On one hand it can be argued that family farmers do not have to pay market rate for wages, given that the majority of the labor comes from the own family so the marginal benefit from an additional unit of labor can be much smaller than on a capitalist farm, leading to more labor being applied, lower labor productivity, but higher land productivity. On the other hand, family farm work has a higher opportunity cost to the family workers than to commercial/larger farmers. Given this high opportunity cost, if the income is not equivalent to what they could get from work in activities off farm they may give up farming.

Historically, the main driver of poverty and inequality in rural Brazil has been unequal access to land, as well as to capital, services and markets. Approximately 4.4 million rural households lack enough land to subsist and need to complement their agricultural income with other sources of incomes (often in poorly qualified and low paying jobs).

The large majority of family farmers, especially in the North and Northeast, are below the poverty line, and most of their household income is derived mainly from agriculture. Improving resilience and raising agriculture yields is important and the efficient use of land is critical for achieving Brazil's economic and environmental goals; however, it is not sufficient. There is a need to combine the social policies (safety nets) with agriculture technology adoption, improved market access, tailored technical assistance and off farm income generating opportunities supported by education/vocational training.

The rates of access to basic public services in rural areas, such as health, water, education, and energy is lower than in urban areas, in particular the North and Northeast.

When regions are compared, the North and Northeast regions have the lowest GDP per capita, highest Gini coefficients and lowest HDI, as well as highest poverty rates.

Of the nearly 5.2 million farm establishments in Brazil, legally-defined family farms comprise 84 percent and account for 24 percent of the total farm area, 74 percent of agricultural employment and 38 percent of the total value of agricultural production. About 50 percent of Brazil's family farms are found in the Northeast and around 10 percent in the North.(World Bank 2015).

The incidence of poverty in rural areas is more than double that in urban areas, with levels of moderate and extreme poverty at 22.6 and 9.1 percent, respectively, in 2013, compared to 6.3 and 3.1 in urban centers. Over half of the 7.6 million of Brazilians living in extreme poverty are located in the Northeast region and many still lack the assets and skills to escape poverty (World Bank, 2015).

Despite substantial gains over the last decade, poverty in Brazil remains high, and more than one person out of five lives below the poverty line. According to the National Institute of

Applied Economics Research (IPEA), extreme poverty reached 7.3% in 2009, down from 15.2% in 2003; while moderate poverty declined to 21.4% from 35.8%. Despite these impressive gains, there are still a large numbers who lack access to basic good services. Reaching the extremely poor, and more importantly, establishing the conditions for their productive inclusion into the Brazilian economy, remains a challenge.

As a response to the problem previously described, the Brazilian Government committed itself to lifting 16 million people from poverty. Through a three-pronged approach that included a productive inclusion component promoting activities in rural and urban areas, the government aimed to increase the productivity of families in extreme poverty towards employment and income generation by providing opportunities to increase their credit and therefore access to domestic markets. Programs such as the National Program for Strengthening Family Farming (PRONAF in Portuguese) represent key elements to the strategy. 2 billion reais, the Brazilian currency, were assigned to fund the program in 2002, reaching over R $ 8 billion by 2007 (DIEESE, 2008).

Credit lines available through federal programs like PRONAF, if well applied, are powerful tools to allow farmers to adapt to climate change. However, distribution and application of funds to the most poor remains problematic. Risks of the strategy include debt or inadequate allocation of resources, which may increase socioeconomic vulnerability rather than reducing it. PRONAF is an emblematic case of the challenges and potential benefits of microcredit programs. It provides funding for smallholder farmers or associations of smallholder farmers. Investment in their access to basic goods and services allows local adaptation to climate change.

In the chapter to follow the main rural credit program in Brazil known as PRONAF will be analyzed in more detail. It seeks to demonstrate the caveats of such initiative and its potential linkage with climate change. To facilitate the analysis, the program logic will be contrasted with

risk-reducing strategies adopted by smallholder farmers according to a literature review conducted by Burnham and Zhao Ma.

CHAPTER 3

UNDERSTANDING PRONAF

According to studies from the World Bank, 26 million Brazilians ceased to live below the poverty line between 2001 and 2013, particularly in rural areas. An important contributor to the reduction in poverty was family farming, which has been a major source of income gains and food security improvements for poor rural families; there are nearly 4.3 million family farmers in Brazil. Concern is growing, however, that climate change could slow or even reverse the progress. This concern is rooted in the fact that most family farmers are highly dependent on climate-sensitive natural resources, and they often lack the financial and technical resources required to adapt and respond to increasing climate risks (World Bank Conference,2015).

As previously demonstrated, Brazil uses public policies as a means to tackle issues such as extreme poverty, food insecurity and lack of water availability. This model has brought positive developmental results to the country.. This approach can be well suited as a model for climate change adaptation. Burnham and Zhao Ma call this the *planned adaptation approach;* in other words, deliberate, strategic actions taken by governments, development agencies, or other actors resulting in policy decisions intended to mitigate climatic impacts on the poor and vulnerable. In contrast, the *autonomous adaptation approach* focuses on individual's or household's actions; these may be either reactions to stressors or measures intended to mitigate negative impact from future stressors (Smit, Burton, Klein, & Wandel, 2000).

The principle difference between autonomous and planned adaptation approaches being the space where the adaptation is generated, planned adaptations are generally considered to be more efficient for addressing the impacts of climate change than autonomous adaptations (Burton, 1996; Smit & Pilfosova, 2001). However, as past development research has shown, the socially

and technologically appropriate interventions which empower communities by providing them with their immediate needs are becoming increasingly important (Cook & Wei, 2002).

Brazil provides a relatively low level of direct support to its farmers (as percentage of gross farm receipts), despite maintaining an extensive range of price and credit policies. Spending on public goods and services (such as rural extension services for instance) that benefit farmers represents only 17 percent of total support to agriculture (compared to 26 percent in the OECD), whereas the remaining 83 percent is distributed via guaranteed prices, government purchases, subsidized credit and insurance. Improvements and increased investments in agriculture innovation for family farmers (agriculture rural development, rural extension services and education) would reduce exposure to production and market risks and increase improved technology adoption.

There is a need for investments in transport networks and rural infrastructure to improve competitiveness, but also to anticipate the expected moves in production and land use according to climate change projections. Brazil has been one of the most cost-efficient producers within the farm, but given the logistics bottlenecks, most of this efficiency is lost when transporting the goods to the final destinations. International best practices suggest ample opportunities to improve rural infrastructure and logistics using Public Private Partnerships, through integration of the rural-urban space, rural communication and information technologies, expanding agriculture risk management instruments and adopting climate smart agriculture practices and tools, stimulating increased investments and greater returns along the rural credit initiatives.

Less than 5 percent of Brazilian agricultural land was under lease or used in partnership in 2006. In contrast, this figure is above 35 percent and above 65 percent for Europe and the United

States, respectively. Possible explanations include the country's lack of well-established property rights, restrictions in land rental legislation, high risk of eviction, and difficulty in enforcing contracts, among others

This chapter will focus on social interventions, more specifically detailing one of the most important federal programs that supports Brazilian family farmers. The National Program for Strengthening Family Farming (hereafter PRONAF) fits the narrative of this paper because it was the first federal program implemented in Brazil to benefit family farmers from various regions and socioeconomic conditions across the country. By understanding the logic of the program and how it evolved throughout its 20 years, we will be able to analyze the possible use of the program as planned adaptation tool for family farmers to reduce climate change vulnerability.

3 PRONAF Background

Brazilian rural areas are remarkable for their diversity of natural habitats, resources, agroclimates and agrarian systems, ethnicity, cultures, social relations, and socio-political organizations. (IBASE, 2006). Public policies have taken little account of this complexity. From 1965 and 1985, the few public policies that targeted rural areas prioritized the production of high valued commodities to boost exports, with the goal to improve the national trade balance; these policies benefited the better-off farmers (Mattei, 2006).

The abundance of available credit and low interest rates enabled modern technologies to boom in some rural areas. However, most family farmers had little or no access to such technologies (Silva et al., 2005). Recognizing the injustice of these policies, farmers started protesting that they were being excluded.

