

AGRICULTURE GLOBAL PRACTICE TECHNICAL ASSISTANCE PAPER

PARAÍBA STATE, BRAZIL

AGRICULTURAL SECTOR RISK ASSESSMENT

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PARAÍBA STATE AGRICULTURE SECTOR RISK ANALYSIS

Volume 1: Risk Assessment
Volume 2: Risk Management Strategy

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CONTENTS

ACRONYMS AND ABBREVIATIONS

ADAB	Agency for Agricultural/Livestock Defense	*Agência de Defesa Agropecuária da Bahia*
ACIS	Agroclimatic Risk Information System	-
ADC	Complete Water Supply Systems	*Sistemas de Abastecimento de Água Completo*
ADR	Rural Development Agent	*Agente de Desenvolvimento Rural*
ADS	Single Water Supply Systems	*Sistemas de Abastecimento de Água Singelos*
AESA	Executive Agency of Water Management of Paraiba	*Agência Executiva de Gestão das Águas do Estado da Paraíba*
AGEVISA	State Agency for Sanitary Surveillance	*Agência Estadual de Vigilância Sanitaria*
AGF	Federal Government Acquisitions	*Aquisições do Governo Federal*
AGRITEMPO	Agrometeorological Monitoring System	*Sistema de Monitoramento Agrometeorológico*
AIS	Agricultural Innovation System	-
ANA	National Water Agency	*Agência Nacional de Águas*
ANATER	National Agency for Technical Assistance and Rural Extension	*Agência Nacional de Assistência Técnica e Extensão Rural*
APL	Local Productive Systems	*Arranjos Produtivos Locais*
ARM	Agriculture Risk Management	-
ASA/PB	Articulation of Paraiba Semiarid	*Articulação do Semi-árido Paraibano*
ASPLAN	Sugar Cane Farmers Association of Paraiba	*Associação de Plantadores Cana da Paraíba*
ATER	Technical Assistance and Rural Extension	*Assistência Técnica e Extensão Rural*
ATR	Recoverable Total Sugars	*Açucares Totais Recuperáveis*
BA	State of Bahia	-
BACEN	Central Bank of Brazil	*Banco Central do Brasil*
BE	Drought Grant	*Bolsa Estiagem*
BNDES	National Bank for Economic and Social Development	*Banco Nacional de Desenvolvimento Econômico e Social*
BR-3	Average Risk of Foot and Mouth Disease	*Risco Medio de Febre Aftosa*
BSE	Bovine Spongiform Encephalopathy	-
CCA	Center of Agricultural Sciences	*Centro de Ciências Agrárias*
CDAF	Direct Purchase from Family Agriculture	*Compra Direta da Agricultura Familiar*
CE	State of Ceara	-
CEDA	State Board for Agriculture Defense	*Conselho Estadual de Defesa Agropecuária*
CEDRS	State Board of Sustainable Rural Development	*Conselho Estadual de Desenvolvimento Rural Sustentável*

CEF	Federal Economic Bank	*Caixa Econômica Federal*
CEPEA	Centre for Advanced Studies in Applied Economics	*Centro de Estudos Avançados em Economia Aplicada*
CONAB	National Supply Company	*Companaia Nacional de Abastecimento*
COOPERAR	World Bank Financed Project	-
COSALFA	South-american Commision Against Foot and Mouth Disease	*Comisión Sudamericana de Lucha contra la Fiebre Aftosa*
CSF	Classical Swine Fever	-
DAP	Capability Statement for PRONAF	*Declaração de Aptidão ao PRONAF*
DATAGRO	Consultancy of Ethanol and Sugar in Brazil	*Consultoria de Etanol e Açúcar*
DBMS	Database Management System	-
EMATER-PB	Paraiba State Company for Technical Assistance and Rural Extension	*Empresa de Asistência Técnica e Extensão Rural da Paraíba*
EMBRAPA	Brazilian Company for Agriculture and Livestock Research	*Empresa Brasileira de Pesquisa Agropecuária*
EMBRATER	Brazilian Company for Technical Assistance and Rural Extension	*Empresa Brasileira de Assistência Técnica e Extensão Rural*
EMEPA-PB	Paraiba State Company for Agriculture and Livestock Research	*Empresa Estadual de Pesquisa Agropecuária da Pariaba*
EMPASA	Paraiba State Company for Supply and Agriculture Services	*Empresa Paraibana de Abastecimento e Serviços Agrícolas*
ENSO	El Niño Southern Oscillation	-
FAEPA	Agriculture and Livestock Federation of Paraiba	*Federação da Agricultura e Pecuária da Paraíba*
FAO	Food and Agriculture Organization	-
FETAG	Agricultural Workers Federation	*Federação dos Trabalhadores na Agricultura*
FGS	Garantia Safra Fund	*Fundo da Garantia Safra*
FMD	Foot and Mouth Disease	-
FNDE	National Fund for the Development of Education	*Fundo Nacional de Desenvolvimento da Educação*
FNE	Constitutional Fund for Financing of the Northeast	*Fundo Constitucional de Financiamento do Nordeste*
FUNCEP	State Fund for Poverty Combat and Eradication	*Fundo de Combate e Erradicação da Pobreza*
GAP	Good Agricultural Practices	-
GDP	Gross Domestic Product	-
GPV	Gross Production Value	-
GS	Garantia Safra Program	*Programa Garantia Safra*
ha	hectare	-
HDI	Human Development Index	-
HLB	Huang long bing	-
HPAI	Highly Pathogenic Avian Influenza	-

IADB	Inter-american Development Bank	-
IBGE	Brazilian Institute of Geography and Statistics	*Instituto Brasileiro de Geografia e Estatística*
IICA	Inter-american Institute for Agriculture Cooperation	*Instituto Interamericano de Cooperação para a Agricultura*
INCRA	National Institute for Colonization and Agrarian Reform	*Instituto Nacional de Colonização e Reforma Agrária*
INMET	National Institute of Meteorology	*Instituto Nacional de Meteorologia*
INPE/CPTEC	National Institute for Space Research	*Instituto Nacional de Pesquisas Espaciais*
INSA	National Institute for the Semi-Arid	*Instituto Nacional do Semi-Árido*
IPCC	Intergovernmental Panel on Climate Change	-
ITZC	Inter-tropical Convergence Zone	-
Km	Kilometres	-
MAPA	Ministry of Agriculture, Livestock and Supply	*Ministerio da Agricultura, Pecuaria e Abstecimento*
MDA	Ministry of Agrarian Development	*Ministério do Desenvolvimento Agrário*
MDS	Ministry of Social Development and Fight Against Hunger	*Ministério do Desenvolvimento Social e Combate à Fome*
MF	Ministry of Finance	*Ministério da Fazenda*
MI	Ministry of National Integration	*Ministério da Integração Nacional*
mm	Millimetre	-
MPOG	Ministério do Planejamento, Orçamento e Gestão	
MST	Landless Rural Workers Movement	*Movimento dos Trabalhadores Rurais Sem Terra*
NCDV	Newcastle Disease Virus	-
NGOs	Non-governmental Organizations	-
OIE	World Organization for Animal Health	*Organização Internacional de Saúde Animal*
OIE/PVS	World Organization for Animal Health / Performance of Veterinary Services	-
PAA	National Program for Acquisition of Food from Family Farmers	*Programa de Aquisição de Alimentos*
PB	State of Paraiba	*Estado da Paraíba*
PEP	Premium for Product Outflow	*Prêmio para Escoamento de Produto*
PEPRO	Premium for Product Equalization	*Prêmio Equalizador do Produto*
PETROBRAS	Brazilian Mixed Capital Energy Company	*Empresa Brasileira de Energia de Capital Misto*
PGPAF	Minimum Price Guarantee Policy	*Programa de Garantia Preços para a Agricultura Familiar*
PGPM	Policy for Mininum Price Guarantee	*Política de Garantia de Preços Mínimos*
PNAE	National School Feeding Program	*Programa Nacional de Alimentação Escolar*

PNCEBT	National Program for Control, Eradication and Prevention of Brucellosis and Tuberculosis	*Progrma Nacional de Controle e Erradicaco de Brucelose e Tuberculose*
PNCRH	National Program for Control, Eradication and Prevention of Rabies	*Programa Nacional de Controle da Raiva dos Herbívoros e outras Encefalopatias*
PNEFA	National Program for Control, Eradication, and Prevention of Foot and Mouth Disease	*Programa Nacional de Controle, Erradicacao e Prevencao da Febre Aftosa*
PNESA	National Program for Sanitary Education	*Programa Nacional de Educação Sanitária*
PNSA	National Avian Health Program	*Programa Nacional de Saúde Aviária*
PNSAA	National Program of Health of Aquatic Animals	*Programa Nacional de Saúde dos Animais Aquáticos*
PNSAp	National Program for Bee Health	*Programa Nacional de Sanidade Apícola*
PNSCO	National Program of Goats and Sheep Health	*Programa Nacional de Saúde de Caprinos e Ovinos*
PNSE	National Program for Horse Health	*Programa Nacional de Sanidade dos Equídeos*
PNSS	National Program of Swine Health	*Programa Nacional de Saúde Suína*
PROAGRO MAIS	Agriculture and Livestock Activity Guarantee Program for Family Agriclture	*Programa de Garantia da Atividade Agropecuária da Agricultura Familiar*
PROAGRO/ PROAGRO TRADICIONAL	Agriculture and Livestock Activity Guarantee Program	*Programa de Garantia da Atividade Agropecuária*
PROCASE	Cariri and Serido Sustainable Development Project (financed by IFAD)	-
PRONAF	National Program for the Strengthening of Family Agriculture	*Programa Nacional de Fortalecimento da Agricultura Familiar*
PROP	Risk Premium for Product Acquisition through Options Market	*Prêmio de Risco para Aquisição de Produto Agrícola oriundo de Contrato Privado de Opção de Venda*
PSR	Rural Insurance Premium Subsidy Program	*Programa de Subvenção ao Prêmio do Seguro Rural*
SDA	National Secretary for Agriculture and Livestock Health	*Secretaria Nacional de Defesa Agropecuária*
SEAF	Insurance for Family Farming	*Seguro da Agricultura Familiar*
SEBRAE	Brazilian Micro and Small Business Support Service	*Serviço Brasileiro de Apoio às Micro e Pequenas Empresas*
SEDAP	State Secretariat for Agriculture, Livestock and Aquiculture Development	*Secretaria de Estado de Desenvolvimento da Agropecuaria e Pesca*
SENAR	Rural Learning National Service	*Servico Nacional de Aprendizagem Rural*
SEPLAG	State Secretariat for Planning and Management	*Secretaria de Estado de Planejamento e Gestão*
SISBI	Brazilian System for Inspection of Animal Origin Products	*Sistema Brasileiro de Inspeção de Produtos de Origem Animal*

SLP	Sea Level Pressure	-
SPEI	Standardized Precipitation Evapotranspiration Index	-
SPI	Standardized Precipitation Index	-
SPS	Sanitary and Phytosanitary System	-
SST	Sea Surface Temperature	-
SUASA	Unified System of Agricultural Health and Food Safety	*Sistema Unificado de Atenção à Sanidade Agropecuária*
SUDENE	Superintendency for the Development of the Northeast	*Superintendência do Desenvolvimento do Nordeste*
SUSEP	Superintendency of Private Insurance	*Superintendência de Seguros Privados*
TA	Technical Assistance	-
TAH	tons of total reducible sugars per hectare	*Toneladas de açúcares redutíveis por hectare*
UEPB	State University of Paraiba	*Universidade Estadual da Paraíba*
UFCG	Federal University of Campina Grande	*Universidade Federal de Campina Grande*
UFLA	Federal University of Lavras	*Universidade Federal de Lavras*
UFPB	Federal University of Paraiba	*Universidade Federal da Paraíba*
UFV	Viçosa Federal University	*Universidade Federal de Viçosa*
USAID	United States Agency for International Development	-
USP/ESALQ	São Paulo University	*Universidade de São Paulo*
VEP	Product Outflow Value	*Valor de Escoamento de Produto*
WHO	World Health Organization	-
ZARC	Climatic Risk Agriculture Zoning	*Zoneamento Agrícola de Risco Climático*

LIST OF TABLES

Volume 1: Risk Assessment

Volume 2: Risk Management Strategy

Annex 1: PROJECTED CLIMATE CHANGE IMPACTS ON AGRICULTURE IN NORTHEAST BRAZIL

Annex 2: VULNERABILITY IN PARAIBA

LIST OF FIGURES

Introduction

Volume 1: Risk Assessment

Annex 1: PROJECTED CLIMATE CHANGE IMPACTS ON AGRICULTURE IN NORTHEAST BRAZIL

Annex 2: VULNERABILITY IN PARAIBA

LIST OF TEXT BOXES

Volume 1: Risk Assessment

Volume 2: Risk Management Strategy

EXECUTIVE SUMMARY

1. **The present study is part of an effort by the World Bank and the State of Paraiba to assess Agriculture Sector Risks as a contribution to the strategic economic development and poverty reduction agenda of the State Government.** It is composed of two phases: an Agricultural Sector Risk Identification and Prioritization (Volume I) and a Risk Management Strategy and Action Plan (Volume II). The study was conducted in close collaboration with the Cooperar agency (which is currently preparing a World Bank financed project) and the Secretary of Agriculture of Paraiba (SEDAP).

2. **Paraiba's agricultural sector when compared to the total national agriculture GDP, detains only 0.7% of total production.** In relation to the Northeast, the State contributes with 11% of total agriculture GDP. Nonetheless, agriculture remains an important source of employment for the largest part of the rural population and the rural population remains vulnerable, in that the impact of a shock will have greater proportional impacts on welfare of a poor household that on a wealthier one.

3. **The risks in Paraiba's agriculture are highly concentrated in a few crops that account for more than 80% of the total agricultural gross output value of the State and 84% of total estimated annual losses due to realized production risks: sugar cane, pineapple, banana, coconut, cassava, maize and beans.** Thus, the priority value chains and subsectors chosen for the risk management analysis, based on the productive structure (reflecting relative importance of both crops and production patterns) are: sugar cane; commercial fruit production; family agriculture; and livestock.

4. **The risk assessment confirmed that there are no risks with critical impact that at the same time are highly probable (1 in 3 years) or probable (1 in 5 years) in Paraiba but there are several probable and highly probable risks that cause moderate or high impact when realized.** It was observed that the important issues identified around these main risks–- require comprehensive measures to complement the already existing federal policies and programs that in some way contribute to manage agricultural risks (*Garantia Safra*, price guarantees, livestock sanitary services, food safety, etc.) and to improve their implementation in Paraiba.

5. **For the sugar cane value chain, the most important risks are: drought; irregular precipitation; possibility of contamination with the *ferrugem laranja* disease; and uncertainty about gasoline price.** The sugar cane industry is the most important agribusiness sector and main economic activity of Paraiba. As a result, any adverse impact on this supply chain has also important financial consequences to the State. For the fruticulture value chain, the four main risks are: irregular rainfall; pests and diseases; pesticide use without needed technical knowledge; and inter-annual price variations. The State of Paraiba always stood out among the largest producing states of pineapple in Brazil, presently ranked as the second largest producer in the country. For the livestock sector (cattle, sheep and goat mainly), the three main risks are: drought; exotic diseases that affect the world beef trade; and zoonotic diseases.

6. **Severe drought, irregular rainfall, and pests and diseases are the main risks affecting family farmers in Paraiba.** When the risks are prioritized taking into account the relative importance of family agriculture in the total number of farmers (there are 148,047 family agriculture farmers in Paraiba out of a total of 167,272 farmers), it results that those risks are the main risks in Paraiba. Accordingly, the solutions scenario

presents strong actions directed towards improving risk mitigation among family farmers, such as adoption of innovative technology, improved agricultural practices and effective marketing mechanisms, as well as better agroclimatic information management, together with recommendations regarding other sectors of the agriculture in Paraiba.

7. **The impacts of the aforementioned risks have greater consequences for human welfare among the individuals, communities and regions of Paraiba that are more vulnerable.** The poorest areas of the state, as measured by earned income per capita, are not necessarily the areas that will be hardest hit by drought. State transfers for old age pensions and *Bolsa Família* serve to diversify the poor's portfolio and buffer the direct effects of drought.

8. **Approximately R$ 28 million (equivalent to US$ 16 million), or 2.3% of the agricultural GDP, was estimated as the value of the average production loss annually in the agricultural sector as a result of unmanaged production risks.** Drought was the main cause of these shocks, sometimes in combination with other events. The calculation involves all crops but the losses are concentrated in the crops whose gross output value accounts for over 80% of the total agricultural gross output value: sugar cane, beans, banana, pineapple, maize, papaya fruit and cassava.). Sugar cane and fruits, especially pineapple, because of their large share in the total agricultural production value of Paraiba, are the greatest determinants of the agricultural losses.

9. **Average figures tend to conceal the actual catastrophic impact that some shocks have at the time they occur.** For instance, during the 2010 drought, losses amounted to R$ 65 million (against the R$ 28 million annual average), or 5.4% of the state's agricultural GDP, and there were much higher losses in previous years: R$ 108 million in 1998, R$ 104 million in 1993 and R$ 82 million in 1996. Not surprisingly, the first two years match with two very severe droughts throughout the state (1998 and 1992-1993).

10. **Losses in terms of the normal production value in 2010 were extreme for important smallholder crops like beans and maize, accounting for R$ 16 million and R$ 7 million losses respectively.** In the same year, the losses of sugar cane and banana reached R$ 18 million and R$ 13 million respectively. In total these four crops accounted for 83% of the total losses in 2010.

11. **The first phase of the assessment identified the following risk management intervention areas to address priority risks:** (i) strengthening State rural extension and technical assistance system including both production and marketing aspects; (ii) review and reinforce State animal and plant health sanitary system; and (iii) improve coordination within fruit supply chains, and (iv) develop an integrated agroclimatic information system. After analyzing a number of programs and projects that are already addressing some of the identified risks along the above solution areas, came up some gaps and complementary actions.

12. As a result, the following are the strategic lines identified during the agriculture risk management assessment – ARM (second phase):

Agroclimatic Risk Information System (ACIS):

a. Development of a Agroclimatic Database Integrated System in the state of Paraiba including federal institutions and AESA
b. Strengthening of the Drought Management Committee, making actions more proactive and less reactive
c. Training to the extension workers associated to inspection procedures in the Garantia Safra project, in order to reduce moral hazard and technical issues

Sanitary and Phytosanitary System (SPS):

Sugarcane

a. Expand the area of sugarcane under biological control
b. Assess the impact of the possible introduction of the ferrugem laranja in Paraiba
c. Set up a surveillance network for ferrugem laranja in Paraíba

Fruticulture

a. Assess the likelihood and impact of the possible introduction of the diseases *sigatoka negra* and *moko* (bananas), *cancro da videira* and HLB (Citrus)

Family Agriculture in the Semi-arid zone

a. Substitute the varieties of *palma forrageira* susceptible to the *cochonilha do carmim* for resistant ones

Livestock Production

a. Reinforce the program for controlling and eradication of brucellosis and tuberculosis
b. Coordination of the animal health and food safety programs→for what?
c. Establish the actual status of CSF and NCDV in Paraiba→meaning?
d. Create the State Agency for Agricultural Health→for what?

Supply Chain Coordination:

a. Identify successful farm to market experiences in Paraiba and assess the viability of being replicated under a massive technical assistance program
b. Develop market oriented business development methodologies for training and providing technical assistance to associated small scale farmers
c. Assess different options to support market development for family agriculture products, including revision of the legal framework to channel public resources

Agricultural Innovation System (AIS):

a. Improve the coordination of the Agriculture Innovation System for family agriculture risk management
b. Improve efficiency of the Agricultural Innovation System for family agriculture risk management - Strengthen the research sub-system
c. Improve efficiency of the Agricultural Innovation System for family agriculture risk management - Strengthen the ATER sub-system
d. Improve efficiency of the Agricultural Innovation System for family agriculture risk management - Enlargement of successful programs and projects

13. **The proposed action plan (detailed in the text) reflects the strategic lines and includes some basic details on who, when and how much is required for the implementation of the actions proposed. The estimated cost of the ARM Action Plan is a total of US$ 18,881,000 over 5 years, with a strong concentration of activities within the first two years.** Out of this total, US$ 6,081,000 would correspond to studies, training and pre-investment and US$12,800,000 to program investments. The EMATER's staff cost is not part of the ARM Action Plan but it is included as a complementary public policy, as has been mentioned by State policy makers.

The summary break down by category of intervention is as follows:

Plan of Action - Category of intervention	Total Cost (US$)	Execution of field programs (US$)	Payments to EMATER staff (US$)	Studies, training and pre-investment (US$)
Agro-climatic Risk Information System (ACIS)	3,211,000	0	0	3,211,000
Sanitary and Phytosanitary System	6,120,000	5,000,000	0	1,120,000
Supply Chain Coordination	205,000	0	0	205,000
Agricultural Innovation System	9,345,000	7,800,000	0	1,545,000
Total Action Plan	18,881,000	12,800,000	0	6,081,000

INTRODUCTION AND CONTEXT

Background

1. The World Bank and the State of Paraiba conducted an Agriculture Sector Risk Assessment for agriculture in Paraiba in Brazil. The assessment was composed of two phases. The first phase was an Agricultural Sector Risk Identification and Prioritization undertaken in June 2014.

2. Expert interviews, in combination with primary and secondary data and literature, provided the basis for this Risk Assessment. The work included consultations with state and federal government, private sector, civil society, and academic stakeholders to inform this analysis and draw a diversity of perspectives on risk management.

3. The rapid risk assessment methodology developed by the World Bank involves several phases. The first phase – the Risk Assessment – provides a diagnosis of the primary risks in the entire agricultural sector. Risks are classified on the basis of the probability of occurrence and degree of impact, from which emerge the prioritized risks for the sector and a list of potential management strategies. Then, those solutions are confronted with the existing programs and projects that somehow address the agricultural risks, and a set of solutions that fill gaps in current risk management is proposed.

4. The first phase serves as the basis for planning the second phase of the risk methodology, which focuses on the development of a Risk Management Strategy and Action Plan. The Action Plan can be executed in the medium-term to mitigate, transfer, and cope with the risks in the sector. The specific solutions are developed in depth with stakeholders in response to the first phase's characterization of risks.

5. The second phase of the Agriculture Sector Risk Assessment aimed to develop an Agriculture Risk Management Strategy by deepening the analysis into the risk management solutions and risk capacity assessment along the lines of the above priority risk solutions areas.

6. Figure 1 on the following page provides an overview of the full process of the World Bank's risk assessment methodology.

7. Brazil has developed a portfolio of agricultural risk management solutions (activities and instruments like *Garantia Safra*, several EMBRAPA research programs, Price Guarantee programs, etc.) that involve management of risks such as drought, pest and diseases and prices. These solutions have a regional or nationwide coverage and their implementation require the participation of many state and federal institutions. However, there is still room for strengthening the risk management capacity of the public and private sector, especially through improving policy and program coordination, taking advantage of synergies and strengthening the support services to the most vulnerable farmers.

Figure 1: Agricultural Sector Risk Management Process Flow

8. The analysis was conducted in close collaboration with the Cooperar agency (which is currently preparing a World Bank financed project) and the Secretary of Agriculture of Paraiba (SEDAP). This report presents the findings and conclusions of the second phase of the Agriculture Sector Risk Assessment.

9. The study is a contribution to the strategic economic development and poverty reduction agendas of the State Government. In the immediate term it provides practical elements for the design of the Sustainable Rural Development project as it helps to incorporate the risk management dimensions into project investments.

Contents of the Report

10. This report is comprised of two volumes: (i) Volume 1: Risk Assessment; and (ii) Volume 2: Risk Management Strategy. Volume 1 continues with Chapter 1, which characterizes the recent performance of the agriculture sector, including agro-climatic and market conditions. It also identifies the productive systems used for this analysis. Chapter 2 describes the main risks in the agricultural sector, capturing market, production, and enabling environment risks along the value chains involved in the selected productive system typologies. Chapter 3 presents the estimations of the aggregate impacts of unmanaged agricultural risk on agricultural losses and production volatility. Chapter 4 identifies risk profiles for different stakeholders, underlying the different types of risk impacts, and then highlights a vulnerability framework. Finally, Chapter 5 presents a prioritization of risks and proposes a preliminary set of priority risk management measures. A short list of potential solution actions is offered as the starting point for a more in-depth solution analysis to be undertaken during the second phase of the risk assessment.

11. Volume 2 is composed of four chapters. Chapter one provides a brief discussion on the agricultural risk profile and risk management options (solutions) in Paraiba and an inventory of current programs, projects and policies that in different ways address the main agricultural risks. Chapter 2

presents an overview of the key agricultural sector features as are relevant for understanding the ARM strategy.[1] Chapter three presents the ARM strategy with respect to the intervention areas identified during the first phase, i.e. weather information system, Sanitary and Phytosanitary System (SPS), supply chain coordination, and Agroclimatic Information Systems, including concrete risk management actions. Chapter four incorporates detailed information on the proposed actions aggregated in strategic lines. It includes information about the estimated cost of the actions, the responsible institution and the timeframe. Moreover, a second table provides a short term calendar by institution.

[1] Volume I of the Risk Assessment already contains a more detailed analysis of the agriculture sector and the recent production and market trends.

VOLUME 1: RISK ASSESSMENT

CHAPTER 1: PARAIBA'S AGRICULTURAL SYSTEM

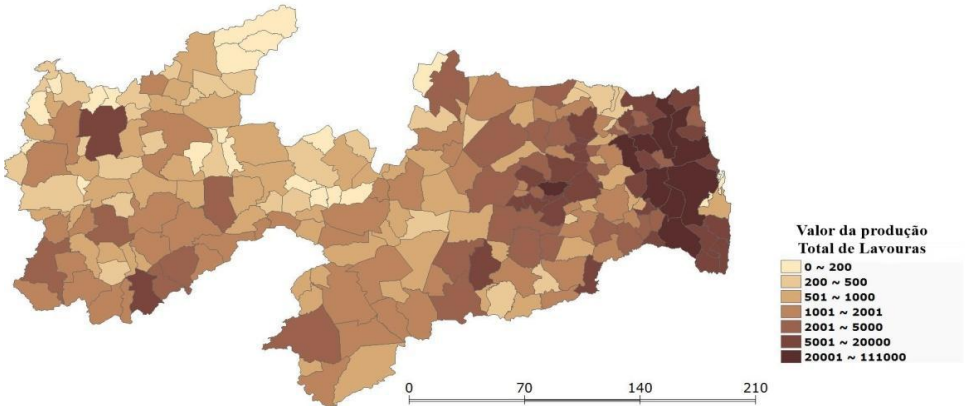
Agriculture Sector Overview and Performance

1. Located in the Northeastern region, the State of Paraiba occupies an area of 56,469.47 km² and has 223 municipalities. Its neighboring states are Rio Grande do Norte, to the North, Ceara to the west, Pernambuco to the south, and the Atlantic Ocean to the east, with approximately 135 km of coast. The climate of Paraiba is tropical humid on the coast, with abundant rainfall. Inland the climate becomes semi-arid and subject to prolonged droughts and low rainfall.

2. The services sector generates the majority of revenues in Paraiba, accounting for 74% of the State's GDP (2011)[2], mainly driven by public services and trade. The agriculture and livestock sector, represents 5.7% of the State's economy (2009)[3] (3.7% corresponds to agriculture and forestry and 2% is livestock production). It is comprised mainly of plantation of sugarcane, fruits (such as pineapple, banana, coconut, among others), cassava (*manioc*), maize and beans, and livestock production (composed mostly of goats and bovines).

3. Due to harsher climate conditions found in the semi-arid inland, most agricultural lands are located in the coastal regions. Figure 2 below shows the distribution of the crop production value among the different municipalities, with concentration of production value in the regions with better agroecological conditions, near the coast (municipalities of *Mata Paraibana* and *Agreste Paraibano*, in particular in the micro-regions of *Brejo Paraibano, Esperança* and *Campina Grande*, and in some municipalities of *Serra de Teixeira* and *Sousa* regions). The lowest production densities are fond in the *Borborema* and *Sertão Paraibano* regions, where livestock raising predominates (see location of regions in Figure 5 in next Section).

Figure 2: Map - Crop Production Value, by Municipality (2009)

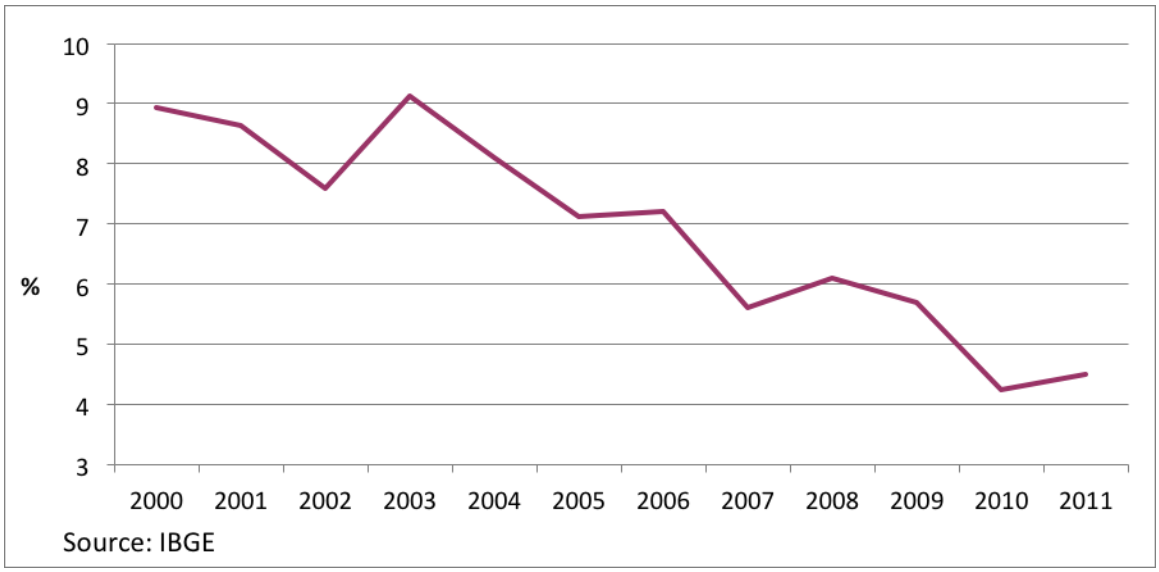


Source: IBGE.

[2] Data from IBGE.
[3] Data from IBGE.

4. Paraiba's agriculture share is very low, 0.7% as compared with total national agriculture GDP and 11% as compared with the Northeast agriculture GDP, as it is a small state with limited agroecological conditions for agriculture. In spite of the continuous growth of Paraiba total GDP throughout the past decade, the agricultural sector has performed poorly. Figure 3 shows the declining trend of the agricultural and livestock GDP share of total GDP of the State.

Figure 3: Paraiba - Share of agriculture and livestock GDP of total GDP of the State



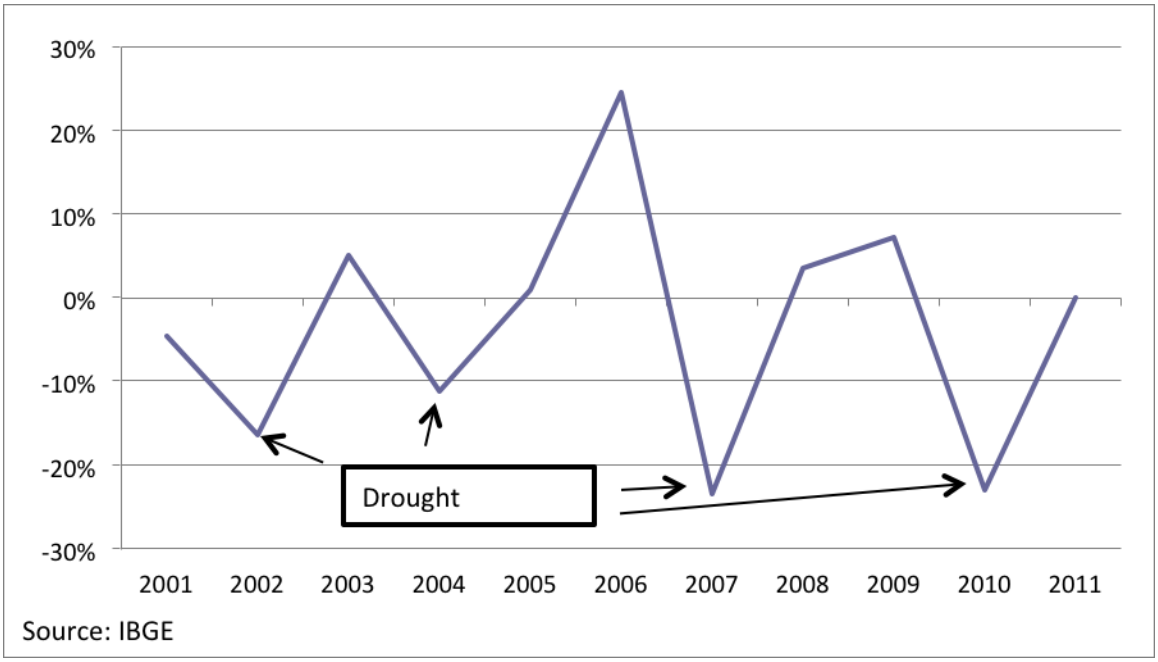
5. Until the second half of the last century the Paraiba economy was mainly agriculture based: agriculture GDP was 56% of total State GDP in 1961 and most of the labor force was employed in agriculture. Several factors contributed to agriculture losing relative importance in the economy of the State, including the increasing urban employment associated to rural-urban migration; the modernization of agriculture and the consequent reduction of demand for workers; the decline in cotton and sisal production during the 70s and 80s as result of increasing demand for synthetic fibers and the *bicudo* (boll weevil) pest attacking cotton crop, which was partially compensated by increasing area under pineapple production; and, above all, the periodic droughts that caused long term decline in the production capacity of many farming systems. Cattle production is still one of the major agricultural activities in the state and stands out as one of the most important enterprises in large farms.

6. In spite of its current relatively low share in the total State economy, agriculture remains an important source of employment for the largest part of the rural population. In effect, out of the 3.7 million inhabitants of Paraiba, 0.9 million live in rural areas (IBGE, Census 2010). Of these, it is estimated that between 74% and 92% are engaged in agriculture and, are mainly family agriculture farms -according to the Agricultural Census of 2006, there are 167,272 farms (IBGE) of which 92% have less than 50 hectares.

7. Drought is a recurrent event in Northeast Brazil. Drought has a strong negative impact on family livelihoods as it represents a challenge in terms of food security; crops such as maize and beans and may cause important losses of livestock. Figure 4 shows the performance of overall agricultural GDP of Paraiba, with clear evidence of the drought effect.

8. It should be noted that the social impact of drought is especially aggravated by the fact that peasant families represent more than 90% of the farmers in Paraiba and irrigation is not widespread - though the participation of small farms in the total irrigated area has increased over recent years (see Text Box 1).[4]

Figure 4: Paraiba - Agricultural and livestock GDP Growth rate



9. The food security implications of drought would have been severe, had it not been for the safety nets in place such as *Garantia Safra* and other government programs (discussed in detailed in the following pages). Furthermore, the very limited diffusion of irrigation in Paraiba, with only 6.8% of farms in 2006, makes the precipitation irregularities and recurrent droughts particularly decisive in agricultural production and food production.

Text Box 1. 1: Irrigation in Paraiba

According to the Agricultural Census of 2006, 11,419 farms, or 6.8% of all farms in Paraiba, had irrigation facilities, with coverage of 58,683 hectares or 1.6% of all farms' area. Compared with the 1995/96 Agricultural Census, the number of farms with irrigation facilities increased by 25% but the

[4] Farms with less than 50 hectares account for 91.8% of total farms, but occupy about 27.9% of total area.

irrigated area decreased by 7.7%. The explanation for this may be found in the vulnerability of the watersheds, as discussed below.

Eighty one per cent of the farms with irrigation infrastructure have less than 10 hectares (9,300 farms or 8% of all farms with less than 10 hectares). However, larger farms (those with more than 500 hectares) with irrigation represent only 0.2% of the total farms with irrigation (24 farms or 2% of all farms with more than 500 hectares) but have more than 20,000 hectares under irrigation or 35% or the total irrigated area. Therefore, irrigation is not a widespread practice in Paraiba, particularly among large scale farmers.

There are twelve irrigation schemes in Paraiba developed by the government, with 12,516 hectares of irrigated area that are intended to benefit 2,000 families. The Federal Government through the National Department Infrastructure Against Drought developed three of them and the other schemes belong to the State Government.

However, there are several restrictions on the use of available water resources due to watershed vulnerability to drought events (quantitative aspects) and restrictions related to water quality (hard water and water salinity levels). In terms of water quality, a study conducted by the Government of Paraiba[5] found that there are moderate restrictions to human consumption and strong restrictions for industrial purpose use. Restrictions are also present in the use of water for crop irrigation, especially in the watersheds of *Jacu*, *Curimataú*, *Seridó*, *Espinharas* and the sub-watershed of *Taperoá*, where the misuse of irrigation water may cause soil salinization, reduce soil water infiltration capacity, plant toxicity, and corrosion on irrigation equipment. Furthermore, lessons learned from irrigated programs that have been implemented in Paraiba suggest that caution should be taken when promoting these types of investments due to collateral damages, including: soil salinization, impossibility of selling all the agricultural production due to an increase of the supply, low profit margins due to high energy costs, etc.

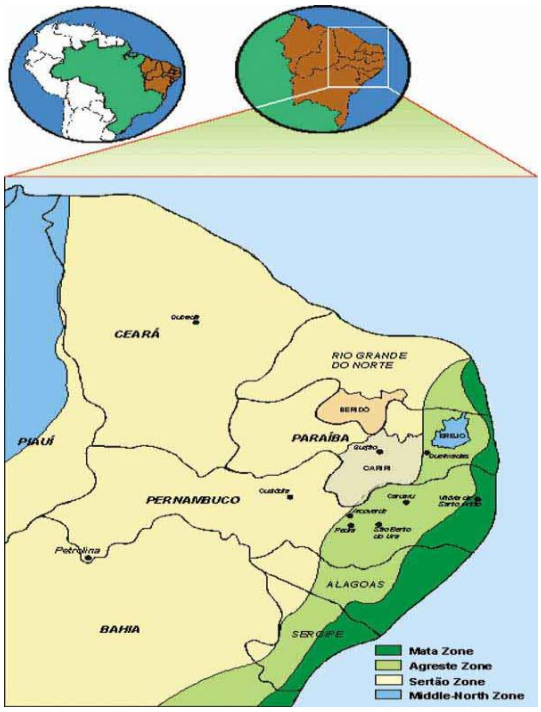
Agro-Climatic Conditions

10. Like in most parts of Northeast Brazil, Paraiba has the following main agroecological zones: the *Mata* zone, the *Agreste* zone and the *Sertão* zone (see Figure 5). In the *Mata* zone there are two important factors for agriculture: high precipitation (over 1,400 mm annually), and relatively fertile soils. This region has been, since colonization, largely dedicated to sugar cane produtction. The *Agreste* zone is located inland in the *Borborema* Highlands (between the *Mata* and *Sertão* zones), with an average annual precipitation around 700 mm, distributed irregularly but concentrated in the period March to August (which is the season of least evapotranspiration), with mild night temperatures. The *Sertão* zone presents higher temperatures, and rains occur during the hottest months. In the *Agreste*

[5] Agência Executiva de Gestão das Águas do Estado da Paraiba. ND. Caracterização da Oferta e Demanda Hídrica no Estado da Paraiba. [On Line] Available from: http://www.aesa.pb.gov.br/perh/relatorio_final/Capitulo%205/pdf/5%20-%20CaracOferDemHidricaPB.pdf

zone, as well as in the *Sertão* zone, the dry season is long, lasting six to seven months and seven to eight months, respectively, with severe droughts every 10 or 11 years. In the *Agreste* zone, the landholdings are smaller (approximately 40 hectares in size), and greatly engaged in dairy production.

Figure 5: Agroecological Zones and Meson-regions



Source: FAO (Cordeiro dos Santos, Djalma and Gonzaga de Albuquerque**)**

Source: IBGE

11. In general, it is known that several phenomena have strong influence on the rainfall pattern within the Northeastern region of Brazil. One is the Southern Oscillation of El Niño (ENSO), a global phenomenon that may cause severe droughts or excess of rainfall conditions depending on its intensity. In general, the different phases of ENSO relate to years with below or above normal rainfall conditions.

However, Northeast Brazil has experienced severe drought events that are not necessarily related to the ENSO, but to the influence of different atmospheric systems that cause rainfall in this region.[6] Other phenomena are: the Sea Surface Temperature (SST) in the Atlantic Ocean, Easterly Winds, the Sea Level Pressure (SLP); the Inter-tropical Convergence Zone (ITZC) – one of the most important factors that determine how generous or deficient rainfall conditions are going to be reported in the northern areas of Northeast Brazil;[7] Cold Fronts, recorded between November and January (cold fronts are organized bands of cloud created in the areas where there is a confluence of cold and hot air masses); and the Upper Tropospheric Cyclonic Vortices that are originated in the Atlantic Ocean between November and March and they move from east to west more often between January and February. In addition, the effects of sea breeze also influence rainfall conditions: continental areas record rainfall values as low as 300 mm compared to the coast (around 1,400 mm annually). The sea breeze, which may affect up to 100 Km inland, is due to the difference in temperature values recorded between sea surface (low temperature) and mainland (high temperature).

12. The rainfall spatial variability experienced in Paraiba in combination with strong temporal rainfall erraticism generates not only dry spells but also severe drought conditions and even flooding.

Agricultural Production and Market Trends

13. The area planted with food security crops has shown a declining trend over the last two decades, especially maize, beans and cassava (see Figure 6 on the following page). Maize and beans, being cultivated for family subsistence in marginal lands, are subject to strong variability in terms of area and output. On the contrary, sugar cane, the main crop planted in Paraiba, considering production value, had a positive performance after 2000, driven by the opening of the European market, the reduction of Indian production and the oil price increase during the 2000s (US$ 19/barrel in 2001 and US$ 132/barrel in 2008). Pineapple planted area also presented significant increase between 1996 and 2008. In turn, yields of all crops have tended to increase or remain relatively stable over the time though showing a great variation between years, due to the effect of recurrent droughts.

14. Livestock production in Paraiba is very dependent on the particular semi-arid agroclimatic conditions. The size of bovine stock has remained almost unchanged over the last two decades (1990 to 2011) at 1.3 million heads contrasting with the national trend (bovine stock increased from 147 million to 212 million at national level over the same period). In turn, heads per hectare increased by 25% during the last ten years.

15. Differently to the bovine stock, goat stock increased significantly during early 2000s (see Figure 7 on the following page), as goats are more adaptable to the semi-arid climatic conditions in Paraiba, but decreased between 2005 and 2010.

[6] Alves and Repelli, 1992, cited by de Almeida and Júnior, 2012.
[7] In general, the ITZC traditional moves to the North between August-October, to the South of the Atlantic basin between February-April; nevertheless, its position as well as its intensity is conditioned upon the SST.

Figure 6: Planted Area by Crop (hectares)

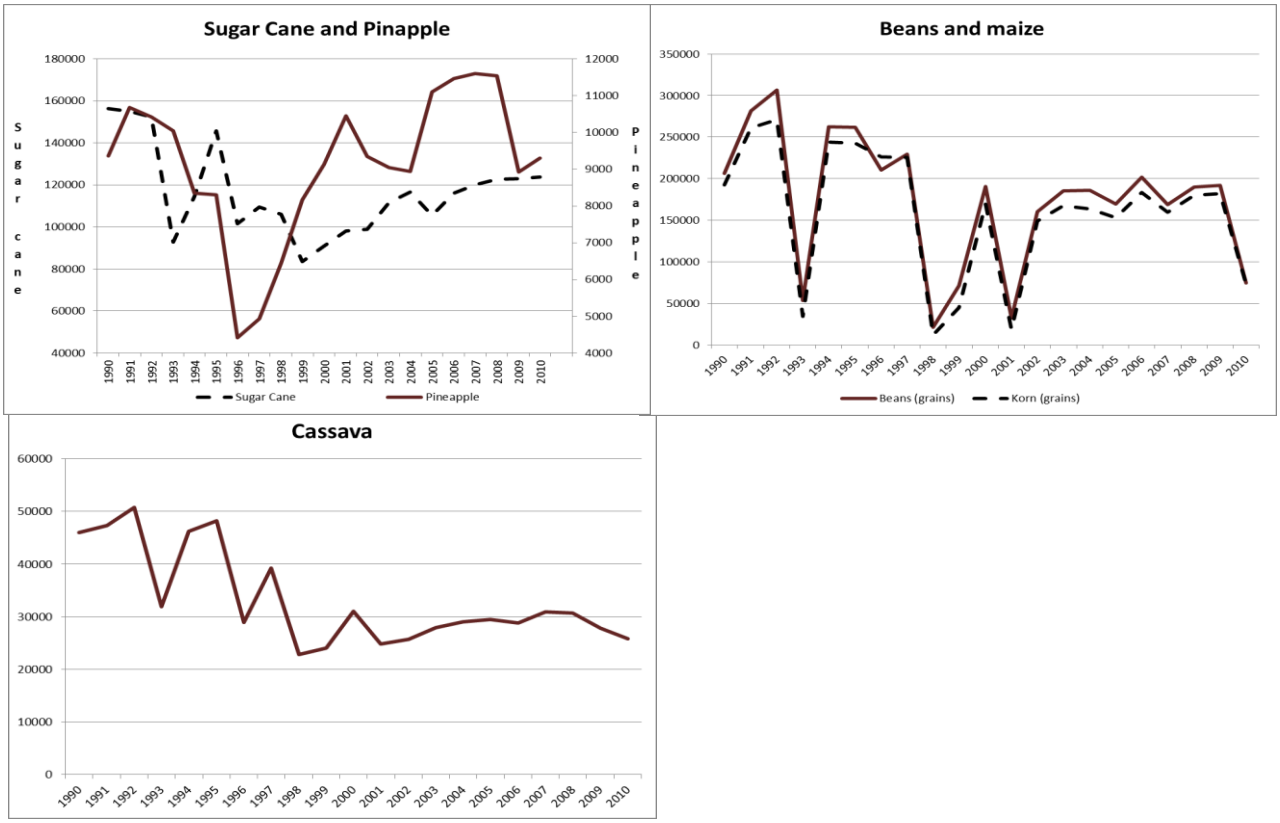
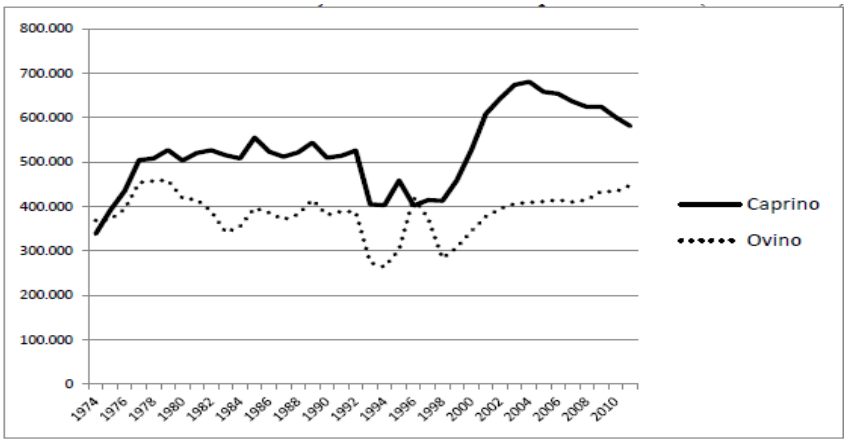


Figure 7: Goat and Sheep Stock (1974-2011)



Source: IBGE

CHAPTER 2: AGRICULTURE SECTOR RISKS

16. Agriculture is inherently variable as producers may incur in moderate losses every year due to sub-optimal climatic conditions at different times thorughout the production cycle or to other production related factors. For the purpose of this report, production risks refer to the more severe and unpredictable adverse events that occur besides these smaller events. They are measured by per yield reductions with respect to the linear trend line greater than 33% of the standard deviation (see details in Chapter 4). Also modest departures from expected prices may cause moderate losses that are not considered risks but unexpected significant price drops is an important risk affecting all actors along the supply chain. The price variations are measured and compared using the coefficient of variation (standard deviation/mean).

