Public policies for adapting agriculture to climate change in semi-arid Northeast Brazil

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Preface

Lucia Marisy Ribeiro de Oliveira, Julien Burte, Eduardo Martins, Jean Luc Battini

Analyzing public policies for agriculture and rural territories and their adaptation to the semi-arid Northeast conditions is a necessity and methodological challenge. For the French-Brazilian Network for Sustainable Development in the Northeast Semi-arid (ReFBN), studies in this area are particularly relevant.

This collection brings together contributions that fall within the framework of the first specific objective of ReFBN: "to promote scientific and technical cooperation between Brazil and France for the resilience of semi-arid socio-ecosystems in the face of climate change."

This book addresses the theme through a series of case studies that illustrate the complexity of the framework of public action for adaptation to climate change and its diversity in the agricultural sector.

These case studies, therefore, bring a double enrichment.

First, regarding knowledge, the analyses offer insights on different aspects of public policies for adapting agriculture to climate change and drought by analyzing their construction, the role of institutional actors, and their first effects.

Second, regarding methodological, various approaches from the human and social sciences are mobilized. They draw on various theoretical frameworks from agronomy, anthropology, political science, economics, geography, and sociology. These approaches show and illustrate various critical analysis processes and monitoring of the instruments and mechanisms of public action.

The richness of the analyses presented here reflects the work of a group of authors from different countries and academic specialties. Most have coordinated their research in the framework of the Public Policies and Rural Development Network in Latin America, associated with the publication of this collection.

The Franco-Brazilian Network for Sustainable Development in the Northeast Semi-arid (ReFBN) and the Embassy of France in Brazil are very pleased to support this work. We are sure it will significantly contribute to the reflective dynamics and the interdisciplinary cross-fertilization of views on the role of policies to build sustainable rural territories in the semi-arid North-East.

CHAPTER 1

Implementing public policies and public action for adapting to droughts in the semi-arid Northeast[1]

Eric Sabourin

Introduction

Several extreme climate events observed in recent years have attracted the public's attention in Latin America on the need to adapt to increasing climate variability. The theme entered the agenda of most governments in the region. In Brazil, climate policies have been influenced by the evolution of the international debate since the 1990s (RODRIGUES-FILHO et al., 2016). The clean development mechanisms and, more recently, reducing deforestation and promoting more sustainable production systems were some of the objectives of these efforts. Notably, the rural sector is among the main sources of greenhouse gas emissions in the country and the sectors most impacted by climate change. Climate projections foresee important changes in temperature and precipitation patterns for Brazilian biomes (MARENGO et al., 2017).

The semi-arid region of the Northeast represents a strategic case in the context of climate change. Although droughts are chronic events in this region, climate variability is expected to increase, generating a series of socio-economic impacts. Increasingly extreme climate events may compromise the resources and response capacity of societies. This scenario highlights the need to implement public policies that consider the increase in climate variability and promote the capacity to minimize, prepare, and recover from potential effects (BOCKEL; SMIT, 2009; CAMPOS, 2014).

1 This chapter mobilizes results from the projects ARTIMIX (Articulating policy mixes across scales & sectors to address adaptation to climate change challenges in vulnerable tropical agricultural landscapes - ANR-17-CE03-0005), TYPOCLIM (Typology and assessment of policy instruments to promote agricultural adaptation to climate change -MUSE-ANR-16 IDEX-0006) and INCT Odisseia (Observatorio das dinâmicas socioambientais - CNPq). This text mobilize results from ATTER Project which has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 101007755.

Brazil, within its National Policy on Climate Change (PNMC), also considers more specific instruments that contribute to climate change adaptation and, among other sectors, the case of agriculture (Milhorance et al., 2020).

In this context, this chapter proposes a crosscutting analysis of the different contributions in this book. The text examines various public policy instruments and public action initiatives on adaptation in agriculture given increased climate variability and, in particular, drought. It proposes a characterization of these policies and the governance arrangements of collective action and public adaptation instruments. The chapter has two parts. The first introduces the institutional context and presents the theoretical and methodological framework. The second develops the main characteristics of the adaptation actions and public policies studied based on the transversal analysis of the cases in this book.

Climate and institutional context

Adaptation policies

The Intergovernmental Panel on Climate Change (IPPC, 2014) defines adaptation as "any adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects that moderates harm or exploits beneficial opportunities."

Examples of adaptation measures in the case of agriculture include several practices: using scarce water resources more efficiently, building flood defenses and raising levee levels; developing drought-tolerant crops, choosing tree species and forestry practices less vulnerable to fire, and separating terrestrial corridors to help species migrate.

The National Plan for Adaptation to Climate Change (NPA, PNA in Portuguese), launched in Brazil in 2016, defined 11 sectoral strategies and national priorities: agriculture, biodiversity and ecosystems, cities, natural disasters, industry and mining, infrastructure, vulnerable populations, water resources, health, food security and nutrition, and coastal areas (MMA, 2016).

Milhorance et al. (2019) mention that most of the NPA/PNA's guidelines are based on existing programs and measures to support agriculture: expansion of storage capacity, inclusive rural production, access to water through rainwater catchment and storage cisterns, and developing agroecological systems.

These authors recall that the National Policy for Food and Nutritional Security (PNSAN) incorporated the motion of universal access to water as one of its guidelines in 2010 and defined the articulation of programs and actions of various sectors that promote the human right to adequate food as a goal.

Figure 1. Political map of the semi-arid region in Brazil

Source: National Semi Arid Institute – INSA, Campina Grande, Brazil

In the context of the Northeast region, the paradigms of *living with the semi-arid region* and *agroecology* are priorities for adapting rural populations in the region to climate change (MMA, 2016). Table 1 presents a typology of the main adaptation policies for the rural sector in the semi-arid region.

Table 1. Main instruments on adaptation in the rural sector of the semi-arid region.

Plan	Program	Instrument
ABC Plan	• ABC credit line; • Pronaf Eco	Credit to transform productive systems
NAP Plan	• One Million Rural Cisterns Programme (P1MC); • One Land Two Waters (P1+2) • Water infrastructure state programs (ProRural, Bahia Produtiva, ProSemiarido)	Decentralized water infrastructure
	• Desertification control program	Technical assistance to restore native vegetation
	• The Harvest Guarantee Programme (over 50% of harvest failure); • The Family Farming Insurance (SEAF);	Climate-related insurance
	• Regional development clusters (goat farming and bee keeping)	Climate resilient productive clusters
	• Family farming credit line (Pronaf, Agroamigo)	Rural credit
	• The Food Acquisition Programme (PAA); • The School Feeding Programme (PNAE)	Food public procurement (commercialization)
	• The Development Programme (Programa Fomento); • The Green Grant Programme (Bolsa Verde); • The Family Grant Programme (Bolsa Família)	Cash transfer (social protection)

Theoretical and methodological background

This contribution examines the various instruments and devices developed in case studies from a classical framework of sociological analysis of public action based on the five main elements adapted from Lascoumes and Le Galès (2012): the types of instruments, actors involved, ideas or concepts mobilized based on adapting agriculture to drought, the modalities of implementation governance, and the main outcomes. Obviously, regarding *a posteriori* reading, this analysis does not have any systemic or statistical character, but it may allow for extracting lessons learned and trends at the regional scale from the contributions examined.

An instrument of public action constitutes a technical and social device that organizes specific social relations between the public power and its recipients, according to the representations and meanings it carries (LASCOUMES; LE GALÈS, 2010, p. 1). To categorize the instruments, we adopted the typology proposed by Hoods and Margetts (2007): direct intervention of the public budget (*Treasury*), institutional/governance (Organization), regulatory (*Authority)*, and information system (*Nodality*).

These distinctions can be enriched by introducing more institutional elements regarding the role of public and private actors in the institutional arrangements. The place of institutions is indeed essential to understanding the design and governance of instruments (HOOD, 1983). Concepts mobilized in public

policies and actions can be imported from the international level and climate change adaptation negotiations (e.g., adaptation, risk, and resilience) (AYKUT; DAHAN, 2014). They can also be incorporated into national or regional proposals, such as "living with the semi-arid," those more specific to the agricultural sector (BERTRAND; AMALRIC, 2017), or alternative paradigms, such as those linked to the concept of agroecology (ALTIERI et al., 2015).

Governance can be more horizontal (vertical) and participatory (hierarchical), with intermediate situations of a mixed nature. Governance can also be integrated, articulated, or coordinated between different instruments or policies at the intersectoral level (Sabourin, 2017). Contrarily, it can be sectoral and segmented. Milhorance et al. (2020) analyze the combinations of instruments (*policy mix*) for adapting agriculture to climate change in the semi-arid area of Bahia and Pernambuco.

Combining the literature (KOOIMAN, 1993; TCU, 2014) with the contributions of this book, we identified four dimensions of governance of public policies, all dynamic, though expressed with somewhat presence and intensity in the modalities of formulation and implementation of the public policies studied. The dimensions are decentralization (*vs.* centralization), intersectoriality (vs. sectoriality), participation (*vs.* hierarchy), and governance in networks. The level of implementation, considering actions and activities at the local scale, can come from executing municipal, state, federal, or territorial policies that integrate the dimension of articulation between multiple levels (SABOURIN, 2018).

Cross-cutting analysis of some tools for adaptation of agriculture to drought

This book integrates 11 contributions. Ten public action instruments or devices for adapting agriculture to droughts are considered, some treated in several chapters.

These public actions and policies, developed from local state or federal levels, are : Adapta Araripe, National Family Farming Support Program (PRONAF) and Agroamigo credit for family farming, harvest insurance Garantia-Safra; Water productive cisterns 2a Água, Local Seed Programs in Ceará, agroecology extension by Federal University of Pernambuco, State Policy on Agroecology and Organic Production (PEAPO) in the state of Sergipe, Pró-Semiárido in Bahia, and the National Territorial Development Program, in the State of Paraiba .

Table 2 at the end of this section summarizes their main characteristics based on the proposed analysis grid.

The instruments

Direct intervention by the public budget (Treasury)

We can distinguish three major subcategories of direct intervention instruments or measures. The first comprises subsidies (e.g., for equipment such as cisterns, dams, or small irrigation *kits*). The second comprises loans in the form of rural credit, following the example of the PRONAF (particularly Semi-Arid, Women, Youth, and Agroecology) and Agroamigo (Aquino et al.). The third compensatory modality of the Crop Guarantee and other crop guarantee policies (Bolsa Estiagem, Seguro Agricultura Familiar) offers partial payment of the losses to the most vulnerable producers given prolonged droughts.

Regulatory instruments (Authority)

We observed a few main regulatory cases. Generally, they are regulatory instruments or measures within a more global public policy: An example includes the requirement of the Access Document to PRONAF (DAP), which allows access to the different modalities of family farming policy, in addition to credit from the PRONAF, analyzed by Aquino et al.

Institutional instruments (Organization)

The rural territorial development policy of the former Ministry of Agrarian Development (MDA) (CANIELLO; VALENCIA) and the policies of public purchases of food from family farmers, mentioned in several chapters, fall into this category.

It is also the case of the Ecoforte program, developed by the National Policy for Agroecology and Organic Production (PNAPO), to support the structuring of organizational networks and strengthen agroecological knowledge management. It is mentioned in the chapters by Canaviesi et al., Milhomens et al., and Monteiro et al.

The organizational dimension (e.g., of the Productive Cisterns program, the Seed Banks in Ceará, or the Pasture Funds in Bahia articulated by Articulação Semiárido Brasileiro [ASA]) also refers to this category of instrument.

Information communication tools (Nodality)

All rural extension instruments or university extension courses, as in the Mandacaru Settlement of Petrolina-PE, mentioned by Freitas et al. in this book, promote information, capacity-building, and organizational actions that correspond to this type.

The Productive Cisterns Program is based on inclusive small investments associated with training and extension. It is also the case with the Agroecology

policy (PEAPO) in the state of Sergipe or the network of Community Seed Houses in Ceará (LOPES; SCHMITT).

Instrument mix

Finally, the local state agroecology and organic production policies analyzed by Canaviesi et al., Monteiro et al., and Milhomens et al. constitute combinations of several policy tools or the *policy mix* associating various instruments that converge toward the same objectives through coordination. It is also the case of the rural territorial development policy in the State of Paraíba analyzed by Caniedo and Valencia Perafán in this book.

The actors

All policies analyzed address the activities of a public institution regarding family farmers. Today, however, in most cases addressed in this book, various other actors are also active, ranging from farmers' organizations, civil society NGOs, universities, banks, rural extension entities, or even federated state or municipal secretariats.

The configurations are diverse, but the classic policy executed entirely by a single public institution (ministry, state secretariat, federal, or state public enterprise) is increasingly rare. Even instruments of public-rural extension today involve calls open to private or civil society institutions, as in the case of the former MDA and PRONAF or the Ministry of Social Development (MDS) with productive cisterns or public food purchases.

Even the extension project of the Federal University of São Francisco Valley (UNIVASF) in the Mandacaru Settlement promotes the construction and operation of a socio-technical network that integrates public (research, extension, funding, teaching), private (commerce), and producer institutions and organizations (FREITAS ET AL.).

Over 15 years ago, federal or state rural territorial development policies began mainly based on family farmers' participation through their organizations, as Caniedo and Valencia Perafán note in this book. This participatory governance has been extended to Social Development policies, particularly in the cistern construction programs, in coordination with Articulação Semiárido, ASA Brazil, which federates 3,000 grassroots producer and civil society organizations.

It is very significant that strategies for adapting agriculture to climate change, in particular to droughts, involve the mobilization of different categories of diversified actors to provide a service and decision-making as close as possible to reality and identity of the beneficiaries, territories, and local conditions.

Concepts mobilized in public action on adaptation to drought

Global concepts

Agroecosystems: this concept defines the specific ecosystem of an agricultural production unit in two reference universes: sustainable agriculture (CONWAY, 1985) for Embrapa's research and agroecology, which refers to a more radical alternative paradigm, presented in the chapters by Monteiro et al. and Milhomens et al. An agroecosystem is an ecosystem with, at least, an agricultural population (HART, 1980). Therefore, it can be understood as a unity of work in the case of agricultural systems, differing fundamentally from natural ecosystems by being regulated by human intervention for a particular purpose (MARTEN, 1988).

In the Adapta Araripe project, the notion of agro-ecosystem is associated with the proposal of consortia and crops or agroforestry systems. Moreover, "to achieve sustainability, the proposal of agro-ecosystems is based on the limited use of energy and external resources, seeking to re-establish food chains, keeping biogeochemical cycles closed as much as possible [and], hence, [keeping] the interest in integrated systems through crop consortia" (ANGELOTTI et al.).

For agroecology promoters, the agroecosystem is defined as a cultivated, socially managed ecosystem; "it is the material anchorage of the processes of matter and energy exchange between the natural and the social sphere" (PETERSEN et al., 2017).

The concepts of vulnerability and resilience are typical of notions originating in the global agenda and associated with the idea of adaptation to climate change (BOCKEL; TINLOT, 2009; PELLING, 2011). Milhomens et al. talk about "climate resilience" and associate it with resistance and resilience of agroecosystems in agroecological transition.

Water security

According to the United Nations (UN/d), ensuring water security means "ensuring sustainable access to quality water in adequate quantity to sustain livelihoods, human well-being, and socio-economic development; ensuring protection from water pollution and water-related disasters; [and] preserving ecosystems in a climate of peace and political stability."

This concept is mobilized for access to domestic water and productive water, particularly regarding the productive cisterns program, One land and Two Waters program, or the Water for All plan (NOGUEIRA; SAITO). Thus, contributing to water security by decentralizing sources and small reservoirs comprises the

adaptation strategies of agriculture to reduce the impact of drought on the poorest people of the semi-arid region (NOGUEIRA, 2017).

The concepts of social technologies and resilience are mentioned in only one case. The notion of social technology for the productive cisterns corresponds to a technical and social adaptation dimension of the self-construction component of these tanks. Following the Institute of Social Technology, Brazil (ITS, 2004), it represents "a set of techniques and transformative methodologies developed [and] applied in interaction with and appropriation by the population, representing solutions for social inclusion and improvement of living conditions."

Local/Regional concepts

Among the concepts of regional origin, "Coexistence with the semi-arid" "Convivência com o semárido" (CSA) is the most referenced in this book through a *mix of* agroecology policy instruments and public action by civil society organizations.

CSA is typical of a concept based on adapting (of people, communities, agricultural production, and resource management) to the reality of a biome characterized by drought. "Learning to live with the semi-arid region, instead of fighting droughts, means reinterpreting how people deal with their natural environment and reviewing the mechanisms and instruments of public intervention. Instead of seeking to transform the region into what it is not, coexistence implies seeking technological alternatives that allow for [valorizing] potentialities and vocations compatible with its real natural conditions and its social context" (BURSZTYN, 2016).

Two chapters mention local crop consortia that refer to the more global notion of agroforestry systems. Agroforestry systems are "productive systems that can be based on ecological succession, analogous to natural ecosystems, in which exotic or native trees are intercropped with agricultural crops, vines, forage crops, [and] shrubs, according to a pre-established spatial and temporal arrangement, with [a] high diversity of species and interactions among them" (EMBRAPA, undated). They are mobilized through environmental recovery strategies and adaptation to climate change (SCHEMBERGUE et al., 2017).

Alternative paradigms

The concept of agroecology, as an ecological practice, science, and social movement (ALTIERI et al., 2015), is also proposed as an alternative paradigm to traditional agriculture, particularly irrigated agribusiness in the PEAPO study in the State of Sergipe, Monteiro et al.'s study in the semi-arid region of Bahia, and Milhomens et al.'s study. For these proposals for public action, agroecology seeks to radically transform agricultural and food systems. It opposes the conventional

export-oriented model, considering that this transformation is necessary to address environmental and social challenges.

Agroecology advocates greater autonomy for producers regarding input markets and oligopolies selling raw materials and promotes the priority use of production unit resources (SABOURIN et al., 2018). Milhomens et al. present agroecology "as an adaptation strategy to reduce vulnerability and increase the resilience of agriculture in the semi-arid region."

Milhorance et al. and Milhomens et al. remind us that the adoption of the agroecological approach is among the initiatives of the sectoral strategy for agriculture in the PNA; however, it belongs to a minority and marginal coalition in the face of agribusiness coalitions that justify the "climatization" of its proposals. These authors state that "without changes in the dominant forms of agricultural policy and production, the agroecological approach will hardly surpass the current stage of isolated and socially invisible experiences" (MILHOMENS et al.).