As a tentative response to the social protests from rural labor associations representing family farmers' rights, the government approved the creation of the National Program for

Strengthening Family Farming (PRONAF) on August 24, 1995. Initially, the program was limited to a financing line. On June 28, 2016, the program was institutionalized through the Decree no 1.946 (Brazil, 1996a). Access to credit mechanisms targeting agricultural investments was added. Currently, PRONAF resources can be used for funding (short term credit), investment (long term credit) and payment of family farmers' shares in agricultural cooperatives.

3.1 PRONAF evolution and transformation

Since its creation in 1996, PRONAF has had four objectives: financing rural credit; infrastructure and municipal services; training of farmers; and rural extension and research (Mattei, 2005). However, in 2003, the Rural Territories Sustainable Development Program (Pronat) was created, taking over the Infrastructure and Municipal Services and training components. Henceforth, PRONAF focused on rural credit. In the same year, the National Policy of Technical Assistance and Rural Extension (PNATER) was put in place, taking charge of research and extension.

However, as Maia et Alli have shown, family farmers are heterogeneous, ranging from farmers that are already well organized and market-oriented to farmers living close to the poverty line, with weak links to markets. In the first years of the program, the funding criteria were the same for all types of farmer. Over time however, PRONAF has evolved and now better targets the needs of family farmers (Sousa, 2009).

In 2009, with the termination of the Special Credit for Land Reform Program ((PROCERA) new categories of beneficiaries were created under PRONAF. Furthermore, the classification of family farmers was broken down by income level and employment characteristics. This new

framework was created to better classify the diverse group of family farmers in order to provide the conditions and programs that they need the most.

Currently, the program targets farmers, fishermen, craftsmen, silviculturists, indigenous hunters and gatherers, African diaspora community members and farmers resettled by the Ministry of Agrarian Development (MDA. To be eligible, these groups must have a gross income no greater than Brazilian R$110,000.00 (approx. US$35,000) per year, excluding resources from transfer programs such as Bolsa Familia. PRONAF has constantly evolved to better support the interactions between beneficiaries and rural credit institutions, as well as other actors that work with family farmers. (Banco do Nordeste, 2013).

3.2 PRONAF goals, targets and principles

The official mission of PRONAF is to promote the sustainable development of family farmers, especially low-income farmers. Often smallholder farmers do not fulfill minimum requirements to get loans from regular banks since these institutions often require collaterals, registrations, and a stable and minimum income which smallholder farmers often are not able to provide. By increasing their resources through credit lines smallholder farmers can become more competitive in local and external markets. The program helps family farmers link to markets by easing access to credit lines. PRONAF aims to reduce rural poverty by boosting the incomes of family farmers. Through PRONAF family farmers can increase their savings from the lower interest rates and special conditions, as compared to other programs mean lower financing costs, and hence higher profits if compared with previous era when family farmers had to borrow at higher rates of interest.

Before PRONAF was created, smallholder farmers were forced to compete for resources with corporate farmers, traditionally the main beneficiaries of farm credit programs. (Schneider et al, 2004).

When PRONAF was created, it was open to farm owners, tenants or partners, with no more than 2 fulltime employees, operating an area no larger than 4 fiscal modules, deriving at least 80 percent of gross income from farming, living on or close to their farm.

To be eligible for PRONAF, family farmers need to seek out a local branch of the government agency that administers the program and obtain a Declaration of Eligibility. Local agencies work with farmers to determine which programs best fit their needs.

PRONAF aims to ensure that eligible beneficiaries are served quickly. The program encourages beneficiaries to help tweak the design of PRONAF. It also promotes public-private partnerships, as well as education and research.

3.3 Plan Safra and the new demands from a diverse Brazilian family farm sector

In 2003, the government created Plan Safra (Harvest Plan), a benchmark in PRONAF history (Delgado, 2012), intended to make the program more responsive to the needs of different types of farmer. Through Plan Safra, other credit lines were created such as PRONAF Youth, PRONAF Women, PRONAF Agroindustry, PRONAF Forest, PRONAF Semiarido, and PRONAF Fisheries. Also, existing lines were strengthened.

These new categories of PRONAF catered better to the different types of farmer, as well as craftsmen, fishermen, and members of the African Diaspora. The various beneficiaries were distributed among 6 different credit lines, distinguished by income source and income level. [3]

QUADRO RESUMO DO CRÉDITO PRONAF 2013/2014

Linhas	Faixa I	Faixa II	Faixa III
Pronaf Custeio	Até R$ 10 mil Juros de 1,5% a.a.	Mais de R$ 10 mil até R$ 30 mil Juros de 3% a.a.	Mais de R$ 30 mil até R$ 100 mil Juros de 3,5% a.a.
Pronaf Investimento (Mais Alimentos)	Até R$ 10 mil Juro de 1% a.a.	Mais de R$ 10 mil até R$ 150 mil Juros de 2% a.a.	
Microcrédito Rural	Investimento: Até R$ 3,5 mil por operação. Juro de 0,5% a.a., Bônus de adimplência de 25% até os primeiros R$ 10,5 mil. Custeio: condições estabelecidas na Linha Pronaf Custeio.		
Pronaf Agroecologia	Até R$ 10 mil; juro de 1% a.a.	Mais de R$ 10 mil até R$ 150 mil, juros de 2% a.a.	
Pronaf Mulher	Até R$ 2,5 mil Juro de 0,5% a.a.	Até R$ 10 mil, juro de 1% a.a. Mais de R$ 10 mil e até R$ 150 mil, juros de 2% a.a.	
Pronaf ECO	Até R$ 10 mil Juro de 1% a.a.	Mais de R$ 10 mil até R$ 150 mil Juros de 2% a.a.	
Pronaf ECO Dendê	Até R$ 8 mil/ha; Até R$ 10 mil, juro de 1% ao ano Acima de R$ 10 mil e até R$ 80 mil por mutuário, juros de R$ 2% a.a.		
Pronaf ECO Seringueira	Até R$ 15 mil/ha; Até R$ 80 mil por mutuário, juros de R$ 2% a.a.		
Pronaf Agroindústria	Individual e Empreendimentos Familiares Rurais até R$ 10 mil; Cooperativas e associações até R$ 1 milhão, respeitando o limite individual de até R$ 10 mil por associado ativo. Juro de 1% a.a	Individual acima de R$ 10 mil e até R$ 150 mil; Empreendimento Familiar Rural acima de R$ 10 mil e até R$ 300 mil; Cooperativas e associações acima de R$ 1milhão e até R$ 35 milhões, respeitando o limite individual de até R$ 45 mil por associado ativo. Juros de 2% a.a	
Pronaf Semiárido	Até R$ 18 mil, juro de 1% a.a.		
Pronaf Jovem	Até R$ 15 mil, juro de 1% a.a.		
Pronaf Floresta	Até R$ 35 mil, juro de 1% a.a.		
Pronaf Custeio e Comercialização de Agroindústrias Familiares	Individual até R$ 10 mil; Empreendimento familiar rural - até R$ 210 mil Associações - até R$ 4 milhões Cooperativas singulares até R$ 10 milhões e Cooperativas Centrais R$ 30 milhões. Juros de 4% a.a		
Pronaf Cota-Parte	Individual: até R$ 20 mil; Cooperativa - até R$ 20 milhões; juros 4% a.a.		
Pronaf Investimento para a Reforma Agrária	Até R$ 20 mil, mais R$ 1.5 mil para ATER. Juro 0,5% a.a.,Bônus de adimplência de 44,186%		
Pronaf Custeio para a Reforma Agrária	Até R$ 5 mil por operação; até 3 operações; juros 1,5% a.a.		

Figure 9: Source: http://pt-pr.org.br/noticias/20/12015/plano-safra-para-a-agricultura-familiar-uma-conquista-desde-2003

3.4 PRONAF Semiarido

Since this paper focuses on the challenges faced in the Brazilian Northeast, PRONAF Semiarido, one of the credit lines created under the Safra Plan, merits special attention. PRONAF Semiarido was created to support investments in hydraulic infrastructure to not only facilitate the access to irrigation but also potentially increase levels of sanitation and in the targeted semiarid areas. To be eligible for this specific line, the family farm needs to be enrolled in the main PRONAF program. Because the Semiarido line is considered supplemental to PRONAF, the maximum amount financed is Brazilian R$ 18,000.00 (approx.US$5750.00), with half of this to

[3] (SeeAppendix A for a table explaining the Basic lines and Specialized lines of PRONAF)

be earmarked for building, extending or modernizing waterworks. The other half could be used to cover the planting of new crops, or the expansion, rehabilitation or modernization of other types of production-oriented infrastructure.