17. The state of Paraiba has suffered from severe droughts, which are reported by stakeholders as the most damaging production risk for all crops. Severe droughts should be differentiated from the recurrent (annual) droughts in the Semi-arid, which are not a risk, but can be regarded as a constraint given their predictability. In addition, erratic rainfall is frequent but of moderate or low impact. The damaging impact of pests and diseases is significant when they are not properly mitigated. Historically, they have been particularly devastating when new pests/diseases arrived and the State technology support services were not prepared to respond adequately (e.g.. cotton boll weevil). Livestock sanitary risks are very relevant. Northeastern export crops, in particular sugar cane, have their prices largely determined by prices in the international and national markets. Northeast producers are price takers.

18. Risks are highly concentrated in a few crops that account for far more than 80% of the total production value of the state and 84% of the total estimated annual losses due to realized production risks in the last 20 years (see detailed calculation in Chapter 4): sugar cane, pineapple, banana, coconut, cassava, maize and beans. They are particularly important both for family food security and for the sustainability of commercial farming. Table 1 shows the relative importance of the main crops in Paraiba in terms of contribution to the State agricultural production value.

19. Based on this productive structure, that reflects the relative importance of both crops and production patterns, the following are the productive systems were chosen for the risk management analysis: sugar cane, commercial fruit production, family agriculture, and livestock -this analytical structure was discussed and agreed with the project Cooperar. Table 2 presents a summary of the information on these productive systems and their most important risks (further discussed along this Chapter).

Table 1: Gross Production Value (GPV) of Main Crops and Indicative Annual Losses, % of Total State Agriculture

Crop	% GPV 2010	% Indicative Annual Average Losses in Value Terms
Sugar cane	35.72%	29.38%
Pineapple	27.95%	14.29%
Banana	10.77%	12.78%
Cassava (mandioca)	6.32%	3.43%
Coco	3.26%	2.06%
Beans	2.22%	14.29%
Maize	0.67%	7.77%

Source: IBGE

Table 2: Summary of Productive Systems' Features and Main Risks

Productive systems	**Products**	**Location ***	**Farmer typology**	**Most important risks**
Sugar cane industry	Sugar cane.	Mata zone.	Smallholders around estates and large estates of several thousand hectares.	Drought. Irregular precipitation (heavy rainfall followed by extended dry spells) in rain fed sugar cane. Disease called "*Ferrugem laranja"* that is not yet present in Paraiba but if arrives could be very damaging. Uncertainty about gasoline price policy:

				risk for entire industry.
Fruit supply chains	The most important fruit grown in Paraiba, in terms of production value, is pineapple. Other fruits grown are grapes, citrus, banana, mangaba, mango, and coconut.	Main producing areas of pineapple are in Mata zone and around Brejo: municipalities of Itapororoca, Araçagi, Lagoa de Dentro and Santa Rita.	Market oriented smallholders.	Irregular rainfall. Pests and diseases affect fruit production but they are normally controlled and therefore impact is low. Pesticide application without the needed technical knowledge risk related to pests and diseases control. Inter-annual price variations that largely respond to changes in production and traded volumes.
Family farming in Semiarid	Cassava, maize and beans, native trees and vegetation provide firewood, fodder for animals, and fruits like *umbu*, small animals, commonly goats.	Family farmers are spread throughout Paraiba but concentrated in the Semiarid macro-region, encompassing the Borborema, Sertão Paraibano, and Agreste Paraibano meso-regions.	Family farming (*agricultura familiar*) is formally defined in Brazil in terms of area, management, labor, and income. The family must manage the farm, and the family must rely on agriculture as their principal source of income.	Severe drought. Irregular precipitation (heavy rain followed by extended dry spells). Pests and diseases are recurrent, they are not controlled and they are a constraint rather than a risk.
Livestock	Cattle, goat, sheep, etc.	There are three types of cattle production regions in the State, with regard to the ecological traits: the Agreste/Litoral region, the	Cattle production is mostly extensive and on semi-arid soils with poor vegetation and low rainfall.	Drought is recognized as a severe risk that causes significant losses in terms of animals, weight lost and reduction of milk and honey

		Cariri/Curimatau region and the Sertão region.		production among others. Main sanitary risks are exotic diseases that affect world beef trade (BSE and FMD). Paraiba is free of these major exotic animal diseases but there is the risk of an outbreak. Other sanitary risks are zoonotic diseases – brucellosis, tuberculosis, cattle rabies (bovine, ovine and goat).

* See map in Chapter 2.

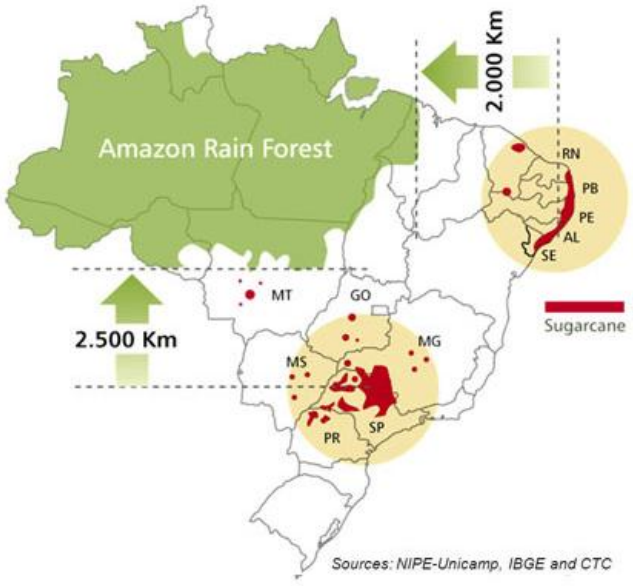
20. This section presents findings regarding the production, market and enabling environment risks for the selected supply chains covering the referred major production systems in the state of Paraiba. The impact of the adverse events on different stakeholders is discussed in Chapter 5.

Sugar Cane Supply Chain

Overview of supply chain

21. Brazil is the largest worldwide producer and exporter of sugar and the second largest producer of ethanol. Sugarcane cultivation in Northeastern Brazil– including Paraiba – dates back to the 16th century. During the 20th century, the sugarcane chain became more dynamic, especially by producing ethanol besides sugar, and progressively moved to the Southeastern and Central regions of Brazil. South-Central Brazil is the heart of the country's sugarcane industry, with 90% of the country's cane and sugar output. Areas marked in red in Figure 8 indicate where sugarcane is harvested

Figure 8: Sugarcane Producing Regions in Brazil



and, sugar, ethanol and bioelectricity plants are located. The relative importance of the production in the Northeastern region has progressively reduced but still remains very important for the economy of the Northeastern states, such as Paraiba.

22. The sugar cane industry (cane plantation and processing in *usinas* – sugar cane processing plants) is the most important agribusiness sector and main economic activity of Paraiba. Historically, sugarcane was mainly for sugar production, but today a large proportion is directed to the production of ethanol (biofuel). Most plantations are distributed along the coast, but there are a few small farms in the *Agreste,* which produce *cachaça* (alcoholic beverage) and *rapadura* (large tablets of brown sugar). In Paraiba there are 8 *usinas* and 1,935 farmers producing sugar cane, 95% being small and micro-producers, in 36 municipalities.[8] However, large and medium scale producers (less than 5% of the total), including the *usinas* nucleus land, with a production scale of over 5,000 tons/year, contribute to about 55% of the total output. ASPLAN (Sugar Cane Farmers Association of Paraiba) calculates that during the 2012/13 seasons the sugar sector in Paraiba provided employment (direct and indirect) to more than 63,000 people.

23. The yield of rain fed sugarcane in the region is lower than the Brazilian average, mostly due to rainfall irregularity. In particular, if compared to the crop grown on Southeastern and Western regions. The average yield in the state is estimated at 50 tons per hectares, but in irrigated areas productivity can be higher than 100 tons per hectare, as a result of reducing water supply uncertainty. In addition, when the hydric stress is managed, there is a better environment for investing in other agricultural practices, like fertilizing, crop management, pest control, all of which contribute to higher yields and reduced production risk. Thus, the stakeholders reported rainfall irregularity as the main risk for the sugar cane sector, affecting both producers and processing plants. Farmer association leaders and some industrial entrepreneurs stated that the lack of appropriate public policies was a main issue, alongside climate irregularity, determining the uncertainty on sector sustainability.

Production risks – Climate risks

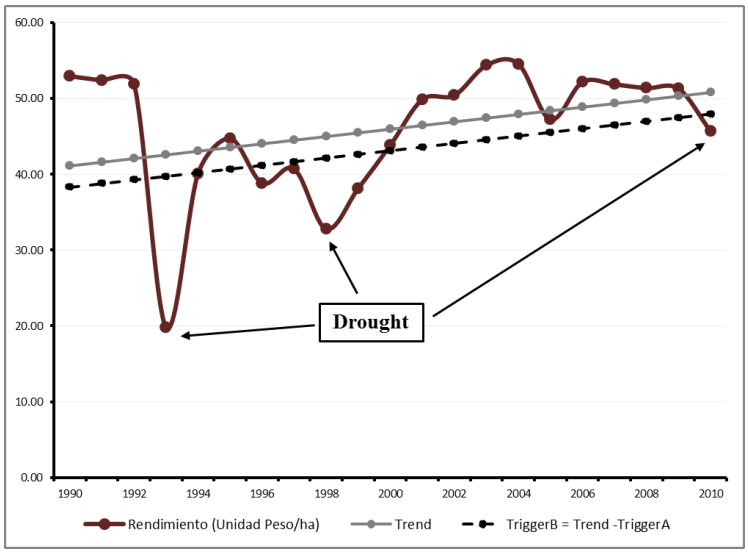
24. One of the risks that constantly affects the value chain in a significant manner is drought. For instance, prolonged dry conditions recorded in 2012 reduced by 25% the State sugarcane production. According to ASPLAN, the rainfall values recorded in 2012 during rain gauges were up to 36% below average (1,484 mm). Figure 9 shows the years where drought caused yields to fall. In addition, irregular precipitation (heavy rainfall followed by extended dry spells) can cause great damage to rain fed sugar cane, mostly affecting smallholders and some large scale *usinas* where irrigation facilities are not present.

25. Climate change may be responsible for the increasing incidence of periodic droughts in Paraiba, but no clear evidence exists. See Annex 1 for more details. Climate change signifies shifts in temperature and rainfall regimes, which affect agricultural productivity by shifting suitable area for

[8] ASPLAN, Setor agroindustrial canaviero do Estado da Paraiba, Joao Pessoa, May 2014.

agricultural production, altering agricultural yields, changing water availability, and producing conditions that increase the likelihood of plant pathogens.

Figure 9: Sugar Cane Yield



Source: Author elaboration.

26. Given that the sugar cane sector is one of the largest contributors to the state's agricultural GDP, any adverse impact on this sector leads to great losses within the supply chain (as shown in Chapter 4) and also important financial consequences to Paraiba due to the amount of taxes collected.[9]

27. Although several years have also recorded extreme drought events in the past, the 2012 year was particularly dry from March (-57%) to May (-38%), August (-77%) to September (-89%), and November (-90%) to December (-85%). Also, the drought conditions experienced in 1998 were as severe as the ones experienced in 2012, and can be explained by the extended drought conditions from June (1997) to May (1998). As a result, the crop yields at state level reduced by up to 17% of the historical mean.[10]

28. The estates owned by the sugar cane processors tend to have a fairly large quantity of irrigated land available (with water from rivers accumulated in reservoirs). This allows them to obtain very high yields in normal and drought years and, above all, allows plants to work at high capacity even in drought years.

[9] http://www.wscom.com.br/noticia/economia/SECA+PREJUDICA+CADEIA+PRODUTIVA+DA+CANA-138981

[10] Information from the Associação de Plantadores de Cana da Paraiba (ASPLAN) and Instituto Brasileiro de Geografia e Estatística (IBGE).

Production risks - Pests and diseases

29. There are three major insect pests attacking sugarcane in Paraiba: the *broca do colmo, broca gigante* and *cigarrinha*. Their presence is very frequent, but impact is relatively low, as farmers suitably manage the pests. On the farms owned by the sugar cane processors there is an intensive use of biological control, which includes parasitic wasps and fungi that parasitizes the insect pest. The biological agents, both wasps and fungi, are produced by the processors on their own laboratories, and sprayed or released on their own farms. There is only occasional need to supplement the biological control with pesticide applications.

30. On the other hand, among the small-scale farmers supplying the *usinas*, there is a more intensive use of pesticides, as they do not have scale to implement and maintain a biological laboratory to produce the wasps and fungi used for pest control. A way to improve their pest control practices would be to implement laboratories operated by the Sugarcane Farmer Association (*Associação dos Plantadores de Cana da Paraiba*), sharing costs and the inputs in order to produce the biological control agents. This approach would not only be advantageous from the economic standpoint, but would also be more environmentally friendly.

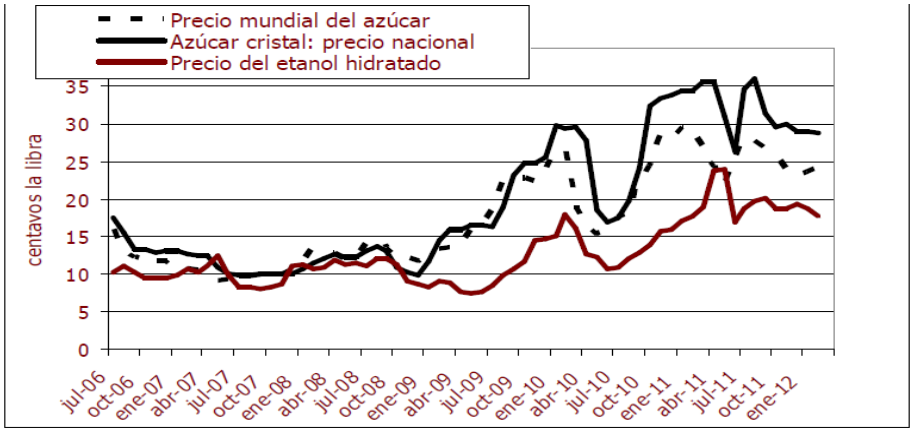
31. In regards to diseases, there is a serious potential phytosanitary threat to the sugarcane production in *Paraiba*, due to *Ferrugem Laranja*. This disease was recently detected in sugarcane plantations in São Paulo and, to date, there is no assessment of its impact. In other countries where it is present - like in Australia - the impact is rated as high. It is very difficult to anticipate when and if the disease will be introduced in Paraiba, and once introduced if the fungus will adapt to the environmental conditions and effectively become a serious threat. Nevertheless, considering its potential damaging impact for Paraiba, this disease risk should be considered of high impact.

Price volatility risks.

32. Sugar cane price volatility is not high in general, both in Paraiba and in Brazil, in spite of the higher volatility of sugar price in the international market. In effect, sugar cane prices are negotiated between producers and buyers and changes in the relative prices between sugar and ethanol result in shifts of industrial output between the two sugar cane products, ethanol and sugar. That type of industrial decision is possible in Paraiba because most processing plants are mixed plants capable of producing both ethanol and sugar. They also tend to cogenerate electricity. All in all the sugar cane industry is efficient at both processing and farm level.

33. The different actors along the supply chain (farmers' association – ASPLAN – and the processing plants), agree on a reference procurement ATR (*Açúcares Totais Recuperáveis*) price. The determination of the reference price takes into account the international price of sugar (in the New York and London markets) and ethanol price (mostly domestically determined as follows the domestic price of gasoline) as well as production costs, and is based on information provided by technical organizations such as CEPEA and DATAGRO. Figure 10 below shows the domestic and international prices of sugar and ethanol.

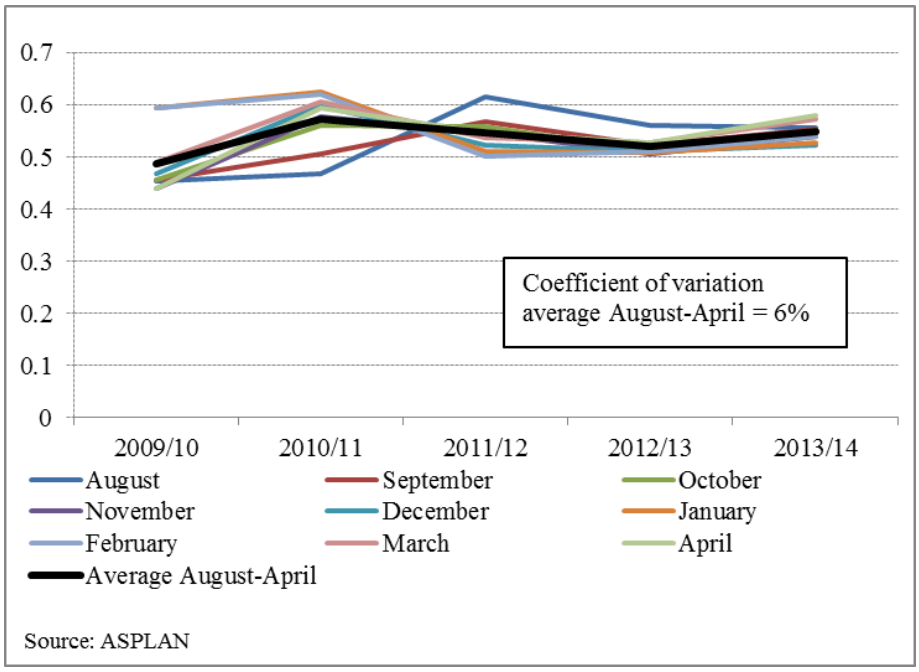
Figure 10: Domestic and International Prices of Sugar and Ethanol



Fuente: Cepea

34. In spite of the volatility of the sugar and ethanol prices (international sugar price varied a hundred per cent in 2010-11), the variation of the sugar cane reference price is relatively low as can be seen in Figure 11, showing the price for the last five years during the marketing season months (August-April).

Figure 11: Sugar Cane Reference Price



35. The coefficient of variation of the sugar cane reference price for any of the months during the period 2009/10-2013/14 does not exceed 13% and the average for the marketing season is 6% (Table 3 below).

Table 3: Price of Sugar Cane - Reference Price Pernambuco State* (Gross Price, R$/kg of ATR)

	2009/10	2010/11	2011/12	2012/13	2013/14	Coefficient of Variation
August	0.453	0.466	0.616	0.560	0.555	12.91%
September	0.456	0.506	0.567	0.523	0.552	8.35%
October	0.455	0.560	0.559	0.510	0.551	8.57%
November	0.439	0.578	0.545	0.505	0.538	10.08%
December	0.467	0.597	0.523	0.510	0.522	8.93%
January	0.593	0.625	0.509	0.508	0.526	9.68%
February	0.594	0.620	0.501	0.510	0.539	9.46%
March	0.489	0.605	0.537	0.525	0.573	8.18%
April	0.439	0.593	0.546	0.526	0.580	11.28%
Average August-April	0.487	0.572	0.545	0.520	0.548	6.04%

Source: ASPLAN

* ASPLAN uses Pernambuco as the reference for sugar cane prices in Paraiba.

Enabling environment risks.

36. The Government of Brazil has been trying to control inflation by suppressing gasoline prices below international levels. This approach has made ethanol less competitive than gasoline for flex-fuel cars, because the price of ethanol is relatively higher at the pump stations. In 2008, 50% of the fuel sold in Brazil was ethanol. Now, it is just above 30%, a drop that is particularly painful to the ethanol industry. Some have called this "the biggest crisis in the history of ethanol"[11]: about 50 sugar cane processing plants have gone out of business in three years in Brazil, leaving about 400 nationwide. Furthermore, PETROBRAS, the national oil company, is reported to be under financial stress. It is not publically known what will be the following steps in terms of government intervention in the determination of fuel prices. This uncertain policy environment prevents appropriate farming and industrial planning and represents a risk to the sugar industry in Paraiba as a whole. In addition, there is uncertainty about exchange rate and the general price index, which poses an important risk of unpredictable cost variability.

37. Moreover, since the Brazilian sugar cane industry is the largest and most diversified in the world,[12] public policies in Brazil may have a direct and significant impact on the world market. The mission, however, did not carry out any analysis on the possible impact of the ethanol policy on the sugar and ethanol world market.

Fruticulture Sector

Overview of Subsector

38. Fruit production in Paraiba includes grapes, citrus, banana, mangaba, mango, coconut and pineapple. They are produced in specific regions of Paraiba. The most important fruit grown in Paraiba,

[11] José Pessoa, a sugar cane producer and miller. The Washington Post, 1 January 2014.

[12] Sugar and ethanol are Brazil's third-largest agricultural export group (after soybeans and meat). Brazil's market share in world's sugar production and export was 25% and 50% respectively in 2010.

in terms of production value, is pineapple. Pineapple is massively exported out of Paraiba and traded in the Recife Market (main) and the wholesale market of João Pessoa.

39. Brazil stands out as the largest global producer of pineapple, annually growing 86,630 hectares, with a current production of 1.5 billion fruits. The state of Paraiba always stood out among the largest producing states, presently ranked as the second producer. Until the second half of the twentieth century, the cultivation of pineapple in Paraiba was concentrated in the municipality of *Sapé* and its surrounding region, located in the transition of the Coastal Plains to the *Seridó* meso-region. In recent decades, the planted area shifted closer to the Coastal areas. One of the causes of the movement is the incidence of *fusariose* disease, which has caused great damage and disincentive for its growing in the traditional producing region.

40. In the assessment by municipality, the first producer of pineapple is *Itapororoca* with approximately 3,000 ha, followed by *Araçagi* with 2,200 ha and *Lagoa de Dentro* with 550 ha. Santa Rita, a small municipality in the outskirts of *João Pessoa* is the fourth most important pineapple producer region of the State. Leveraged by a more organized production chain, it is quickly growing and the trend for the short term is that Santa Rita will surpass *Ipapororoca* as the first producer.

41. There are factors that limit technological improvement of the pineapple production chain, such as the lack of information that contributes to management inefficiency and the poor supply chain coordination, with the exemption of few cooperatives. In present days, the high and rampant use of pesticides along with the flow of residential waste and pesticide containers, are among the biggest environmental concerns. The cultivation of pineapple depends on chemical pesticides.

42. The production of pineapple in the municipality of *Itapororoca* is predominantly marketed to middlemen (*atravessadores*). Part of the production is sold in the Northeast and the rest is exported to the Southeast. Taking advantage of the situation of indebtedness and lack of specific public policies to support farmers, *atravessadores* buy pineapple production from the grower before harvesting, after the first application of fertilizer. They do not care about the preservation of the environment, the working conditions and health of the workforce, or the sustainable local development and even less with the sanity of the product for the final consumer. A report from CONAB foresees in the medium term a reduction of the planted area in the region, consequence of the lack of incentives for small farmers to improve production. That could explain why production is shifting from *Itapororoca* to *Santa Rita*, where better supply chain coordination exists partially with help from APL programs.

Production Risks - Climate

43. Irregular rainfall is a recurrent risk for fruit production. Recently, the drought conditions experienced between August 2012 and March 2013 caused severe problems in the pineapple sector. Production losses were between 20%-25%; in addition, the quality of the products was also affected as the size of most pineapples did not meet the standards required by the market. The drought conditions reported between 2012 and 2013 also impacted on other crops, such as coconut. In the municipalities of *Sousa* and *Aparecida*, around 60% of the total coconut plantations was lost and the level of production

registered in 2013 only met 10% of its historical values. In contrast, coco plantations located near the coast did not registered plant losses but the decline in production was around 20% to 25% (FAEPA, 2013).[13]

Production risks – Pests and diseases

44. Insect pests like the *broca do olho do coqueiro* (coconut) and the disease *sigatoka amarela* (banana) are highly frequent but result in low impact. Both the *broca* and the *sigatoka* are satisfactorily managed by cultural practices, including pesticide application. Citrus, mango and mangaba are frequently attacked by the fruit fly *mosca negra dos citrus*. Trapping or insecticide applications are used to control the pest. The impact of this pest is considered as moderate, along with the pineapple disease *fusariose* that attacks the crop almost every year. Control of the pest can be made by means of cultural practices (clean seedlings, eradication of contaminated plants), use of resistant varieties or spraying of recommended fungicides. As long as these pests are adequately and massively monitored they could be considered as constraints rather than risks. However, no clear evidence on this exists.

45. Quarantine pests like the disease *sigatoka negra* (bananas) and *cancro bacteriano* (grapes), not yet present in Paraiba, may be extremely damaging if introduced in the fruit regions of Paraiba. Consider the devastating effect that boll weevil had on cotton production explained in the Text Box 2 below. Strong actions of the SEDAP (Phytosanitary department of the Paraiba Government), aligned with the Federal authorities, are considered paramount to avoid the introduction of these and other quarantine pests in the state.

46. Finally, a phytosanitary risk considered as probable and with high impact arises from the use of pesticides without the necessary technical knowledge and skill. The result is that farmers may face increased production costs, ineffective pest control and human and environmental hazards as well as fruit contamination with pesticides residues, a risk for consumers.

Text Box 1. 2: The boll weevil and the cotton crisis in northeastern Brazil – A story to remember

Cotton cultivation in Brazil dates back to the colonial era, in the sixteenth century. The Northeast of Brazil, especially the State of Paraiba had always been a leading producer and processor of cotton fiber. Both in the Northeast, as well as in the Southern states of São Paulo, Paraná and Mato Grosso do Sul, where cotton was widely grown until 1990, it was characterized as a smallholder crop, with intensive use of labor force. This reality dramatically changed in the late 1980s, with the entry of the boll weevil (Anthonomus grandis), known in Brazil as *bicudo do algodoeiro*, a global major pest for this crop.

The first record of the boll weevil presence in Brazil is from nearby Jaguariúna and Campinas (State of São Paulo), in February 1983, and subsequently its presence was detected in Paraiba (July 1983). The most solid evidence suggests it was introduced from Southeastern United States, as a

[13] http://www.faern.com.br/novosite/noticia/perdas-da-agricultura-na-paraiba-podem-se-agravar

contamination carried by aircraft, and not by natural expansion of the insect, since the initial infestation was found in cotton fields near Viracopos International Airport, in São Paulo. The initial boll weevil infestations in the Northeast area of Brazil were found in the State of Paraiba, municipality of Inga (July 4th, 1983), most likely due to a secondary introduction from the infested area of São Paulo. By December of the year, over 90% of the cotton cultivated area was infested with boll weevil in the State of Paraiba.

Given the rapid expansion of the pest in the state of Paraiba, as well as on the entire cotton producing surrounding states, there was no way to eradicate the insect and allow the continuity of cotton cultivation. The entry of the pest required a large number of pesticide applications, which increased the cost of production beyond the financial capacity of family producers. As such, cotton profitability in the region fell, resulting in the abandonment of cotton cultivation in Paraiba and other northeastern states. As a result of the boll weevil infestation, there was not only economic loss but also unemployment on a historically poor region. The cotton industry, already weakened by the boll weevil infestation, was further affected in the early 1990s, by the intense and abrupt reduction of import tariffs, which created an unfavorable situation for the Brazilian fiber.

The result was: reduction in the domestic production from one million tons in 1981 to 420,000 tons in 1993; increase in imports, which reached nearly 500,000 tons in 1993 (through the mid-1980s, Brazil was not only self-sufficient in cotton but a major exporter; the cotton area was reduced from 4.1 million hectares in 1981, to 1.3 million hectares in 1995; in the Northeastern region, the area planted dropped from 3.2 million hectares in 1976/77, to 1.2 million hectares in 1986/87; in the first ten years following the boll weevil introduction, the cotton acreage reduction eliminated 800,000 jobs (over one million workers in 1985 to 385,000 in 1994), leading to a massive rural exodus; disappearance of cotton cultivation in Northeast Brazil, with the exception of the Cerrado of Western Bahia, where it is currently grown in large farms, using top technology, intense mechanization, with low demand for labor force. Currently, no smallholders produce cotton in Brazil, due to the high costs of boll weevil control. According to an evaluation made by Santos et al (2001),[14] the private losses due to the boll weevil between 1984 and 1990 were estimated to be over R$ 11 billion.

Price volatility risk.

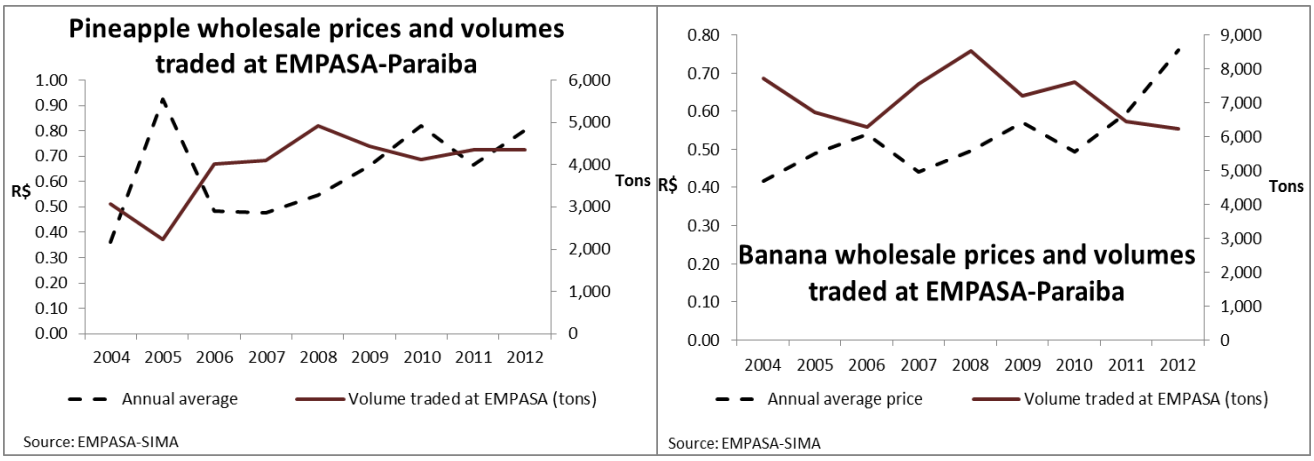
47. Pineapple and banana are among the fruits that are most largely produced and traded in Paraiba. They are both traded at the wholesale market in Joao Pessoa, EMPASA: the mission visited EMPASA and held discussions with several traders. Due to of this interaction, and the analysis of price data provided by the management of EMPASA, it was possible to obtain some conclusions on the price

[14] Robério Ferreira dos Santos, Maria Auxiliadora Lemos Barros, José Wellingthon dos Santos, Kleodósio Leôncio da Silva e Phillipe Farias Ferreira. Impactos da propagação do bicudo e da globalização da economia brasileira na produção interna de algodão. Revista Oleaginosas & Fibrosas, 5(3):423-31. 2001.

behavior of pineapple and banana. The inter-annual price variations of both pineapple and banana largely respond to the changes in production and traded volumes. In effect, the price fluctuates are inversely proportional to the volumes traded in most years. For instance, the 2005 drought in the pineapple producing areas caused a significant reduction in the availability of product and an important increase in price (Figure 12 below).

48. The correlation coefficient between the annual average prices and the volumes traded is -64%, which is considerable high and, in spite of the few observations available (2004-2012), it is a reasonably good indication of the causality of the two variables.

Figure 12: Pineapple and Banana Wholesale Prices and Volumes Traded



49. Lower price volatility would be possible under more coordinated supply chain arrangements and stronger cooperative organization that allow for better production and marketing planning, as is the experience in Santa Rita with pineapple production. Efforts should be made to strengthen farm to market coordination with a view to achieve better production planning and less output volatility, possibly making an extensive use of the APL (*Arranjos Produtivos Locais*) approach, which has been very positively assessed in Brazil.[15] However, this will have to be assessed during the solutions assessment mission.

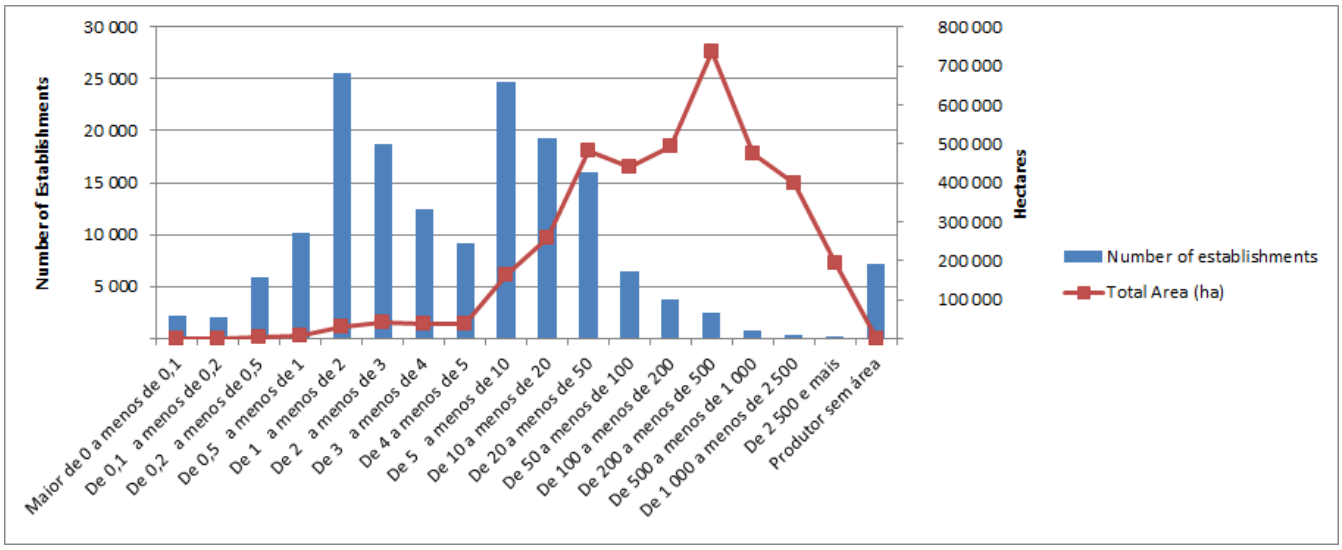
[15] BNDES, Nota Técnica, Produto 9 do projeto "*Análise do Mapeamento e das Políticas para Arranjos Produtivos Locais no Norte e Nordeste do Brasil e dos Impactos dos Grandes Projetos Federais em Estados Nordestinos. www.politicaapls.redesist.ie.ufrj.br*

Family Agriculture in Semi-arid Zone

Overview of Subsector

50. Family farming (*agricultura familiar*) is formally defined in Brazil[16] in terms of area, management, labor, and income. The family must manage the farm, and the family must rely on agriculture as their principal source of income. According to the 2006 Agricultural Census there are 148,077 family farmers in Paraiba (or 91% of the total farmers) covering 1,596,273 hectares, corresponding to 42% of the total area[17]; two-thirds of family farmers have land title. Figure 13 below shows the land tenure structure in Paraiba.

Figure 13: Agriculture Establishments and Landholdings, Paraiba (2006)



Source: IBGE, Censo Agropecuario 2006

51. Family farmers in Paraiba grow temporary crops like: cassava, maize, and beans, on small, rain fed, plots. Especially in dry regions, small farmers raise small animals, commonly goats. Native trees and vegetation provide firewood, fodder for animals, and fruits like *umbu* and nuts like cashew, part of the nutritional security. Family farmers are spread throughout Paraiba but concentrated in the semiarid macro-region, encompassing the *Borborema*, *Sertão Paraibano*, and *Agreste Paraibano* meso-regions. Family farmers often use *fundos de pasto*, or communal pasture regimes, to feed goat and sheep livestock herds. However, these areas often have insecure tenure regimes and are vulnerable to usurpation from competing ranchers. In addition, since the herds rely on natural vegetation, food for animals is vulnerable to drought.

[16] Family Agriculture, *agricultura familiar*, is defined as a form o production where the interaction of management and work is predominant; family agricultures drive the productive process, emphasizing diversification and using an main work force, family labor at times receiving wages (http://www.mds.gov.br/falemds/perguntas-frequentes/bolsa-familia/programas-complementares/beneficiario/agricultura-familiar).
[17] IBGE.

52. In general, family farmers are characterized by little land size, poor soils, low precipitation, low market access due to physical isolation, low access to credit and technical assistance, and low levels of farmer organization. Some attribute low association participation to a lack of incentives to associate and a history of patronage arrangements that small farmers depend on to receive emergency relief supplies in times of drought. Rural credit is concentrated in the wealthier meso-region of *Mata Paraibana* at 40% of the value of contracts but 6.65% of the number of contracts. The Semiarid meso-regions evidence smaller-value contracts.

53. Family farmers consume their own production and sell it through cash transfers from social assistance programs provide a significant proportion of family income and allow food to be purchased outside the household. Livestock provides a particularly important sources of animal protein in meat and milk, and artisan crafts from animal hides provide supplementary income.

54. High rates of female-headed households stand out in Paraiba at about 30% in rural areas. A long history of principally male out-migration to cities leaves family farmering in the hands of women, with many elder folk and children. The percent of dependents (population under age 15 and over age 65) in total population exceeds 50% in many regions of Paraiba. Though dependents represent more mouths to feed that are not economically active, they also help bring in significant income transfers from federal government programs, mainly the Rural Retirement Pension from INSS, comprising up 17% of the average rural family income, and *Bolsa Família*.

Production risks - Climate

55. Family agriculture is largely based on livestock, though maize, beans and cassava are grown for self-consumption. By far the most important risk to the production of these crops is severe drought. In addition to severe droughts, irregular precipitation (heavy rain followed by extended dry spells) is another climate risk for smallholders, as irrigation facilities are not usual. In the 2011-2012 crop season, Paraiba represented the fifth largest Federal State in terms of number of small farmers (86,367 farmers out of a total number of 771,343) enrolled in the *Garantia Safra* program (See Text Box 3 for further details about this compensation mechanism). Given that this compensation mechanism only covers municipalities within the Semi-arid region and that it triggers payout only when the enrolled Municipality registers severe crop losses due to extreme rainfall events (mainly drought), historical payouts disbursed by this program could be used as a proxy of drought events that negatively impacted the small farming sector. Table 4 shows that on average 6 out of 10 years the *Garantia Safra* program disburses compensation payouts above 90% of all enrolled municipalities. The analysis of the historical records of this program shows that the 2011-2012, 2006-2007 and 2009-2010 crop seasons were the worst ever recorded.

Table 4: Number of Farmers Enrolled in *Garantia Safra* Program and Number of Farmers who Receive Payments, Paraiba (2002-2012)

Item	Enrolled Farmers	No. Farmers Received Payments	% Possitive Payments	Total Payout (R$)	Payout/Farmer (R$)
2002 - 2003	29,972	27,147	90.6%	R$ 12,894,825	R$ 475
2003 - 2004	37,562	23,264	61.9%	R$ 12,795,200	R$ 550
2004 - 2005	49,755	47,318	95.1%	R$ 26,024,900	R$ 550
2005 - 2006	54,791	23,947	43.7%	R$ 13,170,850	R$ 550
2006 - 2007	59,310	57,985	97.8%	R$ 31,891,750	R$ 550
2007 - 2008	74,345	24,447	32.9%	R$ 13,445,850	R$ 550
2008 - 2009	83,329	75,112	90.1%	R$ 41,311,600	R$ 550
2009 - 2010	82,205	80,183	97.5%	R$ 48,109,800	R$ 600
2010 - 2011	81,083	30,808	38.0%	R$ 19,717,120	R$ 640
2011 - 2012	86,367	86,367	100.0%	R$ 107,095,080	R$ 1,240

Source: Ministério do Desenvolvimento Agrário (MDA).

56. The severe losses recorded by *Garantia Safra* in 2012 are consistent with the very low precipitation values reported by AESA. In March 2012, only three cities in Paraiba reported rainfall indexes above their historical average values for the same period. The rainfall forecasts made at the time indicated a decrease of up to 40% of the average. As a result, the Government of Paraiba supported different federal programs in order to alleviate farmer losses. Some of these programs include: *Programa Emergencial de Manutenção do Rebanho Paraibano*, *Garantia Safra*; and *Programa Palma Resistente*.[18]

Text Box 1. 3: Brazil Garantia Safra

The *Garantia Safra* program was created in 2002 (Law No. 10420, and then it was modified in 2012 by the Law 12766) with the objective to provide compensations payouts to vulnerable farmers and rural families who are systematically affected by severe drought events and excess water events, within the semi-arid region of Brazil. Given that this federal program reduces the effects of extreme rainfall conditions (mainly drought) it has reduced the need from State Governments and enrolled farmers to request Federal emergency actions. The total annual cost is distributed among the stakeholders (federal, state and municipal governments and the farmers), with the Federal Government as main contributor.

The potential beneficiaries of this program are rural families located in the semi-arid region and with: monthly gross family income of up to 1.5 times minimum wage; plant between 0.6 and 5 hectares of beans, maize, rice, cassava, cotton or any other agricultural activity that effectively coexist with the semi-arid conditions; request their adherence to the program and pay a small contribution to the *Garantia Safra Fund* (FGS) for its enrollment.

Operation: The program triggers a compensation payout when crop losses exceed by 50% the average

[18] Cunha, 2012.

yield at Municipal level. In this sense, all producers enrolled in the same Municipality will be treated equally despite registering a different level of losses at individual farming production units. *Garantia Safra* compensation payouts are primarily defined by a "hard trigger" scheme, which is an index parameter that is calculated by the INMET. This index is derived from the calculation of individual crop water balance models and whose results are extrapolated to Municipal level. Given that rainfall conditions may vary in space and in time, there may be cases in which there are differences between what is recorded by the index and what is recorded at the Municipality level. If this happens, a "soft trigger" scheme is adopted; this means that the state extension service would make field inspections in order to determine the damages incurred.

Compensation amount: R$ 760 distributed in 5 monthly payouts. One of the main advantages about this compensation system reported by the beneficiaries is that they receive the payouts directly and they can use them according to their needs. In addition, the timing of *Garantia Safra* payouts matches with the annual schedule of payment of other social benefits that are managed by the Federal Government.

Garantia Safra has shown to be a very popular compensation payout mechanism among small producers located in the semi-arid region. Over a ten year-period (2002-2011), the number of enrolled municipalities and enrolled farmers overall have increased 300% and 900%, respectively. On average, 57% of the total municipalities nationwide have received payouts. The less catastrophic year, measured by the number of municipalities that received payouts, was the 2010-2011 crop season. Interestingly, the previous and the precedent crop seasons were highly catastrophic where payments were triggered in 9 out of 10 enrolled municipalities.

Garantia Safra*: Program evolution between 2002-2003 and 2011-2012 crop season

Crop Season	Enrolled Municipality	Munic. that received payments	% who received payout	Enrolled Farmers	Farmers who received payments	% who received payment
2002-2003	333	140	42.0%	200,292	85,056	42.5%
2003-2004	367	136	37.1%	177,839	75,810	42.6%
2004-2005	465	311	66.9%	287,681	211,339	73.5%
2005-2006	543	174	32.0%	356,584	106,081	29.7%
2006-2007	471	392	83.2%	346,321	316,529	91.4%
2007-2008	635	181	28.5%	558,606	182,147	32.6%
2008-2009	714	509	71.3%	553,225	423,538	76.6%
2009-2010	859	801	93.2%	661,802	639,227	96.6%
2010-2011	990	243	24.5%	737,920	166,935	22.6%
2011-2012	1035	1015	98.1%	771,343	769,023	99.7%

Source: Secretaria da Agricultura Familiar

Production risks - Pests and diseases

57. Family agriculture crops in the semi-arid (cassava, beans, maize) are susceptible to attacks of caterpillars or diseases. However, farmers prefer not to use purchased inputs and invest in crops (with the exception of some infesting weed control). In this manner, they keep the financial cost of mitigating

phytosanitary risks low. In the eventuality of a pest (insect, disease or nematode) attack, smallholders do nothing and just wait to harvest the remaining production, if any. Their rationale is "*why invest on fertilizers, improved seeds or pest control if the risk of loosing the harvest due to a lack of rainfall is so high*". The impact is on family food security. Adequate technical assistance would be required to improve risk management all together and change farmer attitude towards drought risk management and phytosanitary risk management.

58. Currently, smallholders usually cultivate a type of cactus called *palma forrageira* as feed for goats and sheep and even bovines. A pest called *cochonilha do carmim* is a serious threat for achieving higher biomass production, which is fundamental to feed the animals during hydric stress. The State Government Research Institution (EMEPA) developed a variety that is resistant to the *cochonilha* and the public technical assistance (EMATER-PB) is freely distributing this genetic material to family farmers, to substitute their traditional susceptible varieties, leading to an almost complete control of the pest.

Price volatility risk

59. Price guarantees are used to incentivize production and to provide support to poorer farmers. They are mostly targeted by region, seeking to support poor small farmers (*agricultura familiar*) and commercial farmers. See Text Box 4 with details on the current price support and procurement programs. The result has been more stable prices of basic foodstuffs (like beans, maize, cassava flour, etc.) that are in turn the main crops grown by the family agriculture farmers. Paraiba, however, is a food deficit state and frequently maize (basic foodstuff and key feed) is imported using the PEP mechanism (see Text Box 4 below). These interventions through CONAB, the national food supply agency, have led to the maintenance of stable prices for consumers even during periods of domestic production scarcity in the state. The CONAB State Manager mentioned that most often CONAB is unable to meet their procurement targets because of supply unavailability.