Modalities of governance of adaptation policies

Centralization/decentralization

Although decentralization (e.g., of state policies [ARRETCHE, 1999]) has progressed significantly in Brazil, particularly in social policies over the last 20 years, it is not a process established in a natural and generalized manner. In addition to the adoption of new practices and rules, the main problem lies in the transfer of resources (financial and human) and decentralized norms, including structural ones. The former MDA has experienced tensions between instruments of the Secretariat of Family Agriculture and those of the Secretariat of Territorial Development. It can be verified in the implementation norms of PRONAF (Aquino et al.). Another example is mentioned in the chapters for the National agroecological technical assistance and rural extension policy (ATER agroecology) methodology, which was considered too bureaucratic and centralized. Certain policies can be decentralized to the municipalities, as with the Garantia-Safra, and maintain hierarchical governance (Aquino et al.).

The most notable decentralization efforts for the climate change adaptation strategy were those of social policies (various categories of grants) noted by Mattos et al. and water policies, particularly the MDS programs for the construction of cisterns and underground dams, as evidenced by Cavalcante et al. and Nogueira and Saito.

The policy of recognition and support of grassland communities (*Fundo de pasto*) in Bahia is a successful decentralization and deconcentration of agrarian or land reform, even in its implementation through producer associations (Monteiro

et al.). The same can be observed in the case of community seed banks (LOPEZ; SCHMITT). The application of the notion of multi-level governance completes the decentralization and deconcentration of the State insofar as the articulation between the different levels is planned, anticipated, regulated, and coordinated. It was the case of the territorial development policy, even creating a new level of state action and territory while functioning and supporting autonomous organizational processes of family farmers, as in the case reported by Caniello and Perafán in Paraíba.

Intersectoral governance

Without a doubt, another merit of the former MDA's territorial policy was the attempt to introduce an intersectoral dimension to rural development actions, opening a dialog with the education, health, social development, tourism, and infrastructure sectors.

Embrapa's intervention in Serra do Araripe is in the actions of the Araripe Plaster Industry Hub, a Local Productive Arrangement that associates 16 municipalities in Pernambuco and brings together various public and private actors (ANGELOTTI et al.).

Milhorance et al. analyze the forms of interaction between policies that contribute to climate change adaptation in the states of Bahia and Pernambuco, illustrating how a minimum of coordination and articulation is essential for the success of adaptive strategies. They find that the PNA juxtaposes prior policies without integration. They mention only one case of articulation in the MDS productive cisterns program with ASA member organizations and one space for coordination by discussing state policy actions in Bahia and Pernambuco in the reminiscent territorial council (collegia) of the São Francisco river valley.

Participation vs. hierarchization

Another characteristic of the articulated or territorial policies is that they are participatory and rely on consultation with local organizations and authorities or municipal rural development and environment councils and territorial collegiate bodies. The MDS cisterns program and the former MDA with PRONAF have also transferred resources to municipalities, NGOs, and producer organizations to implement the policy, similar to the management units of the Cisterns Program.

The state policies on agroecology and organic production in Bahia and Sergipe, which supported the *Fundos de Pasto* (community managed collective pasture) in Bahia or the community seed banks in Ceará, were also built and governed by participatory commissions or committees, bringing together public institutions and representatives of civil society or users.

The descriptions of the processes in the different cases in this book show different participation degrees. In the Mandacaru Settlement, this interlocution was long reserved for a single charismatic leader, and the UNIVASF university aimed to train new leaders (Freitas et al.).

In the Adapta Araripe project, farmers' participation is indispensable for experiments in real environments. However, the level of choice or decision on the design or experimentation content can be differentiated per farmers' capacities and resources.

In this book, Nogueira and Saito propose a gender-specific analysis of participation in the case of the productive cisterns program. The fact that the policy of promoting cisterns has been directly based on women has guaranteed productive results insofar as they are responsible for fruit and vegetable gardens in the backyards around their homes. This gender dimension has also been verified in the Mandacaru Settlement (Freitas et al.), Borborema territory in Paraíba (CANIELLO; PERA-FÁN), and the Middle São Francisco (Monteiro et al.).

Network governance

The reports of attempts at network governance in various chapters (Freitas et al.; Monteiro et al.; CANIAVESI et al.; MILHOMENS et al.; CANIELLO and PERAFÁN; LOPES and SCHMITT) also show the great diversity of composition, size, and density of the networks.

In some cases, such as PEAPO in Sergipe or PRONAT in Borborema, the network of local actors pre-exists the policy formulation and promotes its construction, contributing to its implementation. In other cases, the construction or strengthening of a socio-technical network (e.g., around water management, grasslands, or agroecology) is an objective of the intervention. Regarding the seed houses in Ceará, instruments and policies, that favor and others that hinder the dynamics of the network are identified.

Effects and implications

Public actions and policies in this book show four main categories of results regarding adaptation to drought and climate change.

Technical implications

First, there are elements such as positive technical results on species adaptation, cultivated varieties, breeds of small ruminants that are drought-tolerant, more ecological cultivation techniques such as agroecology, organic production and crop consortia or agroforestry systems, and management of the dry forest called *caatinga*. These results are generally associated with rain-dependent agricultural

production or only supported by occasional small irrigation of vegetables, fruits, and forage crops.

Second, there are technical alternatives for local and decentralized water collection and storage, particularly productive cisterns and underground dams. Third, programs such as Prosemi-arido in Bahia, ProRural in Pernambuco,

Seed Banks in Ceará, PRONAT in Paraíba, Water for All, and Agrarian Reform in Petrolina have allowed for constructing collective infrastructure for processing, storage, and commercialization of agricultural raw materials, food, fibers, and handicrafts. However, above all, they have managed to train local human resources to manage and maintain them.

However, the most significant factor in adaptation impacts was the capacity to widely disseminate the technical elements or social technologies as cisterns, fodder palm, fodder silage, or the valorization of *caatinga* resources.

Social effects

One can distinguish social effects in compensation and transfer and social outcomes in population organization. In their contribution, Mattos et al. compare climate data from three drought periods: 1980–1983, 1990–1993, and 2012–2016 and their social impacts. Despite being more prolonged (lasting until 2018 in several areas), the last period did not have severe agricultural and socio-economic consequences. The authors attribute this difference to the greater organization and resilience of farmers to social public policies (*Bolsa Família*, Rural retirement, Bolsa Estiagem, Garantia-Safra) and instruments for adapting agriculture to drought. Regarding the latter, they highlight those brought together in the proposal for living with the semi-arid, water decentralization, networked Technical Assistance and Rural Extension, and agroecological practices. They consider it a "combination of policies of permanent action, social, environmental, [and] infrastructure […] that made the drought of 2012–2016 seem much milder than its predecessors."

Table 1. Characteristics of the adaptation instruments analyzed

Instrument	Type	Concepts	Actors	Governance	Effects
PNA + Cred	Policy mix	CSA	Multiple	Mixed, poorly integrated	Relevance and coherence of C with semi-arid
Adapta Araripe	Information	Sustainable Agri AESS	Embrapa+ IPA, ITEP	Participatory Experimental	Adapts crop and livestock farming techniques
PRONAF -Agroamigo	Treasure	Family farming	Audience,	Hierarchical decentralized	Consolidation of cattle ranching and drought- tolerant agriculture
Garantia-Safra	Treasure	Risks	Family farming	Hierarchical decentralized	Support consumption and purchase inputs
Cisterns 2nd water MDS	Treasure + Information	Social technology/ water security	Multiple	Participatory + NGO + gender	Women productive autonomy
PNBI Bioinsumes	Regulation Authority	Sustainable Agri	Public	Sectoral	Not yet
ATER ext Univ Mandacaru	Information	TAE and AE	Multiple	Participatory , networks	Capacity-building, leadership training
PEAPO Sergipe	Information and organization	AE and PO	Multiple	Participative Networks	Institutionalization of the EA by the actors
PSA Bahia	Information and Regulation	AE, AESS resilience	Multiple	Participation + NGO, Org. prod.	Autonomy, endogenous income, recovery of the caatinga
Territorial Development	Organization and treasure	AE, CSA	Multiple	Intersectora l participator y	Collective infrastructures, capacities in favor AE
Ceará Seeds	Organization and information	CSA	Civil society, O. P.	Participatory , networked	Org. and gender reinforcement, backyard revitalization
AE NSA	Organization and information	AE, CSA, AESS, Resilience	Multiple	Participatory and networked	TAE support, Strengthening socio-technical networks and resilience AF

Legends: AE: Agroecology; FA: Family farming; AESS: Agroecosystems; CSA: Convivência com o semárido; PO: Organic production; TAE: Agroecological transition.
Source: Authors, from the chapters of this book.

Several chapters indicate the role of social or conditional transfer policies in adapting rural populations to the last prolonged droughts. Even the crop insurance *Seguro-Safra* ended up being institutionalized by the drought permanence into an almost perennial instrument, enabling it at the level of beneficiaries as a social and food security policy and not just a productive support to buy new inputs.

Strengthening the organizational and representative capacities of family farmers, particularly women and youth, has been essential for drought adaptation as it has delivered three complementary types of results:

i) The access to public policies and services (non-access remains but is reduced);

ii) The capacity to manage inputs and equipment accessible through rural credit or collective infrastructures obtained from public subsidies;

iii) The capacity for building local organization and territorial or regional articulation in larger organizations or networks.

Political and institutional effects

Regarding ideas and political resources, the success and consolidation of the paradigm of "living with the semi-arid" for family farming in the Northeast of Brazil is a step forward for an increasingly broad coalition of actors originating came from the social movement and state articulations.

Regarding agricultural and rural development strategy, this proposal, associated with water decentralization and agroecological transition (including bio-inputs, organic production, crop consortia, agroforestry systems, management of the *caatinga*, and local seeds), is based on labor intensification as an alternative to capital intensification.

Part of public policies at the federal level that contributes to adapting agriculture to climate change has suffered a major dismantling since the Temer government (2016 for family farming policy and territorial development) or from the Bolsonaro government (2019 for federal councils, environmental, and agroecology policies) (SABOURIN et al., 2020). However, several federated state rural development programs in the Northeast, such as Pró-Semiárido, the Dom Helder Camara Project, or São José Project, linked to loans from international organizations (e.g., World Bank and IFAD), are threatened with closure by the opposition of the federal government's guarantee.

In this context of reduced federal resources, there was an attempt to progressively institutionalize state agroecology policies and food public purchases of family farming products, following the states of Bahia, Sergipe, Ceará, and Maranhão (SABOURIN et al., 2019). However, the processes remain fragile and dependent on ministerial orders and relatively "weak" institutional instruments.

Final considerations

The above results show the attempts to consolidate a strategy of adaptation of agricultural production to climate change given the characteristics and specificities of the resources of the *caatinga* biome. The idea of climate adaptation comes stems from an international agenda but has existed at the territorial level, particularly in the semi-arid Northeast, as per a previous in-depth reflection and experience.

The technological and socio-technical content results from an accumulation of experimentation by research and extension centers and management and horizontal dissemination of adaptive practices of local populations. Rural social movements with academic centers, civil society organizations, and international funding have promoted this strategy. In certain cases, they have integrated more articulated and sufficiently strong coalitions to construct municipal, state, and even federal public policies on family farming, seeds, cisterns, traditional peoples and communities, and agroecology.

Despite the current unfavorable federal political and administrative context, this strategy constitutes a framework and a programmatic basis. It represents a series of advances that seem difficult to be completely broken or dismantled, even in the current context of dismantling federal policies. Several components of the adaptation strategy are not easily reversed such that its implementation does not depend solely on resources linked to federal public policies.

Moreover, most contributions in this book do not always show a critical reading of the policies studied, particularly of innovation or implementation limits or challenges (HOWLETT, 2014). In some cases, these policies are very recent, such as the Agroecology policy in Sergipe. Further, given that there are no results yet, it was only possible to identify the challenges or mechanisms in their construction.

Some chapters describe alternative technical proposals or analyze socio-economic data at the scale of the production units and focus on the progress achieved relative to prior practices or situations. It may also represent the expression of a certain technological, methodological or militant bias in favor of the object of study. However, two chapters do not spare criticism to the policies analyzed: The chapter by Aquino et al. on the limits of content and implementation of PRONAF and *Garantia-Safra* crop insurance, and that where Mesquita et al. show the great lack of articulation and coordination between the different adaptation instruments, particularly through dialog spaces as the municipal and territorial councils.

Most of the chapters present a series of specific recommendations for the maintenance, expansion, or evolution of instruments of adaptation policy

studied. Nevertheless, the first recommendation is coordination or integration between various sectoral policies and the different implementation scales.

Given the intersectoral nature of the climate challenge, more integrated approaches are key to reducing vulnerability to these events (AHMAD, 2009). Indeed, integration is a political process, not just an administrative one. It depends on the coordination of actors, confrontation of ideas, and sometimes mediation (Mesquita et al.).

Different systems have different sensitivities to disturbances and an unequal potential to resist and adapt to these changes. In this context, regionalized analyses of climate policy formulation and implementation are needed, including the different instruments combinations that materialize in each territory, interactions between actors at different levels, and mobilizing distinct adaptation visions and discourses.

References

ADELLE, C.; RUSSEL, D. Climate Policy Integration: a Case of Déjà Vu? **Environmental Policy and Governance**, v. 23, n. 1, p. 1-12, jan. 2013.

AHMAD, I. H. **Climate Policy Integration**: Towards Operationalization DESA Working Paper No 73ST/ESA/2009/DWP/73 March 2009.

ALTIERI, M. A.; NICHOLLS, C. I.; HENAO, A. et al. Agroecology and the design of climate change-resilient farming systems. **Agron. Sustain. Dev**., v. 35, p. 869-890, 2015. Available at: https://doi.org/10.1007/s13593-015-0285-2.

ARRETCHE, M. T. S. Políticas sociais no Brasil: descentralização em um Estado federativo. **Rev. Bras. Cien. Soc**., São Paulo, v. 14, n. 40, p. 111-141, jun. 1999.

AYKUT, S. C.; DAHAN, A**. La Gouvernance du Changement Climatique**: Anatomie d'un schisme de réalité. Gouverner le Progrès et ses Dégâts, Paris : Éditions La Découverte, p. 97-132, 2014. Available at : https://hal.archives-ouvertes.fr/hal-01403103/document.

BERTRAND, F. ; AMALRIC, M. L'élaboration des politiques climatiques locales: usage et portée d'un dispositif de concertation. **Développement Durable et Territoires** v. 8, n. 2, jul. 2017. Available at: https://doi.org/10.4000/developpementdurable.11715 2017.

BOCKEL, L.; SMIT, B. **Climate Change and Agriculture Policies**. Roma: FAO, Easypol draft of Policy Guidelines, 2009

BOCKEL, L.; TINLOT, M. **Introduction and concepts of adaptation, resilience and mitigation.** How to mainstream climate change adaptation and mitigation into agriculture policies? Roma: TCSP, FAO, 2009.

BRASIL. Tribunal de Contas da União**. Referencial para avaliação de governança em políticas pública**s. Brasília: TCU, 2014. 91 p.

BURSZTYN, M. **Convivência com o semiárido** in 2o Seminário e curso internacional de convivência com o semiárido. Adelia Alencar Brasil e Daniquele Pinho Andrade (organizadoras). Instituto Brasileiro de Desenvolvimento e Sustentabilidade – IABS / Editora IABS, Brasília-DF, Brasil - 2016.

CAMPOS, J. N. B. Secas e políticas públicas no Semiárido: ideias, pensadores e períodos. **Estudos Avançados**, v. 28, n. 82, São Paulo, out.-dez. 2014, p. 65-88. Available at: https://doi.org/10.1590/S0103-40142014000300005.

CONWAY, G. R. The properties of Agroecosystems. **Agricultural Systems**, n. 24, p. 95-117, 1987.

EMBRAPA. Sistemas Agroflorestais e recuperação ambiental. Available at: https://www.embrapa.br/codigo-florestal/sistemas-agroflorestais-safs.

HART, R. D. **Agrosistemas**: Conceptos básicos. Turrialba, CATIE, 1980, 211p.

HOOD, C. **The tools of government**. Chatham, NJ: Chatham House, 1986.

HOOD, C. C.; MARGETTS, H. Z. **Looking Ahead**: The Tools of Government in the Digital Age. In: HOOD, C. C.; MARGETTS, H. Z. (Eds.). **The Tools of Government in the Digital Age**. London: Macmillan Education UK, 2007. p. 184-203.

HOWLETT, M. Why are policy innovation rare and so often negative? Blame avoidance and problem denial in climate change policy-making. **Global Environnemental Change**, v. 29, p. 395-403, 2014.

IPCC. Climate Change 2014: **Synthesis Report**. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Geneve: Intergovernamental Panel of Climate Change, 2014.

ITS BRASIL. Tecnologia Social no Brasil. **Caderno de Debate**. São Paulo: ITS, 2004, p. 26.

KOOIMAN, J. **Modern Governance.** New Governement, Society Interaction, London, Sage, 1993.

LASCOUMES, P. ; LE GALÈS, P. «**Instruments**». In: BOUSSAGUET, L. (Éd.). Dictionnaire des Politiques Publiques. 3e éd. Paris : Presses de Sciences Po, 2010, p. 325-335. Avalaible at : https://www.cairn.info/dictionnaire-des-politiques-publiques--9782724611755-page-325.htm.

LASCOUMES, P.; LE GALÈS, P. **Sociologia da Ação Pública**. Maceió: EDUFAL, 2012. 244 p.

MARENGO, J. A.; TORRES, R. R.; ALVES, L. M. **Drought in Northeast Brazil** – past, present, and future. Theoretical and Applied Climatology, v. 129, n. 3-4, p. 1189-1200, ago. 2017.

MARTEN, G. G. Productivity, Stability, Sustainability, Equitability and Autonomy as Properties for Agroecossystem Assessment. **Agricultural Systems**, n. 26, p. 291-316, 1988.

MICKWITZ, P.; AIX, F.; BECK, S.; CARSS, D.; FERRAND, N. **Climate Policy Integration, Coherence and Governance**. Montpellier: Irstea 2009, p. 96. Avalaible at: https://hal.inrae.fr/hal-02598475.

MILHORANCE, C.; SABOURIN, E.; CHECHI, L. **Adaptação às mudanças climáticas e integração de políticas públicas no semiárido pernambucano**. Projeto Artimix, Projeto INCT Odisseia, Série Working Papers n. 2, 2019. 39p. Disponível em: http://inct-odisseia.i3gs.org/wp-content/uploads/2019/12/WP2.pdf.