The purpose of PRONAF Semiarido is to promote sustainable development, facilitate credit access in rural areas and increase family farmers' productivity in semiarid areas Specialized agencies and independent professionals provide technical assistance to family farmers in this category of the program. Family farmers who request financing up to ten thousand Brazilian R$ 10,000.00 (US$???) have ten years to pay off their debt, including a three-year grace period.

3.5 Garantia Safra: Adapting to a new climatic reality

Initially, PRONAF did not address climate change. When the program started in 1996, climate change was not on most politicians' radar screens.

Despite the early lack of a climate change emphasis, PRONAF was sufficiently flexible to adapt quickly to this new priority. In 2012, Garantia Safra was introduced to help mitigate the impact of extreme weather in the Drought Polygon, the most vulnerable area of the Northeast. Garantia Safra is linked to PRONAF and is designed to support family farmers in semiarid regions of the Northeast and surrounding areas. Family farmers enrolled in the program receive an insurance benefit from the federal government when they lose one-half or more of their harvest of crops such as maize, beans, cassava, and cotton, as a result of droughts or torrential rain.

To be eligible for Garantia Safra, farmers must meet the general pre-requisites of PRONAF. Also, their family income must not exceed 1.5 times the minimum wage, they must not plant more than 5 hectares or less than 0.6 hectares, and they must be enrolled before crop planting season (MDA website, accessed on Jan 15, 2017).

3.6 PRONAF through the lens of climate change adaptation

For the last 20 years, PRONAF has focusing on lifting family farmers out of poverty. The program has demonstrated its value as a flexible and inclusive mechanism to improve rural areas. Despite these efforts, the program's approach to climate change could be smarter.

In 2015, Zhao Ma and Burnham reviewed 35 studies of smallholders' adaptation to climate change in developing countries. They also studied the risk-reducing strategies adopted by smallholder farmers from developing countries. The findings of this literature review will be matched with the characteristics of PRONAF to assess the suitability of such program as a climate change adaptation tool platform.

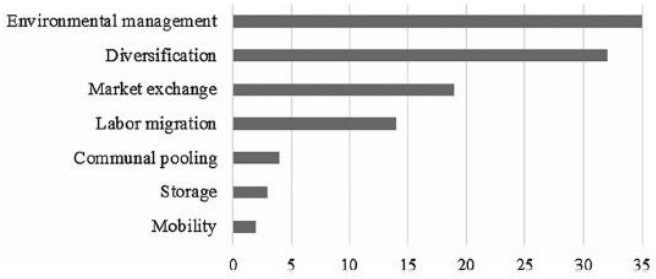

Figure 10: Frequency of a risk-reducing strategy per empirical literature, organized using a sever-category typology from Linking smallholder farmer climate change (Zhao Ma and Burnham, 2015 p.304)

Overall, based on the literature review to be discussed here, there is evidence that indicates the benefit on the usage of bottom-up strategies (which actively involves communities in the designing process). As a result of such strategy, the originated policies could be better targeted and impact more efficiently smallholder farmers' needs. One core issue in the current policy making process is that bureaucrats and policy makers tend to assume that they understand and know best about the needs of the poorer. Rather, policies would be better developed if smallholders would be consulted throughout the process. This would make such new policies to be attuned to what smallholders have done to adapt, helping them to actually refine not only the techniques but also the policies already in place, such as rural credit programs (being PRONAF one good example to

be used in this context) that could potentially be used to improve climate resilience of smallholder famers.

Zhao Ma and Burnham observed that environmental management, diversification, market exchange and migration were the most common responses to climate change.

Environmental management involves the introduction of drought-resistant and short season crops (early maturing seeds). PRONAF's financing conditions could be adjusted to further stimulate the adoption of these types of crops. At present, PRONAF does not reward farmers who introduce climate-smart cultivars (Burnham and Zhao Ma, 2016).

The second risk-reducing strategy identified in the study is crop diversification. By better balancing the crop mix between subsistence-oriented and market-oriented production, farmers may not only increase their profits, they may also reduce the impact of crop failure. Since 2012, Garantia Safra has started to provide diversification incentives by including in the eligibility requirements for the program crops such as maize, cotton, beans, and cassava, that before that year were not included as eligible crops funded by this insurance program.

The third most popular risk-reducing strategy is trade. Zhao Ma and Burnham report that smallholder farmers sell vegetable they have grown in the offseason Without access to markets, crop diversification can be compromised and the smallholder producer will end up needing to adopt storage measures as a risk reducing strategy, which in several cases will not be feasible in the long term.

PRONAF has been supporting family farmers to build the capabilities and conditions to thrive as active actors in local markets. By providing them more flexible condition of repayment through lines that cater to each type of farmer, the program has helped smallholders make the most of market links.

The fourth widely-adopted risk-reducing strategy was migration, which reinforces livelihood diversification. Migration is often a last resort for smallholders seeking to smooth consumption. Northeast Brazil has a long history of outmigration in response to drought.

In the early 20th century, about 300,000 people moved out of the Northeast (Bechimol, 1999). Almost 40 percent of Brazilians have migrated at least once in their lives. There is a positive correlation between poverty and migration. Most migrants from the Northeast have gone to the Southeast, a richer region. Regions such as the southeast of Brazil have benefitted from hiring skilled and unskilled labor, making local capital more productive. On the other hand, less developed regions such as the Northeast have benefitted from upward pressures on wages and through remittances that migrant households return to their region of origin.

Migration has implications for households and regions. At the individual level, migration can be viewed as a reaction to economic opportunity: people who migrate seek higher returns to their skills. At the regional level, migrant flows affect labor markets and the overall prospects for economic development. In principle, migration should equalize returns to the factors of production; although it may also create uneven demands on social services, leading to congestion in areas of net in-migration. (Fiess et al, 2003).

In practice, migration has not removed regional income disparities. Why is this the case? Fiess et al (2003) point to four reasons. First, stocks of human capital have been depleted in areas of outmigration. Second, the highest-paying (professional) jobs are not distributed equally between regions, reflecting disparities in the distribution of business investment.

Third, cost of living is another key driver that stimulates migration trends since different regions have different living costs. Migrants are constantly looking for potential destinations that could provide better income opportunities . Among these destinations, migrants tend to opt or even

prioritize the ones with lower living costs. Finally, owing to market failures and the prejudice and discrimination faced by migrants, there are negative externalities that depress the living standards of migrants in receiving regions. (Fiess et al, 2003).

PRONAF's role in supporting socio-economic improvements in rural areas has helped improve farmer livelihoods, reducing the pressure to migrate. Throughout its history, the program has attempted to be flexible and sensitive to the demands and characteristics of its targeted groups. With some modification of its design, PRONAF can make an even bigger contribution to helping its beneficiaries manage risk. The next chapter will examine the regional distribution of PRONAF funds, asking whether resources could be better targeted to serve the needs of the most vulnerable—including those in areas most subject to climate stress.

CHAPTER 4

PRONAF IMPACT AND CHALLENGES

As previously described, family agriculture plays a crucial role in the social development and economic expansion of Brazil. Family farming produces the majority of food consumed in the Brazilian domestic market and enables the creation of jobs, reducing migration from rural areas.

The National Program for Strengthening Family Agriculture (PRONAF) as described in the previous chapter, since its creation in 1996, has attempted to support smallholder family farmers to improve their livelihoods. After 2004, when the program was significantly restructured to better support the demands of the diverse community of smallholder farmers, the program became an important state instrument for caption of financial and human capitals. Through the program, the state also sought to help small holder farmers' production to be sustainable (Damasceno et al, 2011).