Text Box 1. 4: Brazil - Procurement and price support policies

The Brazilian government operates a series of food procurement and minimum crop price policies and programs. They are the PGPM (*Politica de Garantia de Preços Minimos*), which is concerned with commercial agriculture, and the PAA (*Programa de Aquisição de Alimentos*) that is specifically target family farming. The Ministry of Agriculture (MAPA) is responsible for the former policy, and the latter program is the responsibility of the Ministry of Agrarian Development (MDA).[19] The Federal Government, States and Municipalities implement PAA. The National Supply Company also executes it – CONAB (*Companhia Nacional de Abastecimento*), also participates in the implementation of PGPM. CONAB is a public enterprise that reports to MAPA; it is responsible for managing several agriculture policies and programs related to the supply and demand of food products.

[19] MDA is also responsible for the National Program to Strengthen Family Farming (PRONAF).

The PGPM is an instrument that works as a basis for several types of purchasing or financing operations, always with the objective of supporting producer income. It is used to smooth producer price variations over time and facilitate trade of agricultural products from the surplus regions to deficit ones at competitive prices for the producers, particularly in periods of price drop when the transport cost may represent a serious obstacle for commodity flow across the country. The PGPM uses different instruments. One is the PEP (*Prêmio para o Escoamento de Produto*) program, which involves an "equalization" payment to buyers (wholesalers, processing companies, etc.) who agree to pay the producer a specified minimum price. The equalization premium (subsidy) is determined in an auction, with a maximum fixed selling value set by government. This is the most common instrument. A similar program is PEPRO (*Prêmio Equalizador do Produto*), which provides an equalization payment directly to the farmer and works like a deficiency payment by paying the seller (whether a farmer or a cooperative) the difference between the reference price and the price received at auction. A third program is PROP (*Prêmio de Risco para Aquisição de Produto Agrícola Oriundo de Contrato Privado de Opção de Venda*), which provides a premium to commercial buyers under a sell option contract, i.e. where delivery takes place in the future (for instance, coffee). This instrument works as a hedging mechanism for the farmer. The Government may also operate the Product Outflow Value instrument (*Valor de Escoamento de Produto* - VEP), through which the Government grants a subsidy to buyers that intend to buy government stocks to supply a specific food deficit region that has been prioritized. This instrument would operate when the market price is higher than the minimum price. Under the PGPM, the government also purchases from family farmers and their cooperatives (AGF - *Aquisições do Governo Federal*) at prices that are above market levels when they are below the minimum prices. The impact of this program throughout the economy is not supposed to be relevant. Since 2010 family farming has been entitled to 20% of the resources of the guaranteed minimum price program (PGPM).

The government defines the quality, quantity, value and delivery of the products and establishes the regions to be supplied on a case by case basis. The *Bolsa Brasileira de Mercadorias* (Sao Paulo) and other commodity exchanges operate the government stocks auctions and the CONAB'S commercial stock auctions. Among the main products included in the PGPM are: cotton, beans, rice, maize, cassava flour, milk, sorghum, coffee, etc.

PAA was created by Law in 2003. It serves two basic purposes: promote access to food to those in need and support family farming. The PAA purchases a wide variety of food produced by family farmers including fruits, vegetables, animal products, etc. The Program is implemented through different modalities that do not involve a bidding process: Purchase with Simultaneous Donation, Direct Purchase (CDAF), and Stock Formation by family farming. The Purchase with Simultaneous Donation involves direct purchase of food from family farmers and simultaneous free distribution to people in food and nutrition insecurity as well as to those served by social assistance networks, public facilities for food and nutrition security, and public and philanthropic education institutions. The CDAF (*Compra Direta da Agricultura Familiar*) whereby the

government purchases produce from family farmers (enrolled in PRONAF) at subsidized or market prices (reference prices) to supply populations facing food insecurity. The PAA also contributes to the formation of stocks of foodstuffs produced by family farmers and of stocks managed by family farmers´ organizations; farmers' groups stock part of their production in exchange for a promissory note that provides farmers access to financial resources.

The budget of PAA consists of funds from the Ministry of Social Development and Fight Against Hunger (MDS) and the Ministry of Agrarian Development (MDA). Since its conception, the annual volume of funds invested increased from US$64 million in 2003 to US$434 million in 2012 – an increase of 580%.

Livestock Production Chains

Overview of Subsector and Supply Chain Profile

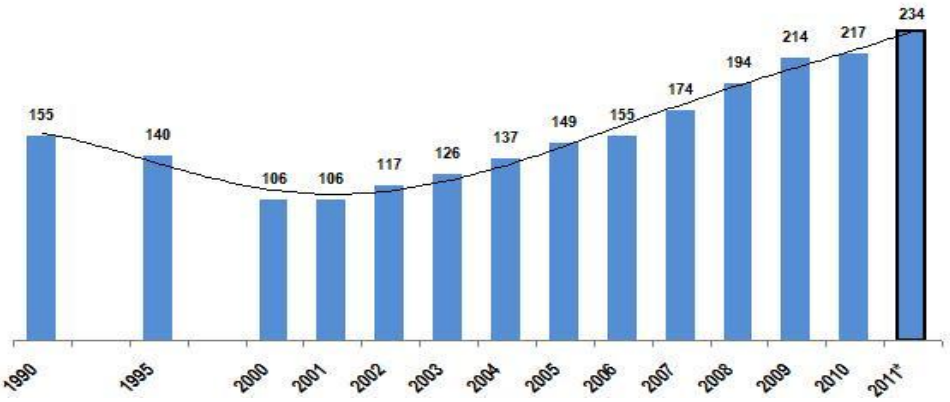
60. Cattle production is one of the major agricultural activities in the state and stands out as one of the most important income generating activities in large farms. Cattle production is mostly extensive and on semi-arid soils with poor vegetation and low rainfall. According to the Committee for Agricultural Planning of the State of Paraiba, there are three types of cattle production regions in the State, in regards to the ecological traits: the *Agreste/Litoral* region, the *Cariri/Curimatau* region and the *Sertão* region.

61. Dairy production in Paraiba is located in the *Agreste /Litoral* region, and is considered jointly with Sergipe, one of the fastest growing milk producing states in the Northeaster Region (Figure 14 below). Milk production is based on extensive grazing with limited animal feed supplementation. In this system, the ration consists almost entirely of grazed pasture grass. Herds are typically in the 30–70 cow size range and consist mostly of crossbred animals. Cows in these herds are usually hand-milked in parlors.

62. The sheep and goat production chain has experienced a very significant increase, especially since the second half of the 1990s (Table 5). This growth occurred due to two main aspects: the first was the policy of the state government to strengthen these herds by providing resources and technical assistance, as well as the introduction of new races; secondly, the adoption of the Food Acquisition Program (PAA) as to ensure market and price for products from livestock strategy (milk, cheese, etc.).

63. Goat milk production has a very important economic role in the semiarid part of Paraiba State. Although the productivity of the goat milk industry in this region is low compared with developed regions worldwide or even with intensive systems in southern Brazil, it is currently the main goat production region in Brazil and is responsible for approximately 20% of the total Brazilian goat milk production. Producers are organized in associations and currently 8 small-scale dairy plants exist for the pasteurization of goat milk.

Figure 14: Evolution of Milk Production in Paraiba, in millions of liters (1990-2010)



Source: IBGE / Pesquisa da Pecuária Municipal
Elaboração: R. ZOCCAL - Embrapa Gado de Leite
2011* Estimated

Table 5: Goat and sheep's Population Evolution in Paraiba (1975-2012)

Species/ year	1975	1980	1985	1990	1995	2000	2005	2010	2012
Goats	390,735	505,342	555,054	509,450	458,477	526,179	657,824	600,607	520,867
Sheep's	370,593	418,382	396,266	380,692	302,611	343,844	411,069	433,032	447,406
Total	761,308	923,724	951,320	890,142	761,088	870,023	1,078,893	1,033,639	968,273

Source: Targino, I et Al . Aspectos da Agropecuaria Paraibana.

64. The swine production chain of Paraiba is relatively small (with small population) and shows a decreasing tendency over the last three decades. The estimated population in 2011 is 151,702 heads. However there is a potential to growth in order to supply the state demands, favored by the availability and the price sustainability of grains.

65. The poultry production chain had an estimated population in 2010 of 7,7 million broilers and 2,2 laying hens and has had an important increase of 56% since 2000. This increase had been favored by the price sustainability policy for corn, which facilitates the preparation of low cost feeds. Poultry production has been a very productive activity for small producers in the rural areas. They are organized in cooperatives. The small producers are being supported to construct small slaughterhouses to guarantee that poultry products have official inspection services (meet official commercial criteria) and can be sold in supermarkets and in interstate markets.

66. The apiculture production chain is important for the rural population in Paraiba. The areas of production of honey are the *Sertao* and *Brejo* regions. The production is of around 500 tons of honey. Production is mainly absorbed within the State, through the federal food programs. The remaining production absorbed by the country and some is occasionally exported to other states. There are around

40 extraction plants to process the honey. Some of these plants are inspected by the Federal and State inspection services, which make the honey suitable for the food programs and interstate exportation market. The main risk faced by apiculture is the drought that kills bees and forces the beehives to migrate to other areas.

Production risks - Climate

67. Most stakeholders interviewed by the mission have identified unreliable rainfall in terms of intensity and distribution as one of the most likely and damaging production risk. Drought also is acknowledged as a severe risk and one with great potential to cause severe impact to livestock. The most recent severe droughts affecting livestock production occurred in 1992-1993, 1998, 2001-2002, 2010, 2012-2013. During the drought periods, cattle, goat and sheep, and apiculture have had significant losses in terms of animals, weight lost and reduction of milk and honey production, among others. It is reported that during the last drought 80% of the honey harvest was lost and 70% of the beehives migrated. The State annual production of honey is estimated in 500 tons. The bee producers have good technical cooperation from EMATER, SEBRAE and COOPERAR among others.

Production risks - Sanitary risks

68. Animal diseases are significant production risks. Their damaging potential varies among animal species and is very much correlated to the actual risk management actions in place. On a global level, there has been a noticeable increase over recent decades in the incidence of exotic animal diseases. Among the exotic diseases that affect world beef trade, two are most relevant: BSE (Bovine Spongiform Encephalopathy or "Mad Cow Disease") and FMD (Foot and Mouth Disease). Paraiba is free of these major exotic animal diseases, which gives a significant advantage to the Brazilian producers and exporters. The situation about the principal exotic diseases risks can be summarized as follows.

69. FMD: In May 2014, Paraiba (and the other Northeastern States: Alagoas, Ceara, Maranhao, North Region of Pará, Bahia, Pernambuco, Piauí and Río Grande do Norte) was certified by the World Animal Health Organization (OIE) as an area is free of FMD, with vaccination. In the past, the presentation of the disease in Paraiba was sporadic and classified as of medium risk. There has not been a case in more than ten years. Currently this risk has diminished because the bordering states are also free with vaccination and there is a strict national program to control movement of animals and animal products in the country, which provides additional protection to prevent the entrance of this disease.[20] In any event, the impact of a disease outbreak could be catastrophic in terms of animal losses, eradication costs and export earning losses, and thus controls must continue.

[20] There exists a Federal Program for the Eradication of FMD coordinated by the Ministry of Agriculture (MAPA), which was started in 1998 and is covering 78% of the area and 99% of the cattle and buffaloes stock. There is also an area free of FMD without vaccination, which covers the State of Santa Catharina. The only states, which are considered infected, are Amazonas (BR-3), Amapá and Roraima (BR-4), in the North Region of the country. The last outbreak of FMD in Brazil occurred in Mato Grosso do Sul and Parana in 2006. (Informe de Situación de los Programas de Erradicación de la Fiebre Aftosa - año 2013 – Documento de trabajo para la COSALFA 41, abril 2014).

70. BSE: According to OIE, Brazil´s risk status for BSE is "Negligible", the safest of all. To reach this status the country presented a risk analysis situation which probes that there are not cases or possible animals imported from countries where the disease is present or imported feed for cattle containing cattle meat flour and that has a surveillance and prevention program in place. The major risk is from the importation of cattle from infected countries and the appearance of atypical cases as it occurred in Mato Grosso in 2014.

71. Highly Pathogenic Avian Influenza (HPAI): Paraiba is currently free of HPAI, Asiatic Types, as the whole country is. However the risk still persists due to the possibility of contamination by wildlife, as has occurred in other parts of the world.[21] In order to prevent entrance of the disease, Brazil has a plan of action that calls for training of professionals and producers to detect the disease.

72. Prevalent animal diseases of economic and public health importance: Bovine, Goat and Sheep Brucellosis is considered by FAO, WHO and the OIE as one of the most important and widespread zoonosis in the world, causing great economic losses. It can be transmitted to humans causing undulant fever and joint arthritis syndromes and is a labor related disease because of the contamination of workers in slaughterhouses. Bovine brucellosis due to *Brucella Abortus* is endemic and the most prevalent *Brucella* infection in Brazil. the National Program for Control and Eradication of Brucellosis and Tuberculosis Animal (PNCEBT) coordinated by MAPA has been in place since 2001. Each state has to follow the orientations of the MAPA Federal Program.[22] A number of studies and surveys were carried out in the State of Paraiba to assess the prevalence of bovine brucellosis. The conclusions varied widely: SEDAP carried out a study in 2013 that indicated the prevalence of bovine brucellosis may range between 2% to 4% in Paraiba; while an evaluation of the Federal Program carried out in 2010 indicated there was a decrease in the number of cases of brucellosis in the Northeastern Region from 4.138 to 2.082 (50.3%) between 2001 and 2010. The general conclusion is that bovine brucellosis is still present in the State of Paraiba and it is both a risk to the animal population and humans (public health). Regarding the presence of *Brucella Mellitensis* in goats and sheep, there is no evidence of its presence in Brazil. *Brucella Mellitensis* represents an important public health risk because it is transmitted to humans by goat milk consumption and can cause severe symptoms.

73. Bovine Tuberculosis is an infectious disease of worldwide distribution caused by pathogenic Mycobacteria that affect humans and several mammal species. It is also considered by WHO and OIE also consider it as an important cause of losses to livestock producers and a serious public health risk. Several studies were carried out confirming that tuberculosis in cattle and goat exists and is a risk to animal production and public health. Salomon, M. and collaborators carried out a study on bovine tuberculosis in 2010, which found that: of the herds investigated, 62 (0.57%) had at least one positive

[21] The current international HPAI or "bird-flu" outbreak began in poultry in Southeast Asia and has since spread to Asia, Europe, the Pacific, the Middle East and Africa. Although many countries have eradicated the virus from their domesticated poultry, worldwide eradication is not expected in the short term.

[22] Normativa Nº6 de 8 de janeiro de 2004. Aprova o Regulamento Técnico do Programa Nacional de Controle e Erradicação da Brucelose e Tuberculose Animal. Diário Oficial da União, Brasília, 12 jan. 2004, Seção 1, p. 6–10: 2001.

animal, and of the animals examined, 136 (0.25%) were positive. Prevalence of tuberculosis in goats it was found to be 10.7% of positive in 10.7% of herds.

74. Classical swine fever (CSF):). According to the surveillance system the last outbreak of CSF in Paraiba occurred in 2006. However, there are risks of introduction because the disease is present in other Northeastern States. A federal program for the eradication of CSF, coordinated by the MAPA, which has led to the eradication of the disease in 49% of the territory, 54% of the properties and 81% of the swine population of the country. As a result, a CSF disease free area has been established which included the states of the South, Southeastern and South Regions, and the states of Tocantins, Bahia, Sergipe and Rondonia. The Northeastern States are considered infected and are the next goal of the CSF eradication program. A survey will be necessary to obtain precise information on the absence of this disease. In addition, the state animal Health Authorities need to update the prevention and contention programs.

75. Newcastle Disease Virus (NCDV):). This is a very important poultry disease, which may lead to serious losses to the producers from killed birds and delays in flock restocking. The State is free of this disease according to non-official information. However, there are no epidemiological studies to verify this situation.

76. Food Safety: There has been an increase in the frequency of outbreaks of foodborne diseases, making food safety a major concern worldwide. Foodborne diseases pose an important risk because they endanger public health and can interfere with the domestic and external markets. There is no published evidence of serious foodborne outbreaks in the state of Paraiba. However, it was found that small producers do not have enough official assistance to control and inspect their production. This situation can lead to risks of contaminated products and presentation of foodborne outbreaks. On the other hand, the lack of official control and inspection system for small producers limit their marketing possibilities. It also prevents the selling of the production for the federal food acquisition programs (PNAE and PAA) that requires the products to be officially controlled and inspected. In regards to slaughterhouses, there is a good federal and state control and inspection service for the large slaughter houses. There is also a municipal network of slaughter houses, but their status regarding official control and inspections services is not very clear. From the information gathered there is not a mechanism of coordination between the Federal, State and Municipal control and inspection services.[23]

77. In summary, food safety is a sanitary risk, because there is an incomplete food safety system to efficiently cover all the steps of the food chain. There is a limited control and inspection service for small producers and there is no coordination mechanism among the agencies responsible for the control and inspection of animal food products.

78. Finally, it is noteworthy that animal health and food safety risks have a significant impact on all livestock food chains stockholders, including producers, processors, distributors, consumers, exporters

[23] The State Government has taking initial steps to create an Intersectoral Chamber of Food Security and Nutrition (CAISAN/PB) with the aim to establish the State System of Food Security (SISAN), which will also take care of food safety aspects.

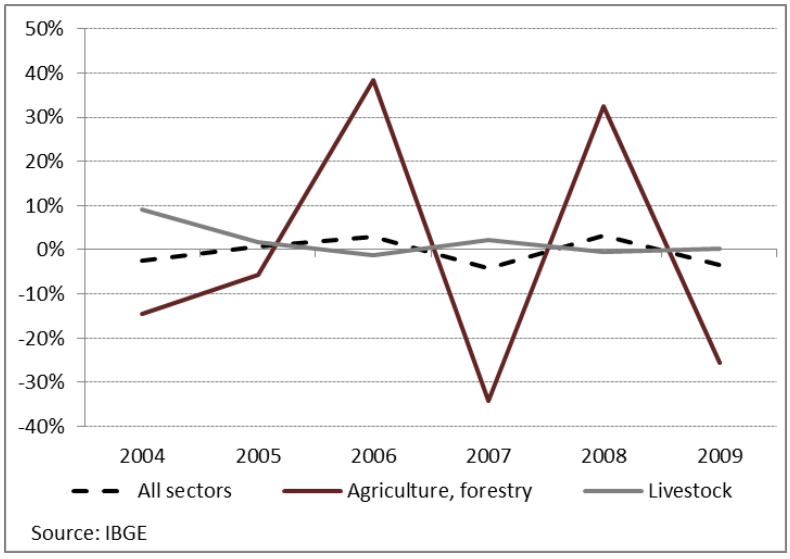
and the government. There have not been recent animal health risk events in Paraiba, however there is a potential risk of occurrence as has occurred in other states of Brazil and countries. In these cases, the impact on government was very high: costs of the actions of eradication, compensation to the producers, etc. On the other hand, exporters suffered high losses from the closing of external markets for long periods of time until the free status was regained.

CHAPTER 3: ADVERSE IMPACTS OF AGRICULTURAL RISKS

Indicative Value of Losses

79. Agricultural production is subject to relatively normal inter-annual variations and occasional shocks caused by climate, sanitary and other causes. Shocks have a direct impact on farmers and other stakeholders in the supply chains, as well as on important fiscal repercussions, reduce the availability of foreign exchange, reduce household and national food security, and in general have an overall macroeconomic destabilizing effect. In effect, the inter-annual agricultural output variations are clearly connected to the overall economy performance (as can be seen in Figure 15 below), although the intensity of the variations in the agricultural GDP are greater than in the overall economy but the direction has been the same in recent years.[24]

Figure 15: Growth Rate Gross Value Added, volume index (2004-2009)



80. The immediate step for analysis is to distinguish shocks from smaller inter-annual variations in output. Available data on actual losses is not always accurate or consistent enough to facilitate comparison and ranking of the costs of adverse events. Analysis was thus based on estimates of the "indicative" value of losses for the 1990-2010period.

81. The indicative value of agricultural output lost in a particular year is calculated as the deviation of the actual yield from the yield trend value. A loss threshold of 0.33 standard deviation from trend is then set to distinguish between losses due to shocks and those that reflect the normal or relatively easily absorbable downturns.

[24] Data from IBGE was available only for the years shown.

82. The yield difference in the years where actual yields were below the loss threshold is then multiplied by the actual area that year, valued at 2010 producer prices and converted into US$ at the 2010 exchange rate. Indicative loss values are also compared to agricultural GDP in the relevant year in order to provide a relative measure of the loss.[25]

83. The quantification of losses presented in this chapter capture production risks, such as drought and pest and disease outbreaks. Approximately R$ 28 million (equivalent to US$ 16 million), or 2.3% of the agricultural GDP, was estimated as the value of the average production loss annually in the agricultural sector as a result of unmanaged production risks. This percentage is higher than the one calculated for Bahia (1.9%). Drought was the main cause of these shocks, sometimes in combination with other events. The calculation involves all crops but the losses are concentrated in the following crops: sugar cane, beans, banana, pineapple, maize, papaya fruit (*mamão*) and cassava, affecting all supply chain actors. As indicated in chapter 3, these crops are responsible for over 80% of state agricultural GDP and are representative of Paraiba's agricultural sector risk profile (see Table 6 for detail information by crop).

84. Average figures are useful to understand the aggregate costs of production risk. However, they tend to conceal the actual catastrophic impact that some shocks have at the time that they occur. For instance, during the 2010 drought, losses amounted to R$ 65 million (against the R$ 28 million annual average), or 5.4% of the state's agricultural GDP, and there were much higher losses in previous years: R$ 108 million in 1998, R$ 104 million in 1993 and R$ 82 million in 1996. Not surprisingly, the first two years match with two very severe droughts throughout the state (1998 and 1992-1993, respectively).

85. Furthermore, the losses in terms of the normal production value in 2010 were extreme for important smallholder crops like beans and maize, accounting for R$ 16 million and R$ 7 million losses respectively. In the same year, the losses of sugar cane and banana reached R$ 18 million and R$ 13 million respectively. In total these four crops accounted for 83% of total losses in 2010.

86. The following are some examples of realized risk impact in the livestock sector:

- 20% of the cattle and 50% of the goat population were lost during the 2012-2013 drought;
- During the last drought (2012-2013) there was a 90% decrease of honey production and 50% of bees died and 70% of the beehives migrated;
- The outbreak of an exotic disease (e.g. FMD or BSE) would have a catastrophic impact (elimination of animals, quarantine and disinfection, loss of external markets, etc.) as occurred during the 2005 FMD outbreak in Mato Grosso do Sul and Parana.[26]

[25] Analysis of this nature requires a consistent set of data on both production and prices, for an extended time period. The source of data chosen was IBGE, where complete statistical information was found for the period 1990-2010.

[26] Study by Costa, et al. on the impact of the 2005 foot and mouth disease outbreaks in Mato Grosso do Sul y Parana. The outbreak had great impact on exports and prices of beef, poultry and pork, which only recovered after the lifting of the import bans by Russia, the main importing country, 28 months later. It was necessary to eliminate 33,741 FMD-susceptible animals (32,549 cattle, 566 pigs, 626 sheep and goats). One to two months after the import ban by Russia and other countries,

Table 6: Indicative Agricultural Losses in Paraiba, per Crop

Crop	Units	Annual average losses (Units)	Annual average losses (R$)	Annual average losses (US$)
Sugar cane	Tons	160,452	8,317,522	4,725,865
Beans	Tons	2,260	4,046,473	2,299,132
Banana	Tons	8,588	3,618,976	2,056,236
Pineapple	1000 fruits	3,217	2,689,170	1,527,937
Maize	Tons	4,646	2,200,976	1,250,555
Papaya fruit	Tons	1,547	1,092,739	620,874
Cassava	Tons	4,273	970,011	551,143
Other			5,375,333	3,054,166
Total			28,311,199	16,085,909
Losses as percentage of Paraiba's agricultural GDP			**2.3%**	

Production Volatility by Regions: The Case of Cassava

87. Cassava constitutes a major source of carbohydrates in the diet of the population of Paraiba, including several processed products, such as flour (*farinha*). Starch (sweet cassava starch or gum), modified starches, baked goods, pasta, snacks, *manioc*, *tapioca*, among others are other products derived from cassava. Cassava plantations are very popular among small farmers because of its rusticity, low demand for production technology, ability to adapt to different ecosystems and the ability to produce even under severe adverse conditions, though at low yields. The maximum planted area was reported in 1990 with more than 52,000 hectares. This area remained relatively stable until 1995 when it started to decrease in all meso-regions within Paraiba. However, the distribution of the planted area across the meso-regions has remained more or less constant over the years.

Brazilian beef exports decreased from 93.8 thousand tons in September 2005 to 66.1 thousand tons in December 2005. Costa, R., David A. Bessler, David A. and C. Parr Rosson, C. Parr. The Impacts of Foot and Mouth Disease Outbreaks on the Brazilian Meat Market. Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2011 AAEA & NAREA Joint Annual Meeting, Pittsburgh, Pennsylvania, July 24-26, 2011 http://ageconsearch.umn.edu/bitstream/103811/1/AAEA%202011%20Costa%20Bessler%20Rosson.pdf

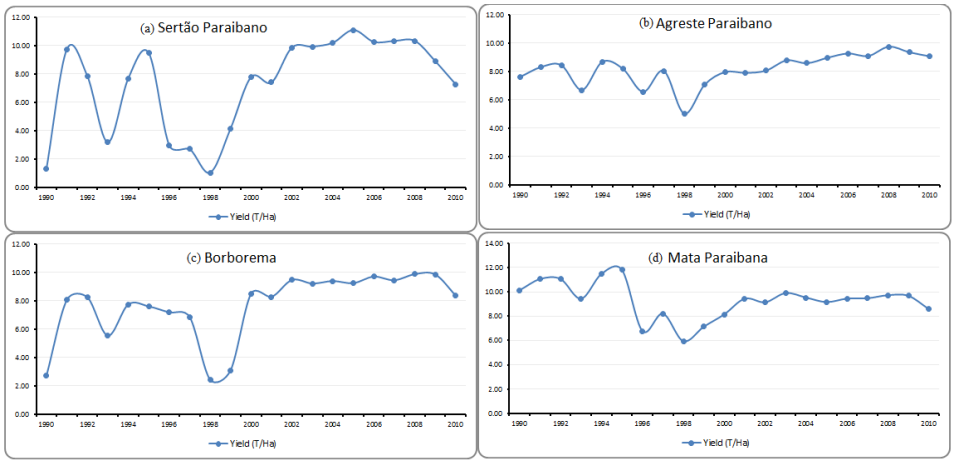
88. The relative production volatility among different meso-regions is measured using the coefficient of variation[27] of yields. All meso-regions show high inter-annual variations: the coefficient of variation of yields (tons/ha) range between 14% in the *Agreste Paraibano* and 45% in the *Sertão Paraibano*, which is the drier region in Paraiba. Due to the different level of area planted, these variations have different impacts on total production (Table 7).

Table 7: Production Volatility by Meso-region

Meso-region	Planted Area, 2010 (ha)	Coefficient of variation of cassava yields
Sertão Paraibano	1,022	45%
Agreste Paraibano	16,998	14%
Borborema	485	30%
Mata Paraibana	7,278	16%
Paraiba	25,783	11%

89. The year of 1998, when a severe drought occurred, shows the most drastic reduction of cassava's productivity in all regions. According to the *Confederação da Agricultura e Pecuária do Brasil*, during this year the severe drought affected all Northeastern states of Brazil. Similar negative yield performance is evident in all meso-regions during the 1992-1993 and 2010 droughts. Figure 17 (on following page) shows cassava yield variability in all the four meso-regions of Paraiba.

Figure 16: Cassava Yield Variability in the Four Meso-regions of Paraiba (1990-2010)



Source: IBGE

[27] Calculated as the standard deviation divided by the series arithmetic media. It shows the extent of variability in relation to mean of the population: the higher the worse.

CHAPTER 4: STAKEHOLDERS ASSESSMENT

Impact of Risks at Individual Stakeholder Level

90. How the losses attributed to risks are distributed among stakeholders along the supply chain is to a great extent a function of supply chain governance and stakeholder capability and opportunities for risk management. This section provides a discussion on the impact of the main agricultural risks identified in the section above on the different actors of the main agricultural supply chains in Paraiba (Table 8).

Table 8: Stakeholder Risk Profile

Stakeholders	Most important risks	Significance of risk	Current capacity to manage risk
All farmers	Unexpected irregular precipitation and severe drought events.	Crop and animal losses. Reduced quality of products: fruits, sugar cane. Family farmers: greater exposition to food insecurity.	Drought tolerant varieties and variable crop cycles.
Smallholders	Insect pests (caterpillars), diseases (viruses, rots), nematodes, palma forrageira mealy bug. Animal diseases: Exotic diseases (FMD, BSE, HPAI), prevalent diseases.	Pests represent an important risk to production if not properly controlled. Elimination of infected animals and losses of production of meat, milk, honey. Restriction to the marketing of products. Public health risk from zoonosis.	Only a minority of the growers adopts mitigation practices, like pest control or resistant varieties. Deficiencies in the provision of technical assistance services (EMATER) make appropriate technologies not easily available to family agriculture. Insufficient supply chain coordination prevents better access to adequate technologies to control pests and to the correct use of pesticides. FMD vaccination.
Livestock producers	Drought. Animal diseases: Exotic diseases (FMD, BSE, HPAI). Animal diseases: Prevalent diseases of economical and public health importance (Brucellosis, Tuberculosis, Classical Swine Fever,	Loss of animals, decreased production. Quarantine and restricted movement and trade of animals and animal products. Public health risk for the transmission to humans.	Some financial aid by the government -Government Programs such as *Garantia Safra* e *Bolsa Estiagem*. FMD vaccination. Federal and State control, prevention, eradication and contingency programs in

	Newcastle Disease).	Food safety from the contamination of meat and milk. Financial loses. Reduced exports.	operation.
Sugar cane processing plants	Drought.	Less raw material available to process. During severe droughts, sugar processors may experience an increase in their production costs because their processing plants operate at lower capacity.	Plants accrue financial losses
Meat Processors/ Exporters	Animal diseases: Exotic diseases.	Shortage of primary products to operate the processing plants. Loss of domestic and external export markets. Loss of credibility.	Good Federal and State inspection and control system for animal's products (SISBI). Partial municipal infrastructure of slaughter houses and control and inspection programs.
Consumers	Food borne diseases	Important food safety problems.	Federal and State meat and milk control and inspection programs. Planned: State Food Security and Safety system (CAISAN, SISAN/PB).
Government (national)	Drought Animal Diseases: Exotic and prevalent diseases. Food Safety.	Social instability. Budget implications.	Budget provisions for risk coping programs (drought support programs, contention and emergency funds, compensation funds).

Vulnerable Hotspots

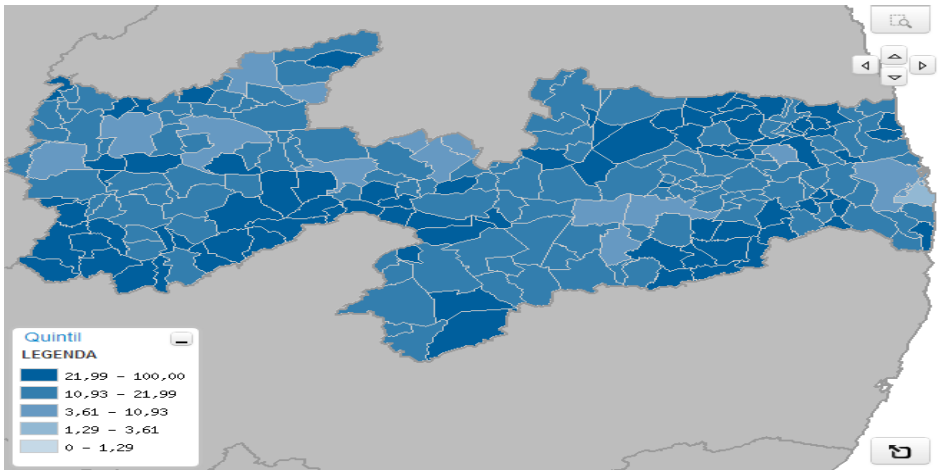
91. The impacts of the aforementioned risks have greater consequences for human welfare among the individuals, communities and regions of Paraiba that are more vulnerable. As we have already seen,

a single risk, such as drought, has different effects on different systems of productions and producers. Vulnerability is the concept that explains the heterogeneity in impact.[28]

92. Though poverty has been declining in the Northeast, as in the rest of Brazil, over the last decade, poverty in rural areas where livelihoods concentrate on agriculture, remains high. In Paraiba, you are twice as likely to be poor if you live in rural areas, than in urban areas. In 2012, 25% of the rural population was poor, compared to 12% in urban Paraiba, and 8.1% of the population was extremely poor. However, in the 170 municipalities of the Paraiba Semi-Arid region, which covers most of the area of the state and most of family agriculture families, the average rate of extreme poverty is 20% (Figure 18).

93. Poverty exacerbates vulnerability because a shock will have greater proportional effects on the welfare of a poor household than on that of a wealthier one. In effect, repeated shocks confine poor rural households into a poverty trap, exhausting savings and dissolving investments that would otherwise help propel the household ahead. Vulnerable households in Paraiba respond to shocks by reducing household consumption, selling household and productive assets, and seeking income sources off the farm with diverse strategies, including migration to urban areas. Expenditures on drought mitigation and emergency measures also divert resources from longer-term investments in human capital and productivity.

Figure 17: Map of the Extreme Poor in Paraiba (2010)



Source: IPEA

94. To capture why vulnerability varies between individuals and between households, vulnerability can be seen as the function of three factors: (i) sensitivity, (ii) adaptive capacity, and (iii) exposure.[29]

[28] Vulnerability is "the likelihood that at a given time in the future, an individual will have a level of welfare below some norm or benchmark." Common welfare indicators include poverty measurements, household expenditures, savings levels, and food security and nutrition measures (such as food consumption score and household dietary diversity). Though vulnerability depends on the severity of external shocks like climate, the likelihood of a drop in welfare depends on both people's context and capacity to act and react. Socio-economic assets and institutions play an important role in people's vulnerability.

i. **Sensitivity** is the degree of impact of the initial shock. Sensitivity can be thought of as the elasticity of household welfare (e.g. consumption levels) in response to a shock.
ii. **Adaptive capacity** is the ability of the household to access ex-post coping strategies that helps the household return to pre-shock welfare levels.[30]
iii. **Exposure** is the probability of the given shock materializing and affecting the household's assets.

95. Annex 2 expands on these relevant indicators and suggests measurements for analyzing vulnerability to drought, the most significant agricultural risk for small farmers in Paraiba. A notional application of this framework to Paraiba indicates that the poorest areas of the state (measured by earned income per capita), are not necessarily the areas that will suffer the most from drought. State transfers for old age pensions and *Bolsa Família* serve to diversify the poor's portfolio and buffer the direct effects of drought.

96. Policy can reduce all three aspects of vulnerability: sensitivity through encouraging diversification away from drought-exposed livelihoods to better adapted sources of income/production; adaptive capacity through education, land regularization, market access and social protection; natural resource management. This methodology should be applied at the municipality level using available IBGE data, and state or policymakers should identify which welfare indicators they wish to prioritize in the analysis. For example, a state that is more concerned with vulnerability that causes hunger or malnutrition will involve a very different policy response than a concern for rural exodus/out-migration. Participatory territorial planning methods should be involved to validate and gain ownership over a technical vulnerability analysis.

[29] Lindoso et al. 2012. "Indicators for Assessing the Vulnerability of Smallholder Farming to Climate Change: The Case of Brazil's Semi-Arid Northeastern Region." Instituto de Pesquisa Economica Aplicada. International Policy Centre for Inclusive Growth.

[30] Adaptive capacity is a subset of resilience. United States Agency for International Development (USAID) defines resilience as the ability of people, households, communities, countries, and systems to adapt to and recover from shocks and stresses in a manner that reduces chronic vulnerability and facilitates inclusive growth.

CHAPTER 5: AGRICULTURE RISK PRIORITIZATION AND MANAGEMENT

97. To better utilize scarce resources, it is important to understand which risks are causing the largest shocks to the sector in terms of losses and observe at what frequency they occur. This chapter summarizes the priority risks faced by the agricultural sector in Paraiba and the possible risk management solutions, as identified, validated, and prioritized with sector stakeholders.

Risk Prioritization

98. Below are the tables containing the agricultural risk prioritization defined on the basis of the probability of the event and their expected impact, for domestic and export crops (Tables 9 through 12). The identified risks located in the grey area represent the most significant ones due to their potential to cause the greatest losses and the higher frequency of their occurrence.

Table 9: Sugar Cane Supply Chain

Impact Likelihood	Low	Moderate	High	Critical
Highly Probable **(1 in 3)**	Pests - broca do colmo, broca gigante, cigarrinha 4/		Sugar and ethanol price and cost uncertainty 1/ 2/ 6/	
Probable **(1 in 5)**	Irregular precipitation (heavy rain followed by extended dry spells) – irrigated sugar cane		Irregular precipitation (heavy rain followed by extended dry spells) – rain fed sugar cane	
Occasional **(1 in 10)**		Severe drought – irrigated sugar cane 3/	Disease -ferrugem amarela 5/	Severe drought –rain fed sugar cane 3/
Remote **(1 in 20)**				

1/ Gasoline and ethanol are substitutes in Brazil, therefore the maximum price of ethanol is set by the lowest price of gasoline. Gasoline price is fixed by the government and currently there is uncertainty about public policies (this is a combination of market and enabling environment risks).
2/ Sugar cane price is agreed among producer organizations and buyers and is subject to lower volatility than sugar price of sugar.
3/ Severe droughts occurred in 1992-93, 1998, 2001-2002, 2010, 2012, 2013.

4/ It is biologically controlled.
5/ This disease was reported in Sao Paulo but not in Paraiba. It is quoted as a risk of high impact because of deficiencies of the SEDAP's basic plant health services.
6/ The cost variability is somehow connected to the exchange rate, the general increase of prices, etc.

Table 10: Fruticulture Supply Chain

Impact / Likelihood	Low	Moderate	High	Critical
Highly Probable **(1 in 3 years)**	Pests –*broca do olho do coqueiro* (coconut) 4/ Diseases -*sigatoka amarela* (banana) 4/	Pests –*mosca negra* (citrus) Diseases –fusariosis (pineapple) Price volatility among not cooperative organized farmers (pineapple) Mosca branca 3/ Price volatility connected to high inter-annual output variation		
Probable **(1 in 5)**		Irregular rainfall	Pesticide application without the needed technical knowledge 1/	
Occasional **(1 in 10)**			Diseases –*sigatoka negra* (banana), *cancro bacteriano* (grapes) 2/	
Remote **(1 in 20)**				

1/ This is a risk for the farmers' health and economy, the consumer health and the environment. Most usually this is the result of inadequate or even absence of technical assistance services to the producers (enabling environment risk).
2/ These diseases were reported in other regions of Brazil but not in Paraiba. They are quoted as a risk of high impact because of deficiencies of the SEDAP's basic plant health services.
3/ Mosca Branca has affected apiculture and *castanha* projects in the Cariri Paraibano region (municipality of Serra Branca).

4/ As long as these pests can be controlled adequately they are regarded as low impact risks or even could be consider constraints if monitoring and control were massive.

Table 11: Family Agriculture Supply Chains - Maize, Beans and Cassava

Impact / Likelihood	Low	Moderate	High	Critical
Highly Probable (1 in 3 years)	Price fall (maize, beans) 2/ Insect pests (caterpillars), diseases (viruses, rots), nematodes	Cochonilha do carmin		
Probable (1 in 5)			Irregular precipitation (heavy rain followed by extended dry spells)	
Occasional (1 in 10)				Severe drought 1/
Remote (1 in 20)				

1/ Severe droughts occurred in 1992-1993, 1998, 2001-2002, 2010, 2012, 2013.

2/ PAA intervenes in the market supporting prices of family agriculture farmers' crops though interventions are limited because of reduced crop surplus. The quota system has to be revised.

Table 12: Livestock Supply Chains[31]

Impact / Likelihood	Low	Moderate	High	Critical
Highly Probable (1 in 3 years)		Zoonotic diseases – brucellosis, tuberculosis, cattle rabies (bovine, ovine and goat) Avian disease Fish diseases Bees diseases		
Probable (1 in 5)	Timely availability of maize for poultry industry and livestock production in situations of nationwide price drop (maize) 4/	Food borne diseases (milk, cheese, poultry and fish)	Irregular precipitation (heavy rain followed by extended dry spells)	
Occasional (1 in 10)	New castle disease (birds) 3/ Classical swine fever 3/			Foot and mouth disease (cattle) 2/ Severe drought 1/
Remote (1 in 20)				BSE (cattle) Highly pathogenic avian influenza

1/ Severe droughts occurred in 1992-93, 1998, 2001-2002, 2010, 2012, 2013. There is contradictory information on losses, most likely about 20%.

2/ The risk is considered occasional subject to the consolidation of the current prevention and contention measures.

3/ Free status can be established if epidemiological studies are carried out to confirm status.

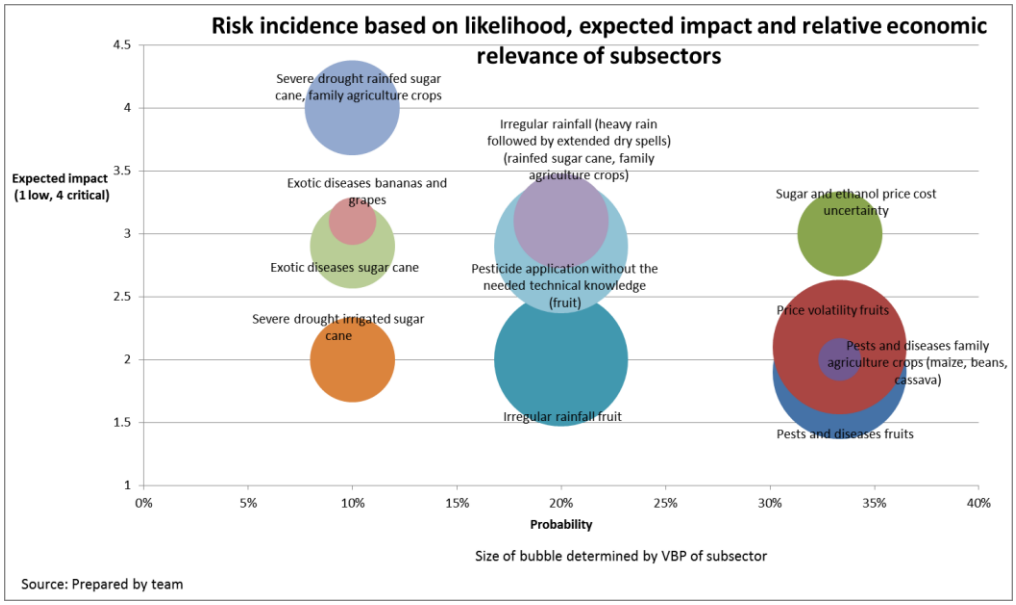
4/ Paraiba is a net importer of maize and when price drops CONAB intervenes to guaranty supplies under the PGPM.

[31] Includes livestock production by family agriculture.

99. Corollary: No highly probable or probable risks with critical impact were identified but there exist several probable and highly probable risks with high impact and moderate impact. The important issues identified for the main risks – limited drought mitigation, uncontrolled pests and diseases, deficiencies in livestock sanitary services, ethanol policy uncertainty and poor fruit market coordination – require comprehensive measures to complement the already existing risk management mechanisms in Brazil (Garantia Safra, Price Guarantees, Livestock sanitary services, food safety, etc.) and improve their implementation in Paraiba.

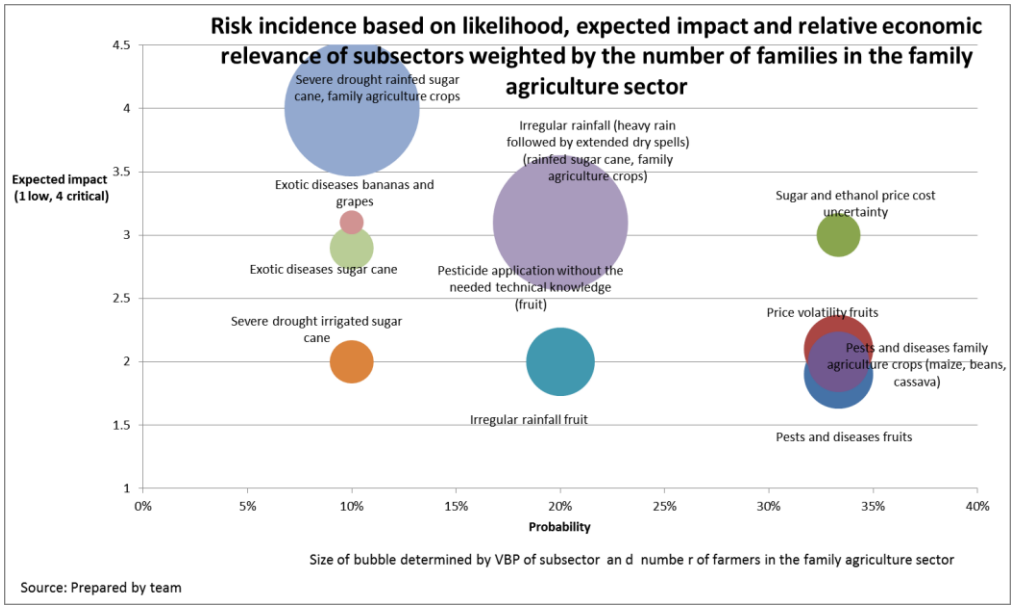
100. Figure 19 below shows the relative importance of the different risks that have moderate to critical impact and refer to the crops that historically have accounted for the larger losses due to agricultural risks (as explained in Chapter 4). Sugar cane and fruits, especially grapefruit (large share in the total agricultural production value of Paraiba), are the greatest determinants of the agricultural losses.

Figure 18: Risk Incidence



101. However, the conclusion is rather different if the risks are prioritized taken into account the relative importance of family agriculture in the total number of farmers (Figure 20). In effect, there are 148,047 family agriculture farmers in Paraiba (2006), out of a total of 167,272 farmers. Under that perspective, results that severe rainfall (estimated to occur 1 in 10 years), irregular rainfall (1 in 5) and pests and diseases (with lower expected impact than the other risks, as explained in Chapter 3) are the main risks in Paraiba. This scenario is one of much higher impact but of lower probability. The solutions scenario should involve strong actions directed towards introducing innovative technology and improving agricultural practices.

Figure 19: Risk Incidence, prioritizing risks



Source: Prepared by team

Proposed Long List of Solutions

102. The potential solutions presented below (Table 13) were identified during field interviews as well as already suggested in various government and non-governmental documents. Usually, risk management strategies are a combination of risk mitigation, risk transfer, and risk coping instruments. Risk mitigation refers to actions taken to eliminate or reduce events from occurring, or reduce the severity of losses; risk transfer are mechanisms to transfer the risk to a willing third party, at a cost (e.g., insurance); and, risk coping (e.g. government assistance to farmers, debt re-structuring, etc.). How instruments are applied for a given risk will likely depend on the current risk management and the probability of the risk and the severity of its impacts.