MILHORANCE, C.; SABOURIN, E.; LE COQ, J. F.; MENDES, P. Unpacking the policy mix of adaptation to climate change in Brazil's semiarid region: Enabling instruments and coordination mechanisms. **Climate Policy**, v. 20, n. 5, p. 593-608, 2020.

MINISTÉRIO DO MEIO AMBIENTE. **Plano Nacional de Adaptação à Mudança do Clima**– Estratégias Setoriais e Temáticas, Volume II. Brasília: MMA, 2016.

NOGUEIRA, D. Segurança hídrica, adaptação e gênero: o caso das cisternas para captação de água de chuva no semiárido brasileiro. **Sustentabilidade em Debate**, v. 8, n. 3, p. 22-36, 2017. Avalaible at: https://doi.org/10.18472/SustDeb.v8n3.2017.26544.

OBERMAIER, M.; PINGUELLI, R. L. Mudança climática e adaptação no Brasil: uma análise crítica. **Estudos Avançados,** v. 27, n. 78, p. 155-176, 2013.

ONU. Water Security and the Global Water Agenda Policy and Analytical Briefs 8 May, 2013. Avalaible at: https://www.unwater.org/publications/water-security-global-water-agenda/.

PETERSEN, P.; SILVEIRA, M. M.; FERNANDES, G.; ALMEIDA, S. Articulação Nacional de Agroecologia (Brasil)**. Método de análise econômico-ecológica de Agroecossistemas**. Rio de Janeiro: AS-PTA, 2017. 246 p.

PELLING, M. **Adaptation to Climate Change**: From resilience to transformation. Abingdon, Oxon (USA): Routledge, 2011.

RODRIGUES FILHO, S.; LINDOSO, D. P.; BURSZTYN, M.; NASCIMENTO, C. G. O clima em transe: políticas de mitigação e adaptação no Brasil. **Revista Brasileira de Climatologia**, v. 19, n.0, 2016.

SABOURIN, E. Governança multinível no desenvolvimento rural: intermunicipalidade e territórios. In: **RP3 – Revista de Pesquisa em Políticas Públicas**, n. 2, p. 78-102, 2018. Avalaible at: http://dx.doi.org/10.18829/rp3.v11i2.

SABOURIN, E.; GRISA, C.; NIEDERLE, P.; PEREIRA LEITE, S.; MILHORANCE, C.; DAMASCENO FERREIRA, A.; SAUER, S.; ANDRIGUETTO-FILHO, J. M. Le démantèlement des politiques publiques rurales et environnementales au Brésil. **Cahiers Agricultures**, v. 29, n.21, 2020. Avalaible at: https://www.cahiersagricultures.fr/articles/cagri/full_html/2020/01/cagri200104/cagri200104.html.

SABOURIN, E.; LE COQ, J.-F.; FRÉGUIN-GRESH, S.; MARZIN, J.; BONIN, M.; PATROUILLEAU, M. M.; VÁZQUEZ, L.; NIEDERLE, P. Public policies to support agroecology in Latin America and the Caribbean, CIRAD, Montpellier**, Perspective 45**, 2018.. https://doi.org/10.19182/agritrop/00020.

SABOURIN, E.; GUÉNEAU, S.; COLONNA, J.; SILVA, L. R. T. (Orgs.). **Construção de políticas estaduais de agroecologia e produção orgânica no Brasil**: avanços, obstáculos e efeitos das dinâmicas subnacionais. Curitiba: CRV Editora e Red PP-AL, 2019, 272p.

SCHEMBERGUE, A.; CUNHA, D. A.; CARLOS, S. M.; PIRES, M. V.; FARIA, R. M. Sistemas Agroflorestais como Estratégia de Adaptação aos Desafios das Mudanças Climáticas no Brasil. **Rev. Econ. Sociol. Rural**, v. 55, n. 1, p. 9-30, 2017.

CHAPTER 2

Drought or just a Dry season? Describing two meanings for the same climate phenomenon

Luis Claudio Mattos, Ana Paula Ferreira and Peter Herman May

Introduction

In the second decade of the 20th century, Brazil's semiarid region experienced successive long periods of drought, locally known as "secas," a concept that evokes calamity, despair and hopelessness for a large portion of the Brazilian population.

The modernization process that marked the country's development after World War II began to treat the abundant poverty in the semiarid region as a "natural" consequence of its biome. As a result, ephemeral, periodic and palliative programs were applied in response to the state of periodic public calamity.

In the second decade of the 21st century, a new millennium, something new has happened. A long-term drought marked the region, without, however, being accompanied by social calamities common in other times. And this was not by chance.

It has never been clearly demonstrated that the long-term dry season is a climatic phenomenon. The drought is only its social consequence, and therefore a social phenomenon. Despite their common origins, they have different meanings. If we analyze separately the climatic phenomenon (dry season) from the social phenomena (drought), we found a better path to promoting the development of the region, designing more appropriate public policies that could consider the regional characteristics. This article presents some elements that support this hypothesis and can serve as references for public management and civil society reaction.

Social relations in the Semiarid Region

One of the best-known characteristics of the semiarid climate is its rainfall irregularity. The long-term dry seasons cause water shortages in rural villages, which, in more critical times, also reach the urban towns located in the region. In addition, irregular rainfall and long periods of no rain causes losses in agricultural crops often lost after the failure of the rainy season to occur.

Given that in their rural households the small farmers produce their own food, this scenario presents a permanent risk to food and nutritional security.

On the other hand, due to social and historical reasons, the level of investment in the region has been low. As a result, there is little added value to agricultural products. Even though agriculture and livestock are the dominant economic activities in the region, they do not necessarily represent the main income-generating activity.

In the semiarid region, environmental issues are at the center of economic and social relations, influencing the agrarian occupation and family habits. This is a coercive power that silently determines the society behavior and structure (DURKHEIM, 2007). The Portuguese word “seca” to refer to "drought" has become widely accepted, in popular terms, as something necessarily negative, inferring meanings that go beyond the climatic phenomena per se. In fact, because of this, the semiarid inhabitants have developed a popular knowledge to resist and overcome the most severe and long-term droughts, generating an important social capital in dealing with critical situations and short water supplies. It was sharing this knowledge that small farmers and peasants established factors that became decisive to achieve a better conviviality with the semiarid. It is in the context of social relations, therefore, that this capital flourishes and reproduces itself.

An important consideration here is the role of women. They have been socially responsible for managing and maintaining the food security stocks, including water for domestic consumptions and food for the entire family. Because of this, the women have developed an accurate notion of food security. Women have, hold, share and thus perpetuate knowledge about food production, often grown in sophisticated backyard systems. The domestic work, historically assigned to the women, has been the result of an unequal and unfair distribution of family work. Furthermore, notably in rural conditions the women play an additional third domestic role not only by mixing reproductive and productive work, but having also to produce the food for attending the family requirements. In the backyards, different productive systems supply the family and the market.

The women have developed strong skills in natural resource management and biodiversity conservation, selecting and preserving seed varieties and small animal breeds that are more adapted for living under semiarid conditions.

When, in long periods of drought, the nearest reservoirs dry up, it is necessary to travel gradually longer distances to supply the family's water needs, a role also played by women. Thus, women in family farming work an average of 58 hours per week, being 23 hours dedicated to so-called "social reproduction", compared to men's 41 hours and 09 hours respectively (FERREIRA, 2008). The invisibility of these numbers in society is perhaps the most perverse aspect of this situation. Often, this work is even invisible to women themselves. They tend to not consider productive work the majority of the effort for producing food for self-consumption that they carry out in their backyards (DI SABBATO, MELO, et al., 2009; MELO; LOMBARDI; FARIA; BUTTO, 2009). For all these reasons, although women represent approximately 50% of the population, they can reach more than 70% of the rural labor force in the semiarid region (FERREIRA, 2008).

The stigmas of the semiarid region - hunger and lack of development

Josué de Castro was one of the pioneers in describing hunger as a social phenomenon. When hunger is collective, it gains a broader dimension, bringing famine and malnutrition to significant portions of the population. In such cases, it differs from circumstantial hunger when it is restricted to small proportions of the population. As social phenomena, Josué de Castro distinguished endemic hunger, when it is more persistent, from epidemic hunger, when its causes are seasonal, transitory or conjunctural. This last category is normally referred to as a crisis or catastrophe (CASTRO, 1984).

Therefore, social calamity during the drought serves as a determinant in the national stereotype of the semiarid region, making it peculiar and distinctive from the rest of the country.

These periods of long-term drought severely test the capacity of farming families to resist and adapt their systems to a continuous process of stock depletion. Being a social phenomenon, the drought is not as a mere economic issue, but rather is a matter of survival. The point is that drought does not have a clear beginning and end. The population only realizes the intensity of drought when it has already caused damage. It begins with the exhaustion of water stocks, but also seeds and food. In attempting to plant successively in the hope of producing, farmers come to use food stocks as seeds without stock replacement. With the deepening of the drought, it reaches the animals and begins to erode the family's

savings. This cycle effectively destroys their ability to plant in a timely fashion,using the entire rainy season, if rainfall is re-established. If families have no means to start again, they will depend on donations, political favors, and assistance from palliative public policies.

The more structured the farm, the better the conditions for overcoming drought (resistance) and restructuring livelihoods afterward (resilience). But to be effective, investments need to be made over years with regular rainfall.

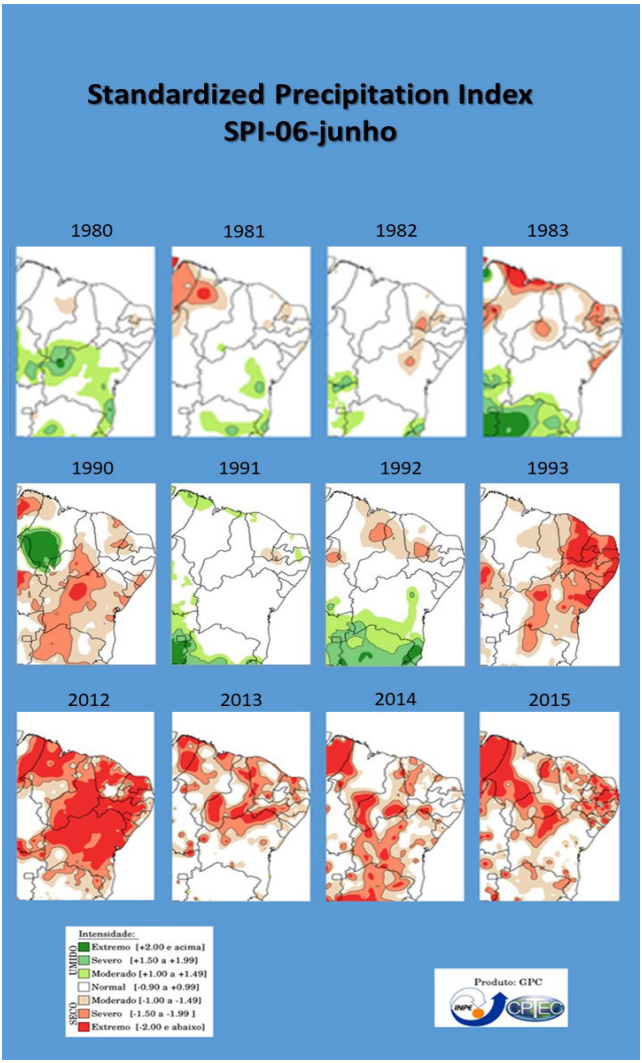


Figure 1. Comparison of the intensity and extent of drought in three distinct periods 1980-1983, 1990-1993 and 2012-2016 in Northeast Brazil. (CPTEC/INPE, 2016)

Three different analogous periods: 1980-83, 1990-93 e 2012-16

In practical terms, droughts are recognized much more by their visible and socially perceived impacts than by the climatological characteristic of some period in question. Some periods, generally long-term droughts, still remain in the popular imaginary of local society. That was the case of 1980-1983 and 1990-1993, to mention just the most recent of the last century. Between 2012 and 2016, despite its higher intensity and longer duration, could be climatically analogous with its predecessors. However, it was not perceived as a drought as a social phenomenon, which made this period different from other historical droughts.

The Standard Precipitation Index (SPI) allows monitoring the discrepancies, namely lack or excess of rains. Using this parameter, it is possible to compare different climate periods and mark some of them as droughts or flooding (CPTEC/INPE, 2016). The data shown in Figure 1 present the SPI for the first six months of the year, or SPI-06-JUNE which represents the rainy season in most of the semiarid region of the Northeast.

The comparison between the three periods clearly indicates that, from the climatic point of view, between 2012 and 2016 the drought was more intense and broader, not only than the two predecessors, but also of the entire history of the records. And yet, the social impacts were far less than those observed in the other two periods cited. In social terms, the period between 1980 and 1983 was one of the most severe in history, with millions of deaths recorded (VILLA, 2000).

This more recent drought began in 2010, without being fully perceived locally. This is explained in part by the more favorable situation in which the affected families found themselves. Except for the crop failure in the first year, no one referred to drought until 2012 (MATTOS, 2017). This "unnoticed dry season" was already an indicator that its impacts would be different from drought. With the same level of rain, previous droughts had already been felt, through exhaustion of food, fodder and water stocks, and consequently, social calamity.

First hypotheses discarded

The data presented above indicate that those analyzed periods were climatically analogous. The variations perceived in terms of magnitude, intensity and longevity weighed even more heavily for the latter. If the heavier drought has almost no social impacts, it is because there is a disconnection between the climatic phenomenon and the social disaster. Definitively, there are some factors that make a lack of rain remain just a dry season, avoiding the drought, with its social calamities.

Another explanation could be demographic. The emigration of the population, especially the rural exodus, which has always been a characteristic of the semiarid region, could help to reduce the demographic density, mitigating the impacts of the droughts or reducing their visible social effects. It is true that the region still exports laborers. However, the last years of the twentieth century presented some trends in changes in the labor market, resulting in a decline in emigration rates. From the demographic point of view, there was no exodus from the region. On the contrary, the population in the region has continuously grown (IBGE, 2006; LEITE; SOUZA, 2012). There was however a change in trend, from exponential expansion to a linear growth. In fact, between 2000 and 2010 the population in all microregions of the Northeast that compose the Brazilian semiarid region increased by more than 8% (MEDEIROS et al., 2012; LEITE; SOUZA, 2012).

Thus, it was a combination of permanent public policies - social, environmental, infrastructure etc. - that made the long-term dry season between 2012-2016 seem much milder than its predecessors' similar periods.

Drivers of change: Conviviality with the semiarid conditions and the decentralization of water supply

Until the 1990s, the predominant idea in public sectors was to combat droughts by expanding the number of dams and other major water infrastructures. Because the investments were generally concentrated in building large reservoirs, this policy was also known as the hydraulic solution (CAMPELLO NETTO, 1994). From that same time on, climate modeling studies have made droughts increasingly predictable (IBGE, 2006; LEITE; SOUZA, 2012) (ARAGÃO, 1986; HARZALLAH; ROCHA DE ARAGÃO; SADOURNY, 1996). The technologies allowed better investments in preparedness and reacting in advance, to avoid social crises.

As a result, it became increasingly evident in society that the drought was historically manipulated by elites whose political capital was built from the domination of the poorest population.

In this sense, the change could only come about through political mobilization in searching for answers. In 1993, faced with the ineffectiveness of this type of policy in mitigating drought and containing social calamity, a combined action of different segments of civil society, led by the National Federation of Peasants and Small Farmers (CONTAG), occupied the Headquarters of the Superintendency for Northeast Development (SUDENE) demanding government commitments to change the policies of drought confrontation (Northern Forum, 1993).

Several water harvesting and storage technologies for decentralized management at household level had already been implemented since the 1990s. However, from the 2000s onwards, they gained strength with their expansion through partnerships between civil society entities and state governments in the Northeast Region, with special support from the Federal Government. The Plaque Cisterns Program became the symbol of this strategy and served as a reference for other subsequent programs of water harvesting and storage, as well as the composition of stocks of seeds, fodder and food.

However, the efficiency of these initiatives in conviviality with the semiarid conditions had never been tested under pressure of long-term droughts. This was only possible in the following decade, with the drought observed between 2012 and 2016.

The peasantry and the semiarid

The pathway for the conviviality with the semiarid climate lies in the relationship between farmers and nature, especially within peasant family agriculture. This relationship is facilitated by the characteristics of peasant agriculture and its division of labor in a particular type of internal equilibrium (CHAYANOV, 1966). From the 1990s on, peasant family farming became a central issue in civil society's demands for public policies. And, it took years before policies could be changed and ideas gained expression as mass policies. Even so, their effectiveness would have to be demonstrated during another long-term period of lack of water.

The proposals were slowly and progressively developed through the innovative capacity of peasant families in the region. They share various services and information, creating a socio-ecological system with great resilience (BAUMGÄRTNER; TIKUBET; GILIOLI, 2010). The combination of alternatives, developed and tested in the context of family farming, has been ordered on the basis of environmental conditions, typical of a noncapitalist economic system. The agricultural farm space was organized according to its environmental characteristics, in order to achieve, therefore, more sustainability.

However, the role of women within the peasant unit should be highlighted. Women are responsible for practically all the systems related to food security, managing resources and investments, with rational choices that resulted in the reduction of damage and social disasters.

In this sense, it could be predicted that the more balanced labor relations are among family members, especially the suppression of the gender division of labor, the better are the productivity and efficiency in the struggle for water, food and nutritional security. By doing this, there will be less effort needed to face adverse conditions. On the other hand, the emancipation of women

represents an important additional source of income for the household economy (SILIPRANDI; CINTRÃO, 2011).

Other factors leading to safety in times of drought

In addition to the aforementioned elements, other factors also helped to build an environment of security during long-term droughts:

- The diversification of economic activities to increase the sources for income generation and stability of livelihoods during droughts.
- Access to social security programs - these guarantee additional income that is invested in their productive and surveillance systems of better conviviality with semiarid climate.
- Building new stocks to withstand longer and increasingly uncertain periods of drought.
- Community interactivity and social relations of proximity - enhance labor savings and the exchange of successful experiences and lessons learned.
- Value addition and market - values the efforts of family members and increases labor productivity.