In the context of the creation of PRONAF, the sustainability gained relevance in the Brazilian public policy scenario. The democratization of public policies, which include different sectors of the society, aim for development that is sustainable not only from an environmental perspective but also from a social, economic and political point of view. However, some authors, such as Guanziroli, argue that the program still requires improvement in encouraging sustainability, given the incentive to produce only high valued crops; in some cases, these crops are not resilient throughout the whole harvest season (Guanziroli, 2007).

Despite the importance of family farming for communities and Pronaf's high operating costs, few studies were carried out to evaluate its impacts on sustainable development of family farmers, employment, income generation and production capacity. An impact evaluation, therefore, becomes necessary to determine the successes and failures of the program. A series of

studies analyzing the first 10 years of PRONAF's implementation will be embedded in this analysis. Unfortunately, no data was collected following the first 15 years of implementation, due to reduction of the budget allocated to that study. Therefore, this chapter will focus on impact given available data despite the aforementioned notable limitation.

4 A sustainable development Era

Late in the 1980s, the sustainability discourse spread around the globe. Advocates defined sustainability as capable of being conserved and durable. This newly emerging paradigm brought to light concerns about not only current but also future generations in regards to production and consumption of goods and services, basic subsistence needs, natural resources and the eco-systemic balance. The concept of sustainable development influenced environmental, economic, social, political and cultural dimensions in the relation between the state and civil society.

Sustainable development refers to processes of socio-economic and institutional transformation that aim to ensure the satisfaction of basic population needs and social equity, both now and in the future, through the promotion of opportunities for economic well-being that are compatible with the ecological circumstances of long term (Rabello, 2008). Conceptually, sustainability refers to a dynamic and flexible meaning centered on respect for life. Reducing poverty, meeting basic needs, improving the quality of life of the population, restoring equity and establishing a form of government that guarantees social participation in decisions are essential conditions for the development process to be considered as sustainable (JARA, 1996).

The official definition of sustainable development was designed on 1987 in the Brundtland Report, also known as Common Future Report. The report, created by the United Nations World Commission on Environment and Development (WCED), also presented methods to overcome the international financial crisis spread around the world at the time and emphasized the importance

of reducing poverty as a precondition to achieve an environmental friendly development. According to the report, only by focusing in improving areas such as natural resources preservation, economic growth, poverty reduction and guarantee of the existence of future generations is that sustainability can be achieved globally.

The creation of PRONAF in 1996 was an attempt by the Brazilian Government to promote action in the key areas mentioned in the Brundtland report by proposing a program that would lift rural livelihoods, often considered the most vulnerable to socio-economic and climate volatilities. Therefore, PRONAF's impact on sustainability will be analyzed in the following section.

4.1 PRONAF Sustainability Index

In 2011, Nagilane Damasceno and others compared beneficiaries and non-beneficiaries of PRONAF in order to build a sustainability index for the family agriculturists who live in the North of the State of Ceará, one of the main states of the Northeast region. The goal was to provide a sample of how much PRONAF was supporting its beneficiaries in becoming more sustainable in the Ceará State. The results of such study were based on both qualitative and quantitative outcomes of semi-structured questionnaires responded by 45 beneficiaries and 45 non beneficiaries randomly selected within the municipalities of Baurité, Iguatú and Queixada. One main point to take in consideration is that given the randomly characteristic of the sample, this study likely have a selection bias influence. It is not possible to assess how similar socially and economically the two groups are given that in the main source the authors did not capture the baseline before the program had started.

The proposed Sustainability Index created by Damasceno et al was based on the creation of 4 additional indexes: socio-economic development index, socio-capital index, environmental index,

and political-institutional index. The Sustainability Index was considered as a simple average of the 4 referred indicators. The following table summarize such indicators and scores assigned.

	Socio-economic development index						Socio-capital index	Environmental index	Political-institutional index
Sub-indicator	Health	Education	Habitat	Sanitary	Economic	Leisure	Interpersonal relations among farmers	Soil preservation and restoration	Public Policies effectivity
Baseline	availability of health services to the family farmers	existence or abscense of educational services accessible to family farmers	type of residence / construction material/ lighting	origin of the water used for consumption	Annual income	Availability of Leisure structure	Concern with the community vs only with the family// influence in the community	Soil conservation/ Plagues control// Livestock activities// Agrotoxic usage intensity// Waste destination	Technical assistance and /or credit recipient
Score range	0 - Lack of Medical or Ambulatory services 3- Regular access to medical and ambulatory services	0 - absence of public or community based schools in the vicinity 4- accessibility to universities in their vicinity	0 - Rented houses 2 - Own houses 0- mud house 3 - brick house 0 - Candle light 2 - electric energy	0 - water trucks 3 - Piped water	0 - < R$ 4980.00 3- R$ 14,940.00	0 - None 3- > three options	yes / no questions and 0 - no influence in the community 4 - great influence in the community	0 - lack of soil conservation 2 - Biologic conservation practices 0 - plague control through agrotoxic usage 2- biologic method of plague control 0 - Fire usage in livestock 1 - no fire usage in livestock activities 0 - 2 por more agrotoxic products used 2 - No use of agrotoxic products 0- usage of fires to eliminate waste 2 - Soil recomposition after harvest	Yes or No questions about: - Technical assistance received - Credit received by a public institution - Technologies received - Technical capacity training received

Table 1: Summary table based on data found in Damasceno et al 2011

Based on the proposed matrix found above, the authors calculated the Sustainability Index of Beneficiaries and Non-beneficiaries of PRONAF, to assess the impact of the program in regards to the sustainability matter. In the table below is described the frequencies in absolute and relative terms.

Sustainability Index ranges (SI)	Beneficiaries		Non-Beneficiaries	
	Absolute value	Relative Freq.	Absolute values	Relative Freq.
0 - 0,5	24	53.3%	41	91.1%
0,5 - 0,8	21	46.7%	4	8.9%
0,8 - 1	0	0.0%	0	0.0%
Total	45	100.0%	45	100.0%

Table 2: Sustainability Index based on Damasceno et al 2011 p 147

Based on the matrix of results found above is possible to argue that both beneficiaries (53%) and non-beneficiaries (91.1%) present low level of sustainability. Nonetheless, beneficiaries (46.7%) achieved a significant higher percentile of sustainability compared to non-

beneficiaries (8.9%). Additionally, beneficiaries had higher scores than non-beneficiaries in all 4 indexes that are part of the Sustainability Index as shown in the table below

Indexes	Beneficiaries		Non-Beneficiaries	
	Weight of index in the composition of Sustainability Index	Percentage of farmers achieving weight range in each index	Percentage of index in the composition of SI	Percentage of farmers achieving weight range in each index
Socio-economic development index	14.30%	31%	14.10%	46%
Environmental index	8.40%	18%	8.00%	25%
Socio-capital index	13.40%	29%	7.20%	24%
Political-institutional index	10.30%	22%	1.50%	5%
Sustainability Index	46.40%	100%	30.70%	100%
T test	5,581 Sig= 0,000			

Table 3: Damasceno et al 2011 p 148 with adaptations

As demonstrated above, the socio-economic development index played significant role in the composition of the Sustainability Index for both beneficiaries and non-beneficiaries, given that 31% of beneficiaries had 14.30% of the socio-economic development index contributing to their Sustainability Index On the other hand, 46% of non beneficiaries had 14.10% of their socio-Economic Development index accounting for their Sustainability Index. Furthermore, beneficiaries and non-beneficiaries presented significant differences in their Sustainability Indexes of 46.4% and 30.7% respectively.

Rates of sustainability index achieved by both beneficiaries and non-beneficiaries are very low. According to the authors, this can be explained by improper agricultural techniques such as lack of soil analysis, absence of plague control mechanisms and non-organic fertilizing techniques (Damasceno et al 2011). Smallholder farmers both beneficiaries and non-beneficiaries of

PRONAF need technical assistance to assist them throughout the year in order for their production to become more sustainable.

Socio-capital capacity is another area that presented low performance in both groups. However, non-beneficiaries were identified as having a higher level of fragility in this cohort. Such lack of participation in the community distance them from an ability to influence decision processes advocated through family farm associations. In this sense, PRONAF may have improved socio-capital capacity in terms of increasing networking and engagement in their local communities. Alternatively, family farmers with increased socio-capital capacity may have been more likely to receive PRONAF benefits. The same can be noticed in regards to the political-institutional capacity. The low level achieved by non-beneficiaries can be explained by the challenge of access to credit, obtaining technical assistance, availability/ accessibility to technologies and capacity training.