Table 13: Proposed Instruments as Solutions to Main Risks

Risks	Mitigation	Transfer	Coping
Climate	▪ Develop an integrated national weather information system for better weather data analysis and improved accuracy of short and medium-term rainfall (weather) forecasting. Some key activities to be considered include: strengthen the institutional capacity of the water management agency (AESA); integration of weather station networks (both at Federal and State level); review and strengthen current institutional coordination (i.e. roles and objectives); improve current mechanism of data/information distribution. ▪ Establish a State Working Group (producers, meteorology service, EMATER, SEDAP, etc.) to provide advice on the application of weather data for production and research. ▪ There are some watersheds (i.e. Gramame Watershed) where water availability for irrigation can be improved. Unfortunately, most of irrigation plans developed in Paraiba do not include the estimation of water demand for the subsistence agricultural farming. Therefore, it becomes relevant to carry out studies with the aim of assessing the restrictions that may prevent meeting the crop water irrigation demands; quantifying the effective area of agricultural farming that can be supplied with water for irrigation, and estimating the financial costs of new/improved infrastructure.	▪ *Garantia Safra*: adjust "hard trigger" (which is based on weather indexes) when the weather stations network is improved, and improvement of the operational procedures for loss adjustments through strengthening of the agro-extension system at the state level; review the rating methodology based on which the premium is defining.	▪ Strengthen the Paraiba Drought Management Committee and development of a drought risk management strategic plan to include agricultural risk management.

Institutional: Climate, Pests and Diseases, Livestock and Market Risks	▪ Strengthen the State agricultural assistance and extension system (see discussion below on this proposal): increase coverage of EMATER's technical assistance for family agriculture farmers and promote private sector suppliers of technical assistance; promote agricultural practices and technologies as well as crop diversification that are appropriate for the semiarid region (sisal, mangaba, umbu, goat/sleep, etc.); expand the use of integrated pest management; coordinate projects and programs with research institutions, academia, NGOs and farmers organizations (agricultural and livestock production); promote (through projects) investments in irrigation in sugar production and other crops; adapt the extension services to each bio-climatic region (e.g., *Sistema Caatinga no Semi-árido*), in particular with reference to livestock; promote increasing supply chain coordination and greater farmer organization (cooperatives, etc.), supply/demand planning and price information dissemination, using APL approach.		
Pests and Diseases	▪ Reinforce the SEDAP's basic plant health services (surveillance, quarantine, laboratory, emergency plans, transit control). ▪ SEDAP should define a strategy towards the universal access to the biological control of major sugar cane pests.		

Livestock Production Risks	▪ Promote the utilization of: *cochonilha* resistant varieties of *palma forrageira* in a coordinated way among the several existing programs; grass resistant varieties for the semiarid areas and the use of silage. ▪ Promote the utilization of animal species, which are more resistant to the semiarid areas such as goats, sheep, poultry and apiculture. ▪ Promote the utilization of adequate systems of drinking water storage for the drought periods. ▪ Update and consolidate (SEDAP) prevention programs for exotic animal diseases according to the new FMD free status of Paraiba State. ▪ Update veterinary services and control and eradication action plans (SEDAP) for prevalent diseases (brucelosis, etc.), according to the epidemiological situation of each disease. ▪ Adopt the SISBI as the inspection system for improving the food safety system (SEDAP in coordination with MAPA). ▪ Coordination of all sanitary and food safety services (AGEVISA, SEDAP sanitary agencies and the municipalities sanitary services) under MAPA leadership. ▪ Request technical OIE cooperation for the performance evaluation of the animal health and food safety services (OIE/PVS and GAP evaluation). ▪ Under the frame of the Intersectoral Chamber of Food Security and Nutrition (CAISAN/PB) and the proposed State System of Food Security (SISA) promote the establishment of a food safety policy and the coordination mechanisms of all the federal, state and municipal entities related to the food safety.		▪ Establish a contingency fund to respond to exotic animal diseases outbreaks.

Enabling Environment	▪ The sugar and ethanol policies are determined at federal level for the entire country. Given the key importance of sugar cane production in Paraiba, they are of vital importance for Paraiba as well as for other sugar cane producing states. The uncertain policy environment (discussed in Chapter 3) prevents appropriate farming and industrial planning and represents a risk for the sugar industry in Paraiba as a whole. In addition, there is uncertainty about exchange rate and the general price index, what poses the important risk of unpredictable cost variability. The sugar and ethanol policies should be more stable and predictable and above all they should not add additional uncertainty to the already volatile sugar and oil/ethanol international markets.		

103. There are many simple and validated technologies in stock or stand-by, poorly or not adopted by the farmers, chiefly small familiar peasants, for whom the almost sole transfer channel is the public technical assistance service. Examples of this situation were found when the mission visited EMBRAPA´s research centers, EMEPA and universities. The mission had the opportunity to visit a few smallholders that were directly supervised by EMBRAPA *Semi Árido* scientists. The technologies being transferred were simple solutions for enhancing production systems on the semiarid and coping with recurrent droughts. In spite of the severe drought affecting the region in recent years, poor soils, inexistent irrigation, etc., theses farmers showed consistent production progress with low financial investment. Other examples were observed by the mission when visited EMBRAPA *Mandioca e Fruticultura,* regarding either varieties of citrus and cassava resistant to key pests, or new technologies for producing clean citrus seedlings, meaning they are certified to be free of pests, and other technologies for pest control. However, these technology adoption initiatives are few and isolated. EMATER's capacity to provide rural extension services is low and requires improvement. Other non-public extension modalities should also be explored. In addition, gender elements should be taken into account considering the large percentage of female-headed families in rural Paraiba (this aspect will be assessed during the solutions mission).

104. A completely contrasting situation was found on entrepreneurial agribusiness, like in the grain production area of Western Bahia (*Cerrados*), or the fruit production clusters of the irrigated districts located close to the *Sobradinho* dam (*Médio São Francisco*), or in southern and southwestern Bahia. The growers of these regions are receptive to innovative and adequate technologies and conscious of the need of access them by receiving proper technical assistance. In this case, farmers either have their own team of professionals or contract private technical assistance. The differences in the business sustainability between market oriented production and family agriculture is largely found in the rate of technology adoption, thus highlighting the importance of the public technical assistance for the sustainability of the family agriculture sector.

Key Risk Management Measures

105. Many programs and projects are already addressing some of the identified risks along the lines of the solution proposed in the Table 13. Table 14 below, contains a number of these projects and programs as were identified by the mission (see Annex 3), indicating their connection with the risk assessment results and the potential gaps to be covered with additional specific risk management actions.

Table 14: Programs and Projects Currently Addressing Some of the Identified Risks

Long list solutions	**Current projects or programs**	**Gap?**
Develop an integrated national weather information system.	Various weather stations throughout the state and in other parts of the Northeast run by different entities, with limited coordination between each other or communication with agricultural producers	Improve coordination
Establish a State Working Group to provide advice on the application of weather data for production and research.		Group to be establish
Irrigation development.	The State of Paraiba has developed Water Management Plans for different watersheds with the aim of providing support to the implementation of both national and state irrigation projects and policies to develop the agricultural sector.	Government programs in place, though studies required to meet deficiencies.
Garantia Safra improvements.		Partial adjustments required
Strengthen the State agricultural technical assistance and extension system.	Various projects to provide technical assistance (EMATER, SEDAP, INSA, PROCASE) but unsystematic and limited in geographic coverage and beneficiaries. Limited coordination between providers and between agricultural research and extension agents.	The entire system to be improved and coordination strengthened
Reinforce the SEDAP's basic plant health services.	State Program for Sanitary Defense	Partial adjustment

Long list solutions	Current projects or programs	Gap?
SEDAP to define a strategy towards the universal access to the biological control of major sugar cane pests.	State Program for Sanitary Defense	Define strategy
Livestock sanitary measures and food safety (see table 13 above).	Existence of a Federal and State Programs for the Eradication of FMD coordinated by the Ministry of Agriculture (MAPA), which was started in 1998. Existence of Federal and State programs for Control and Eradication of Bovine Brucellosis and Tuberculosis. Existence of Animal health Programs for Poultry, Swine's, Apiculture, Goats and Sheep's, Horses and Aquaculture and Fisheries. Existence of Federal and State programs for the Control and Inspection of meat and other animal products. Existence of partial Municipal Control and Inspection of meat and other animal products.	Partial coordination and coverage and need to update programs.
Promote appropriate feeding programs and drinking water management storage.	EMATER livestock extension programs for small producers. Some technical assistance and extension programs from EMBRAPA, SEBRAE, FAEPA/SENAR, INSA.	Poor extension services.
Increasing supply chain coordination and greater farmer organization (cooperatives, etc.).	Isolated project actions.	No related technical assistance services involved in current programs.
Discussion between MAPA, SEDAP and state actors should be pursued regarding state implication of sugar and ethanol policies.		Lack of comprehensive dialogue with large stakeholder participation.

106. The above long list of general solutions and the corresponding gap analysis were used to start narrowing down onto specific solution areas that tackle the key risk issues. The final result will be a package of interventions that could effectively lower volatility and increase resilience in agriculture and since the emphasis is placed on the more vulnerable segments of the supply chains the agricultural risk management program will have a direct positive impact on poverty reduction.

107. In brief, the following are the key risk management areas, deepened in Volume 2: Risk Management Strategy:

1. **Strengthen State's rural extension and technical assistance system for agriculture, livestock and marketing, is key for family agriculture farmers and other small and medium scale farmers in order to access risk management technology and adopt relative practices.** Currently, the State extension services are weak:

    a. Smallholders have difficulties accessing private suppliers of technical assistance;

    b. There are not enough Paraiba State Company for Technical Assistance and Rural Extension (*Empresa de Asistência Técnica e Extensão Rural da Paraíba* – EMATER) extension offices to cover all the municipalities;

    c. Most of these offices do not have enough technical and support personnel to carry out medium or large scale programs;

    d. Extentionists do not have access to updated knowledge and continuous capacitation;

    e. The supporting resources (vehicles, per diem, fuel) are below the requirements for minimum operation levels;

    f. The technological transfer programs have to be revised in order to assure transfer of proved technologies;

    g. EMATER programs and operations should be coordinated at fine tune level with other research and extension institutions working in Paraiba.

    EMATER should allocate more resources to increase the coverage of the extension services, improve program coordination, upgrade training programs, develop risk management tailor made programs, etc. Simultaneously, efforts should be made to put in place private sector based technical assistance services driven by farmers.

2. **Carry out studies with the aim of assessing the restrictions that may prevent meeting the crop water irrigation demands; quantifying the effective area of agricultural farming that can be supplied with water for irrigation, and estimating the financial costs of new/improved infrastructure.**

3. **Strengthen SEDAP's phytosanitary services in order to guarantee proper control and prevention of plant diseases.** This would include:

    a. Programs to avoid the entry of major pests which are not presently attacking crops grown in Paraiba, strengthening sanitary controls, active surveillance and be prepared to eradicate exotic pests detections at first detections;

b. More sound actions to control pesticide trade and use;

c. In addition, institutions in the three levels of sanitary intervention (Federal, State and Municipal) should act in strict coordination.

4. **Enhance animal sanitary risk management to assure adequate protection from exotic and other diseases.** This would require the following actions:

   a. FMD prevention program has to be revised and updated

   b. Control and eradication programs for prevalent diseases of economic and public health importance need to be revised, updated and speed its execution.

   c. Municipal control and inspection programs need to be coordinated and harmonized with Federal and State Programs following SISBI orientations.

   d. Need to establish State food safety policy and mechanism of coordination along the food chain.

5. **Improve coordination within the supply chains and assure fine tuning planning.** Price volatility in important cash crops such as fruits is very much driven by significant inter-annual changes in the domestic supply, resulting in an output-price looping behavior. This behavior is invigorated by poor farm to market coordination and scarce marketing-production planning. In Brazil the APL (*Arranjos Produtivos Locais*) approach, a sort of cluster approach, has become popular since 2004. It is regarded as articulations among supply chain actors for mobilizing resources (credit, technology), facilitate marketing and in general promote greater economic dynamism and less volatility. Value chain or productive partnership approaches could be incorporated into the agricultural risk management strategy in subsectors such as pineapple and could be part of the regular technical assistance services in Paraiba.

6. **Develop an integrated weather information system in Paraiba to improve the analysis of weather data and to improve the accuracy of short and medium-term weather forecasting.** Some key activities to explore during the solutions assessment, would include:

   a. Integration of weather station networks both at Federal and State level;

   b. Review current institutional arrangement coordination, and strengthen the institutional structure and regulatory framework to achieve better coordination between national and state weather authorities;

   c. Improvement of current mechanism of data and information dissemination;

   d. Establishment of a state working group to coordinate and manage the application of weather data in commercial activities, research, and to warm the civil society about the occurrence and magnitude of weather events.

7. **Train Paraiba rural extension officers and professionals associated with *Garantia Safra* on the collection of crop loss data in order to minimize sampling errors and to reduce the risk of moral hazard.** *Garantia Safra* operation is currently based on the estimation of crop losses due to drought events. The losses are derived from a hard trigger or weather index. Given that not all regions have a dense weather station network, hard triggers are extrapolated. Therefore, the possibility that the resulted output does not accurately reflect the actual yields exists. In these cases, *Garantia Safra* compensation payouts are triggered after the conduct of field loss assessments (soft trigger). Loss assessments are made by the state rural extension service or alternatively by professionals with background in agronomy that work in public institutions. There is, therefore, a need to train rural extension officers because there are several crops that are covered under this risk transfer mechanism, and that these crops show different phenological structure and level of resilience to drought.

8. **Strengthen the Paraiba Drought Management Committee**, in order to shift its main focus from reactive activities to emergency preparedness. The solutions assessment could concentrate on the following aspects:

    a. Develop the Committee's drought risk management plan;

    b. Develop a communication plan and a communication system;

    c. Improve institutional capacity (knowledge, training) and legal framework;

VOLUME 2: RISK MANAGEMENT STRATEGY

CHAPTER 1: SUMMARY OF THE AGRICULTURE RISK MANAGEMENT STRATEGY

1. The first phase of the assessment based on the productive structure (reflecting relative importance of both crops and production patterns) identified: sugar cane; commercial fruit production; family agriculture crops; and livestock as the value chains and sectors targeted under the Agriculture Risk Management Strategy. Sugar cane and fruits, especially grapefruit, because of their large share in the total gross output value of Paraiba (73%), are the greatest determinants of the average annual production risk related losses (58%).[32]

2. Limited drought mitigation, uncontrolled pests and diseases, deficiencies in livestock sanitary services and poor market coordination for fruit products are the key issues addressed for reducing losses in Paraiba's agriculture sector. The risk assessment confirmed that there are no risks with critical impact that at the same time are highly probable (1 in 3 years) or probable (1 in 5 years) in Paraiba but there are several probable and highly probable risks that cause moderate or high impact when realized. It was observed that the important issues identified around these main risks–- require comprehensive measures to complement the already existing federal policies and programs that in some way contribute to manage agricultural risks (Garantia Safra, price guarantees, livestock sanitary services, food safety, etc.) and to improve their implementation in Paraiba.

3. Severe drought, irregular rainfall, and pests and diseases are the main risks affecting family farmers in Paraiba. When risks are prioritized taking into account the relative importance of family agriculture in the total number of farmers (there are 148,047 family agriculture farmers in Paraiba out of a total of 167,272 farmers[33]), the main risks in Paraiba are severe drought (estimated to occur 1 in 10 years), irregular rainfall (1 in 5) and pests and diseases (with lower expected impact than the other risks). Accordingly, the solutions scenario presents strong actions directed towards improving risk mitigation among family farmers, such as adoption of innovative technology, improved agricultural practices and effective marketing mechanisms, as well as better agroclimatic information management, together with recommendations regarding other sectors of the agriculture in Paraiba.

4. The Text Box 1 presents a summary of all the general agricultural risk management (ARM) areas recommended at the Risk Assessment.

Text Box 2. 1: Key ARM areas

The following are the Key ARM Areas proposed during the first phase for deepening the analysis during the second phase of the assessment:

- Agriculture Extension and Technical Assistance: Strengthen State's rural extension and technical assistance system for agriculture, livestock and marketing. This is key for family agriculture farmers and other small and medium scale farmers in order to access

[32] See Agriculture Sector Risk Assessment, Volume I.
[33] According to the 2006 Agricultural Census.

risk management technology.

- Supply Chain Coordination: Improve coordination within fruit supply chains. Value chain or productive partnership approaches could be incorporated into the agricultural risk management strategy in subsectors such as pineapple and could be part of the regular technical assistance services in Paraiba.
- Plant Health: Strengthen the State Secretariat for Agriculture, Livestock and Aquiculture Development (*Secretaria de Estado de Desenvolvimento da Agropecuaria e Pesca* – SEDAP) phytosanitary services in order to guarantee proper control and prevention of plant diseases. This would include: programs to avoid the entry of major pests; more sound actions to control pesticide trade and use; and improved coordination among institutions in the three levels of sanitary intervention (Federal, State and Municipal).
- Animal Health: Enhance animal sanitary risk management to assure adequate protection from exotic and other diseases.
- Agroclimatic Information Systems (ACIS): Develop an integrated agroclimatic risk information system in Paraiba to improve the analysis of weather data and to improve the accuracy of short and medium-term weather forecasting.
- Irrigation can also be an important solution to the management of agriculture risks, but careful feasibility assessments need to be done. The first phase of the Risk Assessment also included a proposal to carry out studies with the aim of assessing the restrictions that may prevent meeting the crop water irrigation demands, quantifying the effective area of agricultural farming that can be supplied with water for irrigation, and estimating the financial costs of new/improved infrastructure. However, it was found appropriate to postpone the study of these complex issues and propose that the Sustainable Rural Development Project (follow up to COOPERARII) incorporates them into its activities.

5. The following are the strategic lines identified during the ARM assessment. The detailed actions under each strategic line are contained in Chapter 4: ARM Action Plan.

Agroclimatic Risk Information System (ACIS):

a. Development of a Agroclimatic Database Integrated System in the state of Paraiba including federal institutions and Executive Agency of Water Management of Paraiba (*Agência Executiva de Gestão das Águas do Estado da Paraíba* - AESA);
b. Strengthening of the Drought Management Committee, making actions more proactive and less reactive;
c. Training to the extension workers associated to inspection procedures in the Garantia Safra project, in order to reduce moral hazard and technical issues.

Sanitary and Phytosanitary System (SPS):

a. Sugarcane
   - ✓ Expand the area of sugarcane under biological control;
   - ✓ Assess the impact of the possible introduction of the ferrugem laranja in Paraiba;
   - ✓ Set up a surveillance network for ferrugem laranja in Paraíba.

b. Fruticulture
   - ✓ Assess the likelihood and impact of the possible introduction of the diseases *sigatoka negra* and *moko* (bananas), *cancro da videira* and Huang long bing (HLB - Citrus);
   - ✓ Family Agriculture in the Semi-arid zone;
   - ✓ Substitute the varieties of *palma forrageira* susceptible to the *cochonilha do carmim* for resistant ones.

c. Livestock Production
   - ✓ Reinforce the program for controlling and eradication of brucellosis and tuberculosis;
   - ✓ Coordination of the animal health and food safety programs;
   - ✓ Establish the actual status of Classical Swine Fever (CSF) and Newcastle Disease Virus (NCDV) in Paraiba;
   - ✓ Create the State Agency for Agricultural Health.

<u>Supply Chain Coordination</u>

a. Identify successful farm to market experiences in Paraiba and assess the viability of being replicated under a massive technical assistance program→we already did, doubt there are possibilities to replicate through a "massive technical assistance program"
b. Develop market oriented business development methodologies for training and providing technical assistance to associated small scale farmers
c. Assess different options to support market development for family agriculture products, including revision of the legal framework to channel public resources

<u>Agricultural Innovation System (AIS):</u>

a. Improve the coordination of the Agriculture Innovation System for family agriculture risk management;
b. Improve efficiency of the Agricultural Innovation System for family agriculture risk management - Strengthen the research sub-system;
c. Improve efficiency of the Agricultural Innovation System for family agriculture risk management - Strengthen the Technical Assistance and Rural Extension (*Assistência Técnica e Extensão Rural* – ATER) sub-system;
d. Improve efficiency of the Agricultural Innovation System for family agriculture risk management -Enlargement of successful programs and projects.

CHAPTER 2: PARAIBA'S AGRICULTURE RISK MANAGEMENT FRAMEWORK

Brief Information on the Agricultural Sector

Agroecology

6. Like in most parts of Northeast Brazil, the State of Paraiba has the following main agroecological zones: the *Mata* zone, the *Agreste* zone and the *Sertão* zone. In the *Mata* zone there are two factors important to agriculture, namely high precipitation (over 1,400 mm annually), and relatively fertile soils. This region has been, since colonization, largely dedicated to sugar cane. The *Agreste* zone is located towards the interior, in the *Borborema* Highlands, with an average annual precipitation around 700 mm, distributed irregularly but concentrated in the period March to August (which is the season of least evapotranspiration), with mild night temperatures. The *Sertão* zone has higher temperatures, and the rains occur during the hottest months. In the *Agreste* zone, as well as in the *Sertão* zone, the dry season is long, lasting six to seven months and seven to eight months, respectively, with severe droughts every 10 or 11 years. In the *Agreste* zone, the landholdings are smaller, approximately 40 hectares in size, and greatly involved in dairy production. In the Sertão…

7. Most agricultural lands in Paraiba are located in the coastal regions, due to harsher climate conditions found in the semi-arid inland. The lowest production densities are found in the *Borborema* and *Sertão Paraibano* regions, where livestock raising predominates.

Main features of agriculture in Paraiba[34]

8. Paraiba is a small state with limited agroecological conditions for agriculture. Its agriculture share is very low: 0.7% as compared with total national agriculture gross domestic product (GDP) and 11% as compared with the Northeast agriculture GDP. As compared with the total GDP of the State, the agricultural GDP is 4.5% in 2011.[35] The main economic activity of Paraiba is the plantation of sugar cane, which is processed in *usinas* located in the largest farms; for centuries, sugar cane was used for production of white sugar, but today a large proportion is directed to the production of alcohol fuel. Most plantations are located along the coast. There are 8 *usinas* and 1,935 farmers producing sugar cane, 95% being small and micro-producers in Paraiba.[36] However, large and medium scale producers (accounting for less than 5% of the total number of producers in the State), including the *usinas* nucleus land, contribute to about 55% of the total output.

9. Fruit production is also important in Paraiba. It includes grapes, citrus, banana, mangaba, mango, coconut and pineapple. The most important fruit grown in Paraiba, in terms of production value, is

[34] Sugar cane, pineapple, banana and cassava account for 35%, 27%, 10% and 6% of the State agricultural Gross Output Value in 2010, respectively. That is, the four crops aggregated account for 78% of the total State's agricultural Gross Output Value.
[35] IBGE.
[36] ASPLAN, Setor agroindustrial canaviero do Estado da Paraiba, Joao Pessoa, May 2014.

pineapple, which is massively exported out of Paraiba to the rest of Brazil. Main producing areas of pineapple are the *Mata* and *Brejo* zones. Production is mostly in the hands of small scale farmers with heterogeneous levels of technology development and market coordination.

10. In the *Agreste* and humid areas of *Borborema*, there is beans and cassava cultivation, usually just for subsistence (beans and cassava flour, along with maize, can be stocked up for long periods, and constitute the basic food items of most families) or trading in local fairs. Maize is most common in the *Sertão*, along with plants adapted to dry climates. Regarding livestock, the raising of caprines is more common than of bovines in the *Sertao*. Family farmers are spread throughout Paraiba but concentrated in the semi-arid macro-region, encompassing the *Borborema*, *Sertão Paraibano*, and *Agreste Paraibano* meso-regions.

Family agriculture

11. There are 148,047 family farmers[37] in Paraiba, representing 91% of the total number of farmers in the State, covering a total of 1,596,273 hectares, representing 42% of total areas. Of these, two-thirds have land title. High rates of female-headed households stand out in Paraíba at around 30% in rural areas. Family agriculture is largely based on livestock, though maize, beans and cassava are grown for self-consumption on small, rain fed plots. Especially in dry regions, small farmers raise small animals, commonly goats. Native trees and vegetation provide firewood, fodder for animals, and fruits (like *umbu* and nuts like cashew) are part of nutritional security. Since the herds rely on natural vegetation, food for animals is vulnerable to drought.

12. In general, small land size, poor soils, low precipitation, low market access, low access to credit and technical assistance, and low levels of farmer organization characterize family farmers. Some attribute low participation in associations to a lack of incentives to associate and a history of patronage arrangements that small farmers depend on to receive emergency relief supplies in times of drought. Cash transfers from social assistance programs provide a significant proportion of family income and allow food to be purchased outside the household.

Agricultural Risk Profile and Risk Management Options (solutions)

Agricultural risks and constraints

13. Drought is a recurrent event in the Northeast of Brazil and has strong negative impact on household livelihoods as it represents a challenge to food security crops such as maize and beans and may cause important losses of livestock. It should be noted that the social impact of drought is especially aggravated by the fact that family farmers represent more than 90% of the farmers in Paraiba and water availability (including irrigation) is poor.

[37] Family farming (*agricultura familiar*) is formally defined in Brazil in terms of area, management, labor, and income. The farm must be managed by the family, and the family must rely on agriculture as their principal source of income. Definition of *agricultura familiar* from Law No. 11326.

14. One of the first records of drought in Northeast Brazil happened in the XVIII century, between the years of 1777 and 1779. It is estimated that more than 500,000 people died and mortality rate of animals reached 80% (Campos e Studart, 1997). In the subsequent century, *the Great Drought* took place from 1877 to 1879, followed by other droughts in 1897, 1898, 1915, 1931 through 1932, 1951 through 1953, 1992 through 1995 and 2012 through 2013. The 2012/13 drought is considered the worst drought in the last fifty years (Miranda, 2013). One hundred and seventy municipalities decreed calamity situation during the 2012 drought (almost 80% of the total number of municipalities), and 2.6 million people were affected.

15. Severe droughts should be differentiated from the dry season in the Semi-arid, which is not a risk, but rather a constraint[38] to agriculture development given its predictability. In addition, erratic rainfall (high precipitation followed by a long period of drought) is frequent but of moderate or low impact.

16. The damaging impact of pests and diseases is significant when they are not properly mitigated. They have been particularly devastating when new pests/diseases arrived and the State's support services were not prepared to respond adequately (e.g. cotton boll weevil). Family farming crops in the Semi-arid (cassava, beans, maize) are susceptible to attacks by caterpillars or diseases. However, farmers prefer not to use purchased inputs nor make investments on their crops with the exception of some infesting weed control. Their rationale is "*why invest on fertilizers, improved seeds or pest control if the risk to lose the harvest because of lack of rainfall is so high*".

17. Currently, family farmers usually cultivate a type of cactus called *palma forrageira* as feed for goats and sheep and even bovines, fundamental to feed the animals during hydric stresses. A pest called cochonilha-do-carmim (Dactylopius opuntiae) is a serious threat for achieving higher biomass production and a risk to family agriculture subsistence.

18. A phytosanitary risk with high social, environmental, agronomic and economic impact arises from the use of pesticides without the necessary technical knowledge and skill, which are applied at high rates not in accordance with technical recommendations. The result is that farmers may face increased production costs, ineffective pest control and human and environmental hazards as well as fruit contamination with pesticides residues, representing a risk for the consumer health.

19. Finally, the inter-annual price variations of fruits, mostly pineapple and banana, are also a serious risk for family farmers. The volatility largely responds to changes in production and traded volumes, which is in turn connected to the lack of supply chain coordination, farmer organization and

[38] Constraints are certain conditions that result in sub-optimal performance. For instance, low production yields are a constraint to development and the cause is lack of access to inputs, poor technology, etc. A constraint ignores the volatility in an outcome. There are also trends. Trends are longer term patterns, e.g. declining production yields are the result of structural changes in agriculture, changes in climatic patterns, etc. Risk, in turn, is defined as the possibility that an event will occur that will potentially have a negative impact on the farm and/or the supply chain. Understanding the linkages between these 3 concepts is key for planning and action. The presence of risk often constitutes a constraint, or aggravates an existing one. Therefore, risks and constraints are intrinsically interrelated.

poor production and marketing planning. For family farmers with an important portion of self-subsistence agriculture and limited but essential commercial farming, the low value and unpredictability of their markets is not only a risk but also a restriction for development.

ARM options (solutions)

20. As explained above, Paraiba has a small commercial agricultural sector and a widespread small scale semi-arid rural population that includes extensive subsistence family farmer groups. The risk profile is different with respect to the different types of producers, though drought and unmanaged pests and diseases are a common risk across the State.

21. Drought is the main risk for family farmers in the semi-arid. Small scale commercial farmers are exposed to great market vulnerability, like the fruit producers, sugar cane outgrowers, *usinas* and sugar cane estates suffer from changing policy environment. Larger farmers and *usinas* usually have resources, available tools, and know how to manage other risks.

22. Commercial farmers tend to utilize drought tolerant varieties and variable crop cycles, control pests and diseases and are connected to relatively high value markets. However, only a minority of family farmers adopts mitigation practices like pest control or resistant varieties. Appropriate agriculture risk mitigation technologies are not easily available to family farmers due to: (i) deficiencies in the provision of technical assistance services and (ii) poor supply chain coordination. These factors also prevent family farmers from accessing higher market prices and financial resources for on-farm investments.

23. Such a productive and economic dichotomy makes the ARM strategy necessarily complex and involving a variety of actions of different nature. Given the impacts of realized risks in the past (see Volume 1: Risk Assessment), it can be inferred that there is room for cost-effective risk reduction by investing in programs to mitigate, transfer and cope with agriculture risks. The State of Paraiba could reduce sector losses substantially.

24. As it was identified in the first phase (Volume 1: Risk Assessment), improved ARM should involve a comprehensive approach that tackles problems affecting all supply chains, including, at State level, the availability of better agroclimatic information systems, solid and trusted sanitary and phytosanitary systems and upgraded technological and market support services. At the Federal level it would be expected to have more stable and neutral sugar and alcohol policies, but this discussion goes beyond the scope of this assessment.

25. Family farming is the most vulnerable segment in the sector and currently there are not many ARM options (solutions) available for them outside the regular Federal Government support programs. Thus, many of the proposals below regard institutional capacity building at State level and are to a great extent directed to improving the agronomical and marketing risk management capabilities of family farmers. These measures will also have a positive impact on family farmer food security, and consequently poverty reduction.

Current Institutional ARM Programs and Policies

26. There are a number of State and Federal programs and policies that in one way or another impact the management of agricultural risks. In the past, as back as the XIX century, several measures were taken. For instance: construction of weirs; dams and aqueducts; river transposing; and construction of wells (Miranda, 2013). But they have not been sufficient to mitigate the impact of severe drought. More recently, the Cooperar Project has financed investments in water reservoirs/tanks, Complete Water Supply Systems (*Sistemas de Abastecimento de Água Completo* - ADC), and Single Water Supply Systems (*Sistemas de Abastecimento de Água Singelos* - ADS), which basically consist in drilling wells to store water in public reservoirs that will supply residences (for the ADC) or public distribution systems (ADS systems). In total, 8,180 families benefited from the program (*Projeto Cooperar*, 2014).

27. More specifically, in regards to weather related agriculture risks, Annex 4 provides a detailed description of the current programs and policies. The following are the most relevant initiatives:

- The Agricultural Climate Risk Zoning (ZARC) of Ministry of Agriculture, Livestock and Supply (*Ministerio da Agricultura, Pecuaria e Abstecimento* - MAPA), which aims to minimize the risk related to weather phenomena, and allows identification of the best planting dates in selected municipalities considering different types of soil and crop cycles.
- The Agriculture and Livestock Activity Guarantee Program (*Programa de Garantia da Atividade Agropecuária* - PROAGRO), which is a public insurance operated by financial institutions. It aims to compensate the rural producer for the occurrence of adverse weather phenomena, plagues and diseases afflicting crops and livestock.
- The Agriculture and Livestock Activity Guarantee Program for Family Farmers (*Programa de Garantia da Atividade Agropecuária da Agricultura Familiar* - PROAGRO MAIS) aiming to compensate the Family Farmers for the occurrence of adverse natural phenomena, plagues and diseases. The difference between PROAGRO and the PROAGRO MAIS is the target public: the PROAGRO MAIS focuses solely on family farmers and the traditional PROAGRO aims remaining farmers.
- The Rural Insurance Premium Subsidy Program (*Programa de Subvenção ao Prêmio do Seguro Rural* - PSR), through which insurance companies accredited by MAPA are allowed to operate a subsidy. In general, the program consists of establishing percentages of subventions for each modality of insurance and crops.
- The Garantia Safra Program (GS), operated by the Ministry of Agrarian Development (*Ministério do Desenvolvimento Agrário* – MDA) since 2002. It aims to guarantee minimum conditions of survival of the rural family farmers that are affected systematically by drought or excess rainfall. The family farmers may receive a benefit on the occurrence of drought or excess rainfall, which causes at least 50% of loss on productions of beans, corn, rice, cassava or cotton crops.
- The program Drought Grant (*Bolsa Estiagem* - BE), managed by the Ministry of National Integration (*Ministério da Integração Nacional* – MI), MDA and the Ministry of Social

Development and Fight Against Hunger (*Ministério do Desenvolvimento Social e Combate à Fome* – MDS). This program aims to support families of agricultural workers which have monthly income equivalent to at most two minimum wages and are located in municipalities that are considered to have suffered a disaster or emergency situation recognized by Federal Government.

- The Brazilian Company for Agriculture and Livestock Research (*Empresa Brasileira de Pesquisa Agropecuária* – EMBRAPA) developed an Agrometeorological Monitoring System (*Sistema de Monitoramento Agrometeorológico* - AGRITEMPO), which allows access to meteorological and agrometeorological information for all the Brazilian territory on an aggregated level. Since 2002, the available products are drought maps, water available in soil, rainfall, agricultural drought areas, necessity of reposition by rainfall and accumulated rainfall.
- The National Institute for Space Research (*Instituto Nacional de Pesquisas Espaciais* - INPE/CPTEC) supplies weather monitoring information regarding drought, frost, soil moisture and weather forecast for all Brazilian territory with applicability to agriculture and livestock.
- The World Bank, MI, ANA and state institutions are conducting a technical assistance program named *Preparation for Drought and Resilience to Weather Changes* in response to the long lasting droughts in 2012 and 2013. The goal is to define specific instruments for drought management in a proactive manner, and is based on the concept of risk for the entire Northeastern region.

28. There are several permanent and transitory programs undertaken by the Sanitary and Phytosanitary Program of SEDAP, which are quite the same for all Brazilian states. Among the permanent programs are: the traffic control and the surveillance of animals, plants and its products; pesticide market and use control; and slaughterhouses inspection.

29. As for the transitory programs, follows a list for animal and plant health programs. Animal health programs:

- PNEFA - National Program for Control, Prevention and Eradication of Foot and Mouth Disease;
- PNCEBT - National Program for Control and Eradication of Brucellosis and Tuberculosis;
- PNSA - National Program for Avian Health;
- PNCRH -National Program for Rabies Control and other Encephalopathies;
- PNSE - National Health Equidae Program;
- PNESA - National Sanitary Education Program;
- PNSSO -National Program of Goats and Sheep Health;
- PNSS - National Program of Swine Health;
- PNSAA - National Program of Health of Aquatic Animals;
- PNSAp -National Program of Health Bee.

30. The plant protection programs include:

- Surveillance and maintenance of free area for A2 quarantine pests of citrus (HLB, *pinta preta* and *cancro cítrico*), bananas (*sigatoka negra* and *moko*), grape (*cancro da videira*) and sugarcane (*ferrugem laranja*). The main tasks conducted in this program is the control of the transit of plants and parts of plants, which can host the causal agents of the mentioned diseases. A wider approach could be adopted by involving all the stakeholders, training personnel and establish a protocol for active surveillance, aiming at early detection of any eventual introduction of the pests.
- Monitoring and sanitary control of A2 quarantine pests of *palma forrageira* (*cochonilha do carmim*) and citrus (*mosca negra*). As for the first pest there is an active program in place for substituting the presently used palma varieties by resistant ones. The program is technically solid, and should be scaled up in order to completely substitute the genetic material grown in Paraiba. Regarding the *mosca negra*, the major action is the transit control of host plants, in order to avoid its dissemination. Appropriate control of the pest by growers is the recommended technique in this situation.

31. Concerning food procurement and price volatility, there are a series of Federal food procurement and minimum crop price policies and programs. They are the Policy for Mininum Price Guarantee (*Politica de Garantia de Preços Minimos* - PGPM), which is concerned with commercial agriculture, and the National Program for Acquisition of Food from Family Farmers (Programa de Aquisição de Alimentos - PAA) that specifically targets family farming. The Ministry of Agriculture (MAPA) is responsible for the former policy, and the latter program is the responsibility of the Ministry of Agrarian Development (MDA). The Federal Government, States and Municipalities implement PAA. The National Supply Company (Companhia Nacional de Abastecimento - CONAB) also participates in the implementation of PGPM.

32. Finally, there are a number of State programs and projects of research and technical assistance (with the exemption of the National Institute for the Semi-Arid - *Instituto Nacional do Semi-Árido*, INSA) that provide support to small scale farmers and to family agriculture farmers in particular. However, they are insufficient, both in quantity and quality, to assure optimum risk mitigation practices and technology. They are (see Annex 5 with information on the objectives, activities and other key :

- INSA projects. INSA is a Federal institution belonging to the Ministry of Science, Technology, and Innovation.
- Paraiba Sustainable Rural Development Project (Cooperar). World Bank financed project under preparation. It aims at reducing household vulnerability and improving smallholder access to markets in Paraiba's rural areas.
- Cariri and Seridó Sustainable Development Project (PROCASE). SEDAP-IFAD. It is a local capacity building project that aims at improving smallholder production and market competitiveness and promoting farming practices resilience/adaptive to drought.

- The Paraiba State Company for Agriculture and Livestock Research (*Empresa Estadual de Pesquisa Agropecuária da Pariaba* - EMEPA-PB) projects. EMEPA has nine experimental agricultural research stations throughout the State.
- EMEPA small demonstrative projects:
    - Beekeeping as a tool for improving the quality of life for small rural farmers in the semi-arid of Paraiba;
    - Multiplication and distribution of animal and plant germplasm, seeking to increase family agriculture dairy production of the Piancó Valley;
    - Production and distribution of free-range hens for diversifying farmer families´ sources of income and labor;
    - Program for strengthening family farmers´ goat and sheep breeding;
    - Multinutrient blocks: alternative nutritional strategy for herds during drought periods;
    - Use of solar energy in the sustainable production of irrigated fruits and vegetables;
    - Production and distribution of sorghum seeds to family farmers in the semi-arid;
    - Production and distribution of seedlings for domestic fruit tree plantations in family farmer settlements;
    - Production and distribution of citrus seedlings to family farmers;
    - Programa Palma Resistente.
- EMATER projects. EMATER provides extension services, registration of family farmers, support for access to family farming public policies and services, support for commercialization, food and nutritional security, assessment of losses to calibrate Garantia Safra.
- Sertão Emprendedor (Rural Learning National Service / *Servico Nacional de Aprendizagem Rural* - SENAR, Brazilian Micro and Small Business Support Service / *Serviço Brasileiro de Apoio às Micro e Pequenas Empresas* - SEBRAE). Support for projects of water conservation and, production and conservation of animal forage.

CHAPTER 3: PROPOSED ARM STRATEGY

33. This Chapter presents the ARM strategy proposal based on the existing risk management framework and the identified gaps. It takes into account the main risks identified during the first phase (Voume 1: Risk Assessment) and comprises actions regarding the agroclimatic information system, the sanitary and phytosanitary system, the fruit supply chain coordination and the agricultural innovation system. The detailed justification for the inclusion of these four ARM areas is contained in Volume 1: Risk Assessment.

Agroclimatic Risk Information System (ACIS)

Need for Improved ACIS

34. In order to develop good and integrated drought management policies it is necessary to have a proper database of agrometeorological information, that is, information related to agricultural related topics (i.e. phenology, vulnerability, technical production packages, etc) and data gathered on time and efficiently stored from automatic and/or conventional weather stations that are properly spread out throughout the State.

35. The current weather information system has a relatively low density of agrometeorological stations[39] and deficiencies regarding data collection and debugging. Most of the stations in operation are conventional pluviometric stations where data collection is non-automatic, which can result in measurement failures. Another important point is the low maintenance of existing stations, which may result in malfunction and even the interruption in data collection because of some kind equipment damage.

36. In addition to the technical deficiencies, there is the issue of articulation between state and federal institutions, and between them and the public sector and universities. Furthermore, at operational level there is no communication between the federal stations and AESA's stations. For instance, AESA shares data with the National Water Agency (*Agência Nacional de Águas* – ANA) but this data is not validated before the sharing, which incurs in poor quality information in ANA's database. Moreover, AESA has reduced personnel and office space over the years. There is an urgent need to strengthen AESA's institutional capacity as the responsible institution for meteorological monitoring in the state.

37. The first step is to create an integrated systematic weather database for use by policymakers in the construction of risk management tools. This system should optimize all resources available at both

[39] Compared to other states in Brazil, the density of the stations in Paraiba is relatively low. Taking into account only the automatic stations, AESA owns only 10 stations, that is, approximately 1 station in 5,600 km^2. When all the types of stations are considered (hydrometeorological, automatic, meteorological automatic, conventional meteorological, automatic pluviometer, conventional pluviometer and others) there are 292 stations, with up to 21 years of data available, which increases the density to 1 station in 194 km^2, on average (Banco Mundial, 2014). Out of this total, the majority of the stations are conventional pluviometers, working on manual basis (manual information collection).

federal and state government levels. There are several institutions who could jointly implement this system. These institutions include, among others:

- Water and Sewer Company of Paraiba (CAGEPA);
- National Monitoring Center and Natural Disaster Alerts (CEMADEN);
- Executive Agency of Water Management of Paraiba (AESA);
- National Institute of Meteorology (INMET);
- National Water Agency (ANA);
- National Institute for Space Research (INPE/CPTEC);
- Brazilian Company for Agriculture and Livestock Research (EMBRAPA);
- Brazilian Institute of Geography and Statistics (IBGE);
- Semiarid National Institute (INSA);
- The Secretariat for Agriculture, Livestock and Aquiculture Development of Paraiba (SEDAP);
- Municipalities and the extension workers of the State Company for Technical Assistance and Rural Extension (EMATER-PB);
- Company of Agricultural Research of Paraiba.

38. The density of the stations should be increased. In order to overcome this problem, AESA is submitting a project proposal to the World Bank which includes the purchase of around 20 automatic agro-meteorological stations. The acquisition of these instruments will ensure speed and quality of data collection. In addition, AESA needs to be strengthened with trained personnel in order to guarantee the operation of a database management system that processes and storaes high quality data and information.

39. Furthermore, a committee for the coordination of drought mitigation should be consolidated. The main objective of the committee would be to improve synergy and integration of efforts, inter and intra-institutional, in order to increase the efficiency of drought mitigation public policies and shift its main focus from reactive activities to emergency preparedness. The committee should consolidate and disseminate information concerning the implementation of the risk management policies and encourage the elaboration of technical reports to support the public decision makers. The drought committee could be part of the State Secretariat for Planning and Management (*Secretaria de Estado de Planejamento e Gestão* - SEPLAG).

40. The development of the agro-climatic risk information system is fundamental for proper operations of programs such as *Garantia Safra* and PROAGRO MAIS. Both programs rely on weather information to operate. Further to the database improvements, *Garantia Safra* in Paraiba requires strengthening of extensionist drought assessment skills. The methodologies adopted to evaluate the drought losses are not standardized. Moral hazard issues may arise because of the aforementioned limitations.

Main elements of the ACIS

41. The strategy would comprise the following elements:

42. Development of Agroclimatic Risk Information System in the State of Paraiba. The Executive Agency of Water Management of Paraiba (AESA) manages the actual set of weather stations but there are some difficulties to overcome, including expanding the monitoring coverage. Technical and institutional issues should be taken into account in order to improve the existing infrastructure and operation. The short term suggestion would be to develop an agro-climatic information system that should integrate other databases such as the INMET, CPTEC and ANA databases, with the purpose of improving data quality by standardizing the computational, agrometeorological and statistical procedures.

43. Another important issue is to strengthen the operational capacity of AESA by increasing the number of specialists in its staff. The hiring of personnel by AESA would be important to guarantee the correct execution of the aforementioned procedures and reduce errors in data collection and generation of useful information to a minimum level.

44. The system would comprise the following products and information: agro-climatic bulletins, maps and tables of precipitation, accumulated precipitation, drought, water availability in the soil, weather forecast. The direct benefits to farmers and agents in the state agribusiness would concentrate in the updated information regarding the weather and its impact on agriculture. The decision making process would be more efficient and based on a reliable agro-climatic system.

45. The plan of action in the next chapter contains the specific actions for implementing this strategy.

46. Strengthening the Drought Management Committee. One of the main beneficiaries of the development of an ACIS would be the state drought committee. ACIS would support the members of the committee to create risk management tools and elaborate efficient public policies into more proactive and less reactive actions. The drought committee could be composed by the State Secretaries and the top leaders of government institutions in areas linked to the drought risk management policies.

47. Training of EMATER-PB extensionists on drought impact assessment. EMATER-PB's extensionists are responsible for the enrollment of family farmers in the *Garantia Safra* program and, also act as a claim adjuster to verify the losses in the affected municipalities when drought occurs. About 87% of the inspection reports are carried out by the EMATER´s extension workers.

48. The Paraiba State Company for Technical Assistance and Rural Extension, EMATER-PB, has faced financial and operational difficulties (see AIS discussion below) and its field personnel is not completely able to properly assess the drought impact for *Garantia Safra* when required.

49. This step demands improved training (claim adjustment). Taking this fact into account the recommendation is to develop a short term technical courses for the extension workers. The courses

would be focused on operational, agronomic, climatic and geotechnological aspects of the *Garantia Safra* program. Extensionist training can be supported by State universities and experts from research and education institutions[40].

Sanitary and Phytosanitary Systems

50. Poorly managed pests and diseases are important risks for all agriculture supply chains considered during the assessment. However, the nature and extent of their impact varies significantly from one supply chain to another. Annex 6 provides detailed background information. Animal sanitary quarantine risks are relatively minor in Paraiba but there are still a few issues that require improvement.