Results on public policies

The strengthening of social organization has improved the conditions for the governance of public policies, in a favorable context for debating sustainable development prospects in rural territories. The multifunctionality of family farming has made it possible to strengthen policies for social and economic stability. The concept of conviviality with the semiarid conditions was in the base of the programs created and managed by The Civil Society Network for the Semiarid (ASA) and The Sustainable Development Project for Agrarian Reform Settlements in the Semiarid (Dom Helder Câmara Project - PDHC) (SIDERSKY; JALFIM; ARAUJO, 2020).

The valorization of family farming in rural public policies design was not restricted to the semiarid region. But perhaps it was on the semiarid region that this movement had its greatest impact in Brazil. Approximately 50% of the entire country's small farms are still located in the Northeast region, although this corresponds to only 35% of the area such small farmers cultivate nationwide (EMBRAPA, 2014). Their presence in the semiarid region, in addition to being significant, is associated with extreme poverty, making their results and impacts proportionally more intense.

During the critical period between 2012 and 2016, other government programs and policies were created and expanded, amplifying direct impacts on the income composition of families, and providing stronger food and nutritional security systems for the rural population. The perception of the rural population about its guarantees has changed. Despite the severity of the dry season, they feel themselves assured by the set of investments made through public policies.

The main programs that were active between 2012 and 2016 with relevance for social security were:

Family Grants (Bolsa Família) - Practically all families living in rural areas in the semiarid region had access to the program (100% of those interviewed in the field) between 2010 and 2016. The fact that the resources were primarily managed by women ended up optimizing their use in the family unit to meet a security strategy. In addition to the women empowered in the domestic sphere, the benefits to the family as a whole, especially in terms of food security, were evident.

Rural Retirement - This is the old-age retirement for workers in rural areas, including artisanal fishermen and fisherwomen who worked individually or with the help of their families. All of them have rights to receive from the State a permanent transfer. After 1991 the urban and rural retirement systems were unified, assuring the minimum wage for both. However, since the first decade of century, the Federal Government has promoted the purchasing power of the minimum wage, readjusting it constantly above the inflation rate. In ten years, the value of the retirement payment was elevated from below $100 to more than $200 dollars/mo. Its purchasing power, that was of 1.02 basic food baskets in 1993, passed to more than 2.00 basic baskets, remaining at this level until at least 2016 (DIEESE, 2016).

Maternity Allowance - It is a benefit paid to women rural workers or family farmers, corresponding to the social security category of "special insured", who became mothers either through childbirth or adoption (FEDERAL GOVERNMENT, 2016). Even though it is a temporary benefit, it has become strategic for the household economy, notably in the semiarid zone. Women's double workload is aggravated during the postpartum period. As a result, the women who receive the benefit have more financial autonomy to attend to their health and food needs.

Drought Grant - aid made available between 2012 and 2014 to tackle drought. The Ministry of National Integration was responsible for its distribution. It was intended for municipalities that did not adhere to the Crop Guarantee Scheme (FEDERAL GOVERNMENT, 2015) in areas affected by drought, and for families with a monthly income of less than the minimum wage. The monthly

value of the grant was R$80.00 (around US$32) until the end of the program in 2014. Even though it had a low value and temporary characteristic, it played an important role in breaking the old clientelist relations that fed the drought industry in the past.

Harvesting Guarantee Grant (Garantia Safra) - aimed at family farmers located in the semiarid region who have suffered crop losses due to drought or excessive rainfall (FEDERAL GOVERNMENT, 2016), with contributions from the states and municipalities. It was created in 2002 by the Federal Government and ensures minimum survival conditions for family farmers in municipalities systematically subject to crop loss due to drought or excessive rainfall. In 2016, the total amount paid by this grant was R$ 850.00 (eight hundred and fifty reais) per family, distributed in five monthly installments.

Crediamigo (Small business credits) - was a credit program managed by Banco do Nordeste to stimulate micro-entrepreneurship (individual microentrepreneur, individual entrepreneur, self-employed or business partnership). It was not exclusive to the semiarid region but had repercussions on the region's economy by supporting informal or formal economic sectors. The facilitated bureaucracy - with services provided locally to the enterprise – including rapid release of the loan and renewable loans, gave to the program great reach and integrated it into the semiarid region (BNB, 2017). The relationship between non-agricultural activities, family income and conviviality with the semiarid was perceived, in which part of the income generated thereby was reinvested in the production systems.

Water Trucks Program (Operação Carro-pipa) - water delivery by water trucks managed by the Ministry of Integration in partnership with the Army. The program was recreated in 2010. In 2016 there were almost 6,800 water trucks throughout the semiarid region in the service of the federal program (FEDERAL GOVERNMENT, 2016). Owning a cistern was a basic condition for being a beneficiary of the program. But the order and scale of water delivery are defined jointly between the army and local authorities. Differently from previous aid, grants and benefits, in which cash resources were transferred through a personal and non-transferable card, in this case the benefit was water, distributed from house to house. Its distribution depends on a local operator and the criteria established by the program's local operators. There was no cost or counterpart for the benefited families. As a result, the water tended to be used for many purposes far beyond what the cistern water would have had if it had come just from rain. With the deepening of the drought from 2012 onwards, the distribution of water in water trucks instead of being a complementary water supply, became the rule, with the resurgence of political purposes. Certain politicians asked for

electoral commitments from the families to be beneficiary of the program. The same clientelist practices were used in selection of the drivers of water trucks and the "owners" of water sources. This whole network was constituted by political appointment. These government actions were incorporated into the daily lives of rural families and their food security strategies. The policies shifted from assistance to clientelism. However, most of them incorporated elements of greater autonomy for families, when compared to the old emergency policies, that had been focused on distribution of basic food baskets and enlistment of workers in emergency front services. Income transfers were carried out with more impersonality, with less local mediation and weakening the bonds of commitment and obligation towards political groups. The most visible exception was that of the Water Trucks Program, whose local coordination, through fragile municipal committees, allowed politicians and local elites to control deliveries with private interests.

The dynamics of a semiarid rural farm in three moments

The different policies and actions operate in an integrated system and will be briefly described in the following items considering three situations: (i) normal rainy year, before the interventions; (ii) drought, before the interventions; (iii) Dry season after the interventions and their impacts on social security.

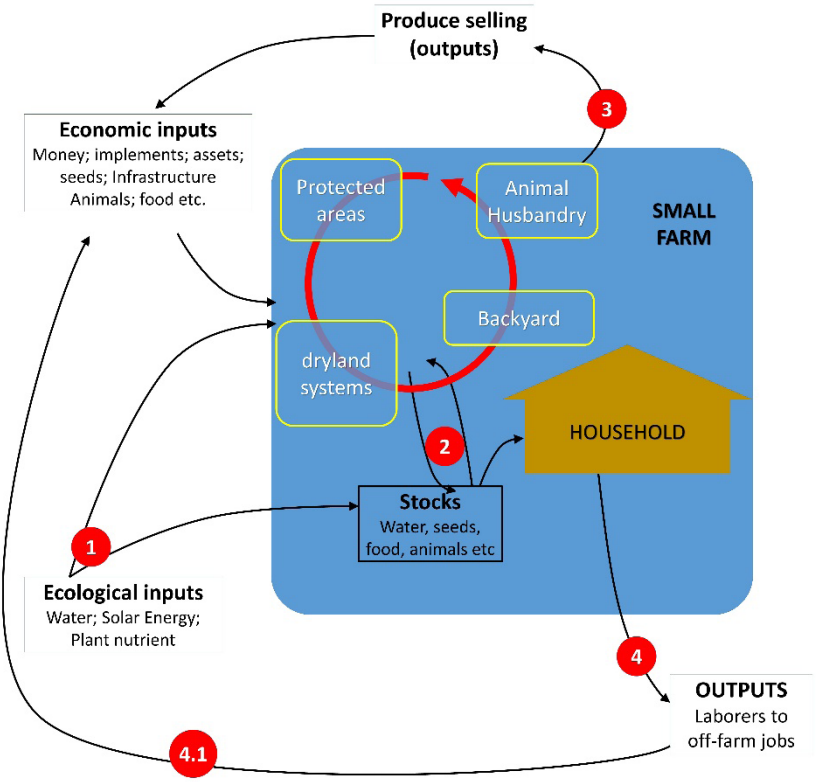


Figure 2 - Functioning of the Family Production Unit - Normal Situation

Situation 1: 'normal' year, before interventions

In a conventional situation, rural households fundamentally depend on the interaction between natural factors and their means of production (Figure 2). Ecological inputs 1 become the basis of the system, feeding the productive systems. For graphical representation they were simplified into four subsystems: dryland systems of production, backyards, protected areas and animal husbandry. They interact with storage systems, mainly rainwater in reservoirs and groundwater in wells. In turn, they feed the food stocks that will serve as a basis for the family's livelihood 2 or can be destined for the market 3. Stocks stabilize production during droughts. The family production unit maintains relations with its surroundings that allow new monetary incomes, either through the sale of products, or through the involvement of part of its members in non-agricultural activities 4. This feeds back into the economic incomes 4.1.

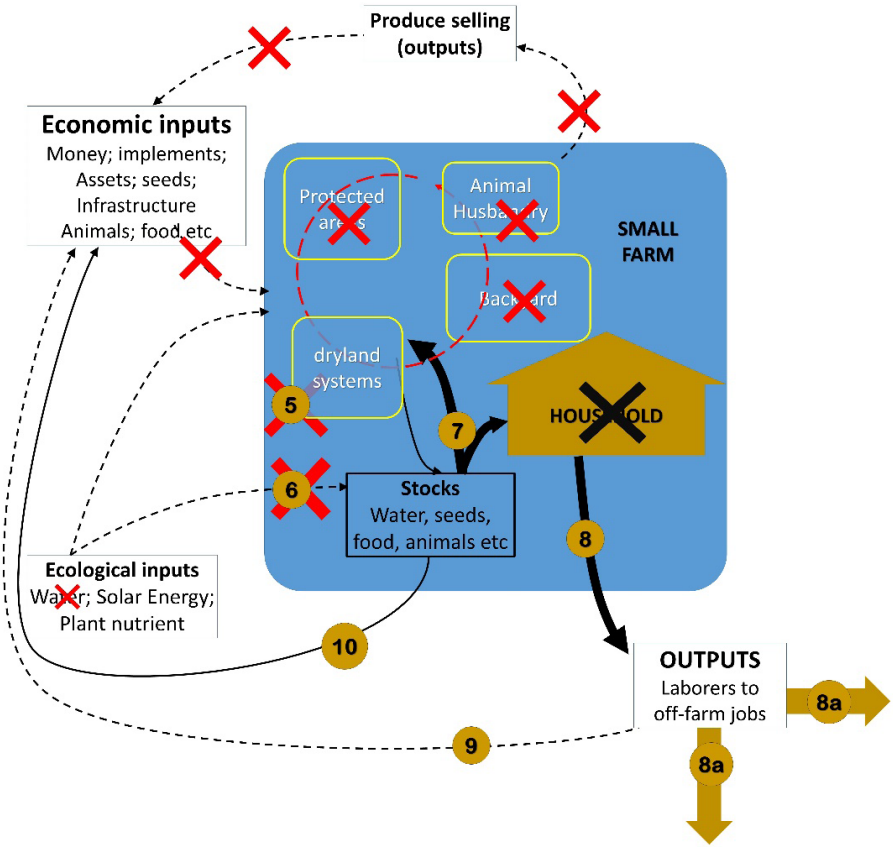


Figure 3 - Functioning of the Family Production Unit - Under impacts of drought.

Situation 2: dry year, before interventions

The crisis generated by a long-term drought begins with crop failure in Dryland Agriculture Systems 5 , which are more dependent on rainfall (Figure 3).

There is also a reduction in the contributions to water storage systems 6. Without replenishment and with the reduction of rainfall in production systems, stocks are exhausted more quickly 7 both due to the greater demand for lifesaving irrigation and the consumption of grain reserves as human or animal food, threatening seed stocks.

With the deepening of the drought, the family nucleus is threatened by migration in searching of work and income opportunities 8. This increases the risk of disruption of the social family structure 8a, reducing income from nonagricultural activities, with an impact on the restructuring of productive systems 9.

Thus, it is the stock itself that is transformed into a sale product to compensate for harvest losses 10, a factor that further increases the pressure on stocks and weakens the potential for recovery of systems after the crisis (resilience).

The circumstances of situation 2 do not occur without public policies. But the results of ineffective policies resemble their own non-existence. In addition, stockpiling policies in large construction projects create an additional attraction for the outflow of labor from region 8a and make the population more dependent on clientelist actions.

Situation 3: after the interventions and their impacts on social security

Observations made in the field show that the aforementioned policies differed from the traditional emergency actions, which have a limited and clientelist nature.

Looking at Figure 4 from the bottom up, we initially see investments in the composition and structure of stocks 11. With the general expansion of decentralized and near-household rainwater harvesting, such as cisterns, new possibilities for better use of rainwater were created. This concept, based on agroecological principles, starts with the strengthening of stocks to resist longer dry seasons and to rehabilitate productive systems after they have ended (resilience). In addition to water, seed and fodder stocks for animal husbandry systems were crucial. The formation of stocks should be in line with the protection of agrobiodiversity, and therefore the maintenance of genetic patterns of plants and animals adapted to the conditions of the semiarid region.

Thus, in crisis conditions caused by drought, stocks are better able to withstand the pressure of demand 12 and keep productive systems that support household demand running for longer. Backyard systems are particularly strengthened by the expansion of water stocks. By maintaining backyard activities, there is continuity in the distribution of products to the market 13, thus maintaining economic income for the family. In addition, backyard systems are strongly related to the family's food security.

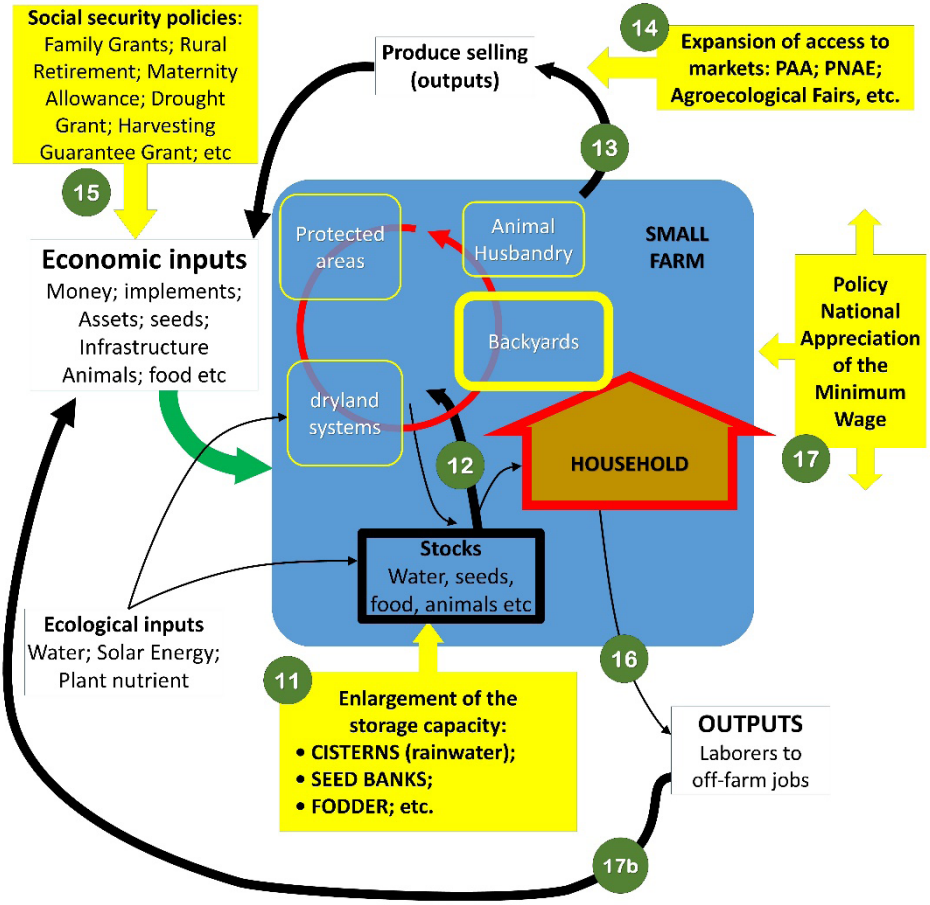


Figure 4. Functioning of the Family Production Unit under the impact of public policies on food security and living with the semiarid region.

This process is combined with a second field of public policies, focused on access to local agroecological markets and institutional markets such as Program of Food Acquisition (PAA) and National Program of Escolar Food Supply (PNAE) 14. Thus, the first synergy between public policies is created, combining the strengthening of storage with increased access to markets. The way of implementing cash transfer programs neutralized the foundations of the "drought industry", which kept families in critical situations that limited their growth capacities, generating cycles of political dependency. The various social security programs have had the effect of breaking the vicious cycle of poverty production and reproduction 15, and have also provided important economic inputs for the family, used as alternative investments to strengthen the replenishment of stocks and

productive systems. Finally, the persistence and importance of non-agricultural activities in family life must be taken into consideration. In this sense, the search for new work opportunities outside the small farm continues to be a reality. Two aspects must be taken into account.

The first one is the local and regional economic dynamism generated by the aforementioned policies. They create conditions to open work opportunities closer to the farm, reducing the impact of migration to other regions 16.

The second one is the national policy of valorization of the minimum wage 17, which made both the job opportunities and the security policies linked to the minimum wage, helping to better compose the families' income, bringing more monetary? incomes 17b. Thus, there is a clear effect on the stability of the family nucleus, with increased benefits for staying in the region, which has increased the opportunity cost of emigration.

Conclusions

The long history of peasant agriculture and civil society in the region has made it possible to affirm their crucial role in the development of public policies. Ideas have been developed and tested locally and have been disseminated and adapted in local and regional social networks, relying also on major mobilizations and demands. These policies have gradually incorporated the concepts of conviviality with the semiarid region on a sustainable basis.

The decentralization of water supply, stockpiling and adoption of lowcost technologies represented key elements for the sustainability of rural development on agroecological bases. These innovations consolidated the concept of conviviality, making coping with long-term dry seasons more efficient. It proves that dry season and drought are not the same.

However, there is also the visible effect of external factors on the stability of family farming systems, particularly the recovery in the value of the minimum wage, the overall economic recovery and cash transfer programs. The latter were in fact partly influenced by civil society's critical approach to the historical emergency programs.