In summary, beneficiaries presented medium level of socio-capital capacity, while non-beneficiaries presented a low level of socio-capital capacity. Such differences may either be a result of PRONAF or of baseline differences between beneficiaries and non-beneficiaries (refer to figure 9 for details on the baseline criteria used). In regards to environmental preservation, despite statistically significant differences between the two groups, both beneficiaries and non-beneficiaries presented low indices. Therefore, this area should be better supported.

4.2 PRONAF's impact on income and employment

When the PRONAF was created, one principal objective was to increase the annual income of smallholder farmers, thereby reducing their economic fragility. In 2007, Guanziroli performed a meta-analysis of 13 prior studies of the impact of PRONAF during its first 10 years.

These 13 evaluations sought to analyze, among several factors, the efficiency of the program in increasing income. PRONAF's impact on increasing income levels was minimal. The small or even null impact on increase of income is congruent with the struggle of many smallholder farmers to repay the credit contracted through PRONAF. PRONAF's beneficiaries often lack experience dealing with the financial bureaucracy involved in most of bank lending processes. Without increase in income, repayment often becomes problematic.

In a separate study, Damasceno also compared the performance of PRONAF beneficiaries and non-beneficiaries' income increase ratios. The author argues that over the years there is no significant difference between beneficiaries and non-beneficiaries' income range coming from both livestock and agriculture activities. Indeed, in absolute terms, non-beneficiaries' annual income from livestock was higher than the amount earned by beneficiaries, likely due to the larger farm size of non-beneficiaries---3 times larger than the ones occupied by beneficiaries. When land size was controlled for, there were no differences in average annual income between the groups.

Other authors corroborate the findings of Damasceno and Guanziroli. Kageyama (2003) and Dias (2006) indicated that PRONAF had not increased income. Magalhães et al (2005) even argued a potential negative impact of the program in regards to income generation of its beneficiaries.

Yet, different from the income scenario, Damasceno observed that the program indeed contributed positively in matters of employment generation. The author verified that while beneficiaries achieved 1.32 employees per hectare, non-beneficiaries achieved only 0.37 in the same scale. Based on the referred t test, it is possible to indicate that there is significant statistical difference in the average of total employment levels generated per hectare between beneficiaries and non-beneficiaries.

Based on the contrasting results achieved by beneficiaries and non-beneficiaries reported in Damasceno's study, it is possible to understand that PRONAF has achieved better impacts on increasing the active labor population of smallholder farmers, however it is also noticeable that such positive impact is not reflected in the income portion. One Expand on why not income but employment increases?

4.3 PRONAF's impact on crop diversification and allocation of resources

A third goal of PRONAF was to strengthen the production capacity of family farmers. By achieving high levels of productivity, family farmers could not only improve growth of local markets and economies, but also become more resilient to climate change extreme events.

Schneider argues that often Brazilian family farmers tend to focus their agricultural production on what is financed by PRONAF's credit lines, instead of investing on what they would have better comparative advantage in the market given factors such as: demand; knowledge on how to produce and natural resources conditions and availability in a given area. Rather, he argues that"family farmers tend to produce more of the same" (Schneider, 2004). According to the author this financing structure do not shift the development standards of rural areas in matters of production as well as in matters of diversification in agricultural production.

Guanziroli highlights that only 11.5% of family farm establishments had a very specialized production, in which one single product represented 100% of the gross value of production. The majority of family farm establishments used diversification strategies, 44.1% of producers achieved from 35% to 65% of their gross value production. An important caveat emerges in the scenario mentioned above. The most specialized producers (29% of the total) are the ones who had the highest income either if analyzed per establishment or per hectare. Additionally, the study co-relates market engagement with a positive and ascendant relationship with income.

Throughout PRONAF's existence, more credit resources have been given to more specialized and higher-income family farmers. It has been recognized that even though PRONAF has provided a variety of supporting mechanisms such as crop insurance and technical assistance to its beneficiaries to incentivize them to diversify their crop plantations as a strategy to reduce the chances of significant losses in case of long lasting drought or any other extreme weather phenomena.However a significant amount of PRONAF's resources have been assigned to family farmers who ended up investing on monoculture of high profitable crops in high demand in external markets, such as wheat and corn. At the same time, a low amount of resources were assigned to production of rice, beans and other products targeted to domestic markets. Indeed, low effort has been made

Regions	Macro-regions*	Population share of each region	Proportion of poor households in regional population	Regional Contribution to the Poverty Gap	Regional Average Poverty Gap
1 Rondonia	N	0.005	0.338	0.001	0.147
2 Acre	N	0.002	0.356	0.000	0.176
3 Amazonas	N	0.011	0.396	0.002	0.196
4 Roraima	N	0.001	0.347	0.000	0.152
5 Para	N	0.023	0.425	0.005	0.194
6 Amapa	N	0.003	0.151	0.000	0.069
7 Tocantins	N	0.006	0.429	0.001	0.180
8 Maranhao	NE	0.029	0.579	0.008	0.288
9 Piaui	NE	0.015	0.564	0.005	0.304
10 Ceara	NE	0.042	0.540	0.011	0.267
11 RGNorte	NE	0.016	0.471	0.004	0.218
12 Paraiba	NE	0.019	0.550	0.005	0.257
13 Pernambuco	NE	0.045	0.512	0.011	0.248
14 Alagoas	NE	0.015	0.577	0.004	0.289
15 Sergipe	NE	0.010	0.503	0.002	0.239
16 Bahia	NE	0.073	0.520	0.019	0.256
17 MinasG	SE	0.108	0.301	0.014	0.133
18 EspSanto	SE	0.019	0.324	0.003	0.144
19 RioJaneiro	SE	0.095	0.202	0.009	0.095
20 SaoPaulo	SE	0.229	0.166	0.019	0.083
21 Parana	S	0.059	0.237	0.006	0.100
22 StaCatari	S	0.034	0.136	0.002	0.055
23 RGSul	S	0.067	0.179	0.005	0.073
24 MtGrSul	CW	0.013	0.289	0.002	0.120
25 MtGrosso	CW	0.015	0.251	0.002	0.106
26 Goias	CW	0.031	0.300	0.004	0.126
27 DF	CW	0.013	0.219	0.001	0.106
Total	Brazil	1.000	0.308	0.145	0.145

*Macro-Regions: N = North; NE = North-East; SE = South-East; S = South; CW = Center-West

Table 4: Regional Poverty and income inequality in 2001 (Ferreira Filho et al, 2006)

Regions	Number of poor households	% change	Number of poor persons	% change	% change employment (heads)
1 Rondonia	-1562	-1.77	-5816	-1.70	1.66
2 Acre	-472	-1.25	-1699	-1.08	1.33
3 Amazonas	-2520	-1.12	-11317	-1.15	0.87
4 Roraima	-504	-2.16	-1631	-1.58	1.35
5 Para	-6295	-1.26	-23209	-1.14	1.14
6 Amapa	-341	-1.73	-1742	-1.83	1.03
7 Tocantins	-1563	-1.12	-5735	-1.00	1.28
8 Maranhao	-7763	-0.93	-29082	-0.79	1.05
9 Piaui	-2246	-0.51	-8435	-0.47	1.04
10 Ceara	-12490	-1.11	-44379	-0.97	1.52
11 RGNorte	-3868	-1.02	-15843	-1.07	1.18
12 Paraiba	-7384	-1.39	-26840	-1.25	1.68
13 Pernambuco	-10994	-0.95	-38069	-0.82	1.22
14 Alagoas	-2950	-0.67	-9438	-0.51	1.07
15 Sergipe	-2468	-0.94	-8046	-0.79	1.33
16 Bahia	-16539	-0.86	-59065	-0.76	1.30
17 MinasG	-43563	-2.65	-155709	-2.49	1.88
18 EspSanto	-15529	-5.08	-54390	-4.69	3.69
19 RioJaneiro	-18823	-1.96	-61346	-1.78	1.20
20 SaoPaulo	-66824	-3.50	-227387	-3.22	1.45
21 Parana	-18042	-2.58	-60858	-2.33	1.53
22 StaCatari	-6890	-3.00	-24349	-2.80	1.09
23 RGSul	-36348	-6.01	-121474	-5.49	2.37
24 MtGrSul	-4330	-2.31	-15172	-2.22	1.26
25 MtGrosso	-3855	-2.02	-14355	-1.93	1.08
26 Goias	-9533	-2.02	-35765	-2.06	1.28
27 DF	-3638	-2.64	-13474	-2.59	1.24
Total	-307333	—	-1074620	—	1.50

Table 5: Number and % change of regional households/ persons who live in poverty (Ferreira Filho et al, 2006)

to support specific productive chains that could be considered climatic resilient but not so much in high demand in the market (Guanziroli, 2005). The issue with such approach is that family farmers become extremely vulnerable to the impact of climate change extreme variations such as long term droughts due to lack of diversification in their production.