Phytosanitary Issues

51. There are two agricultural sanitary bodies in Paraiba, SEDAP and MAPA. Operational actions directly conducted by MAPA are limited, as its attributions are normally focused on interstate and international markets. The program run by SEDAP faces several structural limitations to comply with the diversity of challenges on both plant and animal health. Among these, the following are noteworthy: budgetary, personnel, transport, laboratory and infrastructure constraints. As regards personnel, the problem is not only the reduced number but also the poor training of the professionals. In turn, coordination with the federal body (MAPA) is present and fluid. As regards state official partners like EMEPA and EMATER there is a need for more integration and coordination as is the case with the private sector, in order to reach more efficient results out of the single actors' programs.

52. Studies and negotiations have been set up to create an autonomous State Agency with the mission of protecting the agriculture and livestock of Paraiba from sanitary risks, as well as safeguarding the environment and public health. This Agency should have normative and operational functions and would run not only structural activities (quarantine, surveillance, sanitary education, traffic control, pesticide inspection), but also the transitory programs like targeted pest eradication. It is strongly recommended that the studies and negotiations be speeded up in order to solve present institutional and organizational problems, like autonomy, budget and personnel.

53. The State Board for Agriculture Defense (*Conselho Estadual de Defesa Agropecuária* - CEDA) is an advisory body to SEDAP on agricultural health issues, and it is composed by representatives of government institutions and of the private sector. According to reports from the State Secretary and officials of the Agricultural Health Program of SEDAP, the CEDA is not acting according to the conceptualization that supported its creation, and should be reoriented to effectively discuss and give advice on priorities, programs and operational actions. The creation of the State Agency would be an

[40] The following universities have capacity to participate in the training program: the Federal University of Paraiba (UFPB), the State University of Paraiba (UEPB) and the Federal University of Campina Grande (UFCG), counting on the support of the State Secretariat for Agriculture, Livestock and Aquiculture Development (SEDAP), municipalities and EMATER-PB, besides the universities from other states such as the University of São Paulo (USP/ESALQ), and Federal University of Viçosa (UFV), the Federal University of Lavras (UFLA), and EMBRAP A.

excellent opportunity for an overall discussion on the role of each stakeholder, including the composition, attributions and operationalization of the CEDA.

54. It is also strongly recommended to develop deeper integration of SEDAP (and the future Agency) with the private sector, both to implement cooperative programs and to support producer initiatives. In the case of substitution of chemical control, there are several opportunities, like supporting present capacity expansion of the of Sugar Cane Growers Association of Paraiba (*Associação de Plantadores Cana da Paraíba* – ASPLAN) to produce biological control agents for the sugarcane plantations. Another opportunity is the expansion of the substitution of *palma forrageira* varieties presently grown for resistant ones, where cooperatives, associations and other producer or civil organizations can contribute in order to reach more ambitious targets in reduced time.

55. Active phytosanitary surveillance can also be designed to include the private sector, in particular farmers, especially regarding exotic pests. This action should be concatenated with sanitary education programs, to enhance consciousness of the risk of new pests, and with training to better monitor and early identify new pests. This would increase the probability of success in focused sanitation and pest eradication.

Animal Sanitary Issues

56. Animal health in the state of Paraiba can be ranked as relatively good. Meanwhile, some shortcomings and improvements can be mentioned, regarding animal feeding, quarantine and other diseases as well as institutional issues. The details are contained in the Volume 1: Risk Assessment and the proposals are made in the following section.

Sanitary and Phytosanitary Risk Management Strategy

57. The focus of the phytosanitary and sanitary risk management strategy is to avoid or delay the occurrence of the risk event and manage the impact in the event of occurance. In particular avoiding or at least delaying the appearance of exotic pests and animal diseases. The major actions are sanitary education, surveillance, transit control and eradication. Detailed actions recommended for each one of the supply chain categories follow:

Sugarcane

a) Expand the production of biological control agents to supply the autonomous cane growers' potential demand.

58. Scope: To control the *broca do caule* and *cigarrinhas da cana* with biological control agents, reducing the damage to the crop, production costs and negative environmental impacts.

59. Beneficiaries: Autonomous sugarcane growers.

60. Institutional framework: ASPLAN presently operates a commercial scale laboratory for producing biological control agents, but its capacity is restricted and roughly meets 30-40% of the

potential demand from the growers. The expertise is available in the laboratory but physical expansion is needed.

61. Connection with national policies: There is strong incentive and support from MAPA to implement Integrated Pest Management Programs, which includes the use of biological control agents.

62. Potential benefit: For each 1% infestation of the *broca da cana*, there is a reduction of 0.77% of the weight of raw cane, 0.25% in sugar yield (35 kg / ha) and 0.20% in alcohol yield (30 L / ha), according to Gallo et al., 2002. For biological control, wasps (Cotesia Flavipes) are released in the cane fields at an average of 6,000 adults / ha / year (Biocontrol, no date). In addition to positive environmental impact, biological pest control has economic advantages. The price per hectare of applying insecticides averages R$ 42.00, while the biological control with Cotesia Flavipes, this cost is approximately R$16.00 (Usina Jalles Machado, no date).

63. The losses attributed to the leafhoppers are due to the extraction of sap in the leaves and roots of sugarcane by adults and nymphs, respectively, and the injection of toxins by adults during the suction process. The attack of this pest can result in losses in crop yield ranging from 15% to 80%, reduction of the quality of the raw material with reductions of up to 30% sugar content. In addition, there may be contamination problems in the manufacturing process due to sugarcane deterioration in the field (Claudimir Penatti, Socicana, 2006). Biological control of leafhoppers with the fungus Metarhizium Anisopliae is made using ca. 500 grams of pure conidia or the equivalent of 2-10kg of commercial product per hectare. The cost of biological control can reach up to R$ 40.00 per hectare (Terezinha Monteiro dos Santos Cividanes, personal information41), which is normally equivalent to 10% of chemical control cost (Batista Filho, 2002).

64. Actions planned for the short and medium term are as follows. In order to determine the feasibility of expanding the present ASPLAN facilities for the production of biological control agents, it is proposed to: determine the present demand of biological control agents and forecast the demand for the next 10 years; identify the investments and recurrent resources needed for the expansion of present laboratory facilities, in order to supply potential demand; establish the unitary costs (per hectare) of biological control according to the projections of the expanded facilities, compared to present technology (chemical control); organize a workshop and complementary actions, with interested stakeholders, to discuss the expansion of the biological control agents; decide the next steps, including providing the necessary funds, final expansion projects and chronogram.

b) Establish the risk and the impacts of the possible introduction of ferrugem laranja in the state of Paraíba.

65. Scope: Inform the Government, sanitary institutions, associations, private sector, growers and other stakeholders of the negative impacts of the possible introduction of *ferrugem laranja*.

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66. Beneficiaries: Government, growers, sugarcane processors, sugar exporters, alcohol distributors.

67. Institutional framework: SEDAP has the institutional and organizational conditions to perform this action.

68. Connection with national policies: There is a permanent quarantine service at federal level to avoid or minimize the risks of the introduction of exotic pests, along with surveillance and quarantine pest control services.

69. Potential benefit: Based on the study of Zuza & Borsato (2011), losses in TAH (tons of total reducible sugars per hectare) on sugarcane fields attacked by the *ferrugem laranja* were estimated at 18.82% (-2.19 TAH) for the second cut, 41.02% (-4.85 TAH) for third cut and 33.06% (-3.62 TAH) to the fourth section, an overall average of 30.97%. Economic losses at field level were calculated to be R$94.69 per hectare. There are no fungicides which might avoid its damages and losses registered in Brazil (control of this disease).

70. Actions planned for the short and medium term: Carry out a study to establish impacts (agronomic, sanitary, economic, social, environmental and trade-related) in the case of *ferrugem laranja* introduction in the state of Paraíba.

c) Set up a task force and a voluntary monitoring network to minimize the risk of introduction of the ferrugem laranja.

71. Scope: To protect the State against the introduction of the *ferrugem laranja* and be prepared for its eventual introduction.

72. Beneficiaries: Government, growers, sugarcane processors, sugar exporters, alcohol distributors

73. Institutional framework: SEDAP has the institutional and organizational conditions to perform this action.

74. Connection with national policies: There is a permanent quarantine service at federal level to avoid or minimize the risks of the introduction of exotic pests, along with surveillance and quarantine pest control services.

75. Potential benefits: There are two major benefits. First of all, if the stakeholders are fully organized, focusing on minimizing the risk of introduction, all risky anthropic actions will be avoided or adequately performed. Secondly, just in case of an eventual introduction, there is a large probability of early detection, a key factor for the success of eradication measures.

76. Actions planned for the short and medium term: identify all stakeholders, especially technical assistance professionals, growers and its associations, cane processors, transporters among others; prepare a surveillance plan and a long list of risky actions that might facilitate pest introduction, and the correct procedures for each one of these actions; organize a workshop with the major stakeholders and

smaller meetings in sugarcane production regions, to implement the plans; set up an information services.

Fruticulture

a) Establish the risks and be aware of the impact of the possible introduction of the diseases sigatoka negra and moko (bananas), cancro da videira and HLB (Citrus).

77. Scope: Inform the Government, sanitary institutions, associations, private sector, growers and other stakeholders of the negative impacts of the introduction of these diseases in Paraíba.

78. Beneficiaries: Government, growers, processors and consumers.

79. Institutional framework: SEDAP has the institutional and organizational conditions to perform this action.

80. Connection with national policies: There is a permanent quarantine service at federal level to avoid or minimize the risk of exotic pests introduction, along with surveillance and quarantine pest control services.

81. Potential benefits and losses: Minimizing the risk of pest entry will avoid the losses caused by the diseases, as follow: *Sigatoka negra* is a disease with a potential to completely destroy banana plantations. Fungicide control of the pest is quite expensive and places negative hazards or impacts upon the environment and public health; *Moko* is a disease caused by a bacteria attacking the whole plants. Losses can reach up to 100% of the fruits; *Cancro da videira* is a bacterial disease which reduces both the production and commercial quality of grapes; HLB is recongnized as the most destructive disease affecting citrus. There is no curative control for the affected plants (which must be eradicated).

82. Actions planned for the short and medium term: carry out a study to determine the risk of an eventual introduction of the diseases *sigatoka negra* and *moko* (bananas), *cancro da videira* and HLB (Citrus) and the impacts (agronomic, sanitary, economic, social, environmental and trade-related) of this occurrence.

Family Agriculture in the Semiarid

a) Strengthen and improve the program aiming to substitute the older palma forrageira varieties for the varieties resistant to the cochonilha do carmim, in order to increase the availability of food and water for the goats or bovine herds during the drought season.

83. Scope: Avoid the yield reduction of palma forrageira due to the attack of the cochonilha do carmim throughout the semiarid zone.

84. Beneficiaries: Government, rural households in the Semiarid.

85. Institutional framework: Presently, there is a program to substitute the varieties of *palma forrageira*, susceptible to the *cochonilha do carmim*, by resistant ones, developed by EMEPA. The

institutions involved in this program (SEDAP, EMEPA and EMATER) have the conditions to elaborate a study to enhance the program and implement it on a more ambitious basis.

86. Connection with national policies: There are several federal policies targeting the improvement of the production systems on the semi-arid zone (see under Current Institutional ARM Programs and Policies above).

87. Potential benefits and losses: During the drought season, herds are adversely affected by the shortage of fodder and water, reducing their weight, meat quality, sometimes leading to death or imposing unplanned selling of the animals to avoid even larger losses. Availability of staple fodder like *palma forrageira*, which also is an important source of water for the animals, will substantially reduce the animal losses, enhancing the households' income.

88. Actions planned for the short and medium term: determine the need of *raquetes* (*palma forrageira* basic propagation material) needed to completely substitute the presently grown varieties, susceptible to the *cochonilha do carmim*, by resistant ones; establish a chronogram and the resources to be allocated for the production and distribution of *raquetes*.

Livestock Production Chains

a) Reinforce the program for control and eradication of brucellosis and tuberculosis.

89. Scope: Reduce economic losses, and, health and social impacts of these diseases throughout the State.

90. Beneficiaries: Growers, consumers and the entire society.

91. Institutional framework: There is a program for eradication of livestock diseases in Paraiba run by the State Government, in close coordination with the Federal Government and the private sector.

92. Connection with national policies: There is a national program aiming to the eradication of both brucellosis and tuberculosis, and state programs that are conducted under this framework.

93. Potential benefits and losses: According to Lilia Paulin[42], brucellosis[43] can cause a decrease in meat production by 10%-15% and expand the interval between pregnancies between 12 to 20 months. It also causes 30% increase in animal replacement rate, 15% drop in the birth of calves and decrease of 10%-24% in milk production. In addition, brucellosis can expose the product to sanitary barriers, which reduces the competitiveness in international trade. Similar consequences occur with tuberculosis, being the losses related to animal weight loss, delay in first lactation, reduced number of lactation, shorter

[42] Lília Paulin, scientific researcher at the Instituto Biológico, Centro de P&D de Sanidade Animal. paulin@biologico.sp.gov.br.

[43] The International Organization for Animal Health (OIE) classifies brucellosis as List B disease, meaning diseases that have socio-economic and / or public health importance and significant consequences in international trade in animals and animal products.

duration of lactation, economic losses by the sacrifice of positive reacting animals, barriers to national and international trade and the possibility of contamination and transmission to humans.

94. Actions planned for the short and medium term: evaluate the present implementation of the eradication programs, specially identifying its gaps and deficiencies; implement appropriate actions for enhancing the current programs, including operational actions, advertisement, sanitary education, training and capacitation of stakeholders, and continuous follow up and evaluation.

b) Strengthen the coordination of the animal health services and programs, including food safety programs, in order to rationalize the veterinary and public health protection services.

95. Scope: Reduce the cases of non-conformity of processed animal products for human consumption in the State of Paraiba.

96. Beneficiaries: Growers, processors, Government, consumers.

97. Institutional framework: There are several federal and state institutions involved in the inspection of animal slaughter and animal product processing, with some degree of overlapping and lack of coordination. There is need to involve the different actors (SEDAP, State Agency for Sanitary Surveillance - AGEVISA, CAISAN, veterinary services of the municipalities) under the leadership of the National Secretary for Agriculture and Livestock Health (*Secretaria Nacional de Defesa Agropecuária* - SDA/MAPA) represented by the local MAPA office.

98. Connection with national policies: There are national programs for inspection of slaughter houses and food processors, as indicated in the paragraph above.

99. Potential benefit: Reduced cases of non-conformity of animal products, reduced risk to the public health, reduced economic losses and market barriers. There are no available estimations of financial benefits that would derive from better animal health services coordination.

100. Actions planned for the short and medium term: Organize round tables involving animal slaughter and food processing inspection; develop, agree and approve a common program; develop coordination mechanisms; organize annual workshops for following up the implementation of the common program and coordination mechanisms.

c) Establish the actual status of Classical Swine Fever (CSF) and Newcastle Disease Virus (NCDV) in Paraiba and the measures to reach or maintain the pest free area status. as the last outbreak in the state was recorded in 2006.

101. Scope: Reduce the potential economic and trade related losses, and, the negative impact on public health.

102. Beneficiaries: Farmers, processors, consumers, Government.

103. Institutional framework: SEDAP is responsible for the official veterinary services in Paraiba, including surveillance, eradication of animal diseases and to reach and maintain the disease free area of the State.

104. Connection with national policies: There are national programs to eradicate, reach and maintain CSF and NCDV free areas in Brazil, to which the state programs are subordinated.

105. Potential benefits and losses: Reduced cases of non-conformity of animal products, reduced risk to public health, reduced economic losses and market barriers.

106. Actions planned for the short and medium term: conduct epidemiological surveys regarding CSF and NCDV on the swine and poultry herds, respectively; take the appropriate actions according to the results of the surveys, in case of virus presence; submit official bid for certification of area free of CSF, NCDV or both.

d) Besides the exposed above, it is necessary to integrate EMEPA, universities and EMATER-PB to develop alternatives and promote the use of fodder species suitable for the semiarid areas, for extensive consumption and for silage. In addition, it is recommended to toughen the traffic control barriers and the surveillance systems to support the free area condition of Paraiba for Foot and Mouth Disease (FMD) and Highly Pathogenic Avian Influenza (HPAI).

Supply Chain Coordination

Market Risks and Opportunities

107. Pineapple and banana are among the fruits that are most largely produced and traded in Paraiba. Both are produced mostly for export outside the State. The inter-annual price variation is high and largely responds to the changes in production and traded volumes (see Volume 1: Risk Assessment). This price volatility, which is higher than the average volatility, results in production inefficiencies and limits the commercial development opportunities for individual farmers, mostly family farmers.

108. There is a close relation between production and trade volatility, the poor supply chain coordination and the limited access to adequate market information of most small scale fruit producing farmers. Moreover, the incipient farmer organization in Paraiba is a contributing factor to the poor supply chain coordination among the fruit producers in Paraiba.

109. Closer farm to market coordination and stronger farmer organization are the most evident ways to cope with this situation. There are positive market coordination experiences that can be replicated with the appropriate support. Among them it is worth to mention the pineapple producing and marketing cooperative at Santa Rita, illustrated in the Text Box 2.

Text Box 2. 2: Santa Rita Pinneapple Production Cooperative

This cooperative was born in 1999 due to the need of a group of small scale pineapple producers (43 now) to access a market that guarantees stable demand for their produce, proper price

discovery and contract enforcement. Up to the Cooperative creation, most of the prospective farmers sold their produce to local middlemen or to buyers in the consumer markets outside Paraiba. They used to face high price volatility and serious problems to enforce the contracts. By doing business with the *Bolsa de Hortifrutigranjeiros, Cereais e Produtos Agropecuários do Estado de Pernambuco* (BHCP) the now associated farmers had the opportunity to access an organized and transparent market. The prices are negotiated in a transparent manner and reflect the national and international markets. The BHCP also provides insurance on the products shipped, normally to Sao Paulo and other states in the central part of Brazil, and provides a legal framework to guarantee payment. The prices obtained are not always the highest in the region but there is a high degree of certainty about the business environment and, therefore, farmers have managed to make investments and plan for the medium and long term. The cooperative also receives permanent technical assistance from EMATER-PB, and that is possible because they are organized as a group. The members of the cooperative feel they are better off now and in a position to plan and undertake on farm investments.

110. The Local Productive Systems (*Arranjo Produtivo Local* - APL) approach has been encouraged in Brazil and, in particular, in Paraiba. It is another background type of business development experience to look at. APLs are a sort of cluster approach. APLs are regarded as articulations among supply chain actors for mobilizing resources (credit, technology), facilitate marketing and in general promote greater economic dynamism and less volatility.

111. For instance, the case of the citrus APL in Paraiba, the organizational structure is comprised of governmental and non-governmental organizations, private companies, farmers associations and a cooperative (Coopertange) which is the center of the APL. In the inner circle are the several farmers associations in the different municipalities that are part of Coopertange, in the second circle are the support infrastructure (EMATER, EMAPA, Universities, CONAB, banks, etc.), in the third circle are the companies providing inputs, transportation services, packing, machinery maintenance, etc. However, in spite of this well-structured organization there are no specific provisions for the market and marketing issues. In that regard, there is an opportunity for assessing the APLs in Paraiba and identifying possible areas of cooperation for improving the marketing components. In effect. APLs tend not to include a marketing component.

112. In addition, there are business opportunities arising from procurement and policy stabilization policies and programs managed by CONAB in Paraiba, specially PAA and National School Feeding Program (*Programa Nacional de Alimentação Escolar* – PNAE), that could be incentivized through appropriate technical assistance services and credit facilities.

113. Small farmers are particularly vulnerable to weak food markets and price volatility. The PAA aims to support family farmer production and their access to market through simplified public procurement procedures, and to distribute food in quantity, quality and regularity necessary to food-insecure groups. Fundamentally, the PAA directly addresses one of the central challenges in family farmer production: commercialization. Through State intervention it increases demand for smallholder

food production. The PAA is a potentially important factor in expanding production for families participating in the program as well as for strengthening the collective organizations.

114. PNAE, Brazil's school feeding program, is the other major source of structured demand for family farmers. Purchase from family farmers also aims at promoting local development and complements the income of family farmers. PNAE's procurement objectives, however, include both price and the quality of food and the seasonality of production at local level. Therefore, it offers a stable demand if the quantity, quality and continuity requirements are met.

115. Family agriculture farmers have the opportunity to organize themselves in associations to participate in the CONAB's procurement projects (PAA and PNAE). They provide primary products and add value to their primary products by introducing some processing and incorporating adjustments in the production process that improve the quality of the products. By doing so organized family agriculture farmers can access to CONAB procurement and financial facilities. As was expressed by CONAB' managers in Paraiba, there is unmet demand and enough budget resources to increase the buying programs. The opportunities include fruit processing, chicken abattoirs, milk and dairy, etc., in addition to obtaining quality certifications mostly for animal products.

116. After a while beneficiary farmers can also access commercial market segments that are currently outside their reach. In fact, CONAB's projects offer a fixed price and a procurement long timeframe that usually exceeds one year, in addition to financial resources, allowing for the groups to consolidate their organization and technical skills before attempting to access the open market. This production and marketing upgrade, however, requires strong technical assistance services. The discussion on the Agricultural Innovation System below is relevant.

117. Cooperar made instruments available for market development through its cooperation program. Cooperar participation in market development will be extensively expanded under the next phase (under preparation) and the following actions can complement the initiatives already being planned.

Market Strategy

118. The ARM strategy proposed comprises actions aimed at reducing excessive fruit price and sales volatility faced by family farmers, and, supporting them to take advantage of market opportunities provided by the federal and state policies and programs. Both actions require technical assistant services, availability of credit resources and market development support, involving EMATER-PB, Project Cooperar II and other development projects, the APL initiative, etc.

119. COOPERAR will support a competitive mechanism for supporting small-scale producers, including: identification of market opportunities, development of business plans in conjunction with public and private purchasers, co-financing of investments and technical assistance to producer organizations and capacity building of producer organizations.

120. The following are other recommended actions:

a) Make an inventory of farm to market experiences in Paraiba like the one involving pineapple producer in Santa Rita described above (Text Box 2.2).
b) Identify value adding activities for family farmer groups that can be developed as projects for CONAB's managed PAA or PNAE, carried out in cooperation between CONAB and SEDAP.
c) Investigate successful APL experiences in the State of Paraiba seeking to identify initiatives that require additional support to strengthen market coordination.
d) In cooperation with EMATER-PB, and within the framework of the Agriculture Innovation System explained in next section, develop a methodology to support family farmer organizations to develop business plans regarding activities such as fruit processing, packaging, chicken abattoirs, etc.
e) Assess different market development support options for family farming products, including establishing market space facilities in places like Campina Grande or Patos, as is being planned by the Paraiba State Company for Supply and Agriculture Services (*Empresa Paraibana de Abastecimento e Serviços Agrícolas* – EMPASA), channel public resources through Project Cooperar to transfer resources to farmer organizations for establishing and managing marketing infrastructure, etc.
f) Analyze the legal implications of the above proposal, in particular with respect to the possibility of transferring public funds to farmer organizations, and proposal elaboration regarding Cooperar.

Agricultural Innovation System (AIS)

Current Research and Extension Institutional Framework

121. There are several institutions (see list below) that generate technological innovations for the semi-arid region, both at state and regional level. From the analysis of the major programs and projects of these institutions and interviews with different stakeholders, the issue of a lack of inter-agency coordination arises. Many times, there is a repetition of research topics without the certainty that the tests carried out on the same topic in other research centers are taken into account.

122. The current coordination between the research and the extension agencies also seems to be insufficient; to enable producers to have better risk management, it is necessary to strengthen the coordination among the institutions in charge of technology generation, and between these and the ones in charge of technologic transfer to family farmers.

123. In regard to technical assistance, the several projects and programs that provide technical assistance to family farmers are unsystematic and limited in terms of geographic coverage and recipients. Currently family farmers who receive technical assistance are a minority, and their number is not expected to increase significantly in coming years. It was also verified that the coordination among technical assistance providers is limited, the same as occurs between the research and the extension agents.

124. The technical assistance services should be improved, both qualitatively and quantitatively. The quality of technical assistance refers both to the content of technological packages issued and to the methods and methodologies used to provide technical assistance. It also alludes to the coordination that must exist, not only among the group of institutions that provide technical assistance, but also with the other institutions that are a part of the agriculture innovation system in Paraiba (basically the previously mentioned research institutions).

125. The capacity of EMATER-PB to provide agricultural extension services is low and requires improvements. Bascially, the only transfer channel family farmers have is the public technical assistance service. EMATER-Paraiba currently assists 30% of Paraiba's family farmers (approximately 40-45,000 producers, out of a total of more than 148,000 family farmers), and is not ready to expand its coverage with its current technical staff.

126. On the other hand, there are other technical assistance providers in the State, mainly non-governmental organizations (NGOs). By way of example, the National Institute for Colonization and Agrarian Reform (*Instituto Nacional de Colonização e Reforma Agrária* – INCRA) hires private entities for the provision of technical assistance and extension services to the families living in their settlements (there are more than 300 settlements in Paraiba, with 14,500 families in total). SEDAP has also hired NGOs to develop some programs. COOPERAR is conducting a survey on potential technical assistance providers in the State, as well as to explore other non-public extension modalities.

127. According to several stakeholders, technical assistance provided by these NGOs is not good (some say the same of EMATER) and disagreements exist between EMATER-PB and NGOs. In any case, it is clear that the vast majority of family farmers will still depend on the efficiency of the technical assistance and agricultural extension public system.

128. Faced with the current limitations that hinder technical assistance universalization for the vast number of family farmers in Paraiba's Semi-arid, it is necessary to carry out a detailed analysis for understanding the technological requirements by the different types of farmers. It is necessary to define the most appropriate technological solutions for each group of farmers, to identify the percentage of them who can get involved in profitable agricultural activities, etc. It would be very inefficient to propose uniform solutions for such a heterogeneous rural population.

On the Need for a Working Agriculture Innovation System

129. According to the World Bank (2012), "an innovation system is defined as a network of organizations, enterprises and individuals focused on bringing new products, new processes and new forms of organization into social and economic use, together with the institutions and policies that affect their behavior and performance. It embraces science suppliers as well as the totality of actors and interactions involved in innovation. It extends beyond the creation of knowledge to encompass the factors affecting demand for and use of knowledge in new and useful ways."

130. An Agriculture Innovation System (AIS) does not exist as such in Paraiba, since the organizations that provide services are not structured as a network and they are not minimally coordinated. The system has to be created, but it is useful to refer to it as a consolidation of categories of analysis. The components of the System would be the institutions responsible for knowledge generation, i.e. research centers; the institutions responsible for transferring that knowledge to end-users, i.e. technical assistance and extension agencies; and those in charge of training producers.

131. In Paraiba, and with focus on family farming, the institutions involved in the agriculture innovation system would need to be: (i) on the research side, the EMEPA-PB, INSA, EMBRAPA-Semiárido, and to a lesser extent EMBRAPA-Algodão, EMBRAPA-Mandioca e Fruticultura and the Federal University of Paraíba in the Center of Agricultural Sciences (*Centro de Ciências Agrárias* - CCA/UFPB); and (ii) on the side of technical assistance, extension, and training of family farmers, the EMATER Paraíba, some NGOs, universities, private providers and externally funded projects, as *Cooperar* (World Bank) and *Procase* (IFAD). And regarding institutions not related to semiarid, ASPLAN (*Associação de Plantadores de Cana da Paraíba*) deserves to be mentioned; it carries out technical assistance activities for micro and small sugarcane planters who pertain to family farming.

Main Elements of the Agriculture Innovation System Related ARM Strategy

Improve coordination of the Agriculture Innovation System for family farming ARM

132. As mentioned above, there is need for a strategy focused on the improvement of the agriculture innovation system efficiency and coordination. It is absolutely necessary to establish and/or strengthen inter-agency coordination mechanisms, based on a state policy, clear priorities and the allocation of resources. This requires short and medium-term measures.

133. Currently, there is the State Board of Sustainable Rural Development (*Conselho Estadual de Desenvolvimento Rural Sustentável* - CEDRS), chaired by the Secretary of the SEDAP (*Secretaria Estadual de Desenvolvimento Agropecuário e da Pesca)*, and composed of representatives of the main public entities who support rural development and family agriculture, like the MDA, EMATER, INTERPA, SEDAP, Federal Economic Bank (*Caixa Econômica Federal* – CEF), Banco do Brazil, Banco do Nordeste, *Projeto Cooperar*, CONAB, INCRA and other Secretaries of State, as well as the institutions that represent farmers the most, such as the Agricultural Workers Federation (*Federação dos Trabalhadores na Agricultura* - FETAG), Agriculture and Livestock Federation of Paraiba (*Federação da Agricultura e Pecuária da Paraíba* – FAEPA), Paraíba Rural Producers Union, Landless Rural Workers Movement (*Movimento dos Trabalhadores Rurais Sem Terra* – MST), Articulation of Paraiba Semiarid (*Articulação do Semi-árido Paraibano* - ASA/PB, and NGOs from other segments of civil society. Given its current integration it is a deliberative and consultative body, with poor executive functions, but with the appropriate adjustments it could constitute the right agriculture innovation system coordination framework.

134. In order to better focus the actions of CEDRS in the agriculture innovation system, it would be necessary to create a sub-council or a similar organ that can bring together the institutions that are part

of the agriculture innovation system in a coordinated way. At present, an internal committee was created to propose amendments to the CEDRS regulations in order to become more executive. This could be a good opportunity to make detailed proposals on the agriculture innovation system sub-council integration, definition of roles and interrelations, establishment of procedural rules and to appoint an Executive Secretary. With this general framework in place, it would be possible to formally create the Paraiba Agricultural Innovation System.

135. In addition, it will be necessary to implement measures for the internal coordination of the two sub-systems: one in charge of research, and the other one in charge of technical assistance and agricultural extension. The research sub-system will consist of state and regional institutions. Among the state institutions, the most relevant is EMEPA-PB, which has been strengthened in recent years after undergoing a weakening period. It currently works on adaptive research and technology related solutions for family agriculture and agribusiness (several of those solutions aim at the coexistence with semi-arid) by way of nine Experimental Stations. EMEPA-PB seems to have constant relation and coordination of activities with the research centers of EMBRAPA, but that is not the case with INSA, which is a federal research institution focused on the Brazilian semi-arid.

136. INSA[44] could have an important role in the coordination and organization of the technology generation activities in the Semi-arid. However, the approach taken by INSA seems to have been mostly oriented towards research, putting aside the role of organizer or coordinator. In the technician interviews, both from EMEPA-PB and EMBRAPA-Semiarid, it was agreed that INSA mostly works alone, not interacting with those institutions.

137. Taking into account that no technology generation institution participates in the CEDRS, the proposed short-term action is that INSA must fulfil its mission as the body in charge of organizing semi-arid related research and that it should allocate most of its human and material resources to that assignment. Once the CEDRS is restructured or once the agriculture innovation system coordinating sub-council is created, with all institutions involved in agricultural research under its orbit, then INSA could remain as the organizer of the research sub-system.

138. Regarding the technical assistance and agricultural extension sub-system, all its institutions are part of the CEDRS, so it should be easier to promote coordination. However, as was mentioned before, according to government officers, the relationship between EMATER-PB and NGOs that provide technical assistance is not a good one, there are mistrusts and disagreements between both parties. So until the proposed agriculture innovation system coordinating sub-council is created it might not be possible to make any progress in the organization and coordination of these institutions.

[44] INSA *mission* is to: "Make inter-agency solutions viable for the fulfillment of actions related to the research, training, dissemination, and policy formulation to reach sustainable coexistence with the Brazilian semi-arid from the socio economic and environmental potentialities of the region."

Increase Efficiency of the Agriculture Innovation System for Family Farming ARM

139. Apparently, the activities of both EMEPA-PB and EMBRAPA have many simple and validated technologies in stock or standby, using a set of technologies that reduce vulnerability to drought (*tecnologias de convivência com o semiárido*), but that have not been adopted by the farmers. This means that available technology would not be a constraint for family farmers to improve the production risk management, mainly in the case of semi-arid. In any case, it would be important to carry out a survey to gather precise information regarding available technologies for coexistence with the semi-arid, currently being done in the context of the preparation of Cooperar. The proposal in the short-term is to make an exhaustive inventory of the available techniques and practices that allow an increase of the resilience of agricultural systems and to determine the extent of their implementation at field level.

140. To improve efficiency of the research sub-system, it is essential that the different research institutions do not duplicate research activities and in turn cooperate to potentiate the achievements. This seems to be the case with the *palma forrageira*: both EMEPA-PB and INSA conducted researches to develop varieties resistant to the *Cochinilla-do-Carmim* (Dactylopius opuntiae) – an hemiptera insect that damages plants – and to develop micropropagation techniques of the species to produce large scale seedlings. It seems that EMEPA-PB was the pioneer in these works in the State (using varieties that were previously tested in Pernambuco), and it is not clear why INSA also dabbled in the same area. These inefficacies could be solved once a good coordination environment is in place.

141. In regards to technical assistance and extension sub-system a reference is needed to EMATER-PB (see Text Box 3 with information on EMATER-PB), as the State institution responsible for extension services. But there has been a significant institutional deterioration in Paraiba, something that is widely acknowledged. The strengthening of EMATER-PB is key for family farmers and other small and medium scale farmers to be able to access risk management technology and adopt related practices, since smallholders are almost unable to access commercial technical assistance suppliers. The new technical assistance model should not consider EMATER as the sole technical assistance provider. Family farmers could also receive subsidies to purchase these services in the market.

Text Box 2. 3: EMATER in Paraíba

EMATER was founded in 1975, under the *Secretaria da Agricultura e Abastecimento*, with the objective of collaborating with the competent bodies in the formulation and implementation of technical assistance and agricultural extension policies in the State, and to plan, coordinate and execute technical assistance and agricultural extension programs. In the 90s it suffered from the crisis endured by the entire system in Brazil, when the Brazilian Company for Technical Assistance and Rural Extension (*Empresa Brasileira de Assistência Técnica e Extensão Rural* - EMBRATER), the company that led the system, was closed down at federal level. The recent creation of the National Agency for Technical Assistance and Rural Extension (*Agência Nacional de Assistência Técnica e Extensão Rural* - ANATER) in May 2014, indicates that the Federal Government wants to promote technical assistance and agricultural extension throughout the country. Article 19 of Law 12.897 (18.12.2013) authorizes ANATER to sign "specific partnerships with state bodies in charge of technical assistance and agricultural extension for the

execution of services", thus enabling the transfer of resources to state institutions.

142. One of the issues is technical assistance coverage. Currently EMATER-PB assists 30% of the State's family farmers with approximately 500 field technicians. But EMATER-PB also performs other functions that absorb part of its staff time, for example, registration of farmers for the issuance of the DAP (Capability Statement for PRONAF[45]), which is required by farmers to have access to subsidized agricultural credit. Furthermore, field agents do not work under a results-orientation system, their performance is not measured, and they are not accountable to farmers.

143. Another issue is the limited availability of field technical staff. The company has 15 regional coordination offices and 213 operating units to deal with the 223 State municipalities (177 belong to the semi-arid region), but 40 of those units do not have agricultural extensionists in charge at the moment. The solution proposed by EMATER's technicians and authorities is to increase the number of technical staff. In addition, there is the issue of poor specific technical trainings for extensionists, as apparently was available in the past. Training, update of technical skills and human development are considered key elements. Extension agents do not have access to updated knowledge and ongoing training.

144. Moreover, 38% of the technicians in the company are retired but still working, and R$ 40 million are required in order to terminate their contracts. 70% of the staff is over the age of 50. The Secretary of SEDAP mentioned that in 2015 they will make a call for applications to hire 500 technicians. The last time they made a call was in 2006.

145. Related to the weaknesses of EMATER-PB is the issue of overlapping functions with EMEPA-PB. For instance, EMEPA-PB executes small demonstrative projects (mentioned above and in Annex) financed by the State Fund for Poverty Combat and Eradication (*Fundo de Combate e Erradicação da Pobreza* – FUNCEP) (11,200 beneficiary farmers and total financing of R$ 2.6 million). This most likely happens because EMATER-PB is not capable of providing the technical assistance services.

146. In conclusion, in order to expand the coverage of the extension services, improve program coordination and effectiveness, upgrade training programs, develop tailor-made ARM programs, EMATER-PB needs to increase its budget and improve its effectiveness and results orientation, as current resources and modalities limit the coverage and quality of service.

Improve and Better Target Technical Assistance and Training Programs

147. It is proposed that new technical assistance and training models for technicians and farmers be tested, promoting trainers training, cascade training, farmer to farmer technology transfer methodology, farmer contracting, etc. Another proposal is to widen the use of information and communication technologies (ICT) as a way to reduce costs and reach farmers massively. In this sense the use of cell

[45] PRONAF: National Program for the Strengthening of Family Agriculture - *Programa Nacional de Fortalecimento da Agricultura Familiar*.

phone messaging to transmit technical information should become widespread; and start training producers through distance education methodologies.

148. An interesting example of appropriate program methodology is the *Programa Agente de Desenvolvimento Rural* (ADR), developed by SEBRAE-PB in support of goat farming. The ADRs are people belonging to the communities that have been technically trained. Each one of the *agentes* works with around 20 producers. The program is considered successful[46], since it has improved goat production significantly in the Cariri region, where it originated and currently assists about 1500 family farmers.

149. At the same time, efforts should be made to put in place private sector based technical assistance services driven by farmers. There are many NGOs that perform technical assistance and agricultural extension activities at private level, mainly in INCRA settlements. There are 305 settlements in Paraiba, with 14.5 thousand families living there. In addition, externally funded rural development projects, which have been implemented in the State, *Procase* (IFAD) and *Cooperar* (World Bank), have hired technical assistance providers to develop some activities.

150. It is essential that in the future, EMATER programs and operations are well coordinated with other research and extension institutions working in Paraiba. There is a need to complete a registry of all technical assistance providers in the State, currently underway in Cooperar, including either private entities or individuals who may provide technical assistance to family agriculture. This will help identify available resources and plan a proper coordination between public and private technical assistance supply for family farmers.

151. Finally, there is the issue of targeted assistance. The 1991 Agricultural Law determined that the Union must maintain technical assistance and rural extension services publicly provided and free for small farmers (Primo Junior, J. et al., 2013). But, are all the 148,000 family farmers, especially those in the semi-arid, may not be economically viable agricultural units that would obtain appropriate benefits from technology services.

152. One might think that the recurring droughts would motivate migration to urban areas and, thus, the number of family farmers to decrease over the years. However, the data from the agricultural census does not confirm such hypothesis. Between 1980 and 2006 the number of all farms remained the same, while the area registered in the census did not increase. Considering farms of up to 50 hectares in size[47] as proxy for family farmers, these increased 11.1% between the last two censuses (1995-2006), while its total area increased by 11.9%.

[46] The team was not able to assess the program directly but there are positive evaluations like "O fortalecimento da cadeia da caprinocultura como instrumento de desenvolvimento e geração de renda: um estudo de caso no município de Monteiro/PB, by Gilney Christierny Barros dos Anjos, Universidade Federal de Campina Grande.

[47] 146,291 in the 2006 census, meanwhile family farms were 148,047. Only in the 2006 census the number of family farmers (according to the definition of *agricultura familiar* from Law No. 11326) was estimated.

153. The size of almost 60% of the farms with less than 50 hectares is of less than 5 hectares, with an average area of less than two hectares. It is highly unlikely for a family in the semi-arid to reach the subsistence threshold if it relies only on the production of a farm of less than 5 hectares, or even worse of 2 hectares. In the case of livestock production, the average stocking rate for the Caatinga[48] area is around 12.5 ha/Animal Unit (AU)/year, although the verified average stocking rate is around 4.4 ha/AU/year (A. Maia Neto, 2013). It can be argued that smallholder sheep and goat breeding is carried out with the support of the so-called *Fundo de Pastos*, areas for collective use where flocks of several farmers are extensively raised.

154. Even so, it is most likely that these families currently rely more on other sources of income (such as social assistance and drought and flood compensation programs).[49] Therefore, such rural households may not be very interested in adopting technological innovations requiring additional on-farm investments, higher recurrent costs, and increased use of labor in the farm, which probably is being used to generate income from off-farm sources.

155. The most reasonable approach to such a diversity of rural households is to adapt agricultural extension means and methods to user specific asset situations and market perspective. Therefore, the proposal is to perform a baseline study to determine the extent of household heterogeneity in the semi-arid of Paraiba and to have a first approximation to a farmer typology. It will then be possible to have a better estimate of the number of farmers that have to be targeted with appropriate ARM technological solutions and approaches. EMATER-PB restructuring should follow these results.

156. Some programs, however, are crucial in the semi-arid, such as the upgrading of *Programa Palma Resistente*, and should in any case continue to be a priority. According to EMEPA-PB's technicians, the *Programa Palma Resistente* has a demand of 60 million *rackets* and is expected to produce 13 million in its second phase next year.

[48] Caatinga is the prevailing biome in the semi-arid.

[49] Retirements, *Bolsa Familia*, etc. State transfers from pensions and social assistance programs provide a substantial part of families' incomes and allow food to be purchased outside the household. State transfers for old age pensions and *Bolsa Família* serves to diversify the poor's portfolio and buffer the direct effects of drought.

CHAPTER 4: ARM ACTION PLAN

157. The present ARM action plan reflects the strategic lines described in the previous section and includes some basic details on who, when and how much is required for the implementation of the actions proposed. This is an initial proposal based on possible inputs and which needs to be discussed in detail with the Government of Paraiba.

158. The cost of the entire ARM action plan has been estimated at a total of US$ 18,371,000 over 5 years, with a strong concentration of activities within the first two years. Out of this total, US$ 5,571,000 would correspond to studies, training and pre-investment and US$12,800,000 to program investments. The EMATER's staff cost is not part of the ARM Action Plan but it is included as a complementary public policy, as has been mentioned by State policy makers. The summary break down by category of intervention is as follows:

Table 15: Summary Break Down of Costs by Category of Intervention

Plan of Action - Category of intervention	Total Cost (US$)	Execution of field programs (US$)	Payments to EMATER staff (US$)	Studies, training and pre-investment (US$)
Agro-climatic Risk Information System (ACIS)	3,211,000	0	0	3,211,000
Sanitary and Phytosanitary System	6,120,000	5,000,000	0	1,120,000
Supply Chain Coordination	195,000	0	0	195,000
Agricultural Innovation System	9,345,000	7,800,000	0	1,545,000
Total Action Plan	18,371,000	12,800,000	0	5,571,000

159. The table below contains the basic information for all actions regarding each category of intervention and the final table below summarizes the actions by responsible institution.

ACIS

Strategic Line	Actions	Institution	Period	Resources	Cost (US$)
Strategic Line 1: Development of a Agro-climatic Information System.	1.1 Mapping of the current infrastructure (strengths and weaknesses) of the state and federal weather stations	AESA supported by consultant	I Quarter 2015	Short-term consulting	60,000
	1.2 Verification of quality of data collected by AESA and the federal institutions	AESA supported by consultant	I Quarter 2015	Short-term consulting	45,000
	1.3 Development of debugging procedures for the data available in order to correct failures in the climatic time series collected by AESA and Federal institutions	INMET, ANA, CPTEC, AESA supported by consultant	II Quarter 2015	Short-term consulting	100,000
	1.4 Centralize AESA's database in an unique Database Management System (DBMS), maintenance and	AESA supported by consultant	II Quarter 2015	Short-term consulting	175,000

Strategic Line	Actions	Institution	Period	Resources	Cost (US$)
	increasing the servers capacity and computers				
	1.5 Development of the information system counting on AESA and federal institutions information	INMET, ANA, CPTEC, AESA supported by consultant	II-III Quarter 2015	Short-term consulting	a. 250,000 b. 250,000 Subtotal: 500,000
	1.6 Definition of the weather variables and the products to be released in websites and newsletters and improvement of the product dissemination to family farmers	AESA supported by consultant	II Quarter 2015	Short-term consulting	9,000
	1.7 Review the current institutional structure and strengthening both regulation and structure	AESA, EMATER-PB, SEDAP supported by consultant	II Quarter 2015	Short-term consulting	40,000
	1.8 Establishment of a state working team to guide and coordinate the usage of the data for commercial and research purposes	AESA, EMATER-PB, SEDAP supported by consultant	III Quarter 2015	Short-term consulting	15,000
	1.9 Acquisition and Instalment of agro-climatic weather stations	AESA	I-II-III-IV Quarter 2015.	Infrastructure investment	500,000
Strategic Line 2: Strengthening of the Drought Management Committee, making actions more proactive and less reactive	2.1 Map the current institutional drought response structure and current policies and contract technical studies that take into account the social, environmental and economic issues	EMATER-PB, SEDAP supported by consultant	III Quarter 2015- IV Quarter 2016	Long-term consulting and meeting expenses	a. 40,000 b. 40,000 c. 40,000 d. 40,000 e. 40,000 f. 40,000 g. 40,000 Subtotal: 280,000
	2.2 Creation of a working group to develop and initiate the program of drought management	EMATER-PB, SEDAP	III Quarter 2015	Short-term consultancy and expenses	17,000
	2.3 Creation of Committee´s communication and supervision tools	SEDAP	III Quarter 2015	Meeting expenses	40,000
	2.4 Workshops to standardize the guidelines established by the Committee	SEDAP, EMATER-PB, State Universities and Federal Research Institutions	IV Quarter 2015-IV Quarter 2016	Short-term consultancy and professional training	a. 45,000 b. 45,000 Subtotal: 90,000
Strategic Line 3: Training to the extension workers associated to	3.1 Definition of the training outline (SEDAP and Universities) and development of the training content emphasizing on the institutional,	SEDAP, EMATER-PB, State and Federal	III Quarter 2015-III Quarter 2016	Short-term consultancy	a. 50,000 b. 50,000 Subtotal:

Strategic Line	Actions	Institution	Period	Resources	Cost (US$)
inspection procedures in the Garantia Safra project, in order to reduce moral hazard and technical issues	technical, operational, agronomical and geotechnological issues	Universities and Federal Research Institutions			100,000
	3.2 Establishment of partnerships with Federal and State Universities, and Research Centers in the northeastern region	SEDAP, EMATER-PB	III Quarter 2015-III Quarter 2016	Short-term consulting	a. 120,000 b. 120,000 Subtotal: 240,000
	3.3 Execution of the professional training	State and Federal Universities and Federal Research Institutions	IV Quarter 2015-IV Quarter 2016	Trainers and Short-term consultancy	a. 500,000 b. 500,000 Subtotal: 1,000,000
Total Weather Information System					**US$ 3,211,000**

Sanitary and Phytosanitary System

Strategic line	Actions	Responsible institution	Period	Resources	Cost (US$)
A.Sugarcane A1.Expand the area of sugarcane under biological control	A.1.1 Prepare background information and conduct a workshop to determine the feasibility to expand the present ASPLAN facilities for production of biological control agents	ASPLAN	II-III Quarter, 2015	ASPLAN own resources (personnel and structure)	5,000
A.2 Assess the impact of the possible introduction of the *ferrugem laranja* in Paraiba	A.2.1 Contract a study on the impacts	SEDAP	II Quarter, 2015	Expertise on the subject (University, consultant)	20,000
A.3 Set up a surveillance network for *ferrugem laranja* in Paraíba	A.3.1 Produce the surveillance plans; A.3.2 Organize the stakeholders; A.3.3 Implement the surveillance net	SEDAP	Starting on II Quarter 2015, permanent actions	SEDAP own resources (personnel)	5,000
B. Fruticulture B.1 Assess the impact of the possible introduction of the diseases *sigatoka negra* and *moko*	B.1.1 Contract the impact studies	SEDAP	II and III Quarter, 2015	Expertise on the subject (University, consultants)	60,000

Strategic line	Actions	Responsible institution	Period	Resources	Cost (US$)
(bananas), *cancro da videira* and HLB (Citrus)					
C. Family Agriculture in the Semi-arid zone C.1 Substitute the varieties of *palma forrageira* susceptible to the *cochonilha do carmim* for resistant ones	C.1.1 – Develop a study to completely substitute the varieties on a feasible time frame; C.1.2 – Implement the necessary actions in the field	SEDAP, EMEPA, EMATER	II Quarter 2015 and time frame proposed by the study	SEDAP, EMEPA and EMATER own personnel and resources	5,000,000
D. Livestock Production D.1 Reinforce the program for control and eradication of brucellosis and tuberculosis	D.1.1 Evaluation study; D.1.2 Implementation of recommended actions; D.1.3 Follow up	SEDAP, MAPA	II Quarter 2015 and time frame proposed by the evaluation	MAPA experts and SEDAP operational resources	20,000
D.2 Coordination of the animal health and food safety programs	D.2.1 Round tables for establishing a common program, coordination mechanisms and follow up	SEDAP, MAPA, AGEVISA	I Quarter 2015 and time frame proposed by the evaluation	Own resources of the involved institutions	10,000
D.3 Establish the actual status of CSF and NCDV in Paraiba	D.3.1 Conduct a field epidemiological survey; D.3.2 Take the appropriate measures in case of positive virus circulation; D.3.3 Free area certification	SEDAP	I Quarter of 2016 and time frame proposed by the evaluation	MAPA expertise and own resources of SEDAP	1,000,000
E.1 Create the State Agency for Agricultural Health	E.1.1 Speed up the negotiations and associated legislation	SEDAP	I and II Quarter 2015	Legal support of SEDAP.	No financial costs involved in the negotiations
Total SPS System					**US$ 6,120,000**

Supply Chain Coordination[50]

Strategic line	Actions	Responsible Institution	Period	Resources	Cost (US$)
1. Identify actual farm to market experiences in Paraiba and assess the viability of being replicated massively using a demand driven approach.	1.1 Make an inventory of collective fruit marketing experiences in Paraiba like the one involving pineapple producers in Santa Rita and assess viability	Project Cooperar	I Quarter 2015	Consultant	25,000
	1.2 Identify value adding activities for family agriculture farmers groups that can be developed as projects for CONAB's managed PAA or PNAE and make an assessment of the conditions for success	Project Cooperar and CONAB-PB	I-II Quarter 2015	Consultants	30,000
	1.3 Investigate successful APL experiences in the State of Paraiba	Project Cooperar, EMEPA-APL	I Quarter 2015	Consultant	15,000
2. Business development methodologies for associated small scale farmers	2.1 In cooperation with EMATER-PB, and within the framework of the AIS, develop a methodology to support small scale farmers' organizations to develop market oriented business plans	Project Cooperar and EMATER-PB within framework of AIS	I –III Quarter 2015	Consultant and EMATER-PB	45,000
	2.2 Training of EMATER-PB staff in business development methodologies for small scale farmers	EMATER-PB and CONAB with assistance from Project Cooperar	III-IV Quarter 2015	Project Cooperar staff and consultants	40,000
3. Assess different options to support market development for family agriculture products	3.1 Assess the relevance, applicability and viability of establishing new market space facilities for family agriculture products in places like Campina Grande or Patos, as it is being planned by EMPASA	EMPASA	2015	Independent consultants	50,000
Total Supply Chain					**US$ 205,000**

[50] These proposals are directly linked to COOPERAR's alliances strategy and for which the World Bank and the Government are allocating US$ 23 million.