It is not possible to affirm that the actions and policies toward conviviality with the semiarid region on an agroecological basis have been assimilated by the local peasants in a linear fashion and with the same intensity. But today the peasants of the Semiarid have alternatives for the agroecological intensification of their production systems, as opposed to conventional intensification models. The success of this set of alternatives and policies in coping with the longest and most intense dry season on record (2010-2016) allowed families to make the best decisions regarding their own destiny, without suffering drought effects.

References

ARAGÃO, J. O. **A general circulation model investigation of the response to El Niño**. Colorado: NCAR/CT. Colorado, 1986. PhD Thesis. p. 144.

BAUMGÄRTNER, J.; TIKUBET, G.; GILIOLI, G. Towards Adaptive Governance of Common- Pool Mountainous Agropastoral Systems. **Sustainability**, v. 2, p. 1448-1471, 2010. ISSN 2071-1050.

BNB. **Crediamigo**, 2017. Available at: https://www.bnb.gov.br/crediamigo. Accessed in: jun.2017.

CAMPELLO NETTO, M. S. C. Prefácio - Sobre a ação pública e as secas no Nordeste. In: MOLLE, F. **Marcos históricos e reflexões sobre a açudagem e seu aproveitamento**. Recife: SUDENE/ORSTOM, 1994. ISBN Série Hidrologia 30. p. 190.

CASTRO, J. D. **Geografia da Fome**. 10. ed. Rio de Janeiro: Edições Antares, 1984.

CHAYANOV, A. On the Theory of Non-Capitalist Economic Systems. In: CHAYANOV, A. **The Theory of Peasant Economy**. Homewood, Illinois: The American Economic Association, 1966. Chap. 1, p. 1-28.

CPTEC/INPE. Standardized Precipitation Index (SPI). **Instituto Nacional de Pesquisas Espaciais - Centro de Previsão de Tempo e Estudos Climáticos**, 2016. Available at: http://clima1. cptec. inpe.br/spi/pt or www.cptec.inpe.br. Accessed on: 8 Jul. 2016.

DI SABBATO, A. et al. **Rural Statistics and the Feminist Economy:** a look at women's work. Brasília: NEAD/MDA, 2009. 169 p.

DIEESE. **Technical Note No. 153 - Minimum Wage Appreciation Policy: value for 2016 is fixed at R$ 880.00**. Technical team: Ilmar Ferreira Silva José and Silvestre Prado de Oliveira (technical review). Intersindical Department of Statistics and Socioeconomic Studies. São Paulo, 2016. p. 2.

DURKHEIM, E. What is a social fact? In: DURKHEIM, E. **As regras do método sociológico**. 3. ed. São Paulo: Martins Fontes, 2007. Chap. 1, p. 1-14:165.

EMBRAPA. AIAF 14 - Family Farming in Brazil. **International Year of Family Farming**, 2014. Available at: https://www.embrapa.br/aiaf-14-agricultura-familiar-no-brasil. Accessed in: jun.2017.

FERREIRA, A. P. L. **La importancia de la perspectiva feminista en el empoderamiento de las mujeres campesinas**. Universidad de Córdoba and Universidad Internacional de Andalucía. Córdoba, 2008. Master in Agroecology under the direction of Emma Siliprandi and Angel Calle.

NORDESTE FORUM. **Ações Permanentes para o Desenvolvimento do Nordeste Semiárido Brasileiro**. Recife: CONTAG/ASSOCENE, 1993. 40 p. (with support from CESE, FASE, OXFAM, SACTES (GIZ), SUDENE, CRS and Cáritas Brasileira).

FEDERAL GOVERNMENT. Auxílio Emergencial Financeiro. **Ministry of Social and Agrarian Development**, 2015. Available at: http://mds.gov.br/assuntos/cadastro-unico/o-que-e-e-para- que--serve/emergency-financial-aid. Acesso em: 30 nov. 2016.

GOVERNO FEDERAL. Garantia-Safra. **Secretaria Especial de Agricultura Familiar e Desenvolvimento Agrário**, 2016. Available at: http://www.mda.gov.br/sitemda/secretaria/saf-garantia/sobre-o-programa. Accessed on: 4 dez. 2016.

FEDERAL GOVERNMENT. Ministry of Regional Integration. **Operação Carro-pipa**, 2016. Dispo- level at: https://www.brasil.gov.br/imagens-banners-em-geral/carro-pipa.png/view. Acesso em: 1 nov. 2016.

FEDERAL GOVERNMENT. Valor do Salário-maternidade. **Social Security**, 2016. Available at: http://www.previdencia.gov.br/servicos-ao-cidadao/todos-os-servicos/salario-maternidade/valor--salario-maternidade/. Acessed in: 30 nov. 2016.

HARZALLAH, A.; ROCHA DE ARAGÃO, J. O.; SADOURNY, R. Interannual rainfall variability in northeast Brazil: Observation and model simulation. **International Journal of Climatology**, Boston, v. 16, p. 861-878, 1996.

IBGE. **Continuation of the Agricultural Census Published in the "0" millenniums as part of the General Census of Brazil and in the "5" millenniums as part of the Economic Census**. [S. l.]. 2006.

LEITE, J. C. F.; SOUZA, K. L. D. **O Novo Perfil do Nordeste Brasileiro no Censo Demográfico 2010**. Bando do Nordeste do Brasil - BNB. Fortaleza, p. 106. 2012.

MATTOS, L. C. **Um tempo entre secas: Superação de calamidades sociais provocadas pela seca através das ações em defesa da convivência com o semiárido**. Universidade Federal Rural do Rio de Janeiro - Graduate Course in Development, Agriculture and Society (UFRRJ/CPDA). Doctoral thesis. Available at: http://r1.ufrrj.br/cpda/. Rio de Janeiro, 2017. p.265.

MEDEIROS, S. D. S. et al. **Synopsis of the Demographic Census for the Brazilian Semiarid**. Instituto Nacional do Semiárido - INSA. Campina Grande, 2012. p. 103.

SIDERSKY, P.; JALFIM, F.; **ARAUJO**, E. **A Estratégia de Assessoria Técnica Permanente do Projeto Dom Helder Câmara.** 2. ed. Recife: Ed. PDHC, 2010.

SILIPRANDI, E.; CINTRÃO, R. As mulheres agricultoras e sua participação no Programa de Aquisição de Alimentos (PAA). In: BUTTO, A.; DANTAS, I. **Autonomia e Cidadania:** Política de Organização Produtiva para as Mulheres no Meio Rural. 1. ed. Brasília: MDA, 2011.

VILLA, M. A. **Vida e morte no sertão:** história das secas no Nordeste nos séculos XIX e XX. 1. ed. São Paulo: Editora Ática/Instituto Teotônio Vilela, 2000. 269 p.

CHAPTER 3

Agroecology and family farming: vulnerabilities, resilience, and adaptation to climate change in the Brazilian semi-arid region

Allan Milhomens, Mário Lúcio Ávila, Eduardo de Lima Caldas

Introduction

This article presents agroecology as an adaptation strategy to reduce vulnerability and increase resilience in the semi-arid region and discusses the role of socio-technical networks and policy instruments for adapting to climate phenomena in the region. It employs a literature review and findings of the systematization of experiences.

Climate change is directly associated with the unusual rate of increase in the average temperature of the earth's surface and the greater frequency and intensity of extreme climatic events. According to Marengo (2007, p. 76), this change is "affecting ecosystems, causing the destruction or degradation of habitat and the permanent loss of productivity, threatening both biodiversity and human well-being." The scientific community maintains that such changes have as their main cause the increasing volume of Greenhouse Effect Gases (GHG) concentration in the atmosphere from anthropogenic actions related to changes in land use and the use of fossil fuels, mainly by industrialized countries.

From the social perspective, the predictability of climate change indicates a possible worsening of the socio-economic vulnerability of family farmers in the region, with direct effects on their means of subsistence, predominantly focused on rainfed agriculture (ANGELOTTI et al., 2012).

Among the semi-arid regions worldwide, that of Brazil is the most populous (MARENGO, 2008), covering 1,262 Brazilian municipalities in ten states of the federation, with 1.03 million km² and about 27 million inhabitants with low social indicators (ASA BRASIL, 2020). Approximately 1.4 million farming

families live there, most of whom produce for subsistence (BRASIL, 2019), where, alongside the North Region, the country's highest rates of food insecurity are concentrated (BRASIL, 2020).

To strengthen socio-ecological resilience in the face of current and future climatic events, implementation strategies for coexistence with the semi-arid region are fundamental and stem mainly from the organizational maturing of social movements in the countryside. The Articulation of the Brazilian Semi-arid, known as ASA, created in 1999, is the protagonist and bearer of the narratives of this project, whose objectives should promote the sustainable use and conservation of Caatinga, reinforcing the conceptions and practices of agroecology as one of its principles and the basis for the regional sustainable development (ASA BRASIL, 2002, p. 4).

It is in this context that the family farming movements of the semi-arid region produce, reconstruct, and resume a legacy of experiences where "traditional knowledge and its experiments in the management of nature came to be valued and improved in dialogue with scientific knowledge" (DUQUE, 2008, p. 136), involving public research through universities, Embrapa Semiárido, and various advisory and technical assistance networks of civil society. Converging with the adaptation references, the programs for capturing and storing water for human consumption and agricultural production are strategies for improving the living conditions of rural populations in the Brazilian semi-arid region (AMORIM; GRISA, 2018). The agroecological approach as a strategy to combat poverty and hunger through public state action contributes to this new framework of decentralized management of public policies with the participation of civil society (SIDERSKY et al., 2008). Agroecological production systems can provide a double response to climate change in the context of mitigation strategies and adaptation initiatives (PETERSEN et al., 2009).

By the end of the century, the regional temperature in the Brazilian semi-arid region may increase between 1.5ºC and 2.5ºC (3ºC and 5.5ºC) in a more optimistic (pessimistic) scenario, resulting in a higher or lower level of GHG emissions. Family farmers, poorer champions, and traditional peoples, whose livelihoods are linked to rainfed agriculture, will be quite vulnerable to water deficits, further aggravating their living conditions, food insecurity, and the consequent migration from their lands to urban areas (MARENGO, 2008; MARENGO et al., 2011; ANGELOTTI et al., 2012).

According to Marengo et al. (2011, p. 385), in the semi-arid region, "even though drought is a chronic and continuous situation, the population has not yet adapted to the phenomenon." In the caatinga region, an exclusively Brazilian biome (BRASIL, 2019a), approximately 1.45 million farming families (about

37% of all brazilian family farming) (BRASIL, 2019b) occupy only 4.2% of arable land, with more than half of the population living in extreme poverty (ASA, 2020).

Adaptation to climate change in the context of the development debate

Adaptation cannot be seen only as an adjustment to climate change resulting from anthropogenic causes (EAKIN AND PATT, 2011). According to Lindoso et al. (2013, p. 304), such adjustment is based on the so-called principle of additionality adopted in the basic text of the Convention, which considers adaptation as a response to climate change caused by human activities. Thus, "the adaptive deficit that already exists in the management of natural climate variability, especially in developing countries periodically affected by climate disasters," remains uncovered. In addition to addressing this deficit, adaptive measures should be undertaken in response to the climate vector and context of actions to promote sustainable development to combat the vulnerability of the most susceptible social groups.

Following Pielke et al. (2007), adaptive strategies can and should be prioritized in different initiatives to reduce vulnerability and improve societal resilience to future impacts of climate change, whatever their causes. Thus, unlike an adaptation strategy, this type of marginal adaptation, in the case of the Northeastern semi-arid region, would be insufficient to strengthen the adaptive capacity of family farmers of that region, whose vulnerability to climate change derives mostly from a set of other non-climatic factors.

Adaptation must converge with capacity-building goals necessary to reduce climate vulnerability. Thus, adaptive capacity-building should be considered a dynamic process involving learning and interactive processes of experimentation among social and organizational actors at all levels and geographic scales, from local to global (EAKIN AND PATT, 2011).

Brazil has already instituted its National Policy on Climate Change (NPCC) (BRASIL, 2016), aligned with the normative concept of the Convention (BRASIL, 2020), in which mitigation and adaptation are recognized as pillars in elaborating sectoral plans, including that on agricultural. As Obermeier and Rosa (2013, p. 167) discussed, though regarding policy implementation plans, the debates on adaptation have covered topics such as vulnerabilities and social inequalities. Moreover, the lack of a systemic and integrated vision of adaptation and intersectoral is an indicator of low transversality, "which can have fundamental consequences for the most vulnerable groups."

Therefore, the issue is the challenge of overcoming a vision that presents adaptation as a marginal response to GHG emissions, creating anomalous distortions in public policies and affecting societal ability, especially that of the poorest, to defend themselves from climate impacts (PIELKE et al., 2007). Addressing poverty and inequality to strengthen the adaptive capacity of the most socially vulnerable populations does not always influence political decision making regarding the priority of adaptation and relevant redistribution needs of resources, technologies, land, and water; it does not always improve access to governance systems (ADGER et al., 2003).

Farming and the challenges of climate change adaptation

FAO (2018) estimates that 83% of all losses and damages to agriculture worldwide were caused by droughts in 2017. The IPCC Technical Summary 2019 estimates that 23% of anthropogenic greenhouse gas emissions (2007–2016) are from agriculture, forestry, and other land uses. According to Smith et al. (2008), agricultural land occupies approximately 37% of the Earth's land surface, and agriculture is responsible for 52% to 84% of global emissions of anthropogenic methane and nitrous oxide, which are even more damaging than CO_2. Besides using 70% of global water resources, modern agriculture is a fossil-energy-intensive industry (Altieri; KOOFHAFKAN, 2008). Thus, considering all links in the chain of activities of the food system (from production to consumption and disposal), GHG emissions reach approximately 33% of global emissions (NILES et al., 2017, p. 5).

As one of the global leaders in food production, Brazil is also the sixth-largest emitter of GHGs worldwide, with 3.2% of the world total. Since 2010, Brazil has increased its yearly GHG emission rates by 28.2%. The increasing trajectory of this indicator reflects a reversal of the trend in the Brazilian economy, with the aggravating factor that "*per capita emissions* are higher than the world average, a distortion resulting from high rates of deforestation" (SEEG, 2020, p. 8).

According to Altieri and Koofhafkan (2008, p. 4), the alternative is to "produce more with less" and employ all efforts to reduce risks to production factors. It is essential to drastically reorient monoculture systems (Altieri et al., 2015).

The literature notes strategies for drastically reducing these emissions by adopting measures such as investments in the substitution of fossil energy, recovery of pastures and degraded areas, implementation of agroforestry, direct planting, biological fixation of NO2, reforestation, and treatment of animal waste (SMITH et al., 2008). However, mitigation alone will not solve climate change.

Adaptation measures should be intensified to protect agriculture from increasing droughts, make water use more efficient (PARRY et al., 2009) and, contain or reduce the expected impacts on productivity decline. For Altieri et al. (2015), adaptation is the key factor determining the level of future risk of climate change on food production.

Coexistence with the Semi-arid and new directions for recovering the adaptive deficit: between the past and future

Adaptation to climate variability and development strategies should be treated in an integrated way as convergent and inseparable processes. As per Eakin and Patt (2011), adaptation to climate variability in the semi-arid region can be understood within a spectrum of long-adopted initiatives, with advantages, benefits, and distinct perspectives for social actors of the rural world of the Brazil Northeast Region (specifically the Sertão).

Over the decades, the trajectory of hegemonic public policies was marked by strategies to combat drought at the service of the agrarian elite, the capitalist modernization of agribusiness, and power relations orchestrated by institutional bodies created under the political control and interests of the region's rural oligarchies. The same vicious cycle of the national model of land concentration and low-income distribution, made possible with the support of the State, was reproduced in the semi-arid region of the Northeast. Access to water was almost always guaranteed by public works of water infrastructure, especially as medium and small dams within private properties (DUQUE, 2015). For family farmers, on the margins of most investments in adaptive structures, the climatic variability of the region carries the chronic problem of water scarcity, limiting their capacity for development and adaptation. According to Lindoso et al. (2013), in areas of enclaves favored by the irrigation of agricultural production for extra-regional consumption, finding traditional farmers who coexist periodically with rainfall shortages is possible. The São Francisco Valley Development Company (Companhia de Desenvolvimento do Vale São Francisco – CODEVASF) reports that only 1% of the irrigators are currently family farmers or settlers (MILHORANCE et al., 2019).

Therefore, the technical solutions are chosen mostly to benefit agro-export capital.

The debates on sustainable development in the context of the severe droughts that devastated the region in the 1990s induced a political environment of confrontation with the paradigm of the "drought industry." The family farming

coalition union movements, under the leadership of ASA, brought a proposed paradigm for living with the semi-arid to the political decision-making agenda, bringing together institutional actors from research, technical assistance and rural extension, and civil society organizations (SILVA, 2003; AMORIM; GRISA, 2018).

ASA's political charter establishes that "agroecological conceptions and practices constitute the basis for sustainable development in the countryside." Moreover, the Semi-Arid Declaration highlights the sustainable use of the natural resources of the Caatinga, the breaking of the monopoly of access to water, land, and other means of production, the use of adapted technologies and methodologies, and the strengthening of family farming and food security as premises (ASABRASIL, 2002, p. 4). From 2003, the state-society relationship created new spaces for articulation and participation based on social issues, producing greater fluidity to the demands of the Semi-arid (AMORIM; GRISA, 2018). Thus, before any national public policy to confront climate change, there was an alternative proposed by civil society.

Implementing measures and instruments to combat poverty are pillars in adaptation strategies to the effects of climate variability, especially for the most impoverished rural populations (EAKIN; PATT, 2011; LIN- DOSO et al., 2013). Examples in the semi-arid region include the Cisterns Program, Bolsa Família (Family Grant), the Food Acquisition Program (PAA), and the National School Feeding Program (PNAE). Such initiatives, in addition to the rescue of traditional knowledge with an agroecological focus, articulating innovative forms of planning public action in the Semi-arid, such as the National Policy on Agroecology and Organic Production and different state regulations, have also had a recognized positive impact on the strategies for strengthening agroecology as an adaptation strategy (GUYOT et al., 2015).