4.4 PRONAF regional impact

One of the main critiques in regards to PRONAF's impact unequal regional distribution of benefits Guanziroli points out that the majority to the 13 studies reported in his research, indicate that the regional impact of PRONAF is considered negative, increasing inequality ratios among regions.

In the same lines in 2009, the National Institute of Applied Economics Research (IPEA) launched an assessment about the Socioeconomic Vulnerability of Brazilian smallholder family farmers due to Climate Change. This assessment used a top-down approach to analyze the vulnerability of smallholder farmers within all 5 macro regions of Brazil. Throughout the paper IPEA analyzes PRONAF performance in each region. Surprisingly, even though the majority of smallholder farmers are in the

Main socioeconomic indicators by region

Indicator (2013)	Brazil	Northeast	North	Southeast	South	Central-West
Total Population (Millions) Rural (%)	190.76 15.6	53.10 26.9	15.86 26.4	80.36 7.1	27.38 15.1	14.05 11.2
GDP per capita (US$)	$11,481	$5,533	$7,404	$44,403	$4,424	$14,836
Human Development Index	0.727	0.660	0.684	0.754	0.756	0.753
Gini Index	0.507	0.516	0.487	0.486	0.466	0.524
Extreme Poverty (% of population)	6.63	14.91	14.31	1.96	1.75	2.78
Poverty ratio (% of population)	15.20	30.39	28.74	6.92	5.78	8.14

Table 6: Main socioeconomic indicators by region (World Bank, 2015)

Northeast region of the country, only 25% in the region were able to become beneficiaries of the PRONAF resources due to the programs' requirements. On the other hand, in the South region, which has a lower concentration of smallholder farmers, the program was able to have 38% of smallholder farmers as recipients of PRONAF's resources. According to the report, three factors contributed extensively to such results: majority of farmers with official land entitlement (legal rights to the land); high level of education and higher presence of rural cooperatives (Lindoso et al, 2010).

Region	# Family agriculture		Amount		# of PRONAF contracts	Mean value per contract	Share of Contract Recipient FF Establishments
	Absolute	%	Absolute	%			
Brazil	4,367,902	100	BRL 8,424,000,000	100	1,691,919	BRL 4,978	38.7%
North	413,101	9	BRL 822,000,000	10	104,669	BRL 7,850	25.3%
Northeast	2,187,295	50	BRL 2,064,000,000	25	708,732	BRL 2,912	32.4%
Southeast	699,978	16	BRL 1,808,000,000	21	277,374	BRL 6,516	39.6%
South	849,997	19	BRL 3,160,000,000	38	539,719	BRL 5,854	63.5%
Mid-west	217,531	5	BRL 571,000,000	7	61,425	BRL 8,287	28.2%

Table 7: Family farm establishments and PRONAF data per region year 2007 with adaptations. From Lindoso et al 2010

The table above demonstrates the uneven distribution. Out of the 2,187,295 family farm establishments located in the Northeast region, only 32% were recipients of PRONAF. On the other hand, in the South, where 849,997 family farm establishments are located, 63% of them were beneficiaries of PRONAF. Various hypotheses exist for the discrepancy, from educational level to bank bureaucracy required by the agencies which may act as a barrier to smaller and more income sensitive producers, who often struggle on repaying the funds back to such agencies,. This created a scenario of increased debt for those farmers in this situation (Zani, 2014).

Consequently, the regions which are better off from a social-economic point of view are the ones most beneficiated by PRONAF. This contrasts with the program's stated goal of lifting smallholder farmers out of poverty by providing them the necessary resources to improve their production output and access to markets.

4.5 PRONAF challenges

Based on the literature review and evidence mentioned in this chapter in regards to PRONAF's impacts throughout its first 10 years of implementation, it is note-worthy to point out the challenges that the program has been facing throughout the years.

Among these, the low level of sustainability achieved by both non-beneficiaries and beneficiaries of the program raised a concern from a natural resource management perspective. If a significant shift is not put in place, family farmers' production may decrease with increasing fragility and lack of preservation of the environment.

Another area of great concern is related to income generation. Though the program did increase employment, studies and meta-analyses were not able to identify a significant difference in regards to income generation between beneficiaries and non-beneficiaries. Reasons for such assumption are likely related beyond the scope of the program itself. Externalities such as market forces in the context that with the increase of jobs, the supply has increased but not necessarily the demand. This could potentially explain why while jobs have been created and more smallholder farmers are employed they cannot achieve significant results in income growth.

Additionally, the current design of the program may contribute to incentivize the production of crops and outputs in high demand on external markets. However, it is likely that family farmers could be better off if targeting local markets by offering quality products instead of high quantity of products with standard quality patterns.

Last but not least, PRONAF may not be targeting poorer and often more economic-sensitive smallholder famers. In the first 10 years, the majority of PRONAF's beneficiaries have been the comparatively higher income family farmers, who often have better social-economic conditions to

attend the requirements of the program. PRONAF has not contributed as much in regions such as the Northeast, where the majority of family farmers reside. The majority of beneficiaries are indeed located in the regions that are more socio-economically developed.

In order to be most effective at building climate resilience, PRONAF has to increase its efforts on making sure to better assist poor farmers, generate income, encourage polyculture for local markets, and foster sustainable resource management. The last chapter will examine how PRONAF might be improved to overcome the above mentioned challenges, and therefore increase resilience to climate change and extreme weather events. Such analysis is crucial given that this program is the main program in the country that targets specifically family farmers. Such improvements could corroborate to improve the situation of the great majority of farmers in the whole country since Brazilian farmers on average, face competitive market prices, with relatively low direct support from public policies and programs as compared with other countries according to PSE measurements.

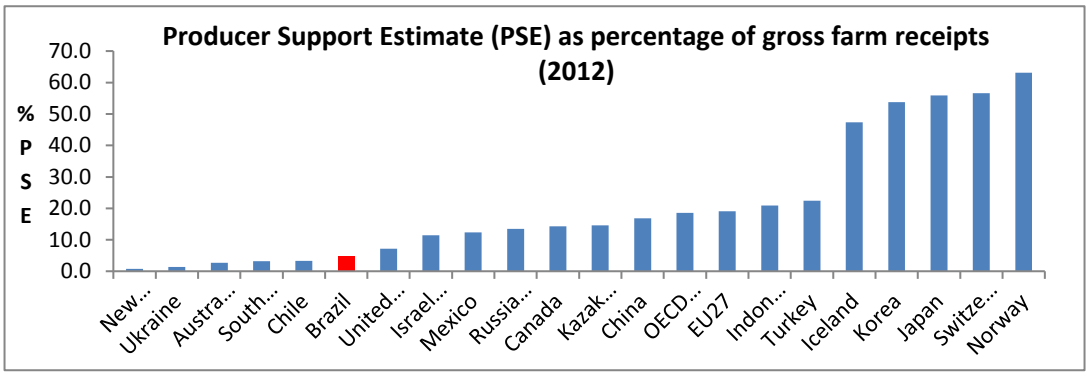

Figure 11: PSE as percentage of gross farm receipts (World Bank, 2014)

The Producer Support Estimate (PSE) measures the amount of support provided by public sector policies and programs as percentage of the gross farm receipts. In other words, it measures the percentage of farmers' income that comes from public policies and programs. In the case of Brazil, in 2012, 4.6% of the income received by farmers came from public sector policies and

programs (price supports through border measures and farmer subsidies). This percentage is relatively low compared to several Brazilian's competitors like the USA, Mexico, Russia, and other OECD countries. However, other countries that compete with Brazil, like Argentina, Australia, Chile, South Africa and New Zealand, provide less income support to their farmers as can be seen in the graphic above.