Strategic line	Actions	Responsible Institution	Period	Resources	Cost (US$)
Coordination					

Agricultural Innovation System

Strategic line	Actions	Responsible Institution	Period	Resources	Cost (US$)
1. Improve the coordination of the Agriculture Innovation System for family agriculture risk management	1.1 Creation of a sub-council within the CEDRS, for the coordination of the institutions that would be part of the Agriculture Innovation System	SEDAP	2015	Consulting services to carry out the study, decide the sub-council integration and how members will be interrelated, internal rules of procedure, appointment of an Executive Secretary, etc.	20,000
	1.2 Carry out negotiations among the research institutions for INSA to work as the body in charge of coordinating semiarid related researches until the creation of the above sub-council	SEDAP	2015	One consultant to conduct negotiations	15,000
	1.3 Formalize and start up the sub-council in charge of coordination of the Agriculture Innovation System within the CEDRS	SEDAP	2015	One consultant to explain the proposal to State authorities and conduct the institutional-political articulation to formalize the sub-council	15,000
2. Improve efficiency of the Agricultural Innovation System for family agriculture risk management - Strengthen the research sub-system	2.1. Carry out a survey to gather information regarding available technologies for the coexistence with semi-arid.	Project Cooperar	2015	Consulting services to make an inventory of techniques and practices known, have they been or not implemented at field level, which will allow an increase of the resilience of agricultural systems used.	45,000

Strategic line	Actions	Responsible Institution	Period	Resources	Cost (US$)
	2.2 Regular meetings to coordinate research activities for the coexistence with semi-arid, until the sub-council is created	INSA, EMEPA-PB, EMBRAPA	2015	One expert to organize the meetings. Premises, equipment	40,000
3. Improve efficiency of the Agricultural Innovation System for family agriculture risk management - Strengthen the ATER sub-system	3.1 Carry out a study to determine different types of smallholders within family agriculture and identify farming development opportunities and specific TA requirements	Projeto Cooperar, EMATER-Paraiba	2015	Consulting services to carry out the study.	60,000
	3.2 Conduct a survey on potential technical assistance providers in the State, as well as explore other non-public TA modalities	Projeto Cooperar	2015	Consulting services and other technical assistance modalities	45,000
	3.3 Conduct a survey to gather information regarding rural households organized in Community Associations	Projeto Cooperar	2015	Consulting services to conduct the survey	45,000
	3.4 Allocate funds to terminate contracts of EMATER´s retired staff.	SEDAP	2015	Allocation of funds from the State budget	
	3.5 Hire 500 extension agents by EMATER	SEDAP	2015-2019	Allocation of funds from the State budget	
	3.6 Test new training models for extension agents and farmers.	EMATER-Paraiba	2015	Consulting services	30,000
	3.7 Establish and implement a program for training EMATER´s personnel and personnel of *non-public technical assistance providers* as identified in the survey proposed under action 3.2.	EMATER-Paraíba	2015-2019	Program prepared by EMATER´s Human Resources Coordination: Allocation of funds from EMATER´s budget to implement the training program	330,000
	3.8 Widen the use of information and communication technologies (ICT) as a way to reduce ATER costs.	EMATER-Paraiba	2015-2019	Contracting a massive SMS system with a mobile telephone company; Implementation of distant education methodologies	420,000
	3.9 Carry out a study to	SEDAP	2015	One consultant	30,000

Strategic line	Actions	Responsible Institution	Period	Resources	Cost (US$)
	assess the SEBRAE-PB "Rural Development Agent Program" (ADR) as an alternative to current extension modes of operation.			to carry out the study	
4. Improve efficiency of the Agricultural Innovation System for family agriculture risk management - Enlargement of successful programs and projects	4.1 Enlarge Programa Palma Resistente to produce 60 million "rackets".	SEDAP, EMEPA-PB, EMATER-Paraíba	2016-2018	Allocation of funds from FUNCEP	6.5 million
	4.2 Expand the coverage of the program for strengthening family farmers´ goat and sheep breeding, to encompass 230 farmer associations and 10,000 farmers.	SEDAP, EMEPA-PB, EMATER-Paraíba	2015-2018	Allocation of funds from FUNCEP	1.3 million
	4.3 Increase production and distribution of sorghum seeds for family farmers in the semi-arid, to benefit 15,000 farmers.	SEDAP, EMEPA-PB, EMATER-Paraíba	2016-2018	Allocation of funds from FUNCEP	450,000
Total Agricultural Innovation System					**US$ 9,345,000**

Complementary Policy Initiatives

160. Below are some policy initiatives that are complementary to the above plan of action.

Policy action	Legal evidence	Indicator
EMATER reform, including allocation of funds to terminate contracts of retired staff (estimated requirement US$ 16 million) and hiring extension agents (estimated requirement (US$ 45 million in 5 years)	Legal instruments approved	New, extension staff profile, with younger and more motivated professionals providing higher quality TA services

The agro-climatic information system described above provides a weather, climate and agro-climatic decision making tools framework. The operation of this system must be performed by an inter-institutional team comprising experts from public institutions and private organizations, therefore requiring policy actions at the involved institutions.	Legal instruments approved	Development of strategic partnership and cooperation. Conformation of the Technical Working Group. Agro-climatic information system in operation. Design, implementation and dissemination of agro-climatic decision making tools. Harmonized procedures for cooperation, data/information/products sharing, and communication

Short-term plan by responsible institution

Agroclimatic Information System

1. AESA

	2015 (cost-US$)				2016 (cost-US$)			
Actions	I	II	III	IV	I	II	III	IV
1.1	X 50,000							
1.2	X 30,000							
1.4		X 150,000						
1.6		X 9,000						
1.9	X 500,000							

2. INMET, ANA, CPTEC, AESA

	2015 (cost-US$)				2016 (cost-US$)			
Actions	I	II	III	IV	I	II	III	IV
1.3		X 85,000						
1.5		X 400,000						

3. AESA, EMATER-PB, SEDAP

	2015 (cost-US$)				2016 (cost-US$)			
Actions	I	II	III	IV	I	II	III	IV
1.7		X 25,000						
1.8		X 10,000						

4. EMATER-PB, SEDAP

	2015 (cost-US$)				2016 (cost-US$)			
Actions	I	II	III	IV	I	II	III	IV
2.1			X 25,000	X 25,000	X 25,000	X 25,000	X 25,000	X 25,000
2.2			X 10,000					
2.4				X 30,000				X 30,000
3.1			X 50,000				X 50,000	
3,2			X 100,000				X 100,000	
3.3				X 500,000				X 500,000

5. SEDAP

	2015 (cost-US$)				2016 (cost-US$)			
Actions	I	II	III	IV	I	II	III	IV
2.3			X 30,000					

Sanitary and Phytosanitary System

1. ASPLAN

	2015 (cost-US$)			
Actions	I	II	III	IV
A1		X 5,000		

2. SEDAP

	2015 (cost-US$)			
Actions	I	II	III	IV
A2		X 20,000		
A3		X 5,000		
B1		X 20,000	X 40,000	
C1		X 300,000	X 400,000	X 400,000
D1		X 5,000		X 5,000
D2	X 3,000			

3. EMEPA

	2015 (cost-US$)			
Actions	I	II	III	IV
C1		X 100,000	X 100,000	X 100,000

4. EMATER

	2015 (cost-US$)			
Actions	I	II	III	IV
C1		X 100,000	X 200,000	X 300,000

5. AGEVISA

	2015 (cost-US$)			
Actions	I	II	III	IV
D2	X 2,000			

6. MAPA

	2015 (cost-US$)			
Actions	I	II	III	IV
D1		X 5,000	X 3,000	X 2,000
D2	X 5,000			

Supply Chain Coordination

1. Project Cooperar en cooperación con EMEPA and CONAB[51]

	2015 (cost-US$)			
Actions	I	II	III	IV
1.1	X 25,000			
1.2	X 15,000	X 15,000		
1.3	X 15,000			
2.1	X 15,000	X 15,000	X 15,000	
2.2			X 20,000	X 20,000

Agricultural Innovation System

1. SEDAP

	2015 (cost-US$)			
Actions	I	II	III	IV
A1		X 20,000		
A2		X 15,000		
A3			X 15,000	
C9		X 15,000	X 15,000	

2. Project Cooperar

	2015 (cost-US$)

[51] These activities have to be adjusted to reflect the preparation of Cooperar II which is underway.

Actions	I	II	III	IV
B1	X 45,000			
C1		X 30,000	X 30,000	
C2	X 45,000			
C3	X 45,000			

3. EMATER Paraíba

	2015 (cost-US$)			
Actions	I	II	III	IV
C6		X 15,000	X 15,000	
C7				X 30,000
C8			X 75,000	X 60,000

4. SEDAP, EMEPA-PB, EMATER-Paraíba

	2015 (cost-US$)			
Actions	I	II	III	IV
D2		X 140,000	X 140,000	X 140,000

5. INSA, EMEPA-PB, EMBRAPA

	2015 (cost-US$)			
Actions	I	II	III	IV
B2			X 20,000	X 20,000

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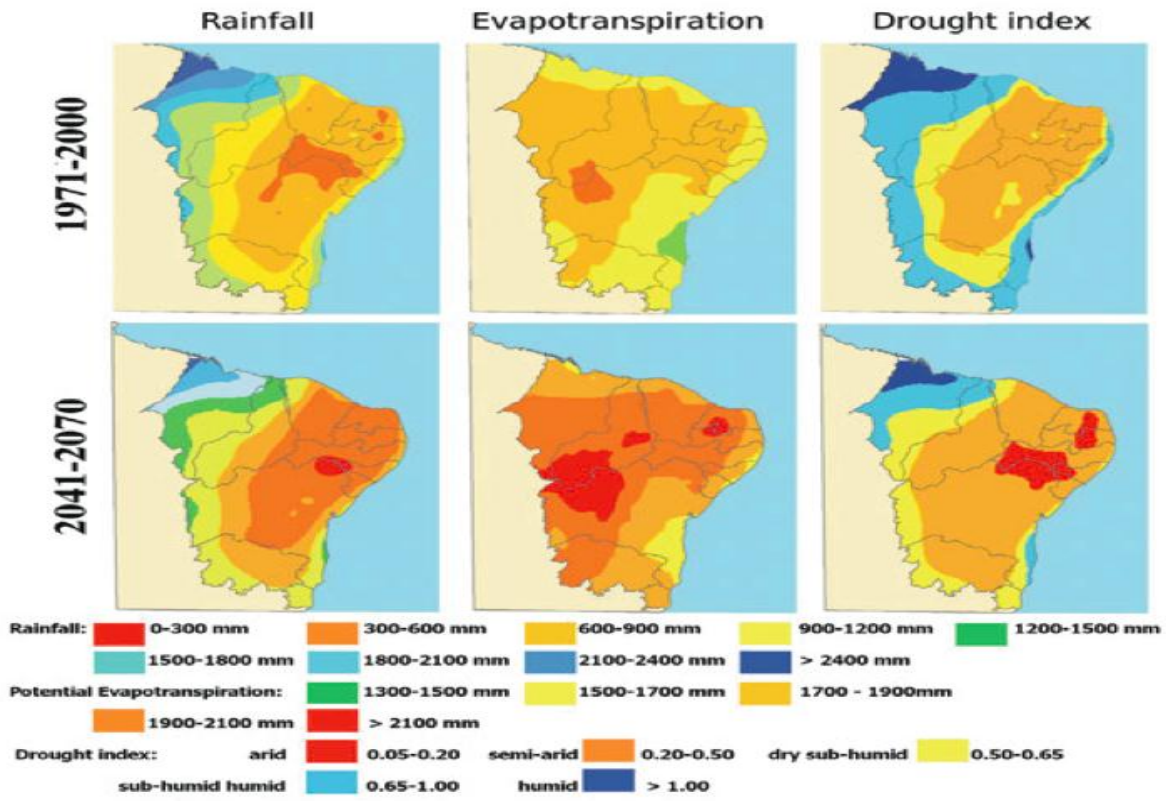
ANNEX 1: PROJECTED CLIMATE CHANGE IMPACTS ON AGRICULTURE IN NORTHEAST BRAZIL

1. It is considered probable that climate change will cause global increases in temperature by 2 to 5.4 degrees Celsius in a pessimistic scenario (Intergovernmental Panel on Climate Change - IPCC A2) and by 1.4 to 3.8 degrees Celsius in the more optimistic scenario (IPCC B2).[52] In Northeast Brazil, this means that rainfall will likely be reduced by 15-20% under the pessimistic scenario. In the Semi-Arid region that covers most of Northeast Brazil, rainfall is already less than 800 millimeters per year and rainfall variability is among the highest in the world.[53] See Figure A1-1 below.

Figure A1 - 1: Northeast Brazil Climate Predictions, 1971-2000 and 2041-2070[54]



Source: World Bank, 2013

[52] The IPCC A2 scenario represents high carbon emissions; the B2 scenario implies low carbon emissions under the hypothesis that all countries sign the Kyoto Protocol.

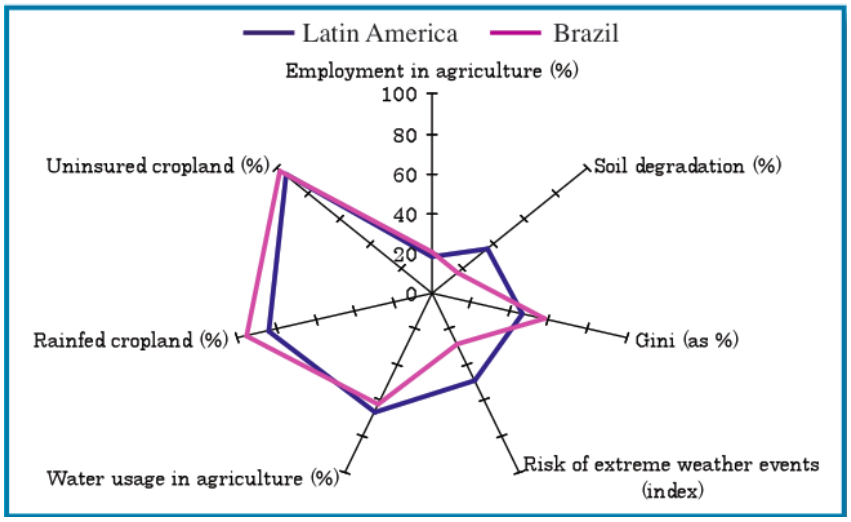
[53] World Bank, 2013. Climate Change Impacts on Water Resources Management: Adaptation Challenges and Opportunities in Northeast Brazil.

[54] Figure shows mean annual precipitation, mean annual evapotranspiration, and drought index (precipitation divided by evapotranspiration) for the periods of 1971-2000 and 2041-2070 (projected) using the MIMR climatic model under the B1 emission scenario. The more red coloration corresponds to increased drought, due to reduced rainfall and/or increased evapotranspiration.

2. Possible impacts of climate change in Northeast Brazil include (i) increased frequency of dry spells and evaporation rates leading to lower soil moisture levels and reductions in water reservoirs, (ii) losses in natural ecosystems such as the *caatinga*, (iii) tendency towards aridization and desertification in the Semi-Arid Region, (iv) water scarcity, (v) climate induced migration to large cities, and (vi) impacts on human health.[55]

3. Figure A1-2 highlights seven indicators that convey vulnerability to climate change in Brazil as a whole. In the Northeast, the vulnerability scenario is more drastic: employment in agriculture, soil degradation, and the risk of extreme weather events indicators are all higher than the country average.

Figure A1 - 2: Climate Vulnerability Indicators[56]



Source: World Bank, 2013

4. In the Northeast, climate change will have significant impacts on the livelihoods of the poorest, those that rely on rain-fed agriculture. Climate change is seen as a migration "push" factor, and migration is projected to increase from the rural Northeast as the value of agricultural production declines due to climate risks.[57]

5. Climate change signifies shifts in temperature and rainfall regimes, which affect agricultural productivity by shifting suitable area for agricultural production, altering agricultural yields, changing water availability, and producing conditions that increase the likelihood of plant pathogens.

[55] World Bank, 2009. Brazil: Country Note on Climate Change Aspects in Agriculture

[56] Employment in agriculture (percent of total employment), rain fed cropland (percent of total cropland), Gini, water usage in agriculture (percent of total annual fresh water withdrawals) from World Development Indicators 2007, 2000-2007 average. Uninsured cropland (percent of total cultivated land area) from the Inter-american Development Bank (IADB), Inter-american Institute for Agriculture Cooperation (IICA) 2002/2003 figures. Soil degradation (percent of total land) from FAO AGL 2005. Risk of extreme weather events (index, annual average 1997-2006) from German watch.

[57] Barbieri et al, 2010. Climate change and population migration in Brazil's Northeast: scenarios for 2025-2050. Population and Environment (2010) 31:344-370.

6. Reductions in area are projected for all but one of the major commodity crops in Brazil. Projected climate change impacts on all currently produced food grains will amount to US$4 billion by 2050. Soybeans are likely to be most affected by climate change, with the soybean sector alone accounting for almost 50% of these economic losses.[58] Margulis and Dubeux (2010) modeled the economic effects of climate change on Brazil's GDP and found that in the worst case, Brazil could lose about 2.5% every year due to the impacts of increasing temperature (Tables A1-1 and A1-2).

Table A1- 1: Impact of Climate Change on Current *Low Risk* Areas Suitable for Cultivation

Crops	Variation relative to current productive area (%)					
	SRES B2 (+1.4ºC to +3.8ºC)			SRES A2 (+2°C to +5.4°C)		
	2020	2050	2070	2020	2050	2070
Cotton	-11	-14	-16	-11	-14	-16
Rice	-9	-13	-14	-10	-12	-14
Coffee	-7	-18	-28	-10	-17	-33
Sugar cane	171	147	143	160	139	118
Beans	-4	-10	-13	-4	-10	-13
Sunflower	-14	-17	-18	-14	-16	-18
Cassava	-3	-7	-17	-3	-13	-21
Maize	-12	-15	-17	-12	-15	-17
Soybean	-22	-30	-35	-24	-34	-41

Source: Margulis et al, 2010.

Table A1- 2: Economic Losses for Key Crops by 2050, projected in pessimistic scenario

Crop	Reduction in "low risk" cultivation area (%)	Scenario A2 Annual Economic loss (Millions Reais)*
Rice	-12	530
Cotton	-14	408
Coffee	-17.5	1,597
Beans	-10	363
Soybean	-32	6,308
Maize	-15	1,511
Sugar cane	145	0

Source: Margulis et al, 2010.

[58] Assad and Pinto, 2008

7. Projections from Assad et al (2012) highlight the severe risks of climate change's negative impacts on three principal agricultural activities in Northeast Brazil (livestock pasture, maize, and beans). However, even under a pessimistic scenario (IPCC Scenario A2), the area suitable for sugarcane in Brazil could double by 2020. For Paraiba, this would offset some of the production lost from other crops. See Figures A1-3, A1-4, and A1-5, below.

Figure A1 - 3: Projected Losses in Pasture Productivity, % relative to 2010 baseline under optimistic and pessimistic scenarios (2020 and 2030)

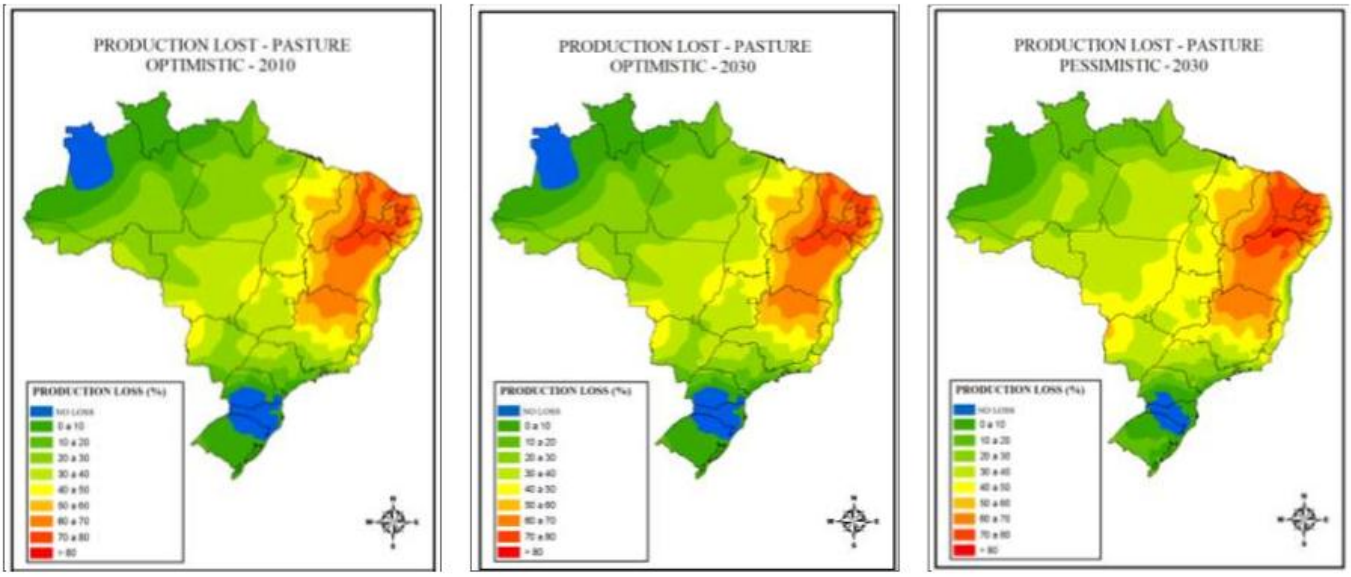


Figure A1 - 4: Impact of Climate Change on Area Suitable for Maize (2010 baseline, 2030 optimistic and pessimistic)

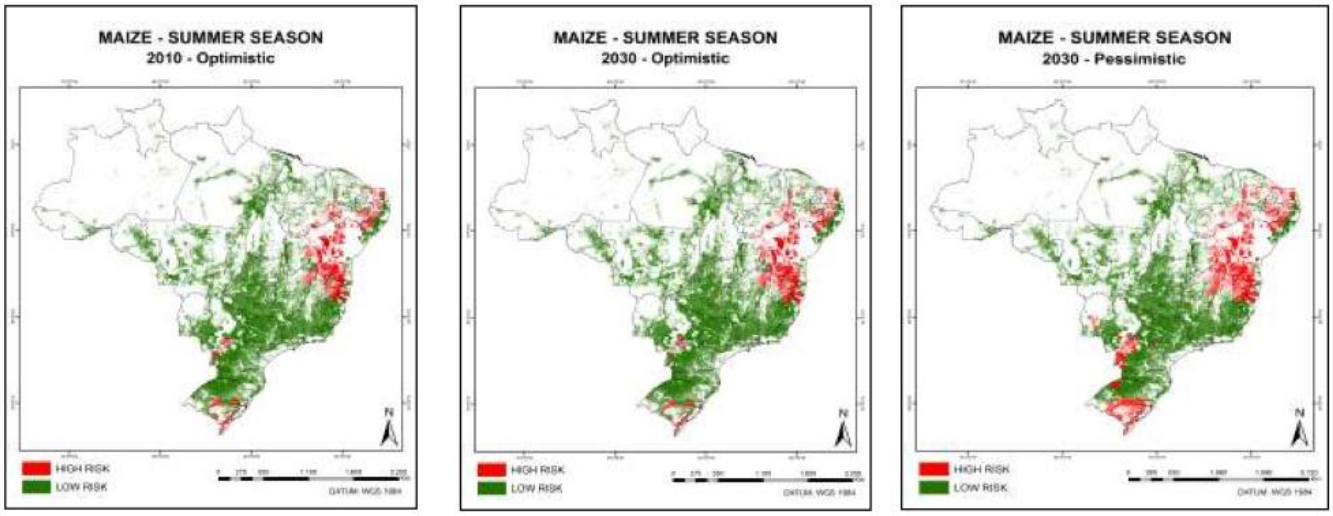
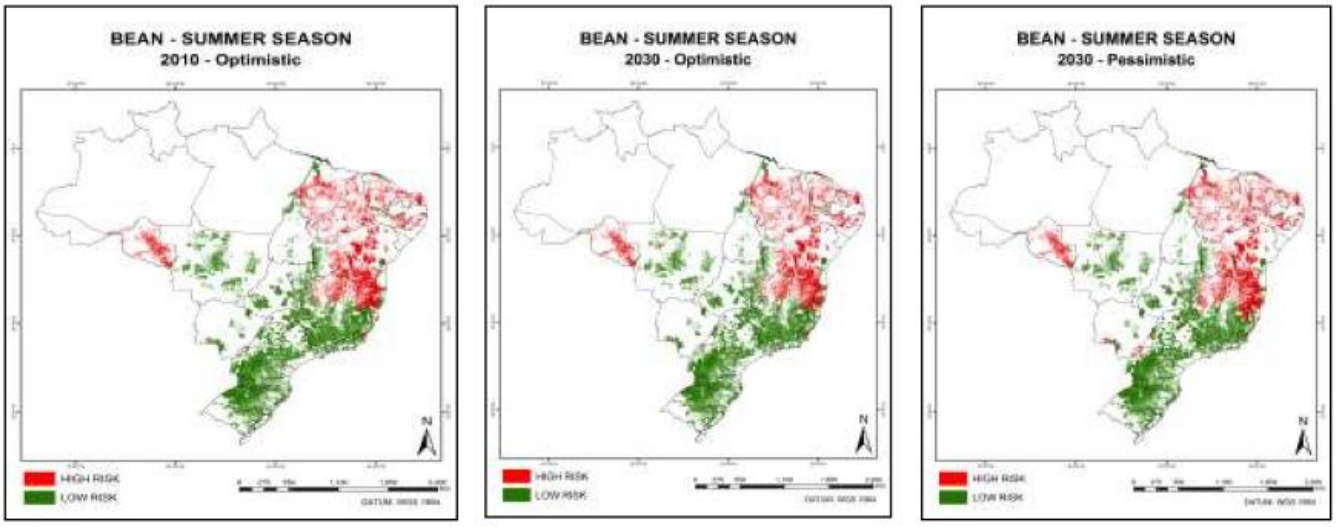


Figure A1 - 5: Impact of Climate Change on Area Suitable for Beans (2010 baseline, 2030 optimistic and pessimistic)



8. Fernandes et al (2011) found that adaptation interventions (short/long cycle varieties, deeper rooted and drought-tolerant varieties, moderate irrigation at critical growth phases, shift in planting dates) can mitigate yield declines in all impacted crops. In combination with incentives and infrastructure for efficient water use, agriculture can evolve to become resilient to climate change, but a business as usual scenario ignoring climate change in the long run will lead to severe losses. Early adaptation planning and investments will save costs and can prevent significant damages.

ANNEX 2: VULNERABILITY IN PARAIBA

1. Climate variability has long been considered a constraint to economic development and poverty alleviation in Northeast Brazil. Long-term impacts of repeated exposure to shocks bring household food insecurity, which is much higher in the rural Northeast than urban, and whose rural levels are amongst the highest in Brazil. Repeated shocks confine rural households into a poverty trap, exhausting savings and dissolving investments that would otherwise help propel the household ahead. Expenditures on drought mitigation and emergency measures also divert municipal resources from longer-term investments in human capital and productivity.

2. The impacts of the aforementioned risks have greater consequences for human welfare among the individuals, communities, and regions of Paraiba that are more vulnerable. As we have already seen, a single risk such as drought has different effects on different systems of productions and producers. Vulnerability is the concept that explains this heterogeneity in impact. This annex explores drivers of heterogeneity in vulnerability in Paraiba.

3. Vulnerability is "the likelihood that at a given time in the future, an individual will have a level of welfare below some norm or benchmark."59 Common welfare indicators include poverty measurements, household expenditures, savings levels, and food security and nutrition measures (such as food consumption score and household dietary diversity). Though vulnerability depends on the severity of external shocks like climate, the likelihood of a drop in welfare depends on both people's context and capacity to act and react. Socio-economic assets and institutions play an important role in people's vulnerability.

4. Vulnerability is not the same thing as exposure to a shock, since many households can experience, say, a drought with different welfare outcomes. Vulnerability research emphasizes that both the settings and the asset levels of a household influence the livelihood strategies households choose.60 Since vulnerability results from the combination of factors exogenous and endogenous to the individual, the same exogenous shock, like drought, affects individuals differently. In addition, if an individual or household is vulnerable to one exogenous shock, it does not follow that the household is vulnerable to all shocks. For example, a subsistence-oriented rural farming household may be vulnerable to drought and other possible climatic shocks like irregular and delayed rainfall, but may not be vulnerable to price shocks if the household is not commercializing its production.

5. Vulnerable households in Paraiba respond to shocks by reducing household consumption, selling household and productive assets, and seeking income sources off the farm with diverse strategies including migration and even prostitution. Households depend on their own production for income as

[59] J. Hoddinott and A. Quisumbing. 2010. "Methods for Microeconometric Risk and Vulnerability Assessment." In *Risk, Shocks and Human Development: On the Brink,* edited by R. Fuentes-Nieva and P. A. Seck, 72. London: Palgrave Macmillan for United Nations Development Programme.
[60] Hoddinott, John. 2014. "Resilience: A Primer." 2020 Conference Brief 8, IFPRI.

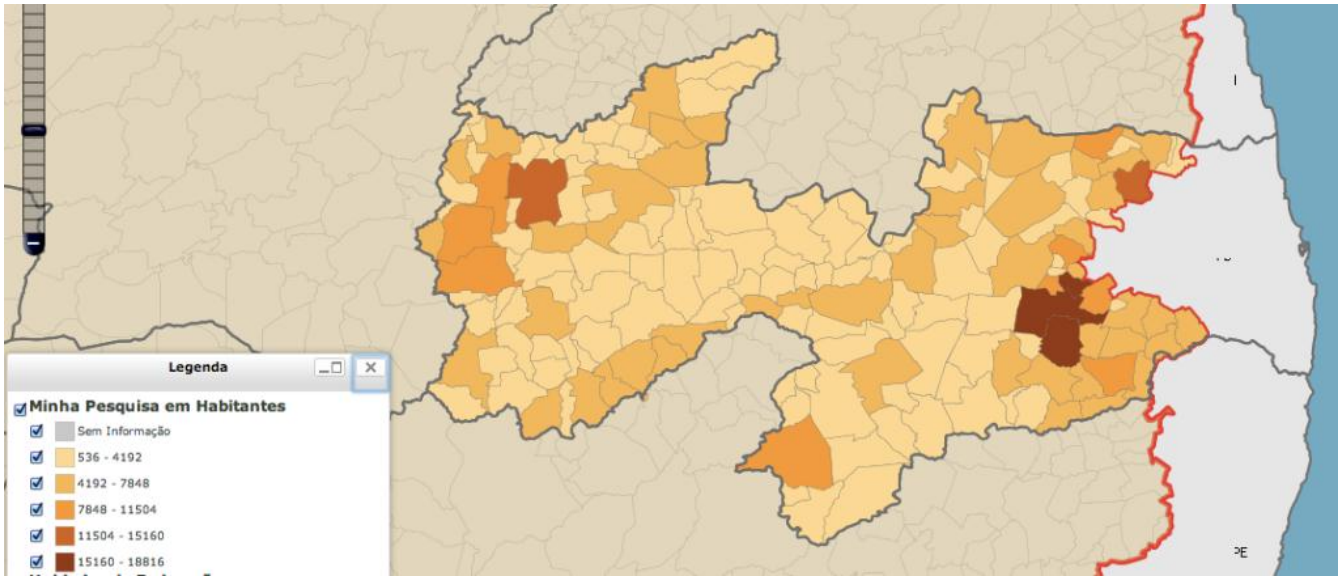
well as their food, so different factors that facilitate access to alternate sources of food and income are important coping strategies after a shock.

6. Thankfully, in the recent droughts in Paraiba, there have been no reported deaths. Fifty years ago droughts triggered famine and mass migration. Because of a mixture of social safety nets and institutional responses, drought kills animals and crops, but not humans.

A. Vulnerability and Welfare Indicators

7. Vulnerability is of greater concern when the household's starting welfare levels are low, because a shock will push a household into even more precarious living conditions. Though technically vulnerability measures marginal changes in welfare of a household, for our purposes the concept is most useful when applied to groups that are already at the margin of decent welfare.

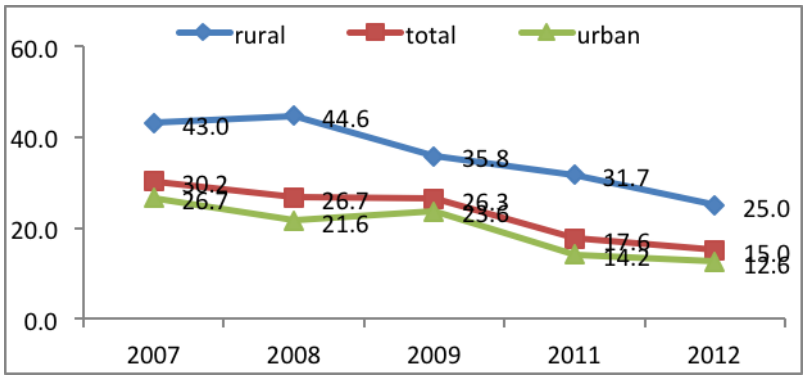
Figure A2 - 1: Distribution of Rural Population in Paraiba (2010)



8. Poverty exacerbates vulnerability because a shock will have greater proportional effects on the welfare of a poor household than on a wealthier household. For this reason, it is worthwhile to look at socio-economic indicators in Paraiba to characterize baseline poverty and asset levels.

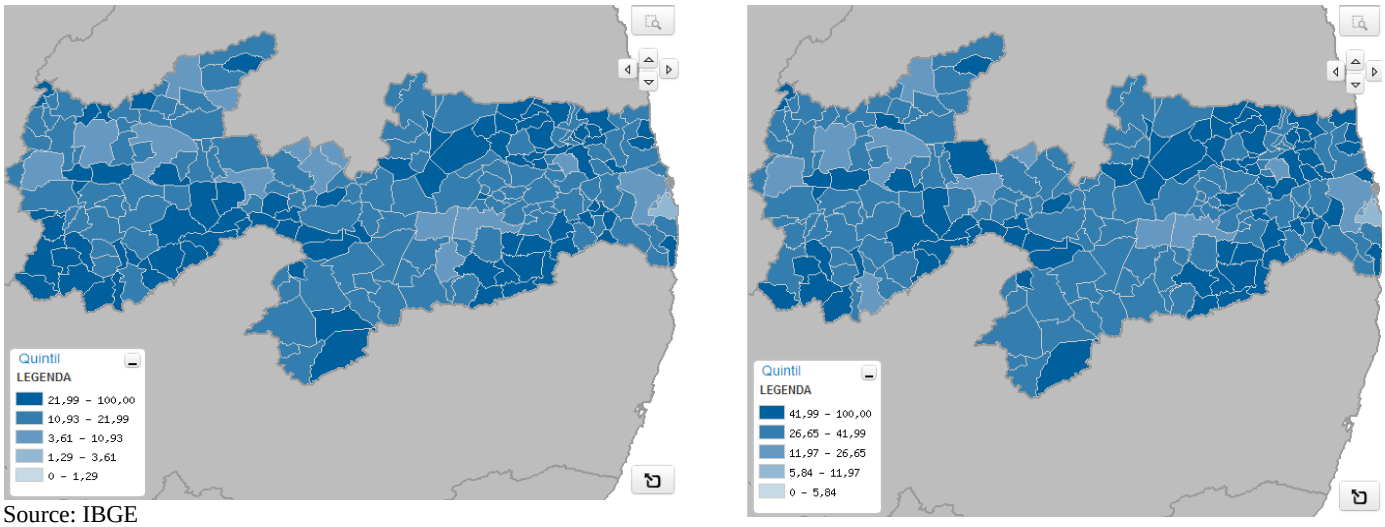
9. Though poverty has been declining in the Northeast as in the rest of Brazil in the last decade, poverty in rural areas, where livelihoods concentrate on agriculture, remain high (Figure A2-2). While in Brazil in 2010 25.5% of the rural population was considered extremely poor, this rate was 35.4% for the Northeast's rural population. The Northeast essentially tied for last place with the North region (35.7%), and drastically behind all other regions of the country (10.2%, 6.8%, and 11.7% in the Southeast, South, and Center-West, respectively). In Paraiba, you are twice as likely to be poor if you live in rural areas, than urban areas. In 2012, 25% of the rural population was poor (per capita monthly income of R$140 or less), compared to 12.6% in urban Paraiba.

Figure A2 - 2: Percent of Population with Monthly per capita Income less than R$ 140 in Paraiba[61]



10. In 2012, in Paraiba, 8.1% of the population was extremely poor (less than R$70 per capita monthly income).[62] However, in the 170 municipalities of the Paraiba Semi-Arid Region, which covers most of the area of the state, the average rate of extreme poverty, less than R$70 per capita per month, is 20%. See Figure A2-3 below.

Figure A2 - 3: Percent of Extreme Poor (left) and Poor (right) in Paraiba (2010)



Source: IBGE

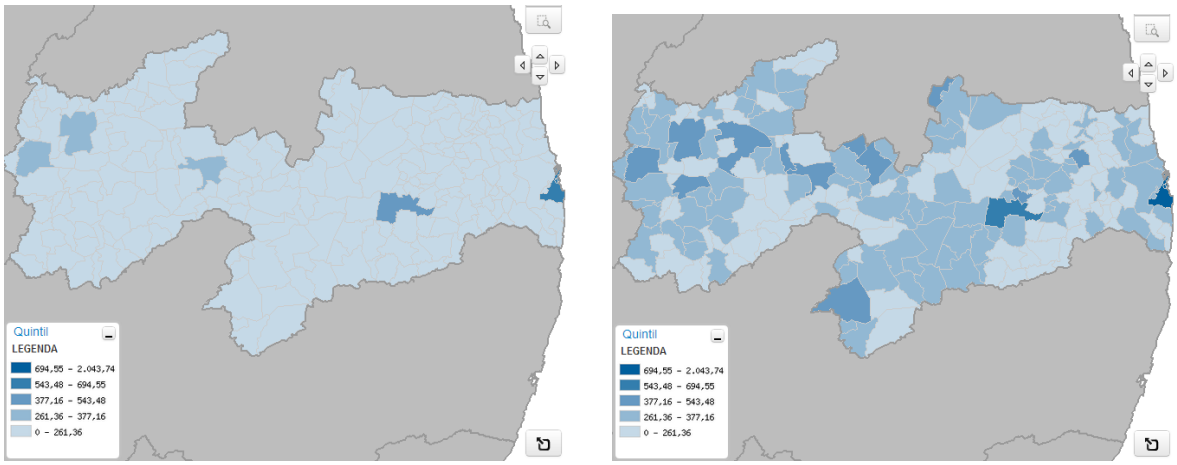
11. Average income per capita closely follows poverty rates. Average income in the majority of municipalities of Paraiba is less than one monthly minimum salary (R$510). Average nominal

[61] World Bank, unpublished data. Author: Aude-Sophie.

[62] Brazil does not have an official poverty line. In recent years, the R$70 and R$140 per capita per month, which are administrative poverty lines defined for the *Bolsa Familia* program and the *Brasil Sem Miseria* Plan, have been increasingly used in place of official poverty lines. The international US$1.25 line is also used on occasion, notably in relation to the Millennium Development Goals (MDG). As a result of methodological differences in the computation of lines and income aggregates, there are sometimes small differences between government and World Bank estimates. However, trends are broadly consistent across methodologies.

household income (monthly) R$660.68; in rural it is just R$252.81. The median is R$330 urban and R$170 rural (Figure A2-4).

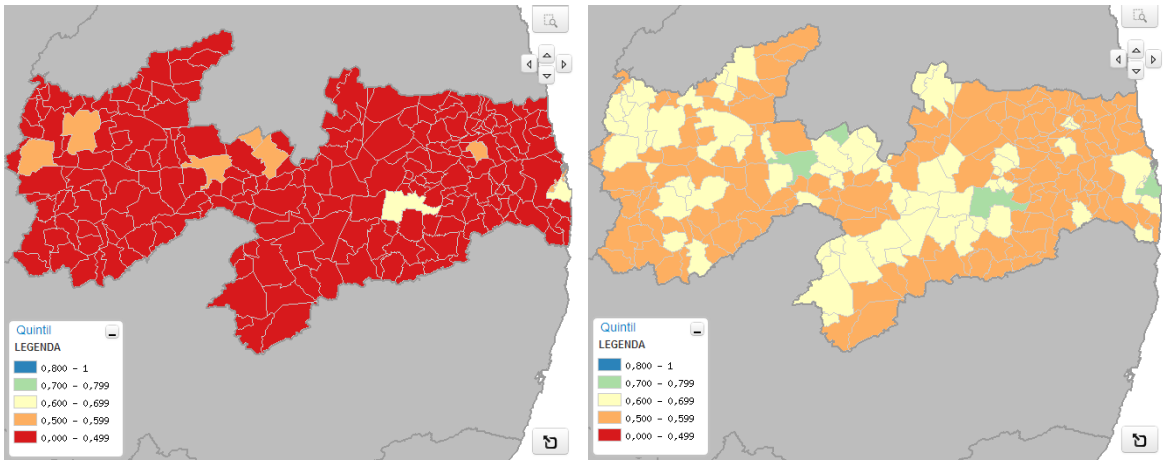
Figure A2 - 4: Evolution of Income per capita, 2000 (left) and 2010 (right)



Source: IBGE

12. The human development index, which accounts for education (literacy and school enrollment rates), longevity (life expectancy at birth) in addition to income (GDP per capita), has improved like other indicators since 2000, but Paraiba remains in the low human development category (Human Development Index – HDI, below 0.499). The municipalities of João Pessoa and Campina Grande consistently stand out on development indicators (Figure A2-5).

Figure A2 - 5: Evolution of Human Development Index, 2000 (left) and 2010 (right)



Source: IBGE

13. Paraiba in 2004, the time of last food security research, had 2.1 million people living with food insecurity. Household income is positively associated with food security. See Table A2-1 and A2-2 below.

Table A2 - 1: Food Insecurity in Paraiba, the Northeast and Brazil[63]

	Paraiba		Northeast Region	Brazil
	Percent households	Total number of people	Percent of households	Percent of households
Less than ¼ minimum salary	20.44%	729,000	21.23%	9.37%
Between ¼ and ½ minimum salary	21.96%	783,000	20.18%	12.45%
Between ½ and 1 minimum salary	11.85%	423,000	12.06%	10.83%
Between 1 and 2 minimum salaries	3.40%	121,000	3.00%	4.51%

Table A2 - 2: Food and Nutritional Security in Paraiba (2004 and 2009)

Food and Nutritional Security in Paraiba		
	2004	2009
Percent of households in situation of food and nutritional security	46.78%	59.04%
Percent of households in situation of food and nutritional insecurity (light)	17.40%	23.52%
Percent of households in situation of food and nutritional insecurity (moderate)	20.76%	10.46%
Percent of households in situation of food and nutritional insecurity (severe)	15.06%	6.97%

[63] http://www.sidra.ibge.gov.br/bda/tabela/protabl.asp?c=3002&z=pnad&o=9&i=P

14. Though 24% of the population in Paraiba is officially classified as rural (2004), the number of food insecure households in rural areas contributes 28% of the total number of food insecure in Paraiba,[64] making food insecurity disproportionately rural.