Vulnerability and socio-ecological resilience in the adaptive context of the Semi-arid

Adaptation, vulnerability, and resilience are interdependent factors in development approaches and are even more relevant as studies on climate change challenges evolve. Vulnerability is associated with adaptation processes and is generally related to social inequities and environmentally unsustainable development practices (OBERMEIER; ROSA, 2013, p. 156). Studies argue that measures based on climate adaptation research, stricto sensu, that do not consider the socio-economic and environmental vulnerabilities of communities do not indicate the "paths to [achieve] a systemic socio-environmental resilience in the future." Causes and effects of vulnerability are associated with unequal access

conditions to development opportunities influenced by political, institutional, and economic dynamics. They include approaches to equity, justice, and social marginalization from historical patterns of domination, which undermine the right of individuals to choices and opportunities (ADGER et al., 2003).

For Duque (2015), the issue of the vulnerability of the people of the Semi-arid is more political-economic than climatic, and land concentration is the root of poverty in the region, which demands urgent measures for agrarian reform. Within one of the most rigid agrarian structures worldwide, the fragmentation of properties is increasing given the intergenerational evolution of farming families, and the size of properties is a restrictive factor for the best performance of family production in the adaptive contexts of living with the Semi-arid (SIDERSKY et al., 2008). The areas of cultivation, especially rainfed crops, and the size of the herd of animals are very small, occupying an average of 3 ha (NASUTI; LINDOSO, 2015).

The transition from vulnerability to resilience is a central challenge to living with the Semi-arid, as advocated by the ASA Program. From the perspective of climate adaptation, overcoming accumulated adaptive deficits depends on contexts and development opportunities (HUQ; REIDE, 2009) linked to reducing social inequities and distributional issues that affect rights of access to resources and policies. For Obermeier and Rosa (2013), socio-economic vulnerabilities must be addressed beyond addressing uncertain climate futures and simplistic debates of vulnerabilities and challenges to making rural systems resilient.

Resilience is the capacity of a system to buffer or absorb disturbances without reducing its adaptive capacity (ADGER, 2000). In the context of agroecosystems, it represents the ability of a system to maintain its functional structure without losing its productivity after an impact suffered, thus maintaining food production when challenged by severe droughts or intense rains (ALTIERI, 2013; ALTIERI et al. 2015). Resilience increases the ability to react to impacts, unlike vulnerability (ADGERr, 2000). The higher the resilience, the lower the vulnerability.

In agroecological contexts such as the Caatinga, social and ecological resilience are interdependent and associated with agroecosystems' resilience mechanisms. The relationship between the two concepts is fundamental, especially in the case of social groups that depend on natural resources for their subsistence. The "resilience of social systems is related [...] in some way to the resilience of the ecological systems on which social systems depend" (ADGER et al., 2003, p. 351).

Social and natural systems interact positively in agroecology. Nicholls (2013) notes that social-ecological resilience enables agricultural systems to withstand and recover from climatic events while helping agri-cultivators develop social

organization strategies involving solidarity-based exchange networks capable of coping with harsh climate externalities.

Following Thompkins and Adger (2004), extending and consolidating social networks as organizational processes of social groups constitute strategies for mobilizing collective interest to reduce social vulnerability and promote ecosystem resilience. Thus, community engagement and the influence of interactive learning exchanges based on successful traditional knowledge management experiences are important tools in building resilience that also contribute to increasing the leadership capacity of social groups. Accordingly, building the adaptive capacity of Sertanejos accords with the rights and security of individuals; it is not exclusively about avoiding possible harm from climate change but the impetus it can provide to strengthen and institutionalize sustainable development goals.

Agroecology and climate change

Agroecology

Agroecology has the scientific, technological, and practical conditions to "develop agroecosystems with minimal dependence on agrochemicals and external energy" (ALTIERI, 2012, p. 15). It is based on the secular experience accumulated by peasants interacting with their environments and locally available resources, including diversification into polycultures with high capacity and resilience to maintain agrobiodiversity and manage possible climate risks on small farms (ALTIERI; KOOHAFKAN, 2008). Regarding mitigation, agroecological agroecosystems radically reduce dependence on fossil energy, eliminate the use of nitrous oxide, reduce GHG emissions, and sequester carbon (PETERSEN et al., 2009).

The readiness of agroecology for the adaptive challenge to climate change worldwide would not affect the productive capacity to supply the population. Its challenges lie at the political level, arising from power relations that define and guide development policies (PETERSEN et al., 2009). This perspective converges with the explanation of Adger et al. (2003) that decision-making on climate change adaptation involves relationships between the state, individuals and their networks, coalitions, capacities, and social capital of the actors, reinforcing the hypothesis of Caldas and Massardier (2020) that, despite innovations, the most important variables to explain the predominance of public policy instruments linked to conventional agriculture over any other alternative are the coalitions of organized social groups and their *brokers* with the state actors.

In Brazil, the perspective is no different. The adoption of the agroecological approach is among the initiatives of the sectoral strategy for agriculture in

the National Plan for Adaptation to Climate Change (BRASIL, 2016), despite belonging to a minority and marginal coalition in the face of agribusiness coalitions that have become "climatized." Without operating changes in the dominant forms of politics and agricultural production, the agroecological approach hardly overcome "the current stage of isolated and [few] socially […] visible experiences to expand its scales of social and geographical coverage to territories across the country" (CAPORAL; PETERSEN,2012, p. 10).

Thus, the expansion of agroecology to the approximately 1.45 million family farmers in the semi-arid Northeast is related to two challenges (ROSSET and ALTIERI, 2017): public policies to support agroecology, with emphasis on education, research, rural extension, training, credit, and social and institutional construction of markets; and gains of scale, with increased production, productivity, and the number of farming families practicing agroecology.

Social organization through local networks of family farmers in various territories, based on learning, exchange, and collective experimentation, is essential to reconfigure current power relations.

Approaches, experiences, and potentialities of agroecology in adaptation strategies to climate variability in the semi-arid region

The agroecological experiences developed in the semi-arid region show significant achievements in coping with climate variability conditions in the region (GUYOT et al., 2015). They reflect socially constructed adaptive processes, focusing on goals, values, culture, knowledge (not necessarily associated with future climate change), and the perception of risks and social choices (ADGER et al., 2003). They involve ancestral technologies for coping with drought applied as management strategies, conservation, and maintenance of soil moisture, such as rock ridges, underground dams, among others, integrating productive alternatives traditionally recommended in the implementation of agroecosystems adapted to the characteristics of the semi-arid region (GUYOT et al., 2015).

In the semi-arid region, the territorialization of agroecology is a process forged in the construction and work of networks supported by various project fronts and public action instruments (NIEDERLE et al., 2019). Social networks increase the adaptive capacity of different vulnerable social groups toward socio-environmental resilience. They connect actors, institutions, and organizations (family farmers, technicians, and researchers); strengthen critical dialogical processes in rural development contexts; and articulate the production and dissemination of

knowledge and practices on the agroecological management of agroecosystems (CHARÃO-MARQUES et al., 2017), thereby creating spaces for innovation.

The territorial dynamics of the agroecology networks, evaluated in the Ecoforte-Networks Program, as per Cortines (2019), create relational flows that interconnect with other networks at different scales (local, national, and international). In the municipalities, they interact with educational and research institutions, strengthen participation in spaces of social control in the scope of public action, experience dissemination, learning, and innovation development. Experiences monitored by this Program testify to the vigor of the agroecology territorialization in at least five networks in the semi-arid region, inducing the implementation of various local experiences.

Among these experiences, the Rede RIS Sobral in Ceará stands out for its mobilization of family farmers in the rescue and conservation of agrobiodiversity, implementing seed banks of native varieties adapted to the climatic conditions of the semi-arid region and developing new forms of relationships between producers and consumers strongly marked by links to the solidarity economy (CORTINES, 2019). According to Canci and Canci (2007, p. 225), "most cultivated local species and creole varieties have resisted extinction thanks to informal seed exchanges," implying the perpetuation of varieties and the importance of providing food security and strengthening cultural ties among family farmers.

Guyot et al. (2015) highlight such strategies to strengthen the socio-environmental resilience of groups in initiatives developed by the Popular Organizations Advisory Service (SASOP) in the semi-arid region of Bahia. They are also guided by crop diversification, management, and storage in native seed banks, soil conservation, and water capture and storage, among other adaptive strategies that confer socio-environmental resilience to farmers and their agroecosystems.

According to Altieri and Koofhofkan (2008), the richness of diversification meets social and economic needs, helps farmers, and wards against future climate change. These processes are based on generation knowledge in agroecology, which, according to Altieri (2012, p. 16), involves multiple actors in innovation, research, and participatory experimentation, "using extension tools based on more horizontal relationships between actors."

The experience of Projeto Dom Helder Camara

In the semi-arid region, the work developed in agrarian reform settlements by Projeto Dom Helder Câmara (PDHC) adopts a pedagogical process of experimentation, dissemination, and replication of experiences that integrates organizational, educational, and technological aspects, giving rise to implementing training strategies focused on groups with common interests. Thus, it brings

technicians and family farmers together within their communities, articulates the participatory confrontation of common problems, and improves their capacities to access public policies (SIDERSKY et al., 2008). In PDHC, the agroecological transition required new methodological approaches that replaced "the notion of technology transfer to adopt a participatory knowledge generation approach." The continuous and permanent technical advisory action is guided by the demand of social groups and families involved.

The pedagogical effects of this initiative reflect the implementation of at least 372 family Demonstrative Units (DUs) with adopted and successful adaptive practices and experiments used in processes of dissemination and multiplication of experiences and knowledge exchange (SIDERSKY et al., 2008).

Among the PDHC adaptive experiences, the reintroduction of agroecological cotton, extinguished in the 1970s by the plague of the cotton bollworm, stands out. Developed together with family farmers, consortium strategies for diversification of rainfed production restored cotton production to acceptable coexistence parameters, with integrated soil and biodiversity management and recovery. In 2013, the production of agrological cotton benefited approximately 1,000 families (ibid, 2008).

Constructing adaptive capacities in these experiences breaks the diffusionist model of public and private technical assistance. As per Caporal (2004), it focuses on endogenous development and the use of locally available means (socio-economic, cultural, and natural) to promote food security conditions and introduce greater social equity and environmental sustainability into agricultural systems.

The social or appropriate technologies for water use, capture, and storage developed in the Cisterns Programs (listed as adaptation strategies) (P1MC and P1+2MC) are strongly emphasized as driving factors for living with the Semi-arid by Amorim and Grisa (2018). For Milhorance et al. (2018, p. 29), these programs were the "gateways to [promoting] agroecological practices, even if these were not their initial objectives." In the context of the agroecological experiences supported by the Ecoforte-Networks Program, such initiatives reduce vulnerability to drought, enabling complementary diversification of productive backyards and forests and rearing animals, especially goats and sheep (CORTINES, 2019).

In some territories, other arrangements for consolidating agroecological agroecosystems complement these initiatives, integrating an artificial front of networks, many of them through projects linked to international donors, universities, or research, extension, and technical cooperation institutions. Access to markets is generally made possible with the support of public policies such as PAA, PNAE, and the National Family Farming Program (PRONAF) (CORTINES, 2019). The introduction of agroforestry systems (SAFs), also associated with

mitigating greenhouse gases, may be a viable alternative for different ecosystems of the Brazilian semi-arid tropics (AGUIAR et al., 2006).

SAFs contain the impacts of climate variability and possible climate change by their capacity to sequester carbon. Studies (ALTIERI; KOOFHAFKAN, 2008) show that these systems also reduce production loss the levels related to water scarcity. Implementing SAFs in recomposing the Caatinga is a strategy to strengthen agroecosystems that involve native tree, shrub, and grass species in the recovery and forage production or productive management (CORTINES, 2019). Adapted and recommended as a strategy for recovering the Caatinga biome, this production system allows for managing native vegetation in consortium with cultivated species and balances ecological and social functions, food production, and soil conservation (MICCOLIS et al., 2016). Gonçalves (2016) documents SAFs with more than 150 tons per ha of vegetal biomass using tree species from the region. This perspective indicates ecologically-based practices to increase the resilience of agroecosystems given climatic extremes and promote carbon reduction in the atmosphere. Thus, if well managed, the Caatinga biome produces forage for grazing and soil protection and maintains and creates reserves of apicultural pasture for beekeeping, an activity highly dependent on biodiversity conservation (SIDERSKY et al., 2008). Beekeeping is a source of additional income for farmers.

Notably, polyculture in the semi-arid North-eastern region, combining trees that produce drought-resistant biomass with food crops, produces diversified foods that increase new consumption habits (FREITAS, 2009). The agroecosystems depend less on water, resulting from the increase in humidity and the diversity of plants densely planted in the same place, thereby ensuring animal fodder throughout the dry season.

As in many other agroecological experiments developed in the semi-arid region, the experience of the Permaculture Institute of the State of Bahia (IPB) involved the training of young people and farmers as community agents and monitors, ensuring the maintenance and transfer of alternatives and practices built in a participatory manner (FREITAS, 2009) that brought together traditional knowledge, technicians and farmers with a focus on efficiency in the use of available resources and reducing economic risks. Non-conventional forms of extension based on horizontal pedagogical mechanisms strengthen the protagonism of farmers and are important tools for exchange and collective experimentation, capable of giving scale to agroecology and promoting the construction of local markets (ROSSET; ALTIERI, 2017).

Final considerations

From the literature review and experiences of agroecology in its most integral sense, articulating cultural, natural, political, social, economic, and technological aspects, this form of producing agriculture is the most favored adaptation to climate change. Accordingly, the strategy of living with the Brazilian semi-arid region is more fruitful than combating drought, and the discourse of combating rather than living with the region serves primarily to feed the drought industry rather than emancipate social movements and organized family farmers.

Despite the advantages of agroecology as a strategy for adapting agriculture to climate change, the political variable of alliances and coalitions of organized sectors with state actors favor implementing more conventional instruments and neglect agroecology and instruments linked to it.

The political and institutional situation reinforces the significant challenges facing federal public policies.

The relationship between the climate issue and agroecology remains a challenge for scholars. In agroecology, advances seem to be less valued in the hegemonic circuits of research. Even given consistent research on the potential of agroecosystems to reduce climate vulnerability, the theme has not mobilized resources from research and teaching centers for academic training, especially in the agricultural sciences, applied humanities, and social sciences.

The innumerable lessons of living with the semi-arid region through agroecology provide a reasonable collection of successful experiences and practices. Their dissemination, however, is a public policy challenge, especially regarding technical assistance and reorienting its purposes and methods to universalize its services to the largest contingent of family farmers in the region.

Scaling up the agroecological approach as an adaptive tool requires support tools to enable productive transitions and reduce the vulnerabilities of different social actors participating in agriculture in the semi-arid region.

References

ADGER, W. N. Social end ecological resilience: are they related? **Progress in Human Geography**, 2000: 24. Available at: http://phg.sagepub.com/cgi/content/abasract/24/3/347.

Accessed on: 22

Mar. 2020.

ADGER, W. N; HUQ, S.; BROWN, K.; CONWAY, D.; HULME, M. Adaptation to climate change in the developing world. **Progress in Development Studies,** v. 3, n. 3, p.179-195, 2003.

ALTIERI, M. A.; NICHOLLS, C. I.; HENAO, A.; LANA, M. Agroecology and the design of climate change-resilient farms. **Agronomy for Sustainable Development**, v. 35, p. 869-890, 2015.

ALTIERI, M. A.. Introdução. In: **Agroecologia:** Bases científicas para uma agricultura sustentável. 3. Ed. revista e ampliada - São Paulo/Rio de Janeiro: Expressão Popular, AS- PTA, 2012.

ALTIERI, M. A.; KOOFHAFKAN, P. Enduring farms: climate change, smallholders and traditional farm communities. **Environment & Development Series**, v. 6, 2008, 63 p.

AMORIM, L. O.; GRISA, C. Combater a seca ou conviver com o semiárido? Public policy forums and arenas in the Brazilian semiarid region. **Raízes,** v. 38, n. 2, jul.-dez. 2018.

ANGELOTTI, F.; FERNANDES JÚNIOR, P. I.; SÁ, I. B. Mudanças climáticas no semiárido brasileiro: medidas de mitigação e adaptação. **Revista Brasileira de Geografia F**ísica, Recife, v. 4, n. 6, p. 1097-1111, 2011.

ANGELOTTI, F.; SIGNOR, D.; GIONGO, V. Mudanças climáticas no semiárido brasileiro: expe riências e oportunidades para o desenvolvimento. **Revista Brasileira de Geografia F**ísica, v. 8, p. 484-495, 2015.

ASA BRASIL, 2002. Carta Política - II ECONASA. Available at: https://www.asabrasil.org.br/ images/UserFiles/File/CARTA-POLITICA-III-ENCONASA.pdf. Accessed on: 18 feb. 2020.

ASA BRASIL. 2020. Declaração do Semiárido. Available at: https://www.asabrasil.org.br/ima- ges/UserFiles/File/DECLARACAO_DO_SEMI-ARIDO.pdf. Accessed on: 18 feb. 2020.

BRAZIL, 2016. **National Plan for Adaptation to Climate Change,** v. 2: sectoral and thematic strategies/Ministry of Environment. Brasília: MMA, 2016.

BRAZIL, 2019a. **Delimitação do Semiárido**. Available at: http://www.sudene.gov.br/delimita-cao--do-semiarido. Accessed on: 28 Oct. 2019 and 21 Feb. 2020.

BRAZIL. 2019b. **Censo Agropecuário 2017**. Available at: https://sidra.ibge.gov.br/tabe-la/6778#result. Accessed on: 18 feb. 2020.

BRAZIL, 2020. **Pesquisa de Orçamentos Familiares 2017-2018**: análise da segurança alimentar no Brasil. IBGE, Coordenação de Trabalho e Rendimento. Rio de Janeiro: IBGE, 2020.

CALDAS, E. L.; MASSARDIER, G. La climatisation des politiques dans un contexte de fragmentation et sectorialisation des agendas et de la mise en œuvre des instruments. **Confins** [En ligne], 46, 2020. DOI: https://doi.org/10.4000/confins.31691.

CANCI, A.; CANCI, I. J. Resgate, uso e produção de sementes crioulas de milho em Anchieta. In: **Biodiversidade e agricultores**: fortalecendo o manejo comunitário. Porto Alegre, RS: L&PM, 2007. pp. 219-226.

CAPORAL, F. R. As bases para a extensão rural do futuro: caminhos possíveis no Rio Grande do Sul. In: CAPORAL, F. R.; COSTABEBER, J. A. **Agroecologia e Extensão Rural**: contribuições para a promoção do desenvolvimento rural sustentável. Brasília: MDA/SAF/DATER/IICA, 2004. p. 49-78.