CHAPTER 5

THE FUTURE OF PRONAF AND FAMILY FARMING IN BRAZIL

5. Reflections on PRONAF and Brazilian family farmer's framework

Smallholder farmers continue to play a critical role in developing economies. They aid in the alleviation of food insecurity and poverty. Unfortunately, low income smallholder farmers are most likely to be harmed by droughts and extreme weather events, expected to increase in regularity and intensity with the passing of the years. Thus, a clear link emerges that demonstrates climate change vulnerability and poverty to be inextricable.

Comparing countries such as Kenya, Mexico, Sri Lanka and Brazil, common challenges came to light. These include lack of smallholder's legal definition, education and access to markets and resources to invest in production. Together, these increase the vulnerability of smallholders to climate change and decrease their resiliency following environmental catastrophes.

Unlike other countries, however, Brazil has tried to implement public policies designed to specifically support small-scale family farmers and improve their resiliency. The primary strategy has been through the PRONAF program. Nonetheless, the present work demonstrated that not all goals of the program were being met in terms of education, equality of distribution and poverty reduction. Second, lack of current data collection makes exact, actualized analysis difficult, but also presents a significant barrier to the betterment and implementation of PRONAF. Despite its admirable agenda, goals and successes in some areas, PRONAF needs structural adjustments to better assist the rural family farmers who are income-sensitive and hence most vulnerable to climate change. This chapter will discuss recommendations and strategies for PRONAF to enhance its positive impact on Brazilian smallholder family farmers and encourage adoption of individualized strategies that may help smallholders adapt to climate change.

5.1 Legal definitions and structure framework for smallholder farmers

One point of convergence in all countries analyzed, of particular importance for Brazil, is the lack of a legal definition of smallholder farmer. Indeed, in Brazil the definition of family farmer is used, rather than smallholder farmer. According to this definition, in order to be considered a family farmer, the establishment should not be bigger than 4 fiscal modules[4]. The problem with such metric is that the size of the fiscal module changes depending on the type of crop produced or even in the geographical region.

As analyzed in chapter one, standardizing the size of land to be part of the criteria for the smallholder definition can be challenging. However, a specific targeted group of smallholders would aid in the clarity and distribution of benefits through programs like PRONAF. A good example of the benefit of this sub-categorization can be found in *Garantia Safra*, one component of PRONAF that provides insurance against potential losses due to crop failure. In the context of *Garantia Safra,* one of the requirements is that the size of the establishments should not be larger than 5 hectares. By stablishing a more precise measure of land size, the program can support a more specific targeted group of smallholders.

5.2 Technical assistance and access to markets

Lack of technical assistance is a second principal challenge affecting smallholder farmers. Campelo et al demonstrated that long periods of droughts harm agricultural production in the Northeast, where they have become more frequent and intense. In order to assure that these regions thrive, technical assistance is necessary. (Campelo et al, 2011)

[4] Fiscal module: tax-related measure based on the potential income generation from the land, ranging between 5 and 110 hectares, depending on the geographical area. Using this definition, 84% of Brazil's farms are family farms, averaging 18.4 hectares

As seen in Chapter 3, PRONAF has been providing this kind of support to its beneficiaries throughout the years. Based on the literature review, however, this aspect of PRONAF still needs considerable improvements to impact its beneficiaries. Campelo et al. argue that a permanent and continuous technical assistance needs to be provided by the government or by Non-Governmental Organizations (NGO). The assistance would focus on the demands, goals and interests of the families in order to promote water security, food security, access to markets, and production and commercialization strategies. The authors postulate technical assistance could reduce rural-urban migration and alleviate poverty (Campelo et al, 2011).

5.3 Diversification

Critiques have been leveled against PRONAF due to its approach in production diversification. Currently, farmer's decision on what to produce is based on what is funded by PRONAF. This results in a limited number of crops being produced. This lack of diversification can be harmful, especially to the smaller and poorer farmers. It also potentially increases the impact of large crop losses due to disease.

Given the lack of technology and financial resources of the majority of the poorer family farmers, irrigation and other high-tech and high-cost alternatives should not be considered as the primary solution to increase diversification in the production. For semi-arid regions, interventions such as substitution of high-volume dependent crops for crops of short vegetable cycles could decrease the need for such high cost interventions and increase resiliency (Andrade, 2001). Thus, products such as ginger, sorghum, peanuts and corn are examples of crops that family farmers should be incentivized to produce.

Diversification leading to resilience, however, is not limited to the crops. Authors such as Wilkinson have proposed diversification as a strategy to reduce rural attrition and income gaps

between rural and urban families. By moving from working on small production systems inside the farm to go working on the agroindustrial sector, the family farmer does not need to move out the rural areas. Currently, the definition of family farmer requires the majority of income to come from on-farm activities. This potentially reduces pluralization of activities and requires potential modification or impact investigation. (Wilkinson, 2000)

More coordinated agriculture and rural development policies and programs in Brazil can also play an important role in increasing agricultural productivity. As seen, agriculture policy and programs in Brazil have been determined by the distinct institutions supporting the sector. Institutional Markets have grown and are key instruments in guaranteeing small farmers insertion into markets (PAA and PNAE), price regulation and income increase, resulting socioeconomic gains. Nevertheless, small-scale farms continue to require targeted support, where farms with less than 5 hectares (nearly 50% of all farms in the Northeast) are too small to allow owners to escape out of poverty, even with high productivity increases.

5.4 Sustainability strategies

Lack of sustainability is a common challenge for the great majority of Brazilian family farmers. Both beneficiaries and non-beneficiaries of PRONAF struggle to achieve sustainable farming. By increasing the sustainability of their production, family farmers could stabilize their income and enter into new markets.

According to Zani et al, due to the lack of cropping and production techniques, the most common issues found in family farmers production are soil degredation and contamination of food by the usage of toxic fertilizers. Barbosa argues that family farmers would benefit from adopting a agro-ecology strategy. Producing high quality organic products would increase monetary value in their production and open new markets. He argues family farmers would benefit from focusing

on producing high-quality and higher-valued organic products. PRONAF could focus its technical assistance efforts to support their beneficiaries on becoming organic-certified producers. Such policies could increase overall impacts of the program on income and the environment. (Zani et al, 2014)

5.5 Constraints in the research

Initially, this work intended to analyze the impact of PRONAF over the past 20 years. Such analysis was meant to assess if the program could be used as a climate adaption tool to support poor Brazilian family farmers become more resilient to climate change.

Through this research, one of the main challenges was absence of updated data and analyses about the program's and Brazilian family farmers' performances. The majority of the data and analyses concentrates on the first 10 years of the program for two principal reasons. First, the majority of agricultural data in Brazil is provided by the Agrarian Census, with the last in 2006. A new agrarian census was expected to be done in 2016, however due to lack of financial resources the new Agrarian Census was postponed to 2018.

Since then, there is no official data regarding socio-economic assessment of rural areas in Brazil. This explains the significant decrease in impact evaluation studies conducted in the last years. The second reason is related to the current political socio-economic situation in Brazil. Since political changes in 2012, the priorities of the government have shifted considerably to other areas. In 2011 Dilma Rousseff was elected president. During the first years of Rousseff's administration had two clear priorities: firstly to implement an austerity reform to lower inflation ratios in addition to decrease the countries' economic internal debt, secondly to boost the country's development growth through investing in the industry sector. Therefore, less funds were allocated to population trends assessment, especially in the agricultural sector.

Along with the lack of data in the last ten years, the quality of the data presented analytic challenges. One good example is found on the variable of literacy in rural areas. In 2006, the data considered only the head of the establishment while measuring literacy. With this data, literacy was not found to be a significant predictor of beneficiary status, a surprising find. Yet, if all the members in the household were considered, results might be different.