15. Families on average spend 20% of income on food and acquire 7.5% of their food from their own production or non-monetary acquisition (2008).

16. Food insecurity also disproportionately affects people of color that identify as *negro* or *pardo*. The majority (68.47%) of all the moderate/grave food insecure households in Paraiba are non-white.[65]

17. When measuring vulnerability, it is important to focus on populations that are most at risk of falling beneath the poverty line, into food insecurity, or other measurement of human development and social welfare. To be systematic the set of measurements of interest should be determined in advance and prioritized in order to work to avoid the worst outcomes. For example, in the Sahel donors agreed upon a limited set of indicators of resilience-related livelihood outcomes and impacts: Reduction in Humanitarian Assistance Needs, Depth of Poverty, Moderate to Severe Hunger, and Global Acute Malnutrition.[66]

B. Vulnerability is Heterogeneous

18. To capture why vulnerability varies between individual to individual, household to household, vulnerability can be seen as the function of three factors: (i) sensitivity, (ii) adaptive capacity, and (iii) exposure.[67]

i. **Sensitivity** is the degree of impact of the initial shock. Sensitivity can be thought of as the elasticity of household welfare (e.g. consumption levels) in response to a shock.
ii. **Adaptive capacity** is the ability of the household to access ex-post coping strategies that helps the household return to pre-shock welfare levels.[68]
iii. **Exposure** is the probability of the given shock materializing and affecting the household's assets.

19. Several indices have been constructed in Northeast Brazil to measure the socio-economic aspects of vulnerability of smallholder farmers. [69] Two examples are included here, with the first (Table A2-3) focused on the risk of drought and the second (Table A2-4) on conditions of social vulnerability to

[64] http://www.sidra.ibge.gov.br/bda/tabela/protabl.asp?c=3000&z=pnad&o=9&i=P
[65] http://www.sidra.ibge.gov.br/bda/tabela/protabl.asp?c=3026&z=pnad&o=9&i=P
[66] FEWSNET Technical Note on Measuring Resilience, USAID June 2013.
[67] Lindoso et al. 2012. "Indicators for Assessing the Vulnerability of Smallholder Farming to Climate Change: The Case of Brazil's Semi-Arid Northeastern Region." Instituto de Pesquisa Economica Aplicada. International Policy Centre for Inclusive Growth.
[68] Adaptive capacity is a subset of resilience. USAID defines resilience as the ability of people, households, communities, countries, and systems to adapt to and recover from shocks and stresses in a manner that reduces chronic vulnerability and facilitates inclusive growth.
[69] Sensitivity, adaptive capacity, and exposure can each be measured through a number of indicators, and several vulnerability indices have been formulated to capture the heterogeneity of impacts of agricultural risk for farmers in developing countries. See Lindoso et al. 2012. Supplementary Material for "Integrated Assessment of Smallholder Farming's Vulnerability to drought in the Brazilian Semi-Arid: a case study in Ceará" for a more comprehensive review of the vulnerability index literature and comparison of various indices. Though there is growing consensus that vulnerability is defined by sensitivity, adaptive capacity, and exposure, consensus does not yet exist for what composite of variables should be measured to determine each of these factors.

contribute to economic ecological zoning for the state of Bahia, which otherwise focuses on physical/natural conditions.

Table A2 - 3: IPEA Vulnerability Index – Indicators of the Three Attributes of Vulnerability of Smallholder Farming

	Attribute of Vulnerability	Indicator
Vulnerability of smallholder farming	Sensitivity (S)	Dependency of smallholder farm income on the crop and animal production (%)
		Municipal population occupied in smallholder agriculture (%)
		Establishments with access to water (%)
		Establishments with rainfed farming (%)
	Adaptive capacity (AC)	Smallholder system product diversification (%)
		Establishments in which the producer is the landowner (%)
		Establishments in which the administrator can read and write (%)
		Establishments in which the producer is a member of an association or union (%)
		Establishments that receive technical assistance (%)
		Agricultural establishments with access to electricity (%)
	Exposure (E)	Aridity Index (AI)
		Annual distribution of rainfall

Source: IBGE (SIDRA) and FUNCEME, 2011.

Table A2 - 4: Social Vulnerability Indicators as defined by the State of Bahia Ecological-Economic Zoning Coordination[70]

Analytical Variables	Indicators
1. Quality of Life Dimension	
Social Services	Inhabitants between 3 and 29 years of age per school
	Number of families per PSF team
Household Infrastructure	Households connected to water network
	Households with bathroom
	Households with trash collection

[70] Diagnóstico da Vulnerabilidade Social. SEPLAN/SEMA Bahia.

	Households with sewage system
	Percent of energy supply
	Housing Deficit
2. Living Conditions Dimension	
Social Exclusion	Death from external causes
	Infant mortality
	Number of children between 0 and 4 years of age
	Life expectancy at birth
	Number of illiterate people older than 15 years of age
	Number of people below the poverty line
	Adolescent pregnancy rate
	Household density
3. Economic Conditions Dimension	
Management Capacity	Municipal budget per capita
	Percent of municipal resources generated by the municipality
Work	Percent of PEA relative to population
Production	Diversification of the economy – Sectorial GDP
	GDP per capita
Income	Income per capita
	Concentration of income (Gini)
Land	Concentration of landholdings (Gini)
Population	Population growth

Box A2-1: Formula for Calculating Socio-Environmental Vulnerability[71]

Index of Socio-Environmental Vulnerability = (Aridity Index * Agricultural GDP) / (Municipal HDI * Basic Education Development Index)

20. This annex expands upon these relevant indicators (socio-economic vulnerability index as presented in Box A2-1) and suggests measurements for analyzing vulnerability to drought, the most significant agricultural risk for small farmers in Paraiba. A number of indicators for sensitivity, adaptive capacity, and exposure can be considered to characterize the vulnerability of farmers.

[71] Santos. 2008. Vulnerabilidades socioambientais diante das mudanças projectadas para o semi-arido da Bahia. Doctoral Thesis, Universidade de Brasília.

C. Sensitivity:

21. Sensitivity is the extent of change in a household's welfare (elasticity) induced by a shock.

22. A number of factors influence the sensitivity of a household to an agricultural shock like drought. Prolonged drought affects household incomes most directly by constraining agricultural and livestock yields. However, income diversification and productive diversification, along with ex-ante mitigation measures, can minimize household sensitivity. Measurements of sensitivity of a household should take into account:

- Household revenue diversification, including access to income transfers (Retirement and disability stipends, *Bolsa Família*);
- Agricultural/productive diversification;
- Access to water resources for productive activities and human consumption;
- Number of dependents.

23. A household with diversified income sources, including non-farm income, and diversified agricultural production will be less sensitive to drought because their principal income sources will not all be affected in the same way. Access to water resources is important to minimize sensitivity because household consumption and production is less dependent on rainfall. Finally, a household with a larger number of dependents is likely to have a more elastic initial response to drought because finite household resources must be divided between more people that cannot contribute substantially to household revenues. However, this is somewhat offset by the fact that these dependents qualify the household to receive social transfers (*Bolsa Família* for children and retirement for adults), so the baseline of these households' revenues may even be higher than without dependents.

24. Fortifying these kinds of characteristics/assets help to mitigate the impact of a shock, reduce sensitivity, and reduce vulnerability.

a) <u>Income Diversification</u>

25. A farming household that has little or no income diversification is more sensitive to an agricultural risk than a household that has a stream of income from non-farm economic activities. In Paraiba, like much of rural Northeast Brazil, agricultural activities are generally the dominant form of occupation (Figure A2-6). In many municipalities of Paraiba, employment in agricultural activities is over 50%. The service industry is the second most important sector of work and often includes public employment (Figure A2-7). 87% of agricultural units in Paraiba classify as family farming (less than four fiscal modules with predominantly family labor).

Figure A2 - 6: Percent of people over age 18 occupied in agriculture/livestock

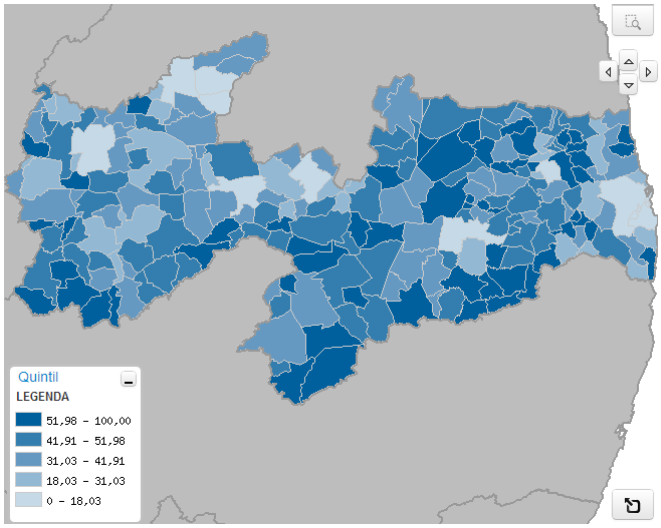
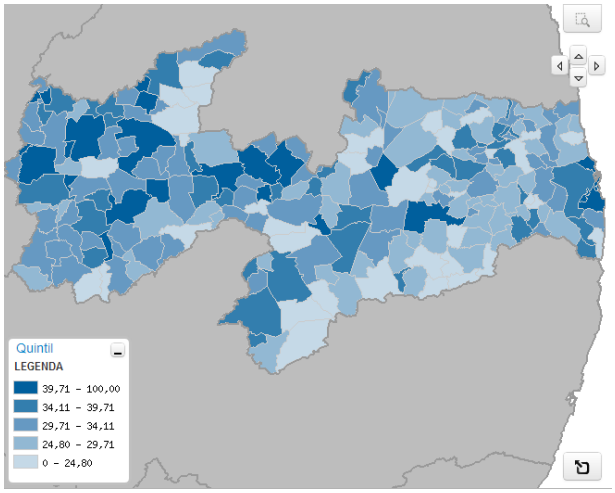


Figure A2 - 7: Percent of people over age 18 Occupied in Service Industry



Source: IBGE

26. However, data on sources of income shows that in reality, families' incomes rely to a large extent on income transfers and public employment. This situation has been referred to as the *novo mundo rural atrasado* – the "new backward rural world."[72]

27. In Paraiba, about 29% of the average monthly family income relies on state transfers (R$493.24), compared to 22.5% average dependency on transfers for the Northeast and 18.5% for Brazil as a whole.[73] A little more than half of family income comes from work (54.9%) and 12.5% from non-monetary income (such as own-production).[74] Retirement stipends from the National Institute for Social

[72] Pedreira 2002
[73] Pesquisa de Orçamento Familiares, 2008. Sidra/IBGE.
[74] Though state-level data disaggregated by rural/urban is not available, for reference at the national level, 20.5% average monthly family income comes from transfers, 53.6% from work, and 18.7% from non-monetary income.

Security (INSS) provides 17% of total monthly family income, on average, in Paraiba, but for families with between R$830 and R$1,245 monthly income, the INSS retirement pension reaches 31.4% of total income, an average of R$321 per month. The INSS pension is equivalent to one minimum salary (R$510) for one person; people in rural areas are eligible for retirement stipends at age 60 for men and 55 for women, as long as their income is less than ¼ minimum salary.[75] There are 32,975 beneficiaries of BPC Old Age and 62,658 beneficiaries of BPC Disabled Persons in Paraiba.

28. *Bolsa Familia* and other federal level transfers are significant, but make up just 2% of total monthly family income in Paraiba (Table A2-6).

Table A2 - 5: Registered Families in the Single Cadaster in Paraiba[76]

	No. of registered families	No. of registered people
Total number registered in *Cadastro Único*	847,339	2,554,720
Registered monthly income between R$140 and ½ minimum salary	126,458	354,221
Registered monthly income between R$70 and R$140	110,811	386,929
Registered monthly income less than R$70	548,094	1,715,275
Beneficiaries of Bolsa Família	508,956	n/a

29. Considering that there are 111,442 family agriculture units in Paraiba, less than a third are registered in the Single Cadaster organized by the Ministry of Social Development. The Single Cadaster (*Cadastro Único*) is used to identify and register families living in poverty and extreme poverty. Registration in the Cadaster is necessary for access to 19 federal transfer programs, including *Bolsa Familia* and *Bolsa Estiagem*, but not *Garantia Safra* or federal retirement stipends.

30. In May 2014, there were 508,956 families receiving Bolsa Familia with a total value over R$81 million. Families received on average R$159.22 per month. 87 percent of beneficiary families have children between the ages of 6 and 15 years of age, reaching a coverage level of 94% of eligible families with children in this age range. See Table A2-7 below.

[75] http://inss.net/amparo-assistencial-ao-idoso.html
[76] Ministério de Desenvolvimento Social, http://aplicacoes.mds.gov.br/sagi/RIv3/geral/relatorio.php#Coordenação Estadual do PBF

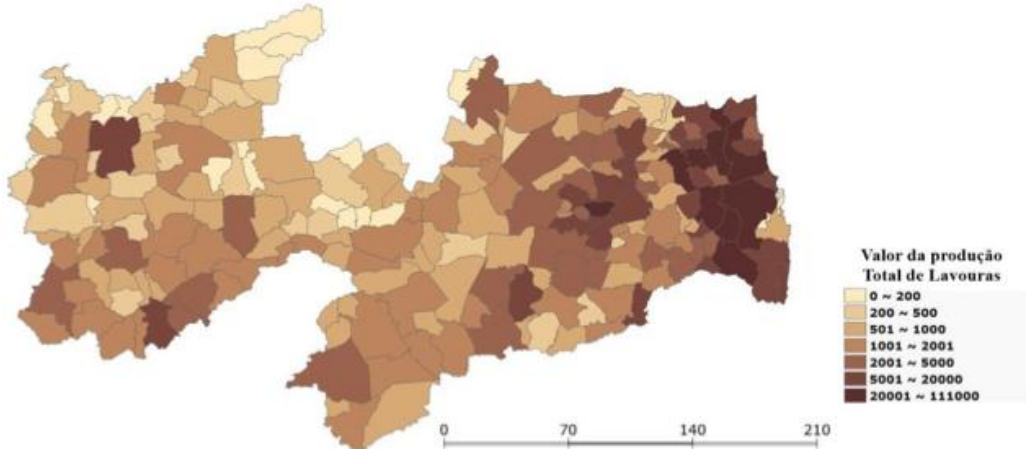
Table A2 - 6: Registered Family Agriculture Families and *Bolsa Família* in Paraíba[77]

Number of families practicing family agriculture registered in the Single Registry[78]	34,516
Number of families practicing family agriculture receiving Bolsa Família	27,925
Number of families practicing family agriculture with monthly income between R$140 and ½ minimum salary	3,134
Number of families practicing family agriculture with income between R$70 and R$140	2,436
Number of families practicing family agriculture with income less than R$70	27,515

b) Agricultural Diversification

31. As illustrated in Figure A2-9 below, the areas with the lowest value added of agriculture are in the *Borborema* and *Sertão Paraibano* meso-regions, despite the fact that these are regions where agricultural activity is the primary form of employment.

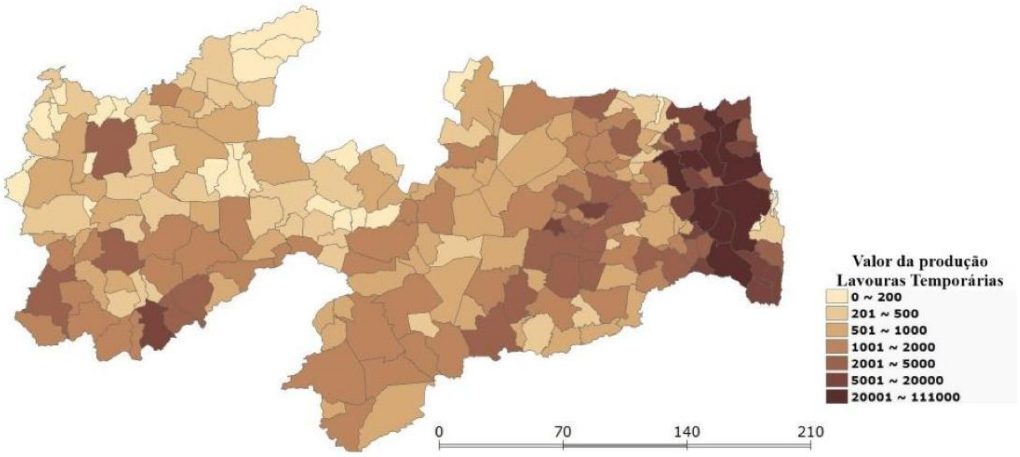
Figure A2 - 8: Value of Agricultural Production from temporary and permanent crops (2009)



32. In the Semi-Arid of Paraiba, farmers concentrate on temporary crops like manioc, maize, and beans (Figure A2-10).

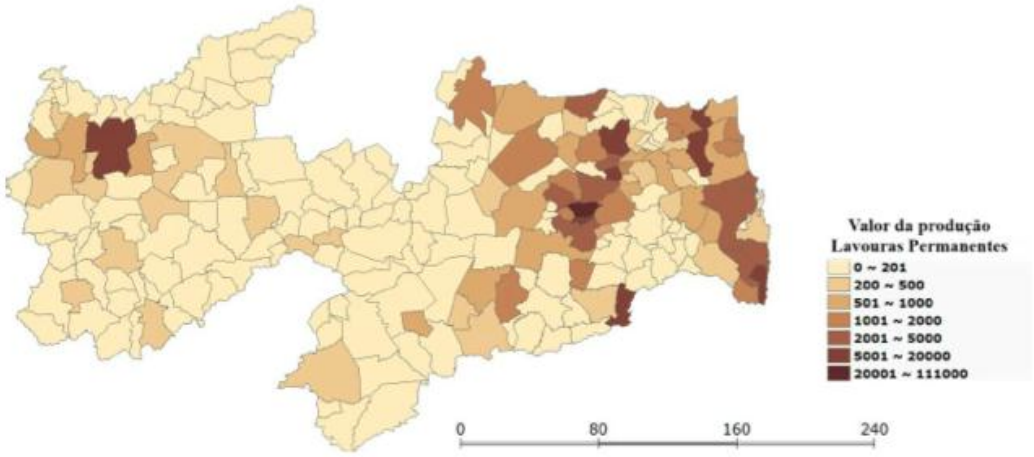
[77] Ministério de Desenvolvimento Social, http://aplicacoes.mds.gov.br/sagi/RIv3/geral/relatorio.php#Coordenação Estadual do PBF
[78] Families that have registered as "agricultores familiares" in the Cadastro Único. These are families whose livelihoods are linked to agricultural activities that rely predominantly on family labor and who produce for self-consumption and sell surplus production.

Figure A2 -9: Value of Agricultural Production from Temporary Crops (2009)



33. Permanent crops like banana, coconut, papaya, mango, and other fruit trees are focused along the coast and *Brejo* micro-regions (Figure A2-11).

Figure A2 - 10: Value of Agricultural Production from Permanent Crops (2009)



Source: IBGE, Produção Agrícola Municipal.

34. An analysis of Agricultural Census micro-data is required in order to quantify the degree of productive diversification on smallholder farms. Households typically rely on a couple of temporary crops like beans, maize, and manioc, and complement this production with small-scale animal production (mostly goats, sheep, and chickens) as well as forest products like native fruit and nut trees (e.g. umbu and cashew). Temporary crops are more vulnerable to drought and irregular rainfall, which can eliminate an entire harvest or make it impossible to plant. Native plants of the *Caatinga* and *Cerrado* are more resistant to dry spells and support food security in these times. However, these trees however are sometimes used for firewood in times of drought when there is little fuel available, thereby eliminating a source of food and income in the longer term.

35. Though the traditional production system focuses on manioc, corn, and beans for subsistence and sale of surplus, livestock is an important component in the rural economy, particularly goats. Goats are known to be well adapted to the dry climate and provide meat and milk for producers. Agricultural production accounted for 68% and livestock 32% of total value of agricultural activities in Paraiba (2006). Livestock is proportionally more important in Paraiba compared to the rest of the Northeast, where livestock contributes 22% of total agricultural value.

36. Between 2010 and 2012, livestock production declined about 20% across municipalities of the Semi-Arid, drastically hit by drought. Livestock suffer not only in the absence of water, but also in the absence of forage material. Typically goats and sheep forage through pasture for food, but in times of drought this vegetation dies and smallholders do not have the resources to purchase food for the animals. Most farmers in dry areas rely on collective pasture (called *fundos de pasto* for goat/sheep livestock, more common in drier areas, and *fecho de pasto* for cattle) for animal forage. These communal pasturelands often rely on collective action to avoid environmental degradation.

37. Households can also diversify agricultural production and incorporate adaptive or drought-resistant crops. A new breed of drought- and pest-resistant cactus (*palma*) recently developed by agricultural research agencies is being disseminated. Storage facilities for animal forage help provide feed for animals during drought months when vegetation is limited.

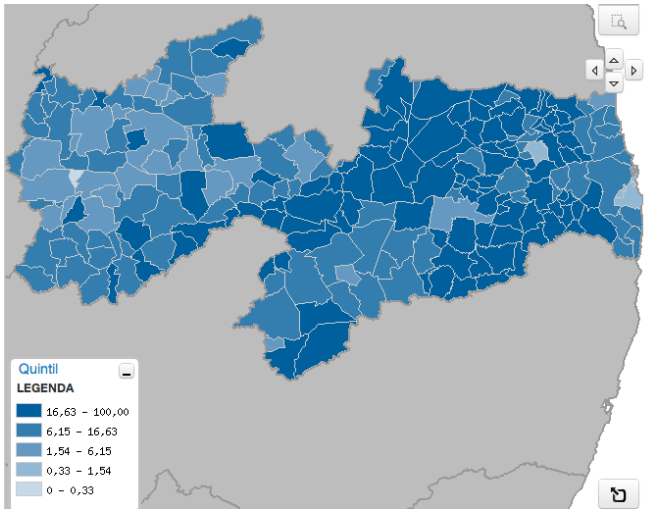
38. Other adaptive and good agricultural practices can bring significant reductions in sensitivity to drought. Soil conservation and the integration of organic matter are important to retain soil moisture.

c) Water Access

39. Despite severe droughts, Paraiba is not devoid of water resources and actually has a number of rivers and lakes. The federal government through the program Water for All (*Água para Todos*) in partnership with state and municipal government build water storage infrastructure like cisterns, wells, and small dams – principally for home consumption, but also on a smaller scale for crop irrigation and animal drinking water.

40. Still, water and sanitation are significant hurdles for rural families especially during drought (Figure A2-12).

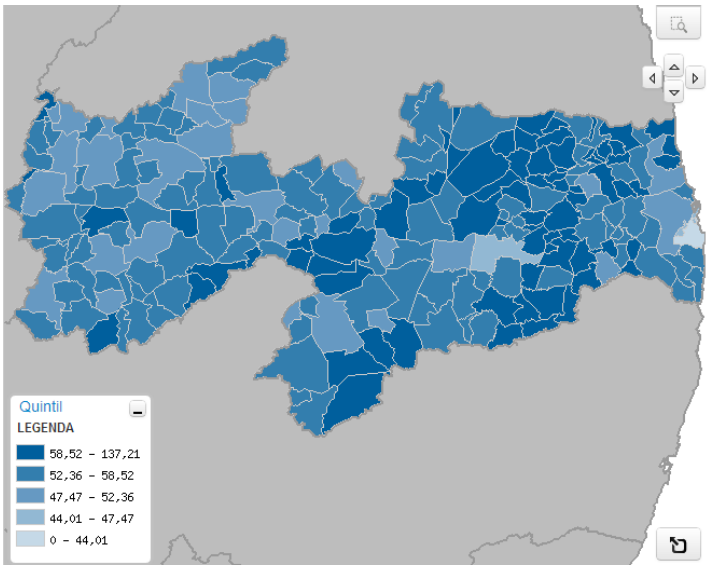
Figure A2 - 11: Percent of People in Households with Inadequate Access to Water and Sanitation[79]



d) Dependency

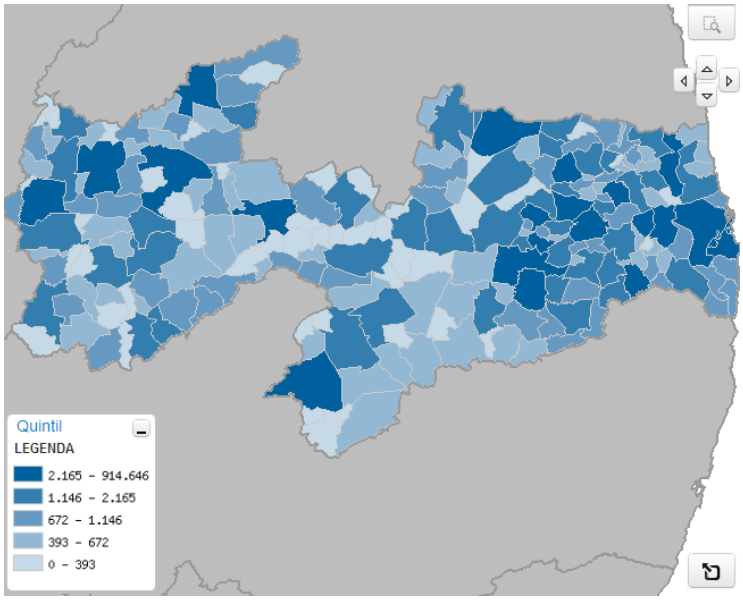
41. Finally, the last important aspect of sensitivity is the number of dependents per household. Paraiba, like much of the rural Northeast, has experienced rural out-migration over the last decades whereby the economically active population leaves rural areas. The dependency ratio (ratio of population less than 15 and more than 65 to the population between 15-65 years of age) is very high throughout Paraiba, especially in some of the poorer meso-regions like the *Borborema* and *Northern Agreste*. This means that it is common that over 58% of the population in these regions is either under age 15 or over age 65 (Figures A2-13 and A2-14, respectively).

Figure A2 - 12: Dependency Ratio



[79] http://www.atlasbrasil.org.br/2013/pt/consulta

Figure A2 - 13: Number of People over 65



D. Adaptive Capacity:

42. Households' access to ex-post coping strategies is closely linked to poverty, social marginalization, and access to public policies. Ex-post coping strategies are diverse. Migration and off-farm work has long been a coping strategy in the Northeast to compensate for loss of production/livestock due to drought; communities and social networks often emerge to help one another in times of need; and state and federal governments have a variety of emergency measures to help families maintain welfare levels during drought like cash, animal feed, and seed transfers.[80]

43. Measurements of adaptive capacity in Paraiba should include the following components:

- Literacy/education level;
- Social inclusion;
- Land title for security of tenure, including pasture land, and to access PRONAF credit;
- Social capital ("horizontal" and "vertical" ties, including membership in producer organizations and patronage arrangements);
- Access to technical assistance and research/technology transfer;
- Access to markets;
- Access to emergency coping services (distribution of food, seed, and fertilizer).

44. The exposed above are forms of capital that facilitate recovery after a shock. Interventions to increase adaptive capacity can consider investing in these categories. The concept of intersectionality

[80] Small farmers in the Northeast do not have access to true risk transfer mechanisms, which could also be considered as a strategy for adaptive capacity. Garantia Safra is not a "true" insurance but rather a fund. Premiums are not calculated by an actuary to reflect risk; every participating farmer pays the same premium and receives the same payout if the index is triggered.

applies in this context, meaning that overlapping disadvantages (e.g. someone with more than one historically marginalized identity like gender and ethnicity) typically present greater social exclusion; i.e., someone with various disadvantages tend to be more socially excluded, than someone with just one disadvantage.

45. Conversely, many of these categories reinforce one another. Social capital can support access to markets and technical assistance; extension agents are more likely to work with organized groups of producers, and group organization can facilitate access to markets.

a) Land Tenure

46. Secure land tenure is an important asset that enables access to coping strategies. Title is required to access PRONAF credit, among other forms of credit, in addition to conveying security of ownership. Property ownership is also important to retain possession of land in times of hardship; people renting land may lose access to land when they cannot produce the resources to pay for rental, either cash or through sharing a portion of agricultural production with the owner (sharecropping). In the Semi-Arid, 69.6% of family farming plots have legal title. For the roughly 76,000 households engaged in livestock and ranching in Paraiba, about 75% own the land on which the animals are raised.

47. Secure tenure is particularly important for pasture for animals (Table A2-8). The three meso-regions with the most livestock producers are the *Agreste Paraibano* (38% of all producers), *Sertão Paraibano* (35%), and *Borborema* (21%). In each of these, ownership is most common, but occupants are the second most frequent category of producers, respectively 14%, 8%, and 12% in *Agreste*, *Sertão*, and *Borborema*.

Table A2 - 7: Tenure Systems for Livestock, Paraiba (2006)[81]

Type of Tenure	Number of establishments	Percent of total
Owner	57,542	75.7%
Occupant	8,919	11.7%
Producer without land	3,837	5.0%
Settled without definitive title	2,772	3.6%
Partnership	1,511	2.0%
Rental	1,469	1.9%

[81] http://www.sidra.ibge.gov.br/bda/tabela/protabl.asp?c=1244&z=t&o=11&i=P

Total	76,050	100%

48. In times of drought, a critical coping strategy is moving the herd to pasturelands that have retained vegetation (Figure A2-15). Whether or not a rancher has access to pasture reserves is an important factor of adaptive capacity. Collective action to preserve communal pasture land is important, but rarely are these lands titled and ranchers must be able to defend outsiders from using their land, which is not always possible especially in times of drought when competition for resources is high. Other ranchers, miners, and land-grabbers also threaten ownership of common lands.

Figure A2 - 14: Schematic Cycle of Land Tenure and Vulnerability for Semi-Arid Ranchers[82]

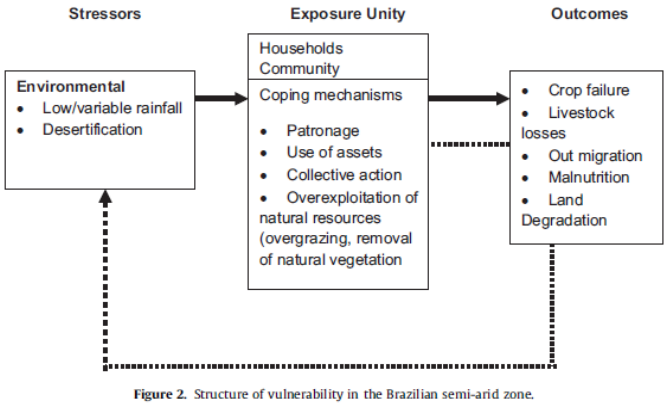


Figure 2. Structure of vulnerability in the Brazilian semi-arid zone.

49. It is more common to raise goats on common pasturelands because they require less investment in fodder than bovines and are lower-value than cows. Fabiano and Holanda (2008) conclude that ranchers who use common pasturelands are less vulnerable to droughts because goats are better adapted to very dry conditions and require fewer resources to maintain.

50. Land occupation, without title, is even higher for temporary crops in Paraiba (Table A2-9).

Table A2 - 8: Tenure Systems for Temporary Crops, Paraiba (2006) [83]

Type of Tenure	Number of establishments	Percent of total
Owner	41,711	59.8%
Occupant	14,095	20.2%
Producer without land	2,922	4.2%
Settled without definitive title	3,103	4.4%

[82] Toni, Fabiano and Evandro Holanda. 2008. The effects of land tenure on vulnerability to droughts in Northeastern Brazil. Global Environmental Change 18, 575-582.
[83] http://www.sidra.ibge.gov.br/bda/tabela/protabl.asp?c=1244&z=t&o=11&i=P

Partnership	4,067	5.8%
Rental	3,874	5.6%
Total	69,772	100%

51. About one third of total agricultural establishments with temporary crops are located in the *Sertão Paraibano* and 40% in the *Agreste Paraibano*, where roughly half of all properties with temporary crops have title. Land ownership with title for permanent crops, typically of higher value, is much higher (80%).

52. The Land Fund (*Crédito Fundiário*) is run by INTERPA, the Paraiba Institute for Land and Agricultural Planning, regularizing land tenure by granting title to the land of occupants or facilitating land purchase by offering subsidized loans to land-poor farmers. INCRA is more active in redistributing land and creating agrarian reform colonies.

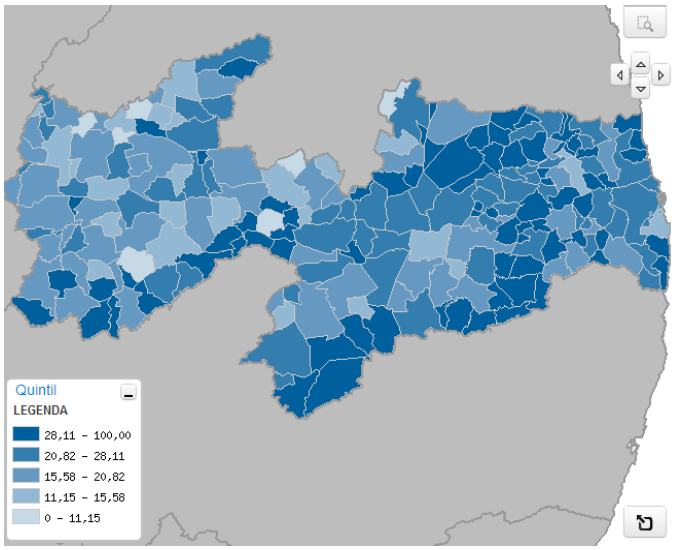
b) Literacy and Education Levels

53. Literacy and education levels play an important role in adaptive capacity because they mediate the kinds of non-farm employment a person can access. Literacy and education also serve as a proxy for a person's general capacity to connect to a wide range of coping strategies to drought.

Amongst households with all members at least 10 years of age, the average number of years of study is 5.8 years. Illiteracy rates in population of 15 years and older is 18.59% (2012).

54. Women with low levels of education that are heads of households with small children are surprisingly common in Paraiba (Figure A2-16), surpassing 28.11% of all households in some of the poorest municipalities of the state. The heavy demands on the single parent's time of children make it more difficult to seek alternative employment and adaptive strategies. It is not possible from this data to say, though, if these families are receiving remittances from a male partner who has migrated or if the female household head is a single mother.

Figure A2 - 15: Percent of Household Heads that are Women who have Not Completed Fundamental Education and have Children less than 15 years of age



c) Social Inclusion

55. Members of historically marginalized social groups like women, *quilombolas*, indigenous, and agrarian reform settlers have particular barriers to accessing adaptive strategies.

56. *Quilombolas* and indigenous peoples, historically marginalized via discrimination and physically remote areas, face particular barriers to recover after a shock due to lower access to services and distance to markets. Paraiba has 25,043 indigenous people, 19,525 of which live in indigenous reserves.

57. Female heads of households are typically disadvantaged in terms of seeking adaptive strategies. As Luiz Gonzaga famously sung, *´Paraíba masculina, mulher macho sem senhor´*, Paraiba has a long history of disproportionate male out-migration, leaving women behind to tend the farm and the family. Female-headed households are high in Paraiba (Table A2-10).

Table A2 - 9: Household Characteristics

Micro-regions	Women headed households[84]	Male headed households	Percent female headed households	Total private households[85]	Percent literacy of women heads of households[86]	Percent literacy of male heads of households
Catolé do Rocha - PB	11.136	21.245	34%	32.396	64%	57%
Cajazeiras - PB	16.274	31.928	34%	48.206	69%	64%

[84] http://www.sidra.ibge.gov.br/bda/tabela/protabl.asp?c=3221&z=cd&o=7&i=P
[85] http://www.sidra.ibge.gov.br/bda/tabela/protabl.asp?c=3168&z=cd&o=7&i=P
[86] http://www.sidra.ibge.gov.br/bda/tabela/protabl.asp?c=3221&z=cd&o=7&i=P

Sousa - PB	17.88	34.05	34%	51.940	67%	60%
Patos - PB	14.662	21.435	41%	36.110	75%	71%
Piancó - PB	6.288	13.721	31%	20.019	58%	53%
Itaporanga - PB	7.219	15.623	32%	22.847	62%	57%
Serra do Teixeira - PB	12.673	19.129	40%	31.816	62%	59%
Seridó Ocidental Paraibano - PB	4.089	7.39	36%	11.481	75%	65%
Seridó Oriental Paraibano - PB	7.82	13.313	37%	21.138	71%	61%
Cariri Ocidental - PB	15.52	22.437	41%	37.972	72%	62%
Cariri Oriental - PB	6.883	11.858	37%	18.742	73%	63%
Curimataú Ocidental - PB	13.575	21.299	39%	34.881	63%	57%
Curimataú Oriental - PB	10.291	15.615	40%	25.915	57%	49%
Esperança - PB	6.512	9.105	42%	15.618	66%	65%
Brejo Paraibano - PB	11.513	20.155	36%	31.672	57%	53%
Guarabira - PB	17.688	30.032	37%	47.729	61%	59%
Campina Grande - PB	59.361	86.245	41%	145.648	80%	81%
Itabaiana - PB	12.348	19.366	39%	31.718	57%	53%
Umbuzeiro - PB	5.972	8.941	40%	14.918	58%	49%
Litoral Norte - PB	13.644	25.852	35%	39.501	58%	59%
Sapé - PB	14.911	22.216	40%	37.132	58%	55%
João Pessoa - PB	126.052	174.598	42%	300.729	85%	87%
Litoral Sul - PB	7.549	14.994	33%	22.544	61%	64%

58. The majority ethnicity in rural Paraíba is *parda*, about two-thirds of the rural population. Whites make up the next largest group, 26.5% of the rural population (Table A2-11).

Table A2 - 10: Ethnicity in Rural Paraiba and Northeast

	Percent of Total PB Population	
Ethnicity	**Paraiba**	**Northeast**
White	5.15%	6.03%
Black (*negro*)	0.95%	1.90%
Parda	13%	18.47%
Amarela	0.14%	0.02%
Indigenous	0.17%	0.16%
Total Rural Population	19.41%	26.58%

d) Social Capital

59. Social capital is an important factor for resilience to risks. Social capital can be both horizontal (between people with the same relative power within a community) and vertical (patronage or clientele relationships between differential powers).

60. Social relationships between community members are important to analyze, as communities with strong social ties may pool resources together in times of hardship.[87] However, formal membership in associations was described as weak in qualitative interviews in Paraiba. There is not a strong tradition of association formation in the Northeast compared to other places regions in the country, such as the South. Just 6.74% are of the interviewees were associated to a union.[88] However, it was highlighted that incentives to organize the society must exist, since it is unlikely to happen spontaneously; with limited public technical assistance available and resources distributed without the need of social formally arrangements (associations, cooperatives, etc.), incentives for formal organization are limited. Councils for Sustainable Rural Development are comprised of producer associations and municipal government representatives to discuss municipal development planning, but experts noted that participation can be erratic since representatives do not receive financial compensation for transportation costs or time.

61. The Northeast Region presents a long history of patronage arrangements and, many times, facilitate access to public services including investments and emergency responses: "Patronage continues to be the dominant tool for survival," and extreme competition exists over access to scarce state services.[89] The *indústria da seca* (drought industry) is a popular phrase that characterizes the business of drought mitigation and emergency efforts in exchange or political support. Several interviewees mentioned the fact that Paraiba has a large number of municipalities, given its small size (223 –Pernambuco, a larger State, has 185), as an indicator of political capture and fierce feudalism-type arrangements.

e) Access to Markets, Technical Assistance, and Public Services

62. Drought is a covariate shock, rather than idiosyncratic, meaning that it affects entire communities, municipalities, and territories. While with idiosyncratic shocks, such as the death of a family member, affected households can often turn to their social networks and community organizations for support coping, covariate shocks like drought in areas where there is limited economic diversification affects the resource upon which everyone depends. Typical *agricultura familiar* in the Semi-Arid involves a system of staple crops like manioc, corn, and beans, along with herds of goats and sheep. While rural families consume some of their production, increasingly these crops are sold more often than they are consumed in the household, as cash transfers and remittances from off-farm income supplement household revenues.

63. The lack of diversification between farmers reduces coping capacity of whole regions and increases competition for limited resources, like water and pasture or forage material for animals.

[87] Meinzin-Dick, Ruth. 2014. Social Capital for Resilience. IFPRI Resilience Conference Brief.
[88] http://www.sidra.ibge.gov.br/bda/tabela/protabl.asp?c=1891&z=pnad&o=3&i=P
[89] http://www.tandfonline.com/doi/pdf/10.1080/1366879022000020194

Coping strategies are often very similar and the homogeneity makes for a less resilient system: when farmers seek to sell their animals, as a last resort, many others are attempting to do the same. While there may be cases of collective action to commercialize animals, more commonly, the bump in supply of animal meat exceeds demand and presses down prices.

64. Distance from markets and infrastructure for supply chains are also very limited. Agricultural producers – especially for milk and meat – face challenges marketing their product in the absence of cold storage facilities and distance to markets.

65. A number of productive inclusion projects, including COOPERAR, exist at the municipal level[90] that provide investments in small farmers or guaranteed markets, as in through Food Acquisition Program from smallholders (PAA) for different crops and milk.

66. A number of municipal, state, and federal level relief services exist to support rural populations during drought (See Stocktaking of Projects and Programs related to Agricultural Risk Management in Paraiba), including *Cesta Básica* (food distribution) to traditional populations,[91] Water for All program (investments in emergency water infrastructure), *Garantia Safra* (for municipalities that lose over 50% of agricultural production due to drought). Access to these programs often requires farmers to register as a family farmer, submitting a DAP (Declaration of Aptitude for PRONAF) at a local EMATER office. In 2006, 11,340 establishments received occasional technical assistance, 29% of which could not read or write; 3,985 received regular technical assistance, 24.8% of which could not read or write; and the remaining 151,961 establishments did not receive technical assistance. The majority received assistance from the government, followed by private technical assistance (4,394), and trailed by cooperatives (412) and other organizations.

67. Technology transfer is sporadic and limited in Paraiba, and agricultural research faces a bottleneck at the stage of application to the producer since EMATER is essentially the only institution offering technical assistance and has about 500 agents for the entire state.

E. Exposure:

68. Exposure is discussed in the climate section of this report in greater detail, but the main message is that the Semi-Arid is not homogenous in climate. Aridity indices are often used to measure this aspect of vulnerability.

F. Scales of Vulnerability Analysis

69. In this section, the focus was on vulnerability of the household. However, vulnerability can be measured at different scales of analysis: the individual, household, community, municipality, region, and so on.

[90] http://aplicacoes.mds.gov.br/sagi/RIv3/geral/index.php#
[91] http://aplicacoes.mds.gov.br/sagi/RIv3/geral/relatorio.34%php#Políticas relacionadas ao Acesso à Alimentação Adequada

70. Commonly, it is assumed that households share resources equally and ownership is collective within the household. In reality, ownership of many household assets is not shared and it is rare to find decision-making jointly distributed between heads of households.[92] In a region with a history of male out-migration, women-headed households are fairly common and respondents noted that gender roles allow women to participate actively in agricultural production and important risk-management activities like water use.