CHARRÃO-MARQUES, F.; SCHMITT, C. J.; OLIVIERA, D. Agencias e associações nas nas redes de agorecologia: práticas e dinâmicas de interação na serra gaúcha e zona da mata mineira. Século XXI, **Revista de Ciências Sociais**, v. 7, n. 1, p. 15-42, jan.-jun. 2017.

CORTINES, A. C. **Sumário Executivo**: redes de agroecologia para o desenvolvimento dos territórios: aprendizados do Programa Ecoforte. Rio de Janeiro: Articulação Nacional de Agroecologia

- ANA, 2019.

DUQUE, G. Água para o desenvolvimento rural: ASA e os Programas P1MC e P1+2 - Desafios da participação sociedade civil - governo. In: GRISA, C.; SCHNEIDER, S. (Orgs.). **Políticas P**úblicas **de Desenvolvimento Rural no Brasil**. Porto Alegre: Editora da UFRGS, 2015. p. 201-2016.

DUQUE, G. Conviver com a seca: contribuição da Articulação do Semiárido/ASA para o desenvolvimento sustentável. **Desenvolvimento e Meio Ambiente**, n. 17, p. 133-140, Editora UFPR, jan.-jun.

EAKIN, H. C.; PATT, A. Are adaptation studies effective, and what can enhance their practical impact? **WIREs Climate Change,** v. 2, p. 141-153, March/April 2011.

FREITAS, P. H. Um novo olhar do sertão: avaliação participativa do projeto policultura no semiá rido. **Rev. Bras. de Agroecologia,** v. 4, n. 2, p. 2951-2955, 2009.

GONÇALVES, A. L. R. **Sistemas agroflorestais no Semiárido brasileiro**: estratégias para combate à desertificação e enfrentamento às mudanças climáticas. Recife: Centro Sabiá/ Caatinga, 2016. 136p.

GUYOT, M. S. D.; FALEIROS, K. S.; GANDARA, F. B. **Agroecologia e resiliência** à**s mudanças climáticas na agricultura familiar**. Piracicaba, SP, nov. 2015. 134p.

HUQ, S.; REID, H. Mainstreaming adaptation in development. **IDS Buletin,** v. 35, n. 3, p. 15- 21, 2009.

LINDOSO, D.; EIRÓ, F.; ROCHA, J. D. Desenvolvimento sustentável, adaptação e vulnerabilidade à mudança climática no semiárido nordestino: um estudo de caso no Sertão do São Francisco. **Rev. Econ. NE**, Fortaleza, v. 41 n. especial, p. 301-332, jun. 2013.

MARENGO, J. A. Vulnerabilidade, impactos e adaptação à mudança do clima no semiárido do Brasil. **Strategic Partnerships**, v. 13, n. 27, p. 7-18, 2008.

MARENGO, J. A. , ALVES, L. M. , BESERRA, E. A. , LACERDA, F. F. Variabilidade e Mudanças

Climá- ticas no Semiárido Brasileiro. In: **Recursos hídricos em regiões** á**ridas e semi-áridas**.

INSA- MCT, Campina Grande, p. 383-422, 2011.

MICCOLIS, A.; KESTREL, F.; MARQUES, H.; VIEIRA, D.; VERDE, M.; HOFFMANN, M.; REH-

DER, T.; PEREIRA, A. **Restauração Ecológica com Sistemas Agroflorestais:** como conciliar conservação com produção. Options for Cerrado and Caatinga. Brasília: ISPN/ICRAF, 2016.

MILHORANCE, C.; SABOURIN, E.; CHECHI, L. Adaptação às mudanças climáticas e integração de políticas públicas no semiárido pernambucano. **Texto para discussão**. Working Papers Series, v. 2, Brasília: INCT Odisseia, 2018.

MILHORANCE, C.; MENDES, P.; MESQUITA, P.; MORIMURA, M.; REIS, R.; RODRIGUES FILHO,

S.; BURSZTYN, M. O desafio da integração de políticas públicas para a adaptação às mudanças climáticas no Semiárido brasileiro. **Revista Brasileira de Climatologia,** Ano 15 , v. 24, p.165- 185, 2019.

NASUTI, S.; LINDOSO, D. Percepção, vulnerabilidade e adaptação aos desafios climáticos: Estudo de caso na Bahia, Ceará, Piauí e Rio Grande do Norte. **Caminhos para uma Agricultura Familiar sob bases Ecológicas**: produzindo com Baixa Emissão de Carbono. In: AZEVEDO, A. A; CAMPANILI, M.; PEREIRA, C. (Org.). 1. ed. revised and current. Brasília, DF: IPAM, 2015. p. 149-162.

NICHOLLS, C. I. Enfoques agroecológicos para incrementar la resiliencia de los sistemas agrícolas al cambio climático. In: **Agroecología y resiliencia socioecológica**: adaptandose al cambio climático. Editors: Nicholls, C. I. E.; RIOS, L. A.; ALTIERI, M. Medellin: Redeagres-CYTED, 2013. p. 18-29.

NIELDERLE, P. A; SABOURIN, E.; SCHMITT, C. J.; ÁVILA, M. L.; PETERSEN, P.; ASSIS, W. S. A

A trajetória brasileira de construção de políticas públicas para a agroecologia. **Redes** (Santa Cruz do Sul. Online), v. 24, n. 1, January-April, 2019

NILES, M. T.; AHUJA, R.; ESQUIVEL, J.; MANGO, N.; DUNCAN, M.; HELLER, M.; TIRADO, C.

Climate change & food systems: assessing impacts and opportunities. Meridian Institute, 2017. Available at: https http://bit.ly/2oFucpe.

OBERMEIER, M.; ROSA, L. P.. Mudança climática e adaptação no Brasil: uma análise crítica. **Estudos Avançados,** v. 27, n. 78. p. 155-176, 2013.

UN, 2016. Paris Agreement. Available at: https://nacoesunidas.org/acordodeparis/. Accessed on: 17 Feb. 2020.

PARRY, M.; LOWE, J.; HANSON, C. Overshoot, adapt and recover. **Nature**, v. 458, n. 30, p. 1101-1103, April 2009.

PETERSEN, P. F.; WEID, J. M. V. D.; FERNANDES G. B. Agroecologia: reconciliando agricultura e natureza. **Informe Agropecuário**. Belo Horizonte, v. 30, n. 252, p. 7-15, 2009.

PIELKE SR, R.; PRINS, G.; RAYNER, S.; SAREWITZ, D. Lifting the Taboo on Adaptation. **Nature**, v. 445, p. 597-8, Feb. 2007.

ROSSET, P.; ALTIERI, M. A. **Agroecology**: science and politics (Agrarian change and peasant studies series). Practical Action Publishing, 2017.

SEEG – SISTEMA DE ESTIMATIVAS DE EMISSÕES DE GASES DE EFEITO ESTUFA. **Análise das emissões brasileiras de gases de efeito estufa e suas implicações para as metas do Brasil**. 2020. Available at: http://plataforma.seeg.eco.br/total_emission. Accessed on: 22 Oct. 2020.

SIDERSKY, P.; JALFIM, F.; RUFINO, E. Combate à pobreza rural e sustentabilidade no semiárido nordestino: a experiência do Projeto Dom Helder Câmara. **Agriculturas,** v. 5, n. 4, p. 23-28, dez. 2008.

SILVA, R. M. A. Entre dois paradigmas: combate à seca e convivência com o Semiárido. **Sociedade e Estado**, Brasília, v. 18, n. 1/2, p. 361-385, jan.-dez. 2003.

SMITH, P.; MARTINO, D.; CAI, Z.; GWARY, D.; JANZEN, H.; KUMAR, P.; MCCARL, B.; OGLE, S.; O'MARA, F.; RICE, C.; SCHOLES, B.; SIROTENKO, O.; HOWDEN, M.; MCALLISTER, T. PAN, G.; ROMANENKOV, V.; SCHNEIDER, U.; TOWPRAYOON, S.; WATTENBACH, M.; SMITH, J. Greenhouse gas mitigation in agriculture. Philosophical transaction of the Royal Society of London. **Biological Science**, v. 363, p. 789-813, 2008.

TOMPKINS, E. L.; ADGER, W. N. Does adaptive management of natural resources enhance resilience to climate change? **Ecology and Society,** v. 9, n. 2, p. 10, 2004. Available at: https://www.ecologyandsociety.org/vol9/iss2/art10/.

CHAPTER 4

Sustainable agriculture as an adaptation measure for Araripe Plaster Pole

Francislene Angelotti, Anderson Ramos de Oliveira, Vanderlise Giongo, Juliane Rafaele Alves Barros, Miguel Júlio Machado Guimarães

Introduction

The Araripe Plaster Pole, located in the Brazilian semi-arid region, is responsible for producing 97% of the gypsum consumed in Brazil, which is considered the best quality gypsum worldwide given its high purity (Barbosa et al., 2014). However, the energy matrix of the factories involved in the gypsum production process in the Araripe region is characterized by firewood use from the Caatinga, most often the result of illegal deforestation. Moreover, monoculture systems, commonly practiced by traditional agriculture in the region, are characterized by predatory extraction of natural resources of soil and vegetation and the consequent oversimplification of the food web, losing the resilience or environmental plasticity of the ecosystem.

The family farmer in the Plaster Pole whose land area is small must produce food on his property (agricultural or livestock) to ensure his food security. The lack of technologies compatible with environmental conservation and adverse climate conditions contribute to the intensifying land use to levels beyond recovery capacity, compromising the socio-economic sustainability of Araripe. Thus, combined with the fragility of the energy matrix, food production through traditional crops can exert negative impacts in the face of climate change scenarios. Models of intercropping and resilient to climate change could ensure food and energy security for the Araripe Plaster Pole. Thus, cropping systems with a multiple and integrated approach can reduce rural system vulnerability and contribute to the social, economic, and environmental development of the Plaster Pole.

Araripe Plaster Pole

The agricultural base of the semi-arid region is family-based, with small establishments. In this region is the Local Productive Arrangement of Gypsum, called the Araripe Plaster Pole (BRASIL, 2018a, AD DIPER, 2020). It comprises the municipalities of Araripina, Bodocó, Cedro, Dormentes, Exu, Granito, Ipubi, Moreilândia, Ouricuri, Parnamirim, Santa Cruz, Santa Filomena, Serrita, Terra Nova, and Trindade (Figure 1).

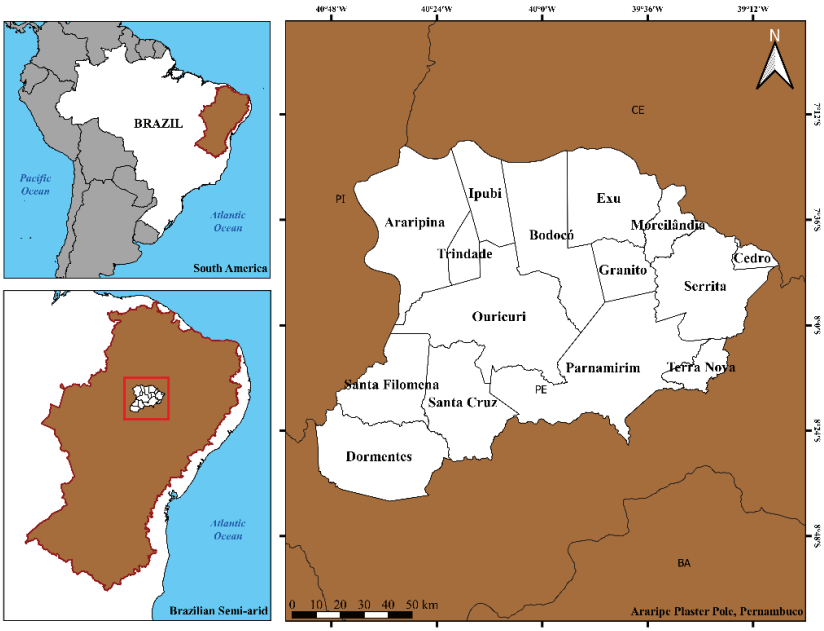


Figure 1. Municipalities that make up the Araripe Region in the Brazilian semi-arid region.

According to Barbosa et al. (2014), the gypsum from the Araripe Plaster Pole is highly pure (80% to 95%) of outstanding worldwide quality. Its importance, apart from the production relevance, is demonstrated by the number of direct and indirect jobs and production chain movement. In the Araripe Plaster Pole, about 40 thousand jobs are generated, resulting from 150 calcination industries, 35 mining companies, and 400 enterprises that manufacture precast gypsum products (BRASIL, 2018a; SITÔNIO, 2019; AD DIPER, 2020). The extraction and processing of gypsum are the most relevant economic activities in the Araripe backlands, generating more than R$70 million per year-1 (AD DIPER, 2020). The entire production chain generates approximately R$ 1.4 billion per year-1

(SINDUSGESSO, 2014). In 2017, the Plaster Pole produced 1.68 million gross tons of gypsum, processing 741 thousand tons (BRASIL, 2018b).

The energy matrix of the factories involved in the gypsum production process in the Araripe region is firewood from the native forest (Caatinga), obtained largely without due observation of the current legislation. In a Webinar held by the Brazilian Service of Support to Micro and Small Enterprises (Sebrae) of Pernambuco in August 2020, the president of the Union of the Gypsum Industry of the State of Pernambuco (Sindusgesso) reinforced the need for determining a more appropriate energy matrix in calcination kilns and implementing environmental projects for regional sustainability (SEBRAE-PE, 2020). According to Sindusgesso (2014), the industries have an energy demand of 54,390 m^3 of firewood per month.

Alternatives to meet this demand have already been presented, including the sustainable forest planning of Caatinga. However, considering that the average production of exploited areas under management is 46.5 m^3 ha-1, after 15 years of rotation, it is necessary to exploit 14,036 ha per year-1 with plans for sustainable vegetation management to meet the demand for firewood fuel of the Araripe industrial park. It implies a total area of 219,541.94 ha of native vegetation under the management regime (SINDUSGESSO, 2014). Thus, the pressure on the native forest is very high, inducing the process of deforestation and desertification of areas, since the edaphic and climatic conditions do not favor a rapid regeneration of vegetation (CAMPELLO, 2013) and cannot meet the demand of the plaster companies (GRANJA et al., 2017).

However, when analyzing the food security of farmers in the Plaster Pole, the main crops grown in the region are beans (*Phaseolus vulgaris* L. and *Vigna unguiculata* L.), cassava (*Manihot esculenta* Crantz), and maize (*Zea mays* L). These three crops account for more than 90% of all agricultural production in the region of the Araripe Plaster Pole (IBGE, 2021), with the municipality of Exu being the largest producer of beans and maize, where Araripina is responsible for the largest production of cassava (Table 1).

Table 1. Main agricultural crops of the municipalities of the Araripe Region.

Municipality	Beans				Cassava				Corn			
	Planted area (ha)	Production (ton)	Average yield (kg/ha)	R$ (Thousand)	Planted area (ha)	Production (ton)	Average yield (kg/ha)	R$ (Thousand)	Planted area (ha)	Production (ton)	Average yield (kg/ha)	R$ (Thousand)
Araripina (PE)	6.000	756	180	1.512	11.000	98.000	8.909	15.680	10.000	630	180	523
Bodocó (PE)	2.500	500	250	1.500	3.100	24.800	11.810	3.546	5.000	660	300	330
Cedro (PE)	400	130	1.111	325	-	-	-	-	1.150	438	1.485	913
Dormentes (PE)	3.000	96	160	255	-	-	-	-	4.500	36	80	24
Exu (PE)	6.000	2.400	400	4.800	3.600	41.600	11.556	6.656	7.500	4.440	600	3.129
Granite (PE)	200	28	280	84	-	-	-	-	600	75	300	53
Ipubi (PE)	5.000	480	200	1.440	3.700	21.500	7.167	6.450	6.500	1.120	400	963
Ouricuri (PE)	8.000	288	180	893	250	1.625	6.500	231	12.000	360	180	310
Parnamirim (PE)	1.200	29	242	78	-	-	-	-	1.200	18	300	15
Santa Cruz (PE)	3.000	252	180	504	-	-	-	-	4.000	96	120	55
Santa Filomena (PE)	3.500	72	60	180	3.000	6.250	2.500	944	5.000	120	60	76
Serrita (PE)	1.200	29	121	81	-	-	-	-	1.600	13	102	10
Moreilândia (PE)	640	12	98	30	100	860	8.600	172	800	130	542	111
Terra Nova (PE)	300	4	133	11	-	-	-	-	300	5	333	4
Trindade (PE)	1.600	60	125	177	100	250	5.000	41	1.200	48	400	41
Total	42.540	5.136	3.720	11.870	24.850	194.885	62.042	33.720	61.350	8.189	5.382	6.557

Source: IBGE, 2021.

Impacts of climate change on Araripe Plaster pole

Global projections indicate that the demand for freshwater, energy, and food increases significantly in the coming decades under pressure from factors such as population growth, economic development, and climate change. Therefore, technologies that promote sustainable development and food security using clean energy and water efficiency while guaranteeing the production of basic foodstuffs are imperative for the Araripe Plaster Pole. According to the Brazilian Panel on Climate Change (PBMC), the climate scenarios for the semi-arid region point to an increase in the average temperature of up to 4.5 °C and a decrease in the distribution of rainfall by up to 50%, considering the last decades of this century, thus inducing an increase in the occurrence of extreme events, such as droughts and prolonged droughts (AMBRIZZI; ARAÚJO, 2013). Regionalized scenarios confirm the trends of increasing air temperature for the municipality of Araripina (LACERDA et al., 2016).

As noted, beans, cassava, and corn are the main crops grown in the region of the Araripe Plaster Pole, with great importance for food and economic security (Table 1). They have socio-economic importance, especially for small producers, and are used for human and animal food. Moreover, they represent important sources of raw material for agro-industrialized products (ARAÚJO; ARRUDA JÚNIOR, 2013; EMBRAPA, 2011; SILVA et al., 2016).

Given the direct relationship of climate and agricultural production, impacts on their cultivation may be diagnosed in climatic scenarios. The increase in temperature can prolong the growing cycle of some cowpea cultivars, apart from promoting a significant increase in the percentage of aborted flowers, reducing the final production of the crop (ANGE-LOTTI et al., 2020; BARROS et al., 2021a). Beyond temperature, changes in rainfall patterns can negatively affect the production of this grain (BARROS et al., 2021b).