5.6 Conclusion

Through this paper, the challenge presented to smallholder farmers by climate change was broached. Current policies specific to Brazil were analyzed, with critiques and strengths noted. Throughout the analysis, the overarching question emerged: how can PRONAF and similar governmental agencies foster resilience to climate change for small holder farmers?

This study started by analyzing the challenges of smallholder farmers living in different countries around the world. Similar challenges such as education, access to markets, land titling and technical assistance emerged as themes regardless of the region. The second chapter focused a more specific analysis on Brazil and the northeast region. This region was selected due to its climate characteristics and relative poverty. The chapter demonstrated the harm smallholder farmers have suffered due to droughts and extreme weather events resultant from climate change. After identifying the challenges faced by Brazilian smallholder farmers, this research focused the logic and background of the PRONAF program, to understand its characteristics and the rationale for its existence. In the fourth chapter, the results of several impact evaluations were reviewed. The available literature was noted to focus mainly on PRONAF's first 10 years. Critiques of the program were identified, including lack of continuous technical assistance, unequal geographic beneficiary distribution, failure to impact income generation and low rates of sustainability and

diversification. Of particular note, the failure to target the most socioeconomically vulnerable farmers is concerning given the goals of PRONAF.

Based on the challenges exposed above, this paper provides recommendations to enhance PRONAF's reach and impact, mainly in aspects such as diversification, sustainability, technical assistance and access to markets. Generation of more current data in the 2018 Agrarian Census will provide further insight into advances or regressions of the program since 2006.

Given the critiques of impact evaluations and absence of current data, it is not possible to say that this PRONAF currently functions as a climate change adaptation tool. Nonetheless, PRONAF has potential to grow to better assist smallholder farmers. A significant increase in matters of efficiency and efficacy could be achieved through considering recommendations proposed here and by the authors reviewed, especially following the publication of the 2018 report. Despite need for revision following analyses, public policies such as PRONAF in Brazil are important tools for building resiliency in vulnerable populations. Other nations can use the example of PRONAF and its pitfalls in order to implement effect adaptation tools for their smallholder populations. As the severity and frequency of extreme weather events increase, these policies will become critical for both the farmers and the populations their crops support.

APPENDIX A

DESCRIPTION OF BASIC LINES AND SPECIALIZED LINES OF PRONAF

Grupos básicos do PRONAF, enquadramentos e finalidades

Grupos	Enquadramento	Finalidade
Grupo A	Agricultores familiares assentados pelo Programa Nacional de Reforma Agrária (PNRA), público-alvo do Programa Nacional de Crédito Fundiário (PNCF) e os reassentados em função da construção de barragens.	Financiamento das atividades agropecuárias e não agropecuárias.
Grupo A/C	Agricultores familiares assentados pelo Programa Nacional de Reforma Agrária (PNRA) ou público-alvo do Programa Nacional de Crédito Fundiário (PNCF) que já tenham contratado a primeira operação no Grupo A	Financiamento do custeio de atividades agropecuárias, não agropecuárias e de beneficiamento ou industrialização da produção.
Grupo B (Microcrédito Rural)	Agricultores familiares com renda bruta anual familiar de até R$ 6 mil.	Financiamento das atividades agropecuárias e não agropecuárias no estabelecimento rural ou áreas comunitárias próximas.
Grupo C	Agricultores familiares titulares de Declaração de Aptidão ao PRONAF (DAP) válida do Grupo C, emitida até 31/03/2008, que, até 30/06/2008, ainda não tinham contratado as seis operações de custeio com bônus.	Financiamento de custeio, isolado ou vinculado, até a safra de 2012/2013.
PRONAF Agricultor Familiar	Agricultores familiares com renda bruta anual acima de R$ 6 mil e até R$ 110 mil.	Financiamento da infraestrutura de produção e serviços agropecuários e não agropecuários no estabelecimento rural, bem como o custeio agropecuário.

Linhas especiais do PRONAF, enquadramentos e finalidades

Linhas	Enquadramento	Finalidade
Agroindústria	Agricultores familiares enquadrados no PRONAF para Agricultor Familiar e suas cooperativas e associações que comprovem que, no mínimo, 70% de seus participantes ativos são agricultores familiares e que, no mínimo, 55% da produção beneficiada, processada ou comercializada é oriunda de cooperados ou associações enquadradas no PRONAF.	Financiamento de projetos de investimento para a implantação, ampliação, recuperação ou modernização de pequenas e médias agroindústrias.
Mulher	Mulheres agricultoras, independentemente do estado civil, integrantes de unidades familiares enquadradas no PRONAF.	Atendimento de projetos de crédito de investimento propostos pela mulher agricultora.
Jovem	Jovens agricultores familiares, entre 16 e 29 anos, que cursaram ou estejam cursando o último ano em centros de formação por alternância ou em escolas técnicas agrícolas de nível médio. Devem pertencer a famílias enquadradas no PRONAF ou que tenham participado de curso ou estágio de formação profissional que preencham os requisitos definidos pela SAF/MDA ou que contem com assistência técnica.	Atendimento de projetos de crédito de investimento propostos pelo jovem agricultor familiar.
Semiárido	Agricultores familiares instalados na região do Semiárido brasileiro enquadrados no PRONAF. O Semiárido compreende áreas com pouca ocorrência de chuvas localizadas no norte de Minas Gerais e Espírito Santo, nos sertões da Bahia, Sergipe, Alagoas, Pernambuco, Paraíba, Rio Grande do Norte, Ceará, Piauí e em parte do sudeste do Maranhão.	Financiamento de projeto de investimento de convivência com o Semiárido, priorizando a infraestrutura hídrica.
Agroecologia	Agricultores familiares enquadrados no PRONAF, exceto aqueles enquadrados nos Grupos A, A/C e B.	Financiamento de projetos de investimento de sistemas de produção agroecológicos ou orgânicos.
Floresta	Agricultores familiares enquadrados no PRONAF.	Financiamento de projetos de investimento de sistemas agroflorestais.
Eco	Agricultores familiares enquadrados no PRONAF, exceto aqueles enquadrados nos Grupos A, A/C e B.	Financiamento de projetos de investimento de tecnologias de energia renovável e ambientais, silvicultura, armazenamento hídrico, pequenos aproveitamentos hidroenergéticos e adoção de práticas conservacionistas e de correção da acidez e fertilidade do solo.
Mais Alimentos	Agricultores familiares enquadrados no PRONAF, exceto aqueles enquadrados nos Grupos A, A/C e B, observando-se que 70% da renda da família deve ser oriunda dos seguintes produtos e atividades: açafrão, arroz, café, centeio, feijão, mandioca, milho, sorgo, trigo, fruticultura, olericultura, apicultura, aquicultura, avicultura, bovinocultura de corte e de leite, caprinocultura, ovinocultura, pesca e suinocultura.	Financiamento de projetos de investimentos voltados à produção de açafrão, arroz, café, centeio, feijão, mandioca, milho, sorgo, trigo, fruticultura, olericultura, apicultura, aquicultura, avicultura, bovinocultura de corte e de leite,caprinocultura, ovinocultura, pesca e suinocultura.
Custeio e Comercialização de Agroindústrias Familiares	Pessoas físicas e cooperativas e associações que tenham, no mínimo, 70% de seus integrantes ativos agricultores familiares enquadrados no PRONAF e que, no mínimo, 55% da produção beneficiada, processada ou comercializada seja oriunda de cooperados/associados enquadrados no PRONAF.	Financiamento do custeio do beneficiamento e industrialização de produção própria e/ou de terceiros.
Cotas-partes	São beneficiados os agricultores familiares filiados a cooperativas de produção que tenham, no mínimo: I – 70% de seus sócios ativos classificados como agricultores familiares e que, no mínimo, 55% da produção beneficiada, processada ou comercializada seja oriunda de associados enquadrados no PRONAF; II – patrimônio líquido entre R$ 50 mil e R$ 70 milhões; III – 1 ano de funcionamento.	Financiamento para a integralização de cotas-partes dos agricultores familiares filiados às cooperativas de produção e reforço de capital de giro, custeio ou investimento.

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