[92] IFPRI Gender Assets and Agriculture Project (GAAP)

ANNEX 3: STOCKTAKING OF PROJECTS AND PROGRAMS RELEVANT FOR AGRICULTURAL RISK MANAGEMENT

Name of Project/Program	Year Initiated	Objective and target group	Components and key activities	Executing Units	Cost
FEDERAL PROJECTS AND PROGRAMS					
Garantia Safra[93]	2002	Crop insurance for families with family income less than or equal to 1.5 minimum salary, living in the area under responsibility of Superintendent of Development of the Northeast (Sudene)	Farmers enrolled in *Garantia Safra* that pay a monthly premium receive indemnity if they live in municipalities that lose 50% or more of their harvest. In PB, 141 municipalities, 80,970 beneficiaries were served in 2012/2013 harvest.	MDA	
Water for All[94]	2011	Expand access to water for	Installation of water facilities	Ministry of Integration	

[93] http://www.brasil.gov.br/observatoriodaseca/garantia-safra.html
[94] http://www.integracao.gov.br/web/guest/entenda-o-programa

Name of Project/Program	Year Initiated	Objective and target group	Components and key activities	Executing Units	Cost
		poor rural populations living in extreme poverty without access or with limited access to water. Must be registered in the Single Social Cadaster of the Ministry of Social Development	(cisterns, irrigation kits, small dams) for human consumption and production purposes, as part of *Plano Brasil Sem Miséria*.	National	
Emergency Water Infrastructure projects of Drought Observatory		Provide emergency water services to areas affected by drought and install water infrastructure to mitigate impact of drought in Northeast Brazil	Operation Water Truck (Carro-pipa) [95] distributes emergency water for human consumption; construction of cisterns for human consumption and production; perforation and recuperation	Ministry for National Integration, National Secretary for Civil Defence, with the Brazilian military, in partnership with State Government	

[95] http://www.brasil.gov.br/observatoriodaseca/operacao-carro-pipa.html

Name of Project/Program	Year Initiated	Objective and target group	Components and key activities	Executing Units	Cost
			of wells		
Emergency Credit[96]	2011	Provide R$3.45 billion in credit for rural producers affected by drought in municipalities declared to be in emergency situations as recognized by the National Secretary of Civil Defense. Must live in the area under responsibility of Superintendent of Development of the Northeast (Sudene)	Credit between R$2,500 to R$100,000, with interest rates from 1% to 3.5% per year. In Paraiba, 203 municipalities were reached in 51,178 operations with a total of R$284 million contracted.	Constitutional Fund for Financing of the Northeast (FNE) through *Banco do Nordeste* Ministry of Finance	R$3.45 billion in credit
Bolsa Estiagem[97]	2004	Cash transfer to family farmers living in municipalities declared to be in emergency	Families receive R$80 monthly. 203 municipalities, 87,879 beneficiaries	Ministry of National Integration, Ministry of Agrarian Development, Ministry of	Monthly cost of R$95.1 million

[96] http://www.brasil.gov.br/observatoriodaseca/linha-de-credito.html
[97] http://www.brasil.gov.br/observatoriodaseca/bolsa-estiagem.html

Name of Project/Program	Year Initiated	Objective and target group	Components and key activities	Executing Units	Cost
		situations as recognized by the National Secretary of Civil Defense.	in PB	Social Development	
Insurance for Family Farming (SEAF)[98]	1991	Family farmer crop insurance for producers that receive PRONAF	Farmer pays 2% of total insured value and Federal Government pays rest of premium. Farmers with 30% of production lost	Ministry of Agrarian Development	
Subsidized Sale of Maize[99]		Provide purchase of maize from family farmers and subsidized sale of maize for animal feed of family farmers in regions affected by drought	Subsidized sale of maize for animal feed at price between R$18.10 and R$24.60. As of March 2014, 115,925 tones were distributed to 20,100 beneficiaries in PB.	CONAB	

[98] http://portal.mda.gov.br/portal/saf/programas/seaf/2259694
[99] http://www.brasil.gov.br/observatoriodaseca/venda-de-milho.html

Name of Project/Program	Year Initiated	Objective and target group	Components and key activities	Executing Units	Cost
Minimum Price Guarantee Policy (PGPAF)[100]	2006	Support family farmers that access PRONAF credit in case of price volatility	Farmers receive discount on credit financing if market price of product drops	MDA	
Program for Price Guarantee Policy (Premium for Product Outflow - PEP, Premium for Product Equalization - PEPRO, Federal Government Acquisitions - AGF)	2006	Rural producer or cooperative receives subsidy or can directly sell production to Federal Government when market price is below the Reference Value price or minimum price for certain crops.	Equalizing Subsidy Paid to Producer (PEPRO)[101], Subsidy for the Distribution of Product (PEP)[102], Acquisition of Federal Government (AGF)[103]		
National School Feeding Program (PNAE)[104]	2009	Support family farmers by purchasing their production for	At least 30% of federal resources provided for school meals	National Fund for the Development of Education (FNDE) and	US$ 37.5 million

[100] http://portal.mda.gov.br/portal/saf/programas/pgpaf
[101] http://www.conab.gov.br/OlalaCMS/uploads/arquivos/f96401d39edbdc51b3c0d399086e0ea9..pdf
[102] http://www.conab.gov.br/OlalaCMS/uploads/arquivos/be89e510efd3cef55fdd7687215b1dcc..pdf
[103] http://www.conab.gov.br/OlalaCMS/uploads/arquivos/f70c4d5eb82e352a8922ca0854ec5270..pdf
[104] http://comunidades.mda.gov.br/portal/saf/programas//alimentacaoescolar

Name of Project/Program	Year Initiated	Objective and target group	Components and key activities	Executing Units	Cost
		local school meals	must be used on the purchase of food from family farmers, giving priority to family farmers in the same municipality as the school	Ministry of Agrarian Development (MDA)	
National Program for Acquisition of Food from Family Farmers (PAA)	2003	Promote access to food to people facing food insecurity, promote social and economic inclusion in the rural areas by strengthening family agriculture	Purchase with Immediate Donation (CDS), Support for the Formation of Stocks (CPR-ESTOQUE), and Direct Purchase from Family Farming (CDAF)	Ministério do Desenvolvimento Social (MDS) e Secretaria Estadual de Desenvolvimento Agrário e Secretaria de Desenvolvimento Social e Combate à Pobreza - SEDES	US$ 3.75 million
Venda em Balcão[105]		Sell grains from national stocks to small-scale livestock producers throughout	Corn, rice, wheat, and nuts for animal feed at subsidized price for producers	CONAB	

[105] http://www.conab.gov.br/conteudos.php?a=559&t=2

Name of Project/Program	Year Initiated	Objective and target group	Components and key activities	Executing Units	Cost
		Brazil	when necessary.		
Unified System of Agricultural and Livestock Health (SUASA)[106]	2006	National unified system for sanitary inspection allows commercialization anywhere within Brazil once approved.	Municipalities have to apply to adhere to the system.	MDA in coordination with state and municipal governments	
Institute for the Semi-Arid (INSA) Projects	2012	Coordination, research, and outreach for Brazilian Semi-Arid region	Promotion of innovation and applied research on themes of desertification, water resources, biodiversity and sustainable use, production systems, development and social technologies, and information management.	Ministry of Science, Technology, and Innovation	

[106] http://portal.mda.gov.br/portal/saf/programas/suasa

Name of Project/Program	Year Initiated	Objective and target group	Components and key activities	Executing Units	Cost
STATE PROJECTS AND PROGRAMS					
Paraiba Second Rural Poverty Reduction Project (COOPERAR II)		Promote sustainable rural development and participatory governance through grant financing to producer associations throughout the state for agricultural and water/sanitation investments	Municipal Councils for Sustainable Rural Development propose a community development project for grant financing and technical assistance.	World Bank, Projeto Cooperar	US$20.9 million loan from World Bank, plus US$4.8 million from PB and US$2.46 from local communities.
Project Cooperar		Promote sustainable rural development and participatory governance through grant financing to producer associations throughout the state for agricultural		World Bank	

Name of Project/Program	Year Initiated	Objective and target group	Components and key activities	Executing Units	Cost
		and water/sanitation investments			
State Program of Seed Production and Distribution		Provide maize, beans, and cotton seeds to family farmers with less than half a minimum salary	Support PB self-sufficiency in production and distribution of high quality seeds	SEDAP	
Paraíba Milk Program	2003	Purchase milk from family farmers; provide milk to poor populations with high nutritional needs (pregnant, lactating, children under age 6, elderly without retirement stipend)	Benefits 120,000 families living under the poverty line in 123 municipalities of PB, each receiving 1L of milk per day. Purchases milk from 3,600 producers who benefit from guaranteed market	SEDAP	
Cariri and Seridó Sustainable Development	2012	Reach 18,000 rural households in 5 micro-	Local capacity building, improve smallholder	International Fund for Agricultural Development,	US$48 million (50% IFAD, 34% State Government,

Name of Project/Program	Year Initiated	Objective and target group	Components and key activities	Executing Units	Cost
Project (Procase)[107]		regions of PB: Cariri Ocidental e Oriental, Seridó Ocidental e Oriental, and Curimataú Ocidental.	production and market competitiveness, promote farming practices resilience/adaptive to drought	SEDAP	16% farmer associations)
State Irrigation Project of Várzea de Souza (Pivas)		Irrigation project for Alto Sertão Region to reach 178 small producers and 141 agrarian reform settlement families.	Install irrigation for 4,390 hectares for fruit and sheep production, experimental agricultural stations, and an agrarian reform settlement.	SEDAP	
State Program for Agriculture/Livestock Defense		Program to register, inspect, and enforce sanitary conditions for the production and circulation of agriculture and livestock	National Programs for Control, Eradication, and Prevention of Foot and Mouth Disease (PNEFA); Control of Rabies	SEDAP	

[107] http://www.ifad.org/media/press/2012/63.htm

Name of Project/Program	Year Initiated	Objective and target group	Components and key activities	Executing Units	Cost
			(PNCRH); Sanitary Education (PNESA); Horse Health (PNSE); Sheep and Goat Health (PNSCO); Swine Health (PNSS); Aquatic Animal Health (PNSAA); Bee Health (PNSAp). Program of Animal Transit and Quarantine.		
State Program for Plant Sanitary Defense		Program to prevent, monitor, control, and eradicate plant pests, with focus on several priority crops: banana, citrus, grape, sugar, and forage cactus	Maintenance of pest free area, monitoring and sanitary control, transit enforcement, and pesticide use.	SEDAP	
State Business for	1976	Provide applied	Experimental agricultural	State Secretary of	

Name of Project/Program	Year Initiated	Objective and target group	Components and key activities	Executing Units	Cost
Agricultural/Livestock Research of Paraíba (EMEPA) Projects		research for family farmers and agribusiness in Paraiba and help form state public policy in agricultural sector.	research stations	Science and Technology, SEDAP, and can capture resources from external sources (e.g. COOPERAR)	
EMATER Projects		Advisory and extension services for family farmers in Paraiba. 184,000 family farmers served in Paraiba.	Registration of family farmers, support for access to family farming public policies and services, support for commercialization, agroecological transition, food and nutritional security, assessment of losses to calibrate *Garantia Safra*.	SEDAP	R$244 million (2012)

Name of Project/Program	Year Initiated	Objective and target group	Components and key activities	Executing Units	Cost
Sertão Emprendedor [108]		Over 1000 municipalities in the Semi-Arid region of 9 Northeastern states	Support for projects of water conservation, production and conservation of animal forage.	SENAR, SEBRAE	
Programa de Formação e Mobilização Social para a Convivência com o Semiárido	2003	Support the construction of participatory processes for rural development in the Brazilian Semi-Arid to promote food sovereignty and security through sustainable income generation.	One Land Two Waters (P1+2)[109] and One Million Cisterns (P1MC) support sustainable income generation. *Articulação do Semi-Arido* (ASA) represents close to 1,000 NGOs in the Northeast.	*Articulação do Semi-Arido*	

[108] http://www.senar.org.br/programa/sertao-empreendedor
[109] http://www.asabrasil.org.br/Portal/Informacoes.asp?COD_MENU=1151

ANNEX 4: OUTLINE OF WEATHER RISK MANAGEMENT RELATED PROGRAMS AND PROJECTS

As a result of recurrent droughts, many initiatives of risk management were created, mainly by the Federal Government and institutions but also by State institutions. The most important ones are listed below.

The **MINISTRY OF AGRICULTURE, LIVESTOCK AND SUPPLY (MAPA)** is responsible for the Agricultural Climate Risk Zoning (ZARC), which aims to minimize the risk related to weather phenomena, and allows identify the best moments for planting in selected municipalities considering different types of soil and crop cycles. Based on these parameters it is estimated that 2 out of 10 years face considerable losses when the planting is done on the recommended period. The ZARC started in 1996 for the wheat crop and nowadays it includes 40 crops, 16 of annual cycle and 24 permanent crops, covering 24 states (BRACALE, 2012).

The **FEDERAL GOVERNMENT** created by law nº 5,969, from December 11th 1973, the Agriculture and livestock Activity Guarantee Program (PROAGRO) (Table 1). Basically the covered risks are adverse weather phenomena, plagues and diseases afflicting crops and livestock. The PROAGRO is a public insurance operated by the financial institutions. Its management is under the responsibility of the Central Bank of Brazil (BACEN), which articulates permanently the Ministries of Finance (MF), Planning, Budget and Management (MPOG), Agriculture, Livestock and Supply (MAPA) and Agricultural Development (MDA). The revenue of the PROAGRO is constituted in its majority by the Federal Government funding. On the other hand, payment of coverage (indemnity) constitutes the biggest portion of the expenses. The claim adjustment to confirm the losses are done by technical assistance institutions. The farms eligible for PROAGRO are the ones which are associated with agricultural costing, funded or not, and the they should necessarily follow the ZARC recommendations, except the properties which are associated to the National Program for Family Farming Strengthening (PRONAF) and the ones located in states not covered by the ZARC. The maximum liability per agent of the PROAGRO is US$ 130,434 (Resolution nº 4,111/12). The insurable risks are: a) Excessive rainfall, frost, hail, drought, excessive temperature oscillations, strong winds, cold winds, and disease and plagues without methods of control; b) on livestock costing credit operations: losses incurred by diseases without methods of prophylaxis. The compensation of the program may range from 70% to 100% of the coverage limit. In case where there is irrigation in the farm the compensation will be 100% of the coverage. The PROAGRO premium rates are: i) 1% for irrigated farms; ii) 2% for the farms associated to PRONAF, except irrigated farms; iii) 3% for the others; and, iv) 5% for the non-funded farms (OZAKI, 2013);

The **FEDERAL GOVERNMENT**, through the resolution nº 3,234/04, created the Agriculture and livestock Activity Guarantee Program for the Family Farmers (PROAGRO MAIS). The difference between PROAGRO, also known as TRADITIONAL PROAGRO, and the PROAGRO MAIS, is the target public. The PROAGRO MAIS focuses only on the Family Farmers and the TRADITIONAL PROAGRO aim the remaining farmers. The PROAGRO MAIS is regulated according to the Traditional PROAGRO, including the ZARC rules. The most important rules regarding the program are: i) The coverage is equal to 100%; ii) Obligation of associating to the program when obtaining agricultural costing credit from PRONAF; iii) It is possible to insure up to 65% of the expected net revenue; iv) The

trigger for receiving the compensation is the gross revenue, that is, if the gross revenue obtained is less than 70% of the expected gross revenue then the farmer is compensated; v) Covered risks: excessive rainfall, frost, hail, drought, excessive temperature oscillations, strong winds, cold winds, and disease and plagues without methods of control; vi) The premium rate is 2%. In case where the farm is irrigated and located in the semiarid region, the rate is 1%.

Table 1. Operational results of PROAGRO TRADICIONAL (PT) and PROAGRO MAIS (PM).

From the crop year 1998/99 to the crop year 2009/10, the total number of contracts of PT and PM presented relative growth until the crop year 2006/07, when it started to decrease because of the relative increase of the private crop insurance (Figure 1).

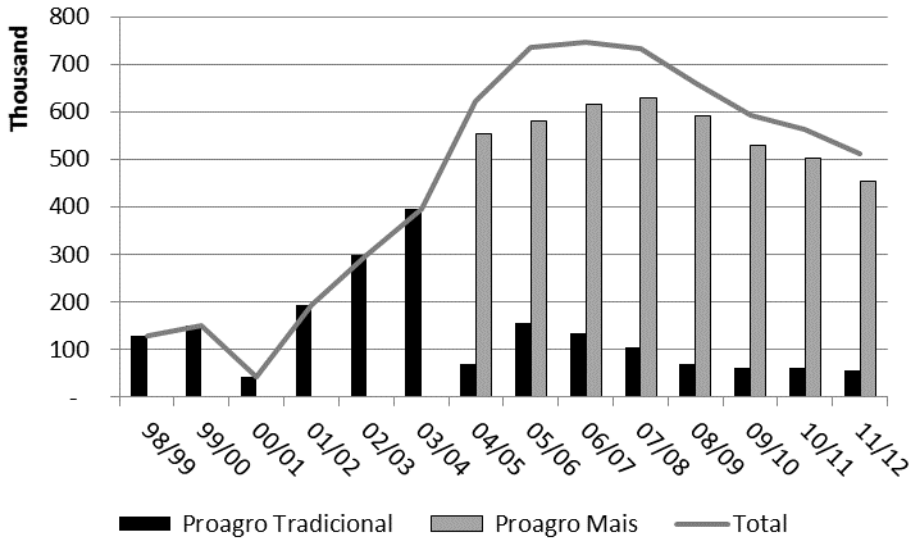


Figure 1. Amount of operations hired from TRADITIONAL PROAGRO, PROAGRO MAIS and total, from crop year 1998/99 to 2011/12, in thousands.
Source: Central Bank of Brazil (2014)

Another important variable in the program is the liability that shows how much is being insured each year. In both programs, the liability increased until the crop year 2008/09, when it started to decrease.

Considering only the PT, until the crop year 2004/05 the liability was, on average, equal to US$ 339 million. From 2005/06 to 2011/12, the average number increased to US$ 1 billion. After the creation of PM, the liability of both programs increased to US$ 1.8 billion, on average. (figure 2).

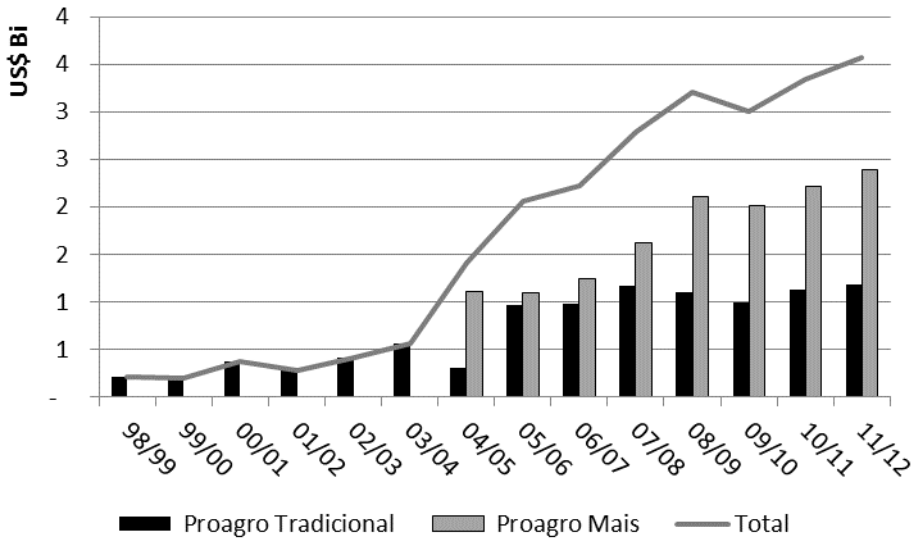


Figure 2. Liability in the PT, PM and total operations from 1998/99 to 2011/12, in US$ billion.
Source: Central Bank of Brazil (2014)

The Figures 3 and 4 show, respectively, the quantity of claims and the total indemnity for the PT and PM, in the period from 1998/99 to 2011/12. Four considerable peaks can be noticed: 2004/05, 2005/06, 2008/09 and 2011/12, with respectively (in thousands) 282.3, 184.4, 101.8 and 123.4. In these four years, the PM was responsible for respectively, 96%, 82%, 83% and 90% of the total claims.

Regarding the total indemnity, the crop year 2011/12 presented the highest value, summing a total close to US$ 434 million (figure 8). The crop years 2004/05, 2008/09 and 2005/06 also presented high values. The total indemnity paid in the period accounted for a little over US$ 1.6 billion.

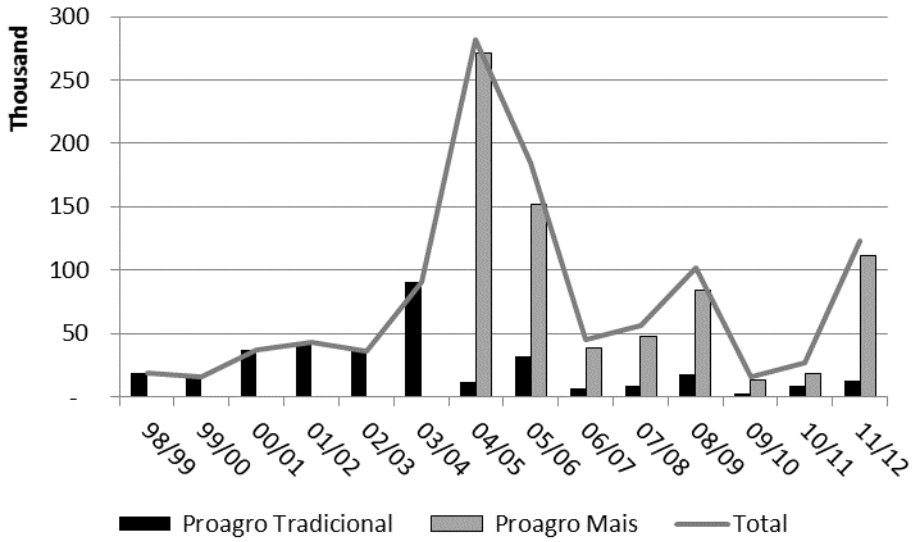


Figure 3. Amount of claims in the PT, PM and total, from 1998/99 to 2011/12, in thousands.
Source: Central Bank of Brazil (2014)

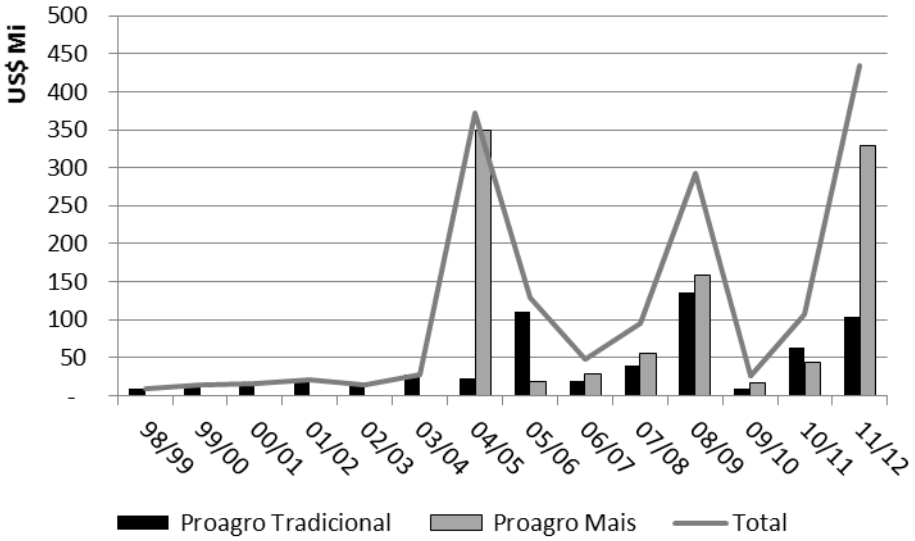


Figure 4. Total indemnity in the PT, PM and total, and total, from 1998/99 to 2011/12, in US$ million.
Source: Central Bank of Brazil (2014)

From the crop year 2004/05 to 2011/12, considering the average number of contracts, the most important crops were corn (43.6%), soybean (18%) and coffee (8.7%). Regarding the territorial concentration, the south region of Brazil presented considerable importance. In average values, the region was responsible for 67.5% of the contracts, followed by the northeast region (13.6%) and southeast (14.9%). In the south region, the state of Rio Grande do Sul (36%) is the most important, followed by Paraná (19%) and Santa Catarina (12%).

Accounting for the average indemnity in the analyzed period, the corn crops represented almost 48.2%, and average value equal to US$ 100 million, followed by the soybean (29.1%) and wheat (15.7%). Besides the short average participation on the total number of contracts, the wheat crops have relatively high importance on the average indemnity. The south region accounted for almost 91.9 % of the total indemnity. The state of Rio Grande do Sul was responsible for about 48.2%, Paraná, 33.6% and Santa Catarina, 10.1%. The northeast region accounted for 5% of the total indemnity. In the region, Bahia (2%), Sergipe (1%) and Ceará (1%) were the most important states. Among the risk covered, in the period analyzed, drought accounted for over 86% of the total indemnity

The **MINISTRY OF AGRICULTURE, LIVESTOCK AND SUPPLY** (MAPA) is responsible to operate the Rural Insurance Premium Subsidy Program (PSR) created by the law 10,823/03 (Almeida, 2007; Ramos, 2009). In general, the program consists of establishing percentages of subventions for each modality of insurance and crops. This percentage corresponds to the liability taken by the government. For instance, if the total premium is equal to US$ 10 thousand and the percentage of subsidy is 50%, the farmer is responsible for US$ 5 thousand and the Federal government the remaining premium. The limit for the subvention in the agricultural modality, per farmer and year, is US$ 41.740. The farmer will be able to receive subsidy for more than one crop, since the total does exceed the maximum value. For the modalities of livestock, forests and aquaculture insurance, the limit is US$ 13.900 per modality (Resolution nº 26/12).

Table 2. Operational results of PSR.

Since the beginning of the PSR, in 2005, until the year of 2009, there was a relative growth. In 2005, the total area insured by PSR was close to 68 thousand hectares and reached the maximum area in 2009, covering almost 6.7 million hectares. From 2009, the total area decreased and stabilized in 2012, covering approximately 5.2 million hectares (figure 5).

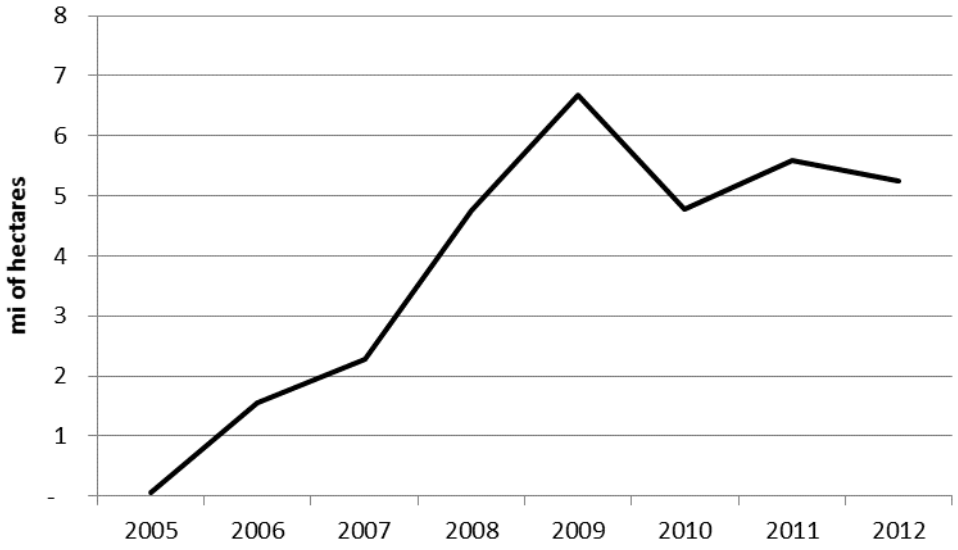


Figure 5. Evolution of the total insured area in PSR, from 2005 to 2012, in million hectares.

Source: MAPA (2014).

The causes for the reduction of the growth rate in PSR are related to the budget constraints and operational difficulties. Up to 2008, the resources available for the PSR were sufficient to the insurance companies to operate the subsidy program. In that year, out of US$ 70 million available, US$ 69 million were effectively spent. However, this scenario changed in 2009, when the demand exceeded the total budget available in US$ 39 million. That is, the government owed money to the insurers.

In December 2009, the government approved a bill for extra resources to cover the dept. However, according to the PSR regulation, the subvention resources must be used in the same year of its availability. Since there was no use for the same year, the insurance companies did not receive the resources.

At that time, the government signaled that part of the budget for 2010, in total US$ 104 million, would be used as payment for the US$ 39 million debt from 2009. This situation stressed the market. Besides not having increased the amount of resources to the PSR, the budget decreased in US$ 39 million. However, in May 2010, the government approved the law 12,241 giving additional credit of US$ 39 million for that year's budget. Despite of this fact, the problem reoccurred in the second semester of 2010, and all the following years.

Nowadays, the insurance companies authorized to operate in the PSR are: Allianz Seguros S.A., Essor Seguros S.A., Fairfax Brasil Seguros Corporativos S/A, Grupo BBMapfre (Companhia de Seguros Aliança do Brasil e Mapfre Seguros), Nobre Seguradora do Brasil S.A., Porto Seguro Companhia de Seguros Gerais, Sancor Seguros do Brasil S.A. and Swiss Re Corporate Solutions Brasil Seguros S.A (MAPA, 2013).

The reinsurance companies operating rural insurance are: Austral Re, Catlin Brasil Serviços Técnicos Ltda, Everest RE Group Ltda, Hannover Re Escritório de Representação no Brasil Ltda, Instituto de Resseguros do Brasil – IRB, Lloyd`s Escritório de Representação no Brasil Ltda, Mapfre Re Assessoria, Münchener do Brasil Serviços Técnicos Ltda, PartnerRe Escritório de Representação no Brasil Ltda, Scor Brazil Ltda, Swiss Re Brasil Serviços e Participações S/C Ltda and XL Re Holding.

According to data from the Superintendency of Private Insurance (Superintendência de Seguros Privados – SUSEP), in the crop year 2012/13, the Insurance company Aliança do Brasil accounted for 58.4% of the total premium of the sector, followed by Mapfre Seguros Gerais, accounting for 10.2%, Nobre Seguradora do Brasil, 7.5%, and Allianz Seguros, 6.4%. The five companies together accounted for 83% of the market. The participation of the first two mentioned accounted for approximately 70%.

In 2012, the grains insured, such as soybean, wheat, corn, rice and others, represented almost 91% of the total insured area, almost 75% of the subvention paid, 73% of the total premium collected and 73% of the global liability. The soybean was responsible for 40% of the total liability and of the total premium collected, 57% of the total insured area and 37% of the subvention paid.

Regarding the regional concentration, in 2012, the south region demanded the highest quantity of resources of the PSR, accounting for approximately 61% of the total. The states of Paraná and Rio Grande do Sul were demanded over 50%. The Central West and Southeast regions accounted for 18% each. Considering the total liability, collected premium and insured area, the results are similar. There is relative concentration in the states of Paraná and Rio Grande do Sul (Figure 6).

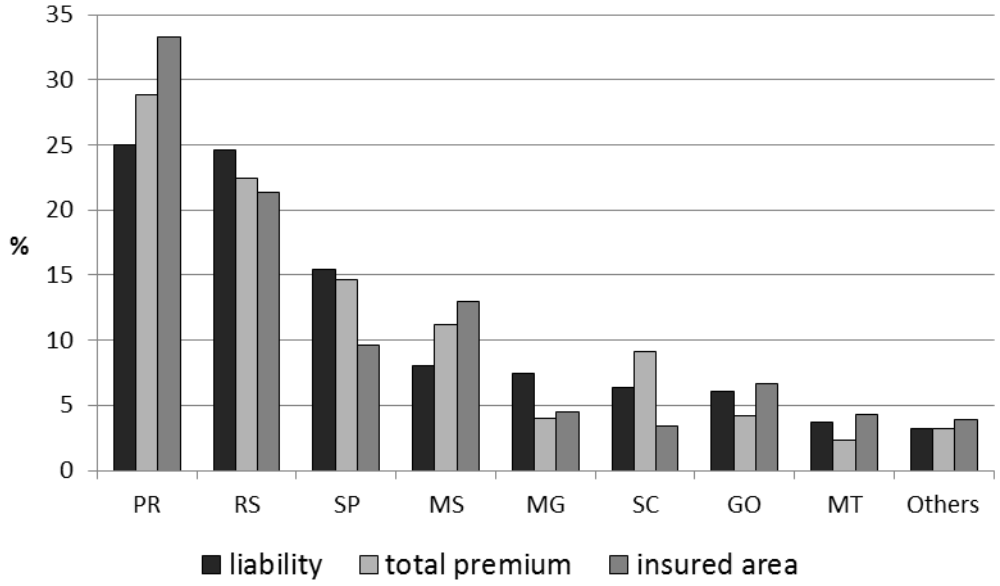


Figure 6. State participations on total liability, total premium and insured area. Values in %. Source: MAPA (2014)

The **MINISTRY OF AGRICULTURAL DEVELOPMENT (MDA)** is responsible for the Garantia Safra (GS) since 2002. It aims to guarantee minimum conditions of survival of the rural family farmers of municipalities located in the area which the Superintendence of Northeast development (SUDENE) works on and are also affected systematically to losses due to drought or excess rainfall (Law nº 10,420/02 and 4,962/04). The family farmers may receive a benefit on the occurrence of drought or excess rainfall which causes at least 50% of loss on productions of beans, corn, rice, cassava or cotton crops.

The **MINISTRY OF NATIONAL INTEGRATION (MI), MINISTRY OF AGRICULTURAL DEVELOPMENT (MDA) AND MINISTRY OF SOCIAL DEVELOPMENT (MDS)**, manage the program "Drought Benefit" (BE) created by the Law nº 10,954 from September 29th 2004. The program supports agricultural families , which receive a limit of an average of two minimum wages monthly as income and are located in municipalities that are considered to have suffered a disaster or emergency situation recognized by federal government. The criteria for being eligible are: i) Being a Family farmer with a declaration of aptitude to PRONAF (DAP); ii) Being registered to the "Single Registration for

Social Programs of the federal government"; iii) Not being associated to the GS program. The associated worker receives US$ 76,00 per family.

The **BRAZILIAN COMPANY FOR AGRICULTURE AND LIVESTOCK RESEARCH (EMBRAPA)** developed an agrometeorological monitoring system (AGRITEMPO), which allows access of meteorological and agrometeorological information for all the Brazilian territory, on an aggregated level. Since 2002, the products available are drought maps, water available in soil, rainfall, agricultural drought areas, necessity of reposition by rainfall and accumulated rainfall. The AGRITEMPO also allows the consultation of information from the weather stations, although there are limitations for data access.

THE **NATIONAL INSTITUTE FOR SPACE RESEARCH (INPE/CPTEC)** supplies products on weather monitoring information, such as, drought, frost, soil moisture and weather forecasts for all the Brazilian territory with applicability to agriculture and livestock. Among the available products are the maps of: i) soil water availability; ii) irrigation necessity; iii) soil management conditions; iv) phytosanitary treatment conditions. The CPTEC also allows the consultation of information of weather stations, although there are limitations for data access.

The **WORLD BANK, MINISTRY OF NATIONAL INTEGRATION (MI), THE NATIONAL WATER AGENCY (ANA) AND STATE INSTITUTIONS** are conducting the technical assistance named "Preparation for drought and resilience to weather changes", because of the long lasting droughts in 2012 and 2013. The main objective is to define specific instruments for drought management, in a proactive manner, and it is based on the concept of risk for all the northeastern region. The drought monitor is based on two indexes named SPI (standardized precipitation index) and SPEI (standardized precipitation evapotranspiration index).

ANNEX 5: STOCKTAKING OF RESEARCH, EXTENSION AND COOPERATION PROGRAMS AND POLICIES

Name of Project/ Program	Year Initiated	Objective and target group	Components and key activities	Executing Units	Cost
FEDERAL PROJECTS AND PROGRAMS					
National Institute for the Semi-Arid (INSA) Projects	2012	Coordination, re-search, and outreach for Brazilian Semi-Arid region	Promotion of innovation and applied research on themes of desertification, water resources, biodiversity and sustainable use, production systems, development and social technologies, and information management.	Ministry of Science, Technology, and Innovation	
STATE PROJECTS AND PROGRAMS					
Paraiba Sustainable Rural Development Project	2015	Reduce household vulnerability and improve smallholder access to markets in Paraiba's rural areas. Key beneficiaries are rural households, organized in community associations (CA) and family farmers, associated in producer organizations (PO).	Institutional Strengthening, Vulnerability Reduction, Productive Alliances. Reduce the incidence of waterborne diseases; increase smallholder volume of sales under alliances; reduce the volatility of agricultural output; increase the level of occupation and employment in alliance partners.	World Bank, COOPERAR-PIU	US$50.0 million loan from World Bank, plus US$29.86 million from PB.
Cariri and Seridó Sustainable Development Project (Procase)	2012	Reach 18,000 rural households in 5 micro-regions of PB: Cariri Ocidental e Oriental, Seridó Ocidental e Oriental, and Curimataú Ocidental.	Local capacity building, improve smallholder production and market competitiveness, pro-mote farming practices resilience/adaptive to drought.	International Fund for Agricultural Development (IFAD), SEDAP	US$48 mil-lion (50% IFAD, 34% State Government, 16% farmer associations)
EMEPA-PB PROJECTS	1976	Provide applied research for family farmers and agribusiness in Paraiba and help form state public policy in agricultural sector.	Nine experimental agricultural research stations throughout the State.	State Secretary of Science and Technology, SEDAP, and can capture resources from external sources (e.g. COOPERAR)	
EMEPA small demonstrative projects					
Beekeeping as a tool for improving the quality of life for small rural farmers in the semi-arid of Paraíba	2013	Enhance and integrate beekeeping to farm productive activities. 103 families linked to 9 associations in 9 municipalities.	Distribute improved bees and beekeeping kits to farmers; train farmers about beekeeping.	EMEPA, with FUNCEP resources	R$ 86,000
Multiplication and distribution of animal	2013	Improve productivity and economic efficiency of milk	Distribute 20 tons of seeds and forage seedlings; inseminate	EMEPA, with FUNCEP	R$ 222,000

Name of Project/ Program	Year Initiated	Objective and target group	Components and key activities	Executing Units	Cost
and plant germplasm, seeking to increase family agriculture dairy production of the Piancó Valley		production in family farms. 240 family farmers producing milk in the Piancó Valley	1,500 cows.	resources	
Production and distribution of free-range hens for diversifying farmer families´ sources of income and labor	2013	Spread the breeding of free-range hens using family labour. 250 family farmers	Install a production unit of chicks in Lagoa Seca Experimental Station; distribute 250 chicken breeding kits with 25 chickens each; train farmers on poultry raising.	EMEPA, with FUNCEP resources	R$ 92,000
Program for strengthening family farmers´ goat and sheep breeding	2013	Incorporation of qualified genetics in EMEPA herds of sheep and goats, which after multiplied will be put at the disposal of family farmers. 750 family farmers	Purchase female goats and sheep; transfer imported embryos to them; distribute to family farmers and participating associations of government programs of production of milk and meat, 366 males and females descendants from imported embryos.	EMEPA, with FUNCEP resources	R$ 315,000
Multinutrient blocks: alternative nutritional strategy for herds during drought periods	2013	Reduce the vulnerability of the animal production systems due to the nutri-tional deficit of pastures in dry periods. 1,750 family farmers linked to 50 associations.	Production of 200,000 multi-nutrient blocks; purchase of the equipment for block manufacturing to be distributed to selected producer associations.	EMEPA, with FUNCEP resources	R$ 973,000
Use of solar energy in the sustainable production of irrigated fruits and vegetables	2013	Encourage the use of solar energy in pumping water for irrigation of vegetables and fruit trees of family farmers. 100 family farmers.	Installation of 100 kits of irrigation by micro aspersion with use of solar panels for pumping water, to irrigate vegetables and fruit trees on a small scale.	EMEPA, with FUNCEP resources	R$ 473,000
Production and distri-bution of sorghum seeds to family farmers in the semi-arid	2013	Use the forage sorghum as an alternative to provide greater volume of fodder during dry periods. 1,500 family farmers linked to 15 producer associations.	Planting 15 hectares to produce sorghum seeds; distribution, in three years, of 45 tons of sorghum seeds.	EMEPA, with FUNCEP resources	R$ 109,000
Production and distri-bution of seedlings for domestic fruit tree plantations in family farmer settlements	2013	Increase the production of fruit species in rural settlements, enabling the absorption of labor. 5,000 family farmers from rural settlements in 109 municipalities.	Restore the nursery and the sown field of Experimental Station in João Pessoa; produce and distribute 200,000 seedlings of fruit trees.	EMEPA, with FUNCEP resources	R$ 176,000
Production and distribution of citrus seedlings to family farmers	2013	Produce and distribute Tangerine seedlings of high productive potential for family farmers of Borborema.	Recover the greenhouse for production of citrus seedlings of Lagoa Seca Experimental Station; produce and distribute 66,000 high agronomic quality	EMEPA, with FUNCEP resources	R$ 108,000

Name of Project/ Program	Year Initiated	Objective and target group	Components and key activities	Executing Units	Cost
		1,500 family farmers in 9 municipalities of Borborema	Tangerine seedlings.		
Programa Palma Resistente	2013	Combat the plague of "cochonilha-do-car-mim" with distribution and multiplication of vegetative material from resistant varieties of *Palma forrageira.* 20,000 farmers.	Immediate distribution of 4.5 million of *rackets* for 4,500 farmers. Creation of 83 points to multiply the resistant varieties in farms, to produce 13 million of *racket*s the next year	SEDAP, EMEPA, EMATER, with FUNCEP resources	R$ 3.5 million
EMATER Projects		Advisory and extension services for family farmers in Paraiba. 38,500 family farmers technically assisted in Paraiba.	Extension services; registration of family farmers, support for access to family farming public policies and services, support for commercialization, agroecological transition, food and nutritional security, assessment of losses to calibrate *Garantia Safra*.	EMATER Paraiba	
		Strengthening of fami-ly agriculture, im-provement of the coexistence with the semi-arid and promo-tion of sustainable rural development.	Recovery and soil conservation practices: 4.042 farmers. Silage and hay production practices: 576 farmers. Poultry raising: 2.315 breeders. PNAE: 2,378 farmers PAA: 2.984 farmers Rural credit: 4.204 proposals prepared. "Brasil sem miséria": 1.014 rural families.		
Sertão Emprendedor		Over 1000 municipalities in the Semi-Arid region of nine Northeastern states	Support for projects of water conservation, production and conservation of animal forage.	SENAR, SEBRAE	

ANNEX 6: BACKGROUND INFORMATION ON PESTS AND DISEASES IN PARAIBA

Sugar cane. Despite several pests are associated with the sugarcane cultivation, according to the historic records the broca do colmo (Diatraea saccharalis), broca gigante (Telchin licus) and cigarrinha (Mahanarva fimbriolata) are considered the key pests, due to the frequency and intensity of its attack and the potential or actual damage to the crop. Possible damages caused by the broca do colmo are reduced yield, death of gems, cane lodging by wind (if the galleries are transverse), dying of tips - known as dead heart - aerial roots and lateral shoots. The damages of the broca gigante produce vertical galleries inside the stem, causing the complete destruction of the stem, reduction in germination, and also open the doors for fungi that cause rots. Damages caused by the attack of the cigarrinha are extraction of large quantities of water and nutrients from the roots by nymphs, reducing sugar content in the stalks, increasing fiber content, increasing the number of dead stems (which reduces the milling yield), and increasing content of contaminants, making it more difficult to recovery sugars and inhibiting the fermentation.

Although the attack of these pests is frequent, the impact is relatively low, because the farmers suitably manage them. Control can be made via cultural practices, suppression of alternative hosts, and biological or chemical control.

On the farms owned by the sugar cane processors there is an intensive use of biological control, which includes parasitic wasps and fungi that parasitizes the insect pests. The biological agents, both wasps and fungi, are produced by the processors on their own laboratories, and sprayed or released on their farms. Only occasionally there is a need to supplement the biological control with pesticide applications.

The ASPLAN (Autonomous Sugarcane Producers Association of Paraiba) also maintains a commercial production of biological control agents. Prior to the present and lasting drought season, the laboratories located at the Camaratuba Experimental Station produced an annual amount of 30 tons of Metarhizium anisopliae (fungi), which is enough for the biological control of cigarrinha in approximately 8,000 hectares. Regarding Cotesia flavipes (wasps), 138.000 insects used to be produced each year, which corresponds to a coverage of 27,531 hectares (Personal Information, Engo. Agr o. Vamberto Freitas110). The estimated sugarcane area in Paraíba for the 2013-2014 season is in excess of 122,000 ha (CONAB, 2014), from which roughly 35% will be conducted by autonomous growers (Personal information, ASPLAN). In this case, biological control coverage on the autonomous cane growers would be around 20-60%, depending on the pest to be controlled.

A potential threat to sugarcane production is the quarantine disease Ferrugem Laranja, caused by the fungus Puccinia kuehinii, which is present in sugarcane plantations in São Paulo, but absent from

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Paraiba up to the moment. It is very difficult to anticipate when and if the disease will be introduced in Paraiba, and once introduced if the fungus will adapt to the environmental conditions and effectively become a serious threat. There is no assessment of its impact to local plantations and the probabilities of entering the state and successfully establish on the cane plantations. In other countries where it is present - like in Australia - the impact is rated as high. Nevertheless, considering its potential damaging impact for Paraiba, this disease risk should be assessed as of high impact.

Fruticulture. Pineapple, coconut and bananas are the most largely produced and traded fruits in Paraíba. Several species of citrus, besides manga, mangaba and grapes are also cultivated.

Banana plantations are subject to the attack of sigatoka amarela (caused by the fungus Mycosphaerella musicola). The pest is conveniently managed by adequate cultural practices, resistant varieties and the application of fungicides. The key pest present on coconut in Paraiba is the broca do olho do coqueiro (Rhynchophorus palmarum). The pest is conveniently controlled by trapping or using biological control. Citrus, mango and mangaba are frequently attacked by the fruit fly mosca negra dos citrus (Rhynchophorus palmarum). Insect trapping or insecticide applications are used to control this pest.

The pineapple disease fusariose is caused by the fungus Fusarium subglutinans f.sp. ananas and is very frequent on pineapple plantations. Control of the pest can be made by means of cultural practices (clean seedlings, eradication of contaminated plants), use of resistant varieties or spraying of recommended fungicides.

Potential serious threats to the fruticulture in Paraíba are the diseases sigatoka negra (Mycosphaerella fijiensis) and moko (Ralstonia (Pseudomonas) solanacearum (Race 2), which attacks bananas, and the cancro bacteriano (Xanthomonas campestris pv. viticola), a pest of grapes. Both are quarantine pests for Paraiba and present on other Brazilian states. They may be extremely damaging if introduced in the fruit regions of Paraiba, but there is no definitive assessment of its potential impact up to the moment.

Family Agriculture in Semiarid Zone. The natural vocation of this region is the livestock production, mainly sheep and goats, being agriculture a side activity, normally for self-consumption. The crops grown in the semiarid zone are cassava, beans and maize, normally cultivated under low technology production systems, with minimum or none use of inputs like fertilizers or pesticides, being the seeds or manivas (cassava) supplied by the goverment. As the climatic risk is very high, growers do not take into account the phytosanitary risks, this way pests are usually not controlled, exception made for a small group of family growers more closely supported by technical assistance.

In order to feed the herd (and also as a water supplier), smallholders cultivate a cactus called palma forrageira. A pest called cochonilha do carmim (Dactylopius coccus) is a serious threat for the yield and even the production of palma. The State Government Research Institution (EMEPA) developed four varieties resistant to the cochonilha and the public technical assistance (EMATER-PB) is freely distributing this genetic material to the family farmers, to substitute their traditional susceptible varieties, leading to an almost complete control of the pest. Although important, the program must be enhanced to benefit the majority of the smallholders of the semiarid.

Livestock Production Chains. The state of Paraiba is free of the Foot and Mouth Disease (FMD) with vaccination, certified by the World Animal Health Organization (OIE) in May 2014. During the last ten years, there was no record of FMD cases in the state. Currently this risk has even diminished because the bordering states are also free of FMD with vaccination and because there is a strict national program to control movement of animals and animal products in the country. Paraiba is also a territory considered free of the Highly Pathogenic Avian Influenza (HPAI) and the risk is low as the state is not on the major routes of migratory birds, which are the main vectors that spread the disease. There is no specific risk classification for the Bovine Spongiform Encefalopatitis (BSE) for Paraiba, but Brazil has been included on the "Negligible" status, the safest of all, therefore the state can be classified in the same risk status.

Paraiba is also apparently free of Classical Swine Fever (CSF) as the last outbreak in the state was recorded in 2006. Similar situation is verified regarding Newcastle Disease Virus (NCDV) as no recent outbreaks were detected, but no epidemiological studies were conducted to confirm this status.

The Bovine, Goat and Sheep Brucellosis and Bovine Tuberculosis are endemic zoonosis. A SEDAP study of 2013 demonstrated that the prevalence of bovine brucellosis ranged between 2% to 4% in Paraiba, and in an evaluation of the Federal Program carried out in 2010 it was observed that there was a decrease in the number of cases of brucellosis in the Northeastern Region from 4,138 to 2,082 (50.3%) between 2001 and 2010. Salomon and collaborators carried out a study on bovine tuberculosis in 2010, which found that: of the herds investigated, 62 (0.57%) had at least one positive animal, and of the animals examined, 136 (0.25%) were positive. Prevalence of tuberculosis in goats it was found to be 10.7% of positive in 10.7% of herds. Regarding the presence of Brucella mellitensis in goats and sheeps, there is no evidence of its presence in Brazil.

There are no official records of serious recent foodborne outbreaks in the state of Paraiba; however, it was found that small producers do not have enough official assistance to control and inspect their facilities for processing food derived from animals. This situation can lead to risks of contaminated products and presentation of foodborne outbreaks. On the other hand, the lack of official control and inspection system for small producers limit their marketing possibilities, including the selling of the production for the federal food acquisition programs (PNAE and PAA) that requires the products to be officially controlled and inspected.

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