For maize, night temperatures above 24 °C increase the respiration rate, reducing photo-assimilates and causing a fall in production (SANS et al., 2001). Regarding water deficit, like cowpea, maize is also sensitive to stress during the reproductive phase of the crop, preventing it from reaching its growth and production potential (BERGAMASCHI; MATZENAUER, 2014).

The cassava, in turn, is a species adapted to tropical climate regions and can be grown in places with a temperature range between 18 °C and 35 °C (JARVIS et al., 2012; NWAIWU et al., 2014). However, the range between 25 °C and 27°C is considered optimal for plant vegetative activities (JARVIS et al., 2012; NWAIWU et al., 2014). For this crop, prolonged water deficit leads the cassava plant into a dormant or resting period (ALVES, 2006), and temperatures above

37 °C paralyze bud sprouting in the manioc (GABRIEL et al., 2014), resulting in reduced production.

Thus, the real problem faced by producers/agriculturalists in the region of the Araripe Plaster Pole is the current energy fragility (energy matrix) and food fragility (traditional crops), aggravated by climate change scenarios.

Adaptation measures for sustainable agriculture in Araripe Plaster Pole

The family farmer of the Plaster Pole must produce food on his rural property, whether food crops or animal husbandry, especially sheep and goats, to ensure their food security. Moreover, he uses firewood from the Caatinga to serve the plaster industry and as a primary energy source for burning (JALIL et al., 2017; BARROS JÚNIOR et al., 2018; GIODA, 2019).

Given this problem, intercropping models emerge as an alternative to ensure energy and food security in the region. In this context, cropping systems include economic efficiency, resources, and improved livelihoods to develop the Araripe region.

We highlight some important initial steps, such as the *screening of* cultivars tolerant to the increase in temperature and water deficit to indicate intercrops. The use of tolerant materials enables an increase in the adaptive capacity and resilience of crops, ensuring sustainable development and food security. Based on the diagnosis of tolerant cultivars, the proposed crops should be based on intercropping (human and animal) food and energy crops. Hence, to address the energy aspect, the alternative would be to invest efforts in the use of crops that show resilience and high productivity and can be used by the plaster industry, as in sorghum biomass (*Sorghum bicolor (*L.) Moench). Accordingly, it is expected to offer options that ensure food, energy, and water security (Figure 2) for the region, given that such crops should not be selected based on their adaptive characteristics to the semi-arid region. To ensure water security, besides genotypes with tolerance to water deficit, management alternatives that promote efficient water use and rainwater capture and storage must be implemented (RIBEIRO; OLIVEIRA, 2019). Other technologies, such as using nitrogen-fixing bacteria, mulching, and agroforestry systems, can integrate the cropping systems (Figure 2).

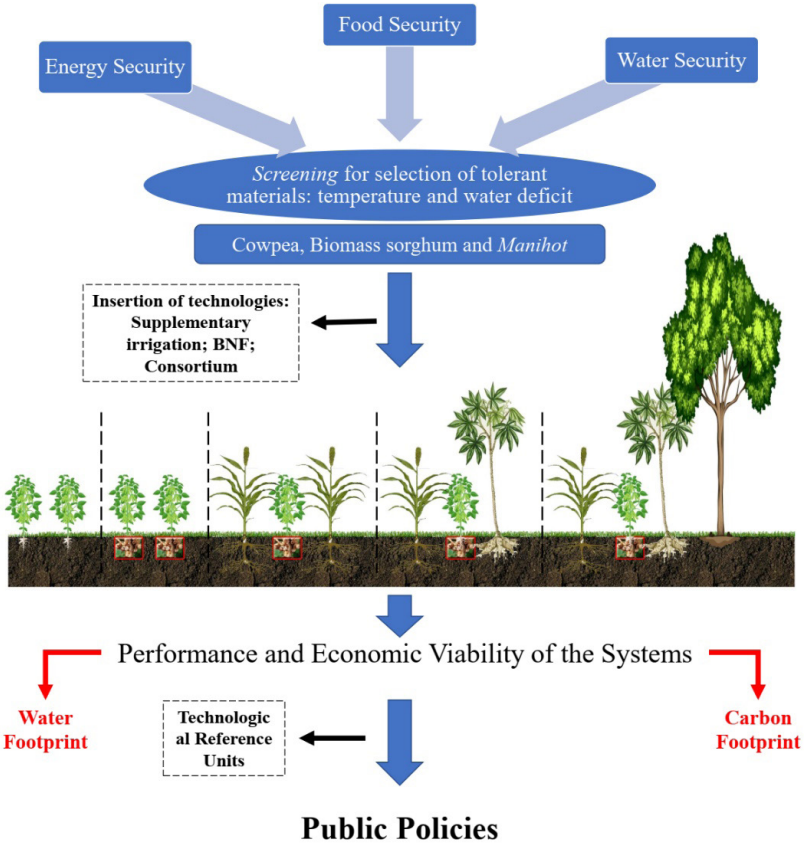


Figure 2. Strategies for sustainable development of agriculture in the Araripe Plaster Pole, Brazil.

Implementing monocultures is characterized by oversimplifying the cultivation system, compromising the natural renewal and maintenance of soil fertility. Thus, external means are sought to replace nutrients to crops through artificial fertilizers, almost always from non-renewable sources. This leads to a reduction in the resilience or plasticity of the system, comprising the capacity of organisms to address climatic adversity, adapt to change, or resist the pressure of adverse situations, thereby reducing their stability to variations in environmental factors.

It then increases vulnerability given ecological imbalances and the need for external intervention for adequate production levels. All factors compromise the production system's sustainability.

Thus, to achieve sustainability, the proposal of agroecosystems is based on the limited use of energy and external resources to re-establish the food chains and keep biogeochemical cycles closed as much as possible, hence inducing interest in

integrated systems through intercropping. Adopting intercropping minimizes the fragility of traditional production systems and the effect of total removal of areas in the region, increasing resilience. Using agroforestry systems, where the biomass from periodic pruning can be incorporated into the soil, transfers nutrients from the trees to annual crops (NAIR, 1993), reducing competition for light, water, and nutrients within the system (MARTINS et al., 2013). The interactions of soil, animal, and plant species in all directions and different magnitudes are notable in the agroecosystems, representing the potential for economic and environmental benefits for producers and society. They are multifunctional systems with the possibility of intensifying production through the integrated management of natural resources, avoiding degradation, and promoting the recovery of productive capacity (SILVA, 2004) beyond being a measure of mitigation and adaptation to climate change impacts, hence attributing greater resilience to food, energy, and water security. Thus, developing multifunctional agroecosystems is a highly viable option for the Araripe region. Within these systems, selecting traditional food crops of the semi-arid region, such as cowpea and cassava, has fundamental importance given their socio-economic value for the Northeast, mainly because they constitute a basic food component of the populations and are sources of protein and carbohydrates, rich in minerals and fibers (FUKUDA, 2001; FREIRE et al., 2011). Further, cowpea and cassava can be used as forage, hay, silage, flour for animal feed, and green manure and for soil protection. According to Freire Filho et al. (2011), cowpea has a short cycle and low water requirements and rusticity. It also fixes nitrogen through bacteria symbiosis, which gives it the advantage of developing in low fertility soils. In tropical environments, such as the semi-arid region, biological nitrogen fixation (BNF) is vital because soils have low fertility, and nitrogen availability is poor given nutrient losses in the soil-plant system (MARINHO et al., 2014). Thus, cassava is extensively used by humans for its important social role as a source of carbohydrates, wide adaptation to different ecological conditions, and productive potential.

Alternatively, one can opt for intercropping with maniçoba (*Manihot pseudoglaziovii* Pax & K. Hoffm). Maniçoba is a native species of the Caatinga, ecologically adapted to the semi-arid region and with drought-tolerant characteristics.

The cultivation of native species of the Caatinga is an important alternative to increase the supply of forage, valuing the regional biodiversity. These plants stand out as forage, given their high degree of palatability. Further, maniçoba has a good protein content and digestibility (SANTANA et al., 2008), meeting the dietary needs of livestock. As an option for intercropping, biomass sorghum is a viable alternative for expanding energy sources for farmers in the Araripe

region, as it produces high-quality biomass. Moreover, sorghum has an efficient photosynthetic process, similar or even superior to that of sugarcane (Saccharum officinarum) and elephant grass (Pennisetum purpureum Schum.). The ability to adapt to tropical and temperate climates, its high water use efficiency, its tolerance to drought, and its potential capacity to produce large quantities of lignocellulosic biomass are some of the numerous strengths of this species (PARRELLA, 2013). Biomass sorghum is a more promising technology than grass and even eucalyptus, given that the species can reach yields of 150 t ha-1 of fresh mass (50 t ha-1 of dry matter) in a cycle of only five months. Additionally, biomass sorghum can be propagated via seeds, generating a lower operational cost.

Another positive aspect of biomass sorghum is the chemical characteristics of the raw material, desirable in combustion processes in calorific value, fixed and volatile carbon content, ash content, and alkali metal content. As deforestation has intensified in recent years in the Araripe region, an energy alternative can positively impact the sustainability of the region, generating income for family farmers and avoiding deforestation. Notably, sorghum biomass is another energy component that primarily reduces the use of firewood from Caatinga because the sorghum dry matter has a lower density than firewood, addressed using densified products such as briquettes and *pellets* (SIMEONE et al., 2018).

Research on biomass sorghum began in the states of Minas Gerais and São Paulo, given the location of Embrapa Maize and Sorghum. However, research on using this grass as a primary energy source has garnered the attention of producers in Mato Grosso and other states in the Midwest and Southeast. The possibility of its adoption in the semi-arid region, notably in the Araripe region, is significant when considering conservation issues in the Caatinga Biome.

Another alternative would be BNF, where bacteria fix atmospheric nitrogen into organic compounds used by plants, reducing the need for nitrogen fertilizers and improving the uptake of water and nutrients. Thus, this technique allows for greater plant production and an increase in the ability to withstand environmental stresses, which can be an additional tool in integrating family farming technologies, increasing the productive potential of agricultural activity. Prior studies indicate the potential use of this association for legumes (SUAREZ et al., 2008; NEUMANN; GEORGE, 2009). For cowpea, four *Bradyrhizobium* sp. strains are currently authorized to produce inoculants in Brazil (BRASIL, 2011), the most widespread being strain BR 3267, originating from soils of Petrolina (MARTINS et al., 2003), thus demonstrating the potential of the region as a source of efficient microorganisms. Furthermore, the plant genotypes cultivated in the semi-arid region show variable responsiveness to the inoculation of bacteria used in commercial inoculants (MARI-NHO et al., 2014), reinforcing the need

for constant prospecting of new rhizobium isolates. Thus, selecting new isolates of rhizobia for cowpea is an important objective cultivated under conditions of environmental stress and may be an important initiative to obtain new bacteria for this crop, given that studies to select new bacteria in the Brazilian semi-arid region remain scarce, and data on bacterial selection from combined conditions of high temperature and water deficit are non-existent.

Table 2 presents the systematized information about the main impacts of climate change in the Araripe region. Notably, given this diagnosis, adaptation measures can be adopted to reduce the negative effects foreseen in future scenarios (Table 2). Assertive public choices should be sought to promote sustainable development effectively. Thus, the proposition of public policies that support the adoption of adaptation measures should be developed per the local reality, allowing for the exploitation of economic opportunities and social (ROMERO; ZUGMAN, 2010). Implementing viable measures, economically and managerially, is of paramount importance, given that producers must be willing to adopt them for their effective use (MAGALHÃES, 2017).

Table 2. Options for adaptation measures in the face of impacts caused by climate change.

	Impacts	**Adaptation measures**	**References**
Increase in air temperature	Crop cycle extension; Increase in flower abortion; Paralyzes bud sprouting; deviation of photo-assimilates; seriously compromising the grain yield; Increases the severity of water deficit; Loss of biodiversity; reduction in agricultural production	Selection of tolerant cultivars; Change of planting time; No-tillage system in straw; Use of plant cocktail; Polyculture; Conservation and use of genetic resources of cultivated and native species; Crop integration; Public policies	ANGELOTTI et al. 2012; GIONGO, 2019; BARROS et al., 2021a ; PAUL et al., 2017 MAGALHÃES, 2017 SANS et al., 2001
Changes in precipitation patterns	Reduced stomatal aperture; drop in photosynthesis; Increased leaf temperature, thus affecting respiration; Drop in production; Reduced growth and dry matter	Rainwater harvesting technologies (cisterns, underground dams); Biological nitrogen fixation; Growth-promoting rhizobacteria in plants public policy	CESANO et al., 2012; BRITO et al., 2012; MARINHO et al., 2014
Energy Matrix	Deforestation; Desertification; Loss of biodiversity	Alternative energy sources for burning; Energy forests; Public policies	PARRELA, 2013; OLIVEIRA et al., 2018

The adaptation measures stem from the observation that production systems for family farmers should be much more structured and complex, seeking the integration of technologies to meet food, water, and energy demands, where the survival of farmers and quality of life are considered. However, all actions should be based on sustainable systems and conserving and preserving the Caatinga Biome. Actions of this type are guided via multidisciplinarity to visualize the necessary transversality in complex systems such that the whole is considered when proposing an intervention or productive system model to the producer. Thus, it is simultaneously a great opportunity and a challenge, being fundamental to consolidate the structuring of production units and promote sustainable development for family farming in the Araripe Plaster Pole.

Final considerations

The socio-economic role of gypsum in the communities living in the semi-arid Araripe region will be maintained in the coming decades. Efforts should be intensified to improve the energy performance of the gypsum production chain and develop simple and cost-effective options to promote the sustainability of a diverse farming base. Desertification, drought, and global warming justify the need for serious reflection on establishing new strategies for gypsum production and agriculture to improve food production and income generation without detrimental environmental effects. Therefore, the region's development objectives should move toward conservation and sustainable management of natural resources while concentrating efforts to optimize gypsum production and agricultural products sustainably, including livestock. However, strategies should also be designed for the broad transfer and adoption of options to entities such as local communities, farmers' associations, and NGOs. Equipping policymakers with technical data and forward-looking scenarios is also a strategy to boost the region's sustainable development.

The projection of multifunctional agroecosystems should be the focus of the proposal of resilient systems incorporating technologies developed over the years, with emphasis on selecting plant species tolerant to salt, water, and thermal stress, the use of rhizobial inoculants for the economic and environmental benefit of legumes and intercropped crops, adopting no-tillage farming systems, planting native tree species and technologies for collection, and storage and use of rainfall with high efficiency and productivity.

The models of functional, sustainable, intensive agroecosystems use increasing levels of complexity in the inter- and intra-relationships of their multiple components as strategies to increase resilience and water, food, and energy security. Thus, implementing cropping systems that integrate food and energy crops

using water-efficient materials can be the basis for formulating public policies that contribute to the diffusion and incorporation of such strategies in other regions, communities, and governmental organizations. The cropping system proposals support energy and nutritional security policies to address climate change, strengthening sustainable agriculture.

References

AD DIPER. **Pernambuco Economic Development Agency**. Relatório de atividades 1o trimestre de 2020. Recife: AD DIPER, 2020.

ALVES, A. A. C. Fisiologia da manioca. In: **Aspectos socioeconômicos e agronômicos da manioca**. Cruz das Almas: Embrapa Mandioca e Fruticultura Tropical, 2006. p.138-169.

AMBRIZZI, T.; ARAÚJO, M. **Executive summary: scientific basis of climate change**. Rio de Janeiro: Brazilian Panel on Climate Change, 2013. p. 23.

ANGELOTTI, F.; BARROS, J. R.; BARBOSA, L. G.; SANTOS, C. A. F. Cowpea development under different temperatures and carbon dioxide concentrations. **Pesquisa Agropecuária Tropical**, v. 50, n. 1, p. 1-7, 2020.

ANGELOTTI, F.; GIONGO, V. Ações de mitigação e adaptação frente às mudanças climáticas. In: MELO, R. F.; VOLTOLINI, T. V. (Orgs.). **Rain-dependent family agriculture in the semi-arid region**, 2019. p. 445-467.

ARAÚJO, R. M.; ARRUDA JUNIOR, S. Cassava culture: case study in the agreste potiguar in the light of relationships Inter actors. **Holos**, v. 6, n. 1, p. 52-72, 2013.

BARBOSA, A. A.; FERRAZ, A. V.; SANTOS, G. A. Caracterização química, mecânica e morfológica do gesso obtido do pólo do Araripe. **Cerâmica**, v. 60, n. 356, p. 501-508, 2014.

BARROS JÚNIOR, A. P.; SOUZA, W. M.; ARAÚJO, M. S. B. Vulnerabilities, workers and flour houses: scenario of risks in the agreste of Pernambuco. **Gaia Scientia**, v. 12, n. 3, p. 94-108, 2018.

BARROS, J. R. A.; GUIMARÃES, M. J. M.; SILVA, R. M.; RÊGO, M. T. C.; MELO, N. F.; CHAVES, A. R. M.; ANGELOTTI, F. Selection of cowpea cultivars for high temperature tolerance: physiological, biochemical and yield aspects. **Physiology and Molecular Biology of Plants**, v. 27, n. 1, p. 1-10, 2021a.

BARROS, J. R. A.; GUIMARÃES, M. J. M.; SIMÓES, W. L.; MELO, N. F.; ANGELOTTI, F. Water restriction in different phenological stages and increased temperature affect cowpea production. **Ciência e Agrotecnologia**, v. 45, n. 1, p. 1-12, 2021b.

BERGAMASCHI, H.; MATZENAUER, R. **O milho e o clima**. Porto Alegre: Emater/RSAscar, 2014. p. 85.

BRAZIL. **Ministry of Mines and Energy. Statistical Yearbook of the Nonmetallic Transformation Sector: 2018**. Brasília: Ministry of Mines and Energy - Secretariat of Geology, Mining and Mineral Transformation, Department of Mineral Transformation and Technology, 2018a. p. 86.

BRASIL. Departamento Nacional de Produção Mineral. **Anuário mineral estadual – Pernambuco: 2018**. Brasília: DNPM, 2018b, p. 18.

BRASIL. **Ministério da Agricultura, Pecuária e Abastecimento. Instrução Normativa Nº 13, de 24 de março de 2011.** Aprovar as normas sobre especificações, garantias, registro, embalagem e rotulagem dos inoculantes destinados à agricultura, bem como as relações dos micro-organismos autorizados e recomendados para produção de inoculantes no Brasil, na forma dos Anexos I, II e III, desta Instrução, 2011, p.3-7.

BRITO, L. T. de L.; CAVALCANTI, N. de B.; SILVA, A. de S.; PEREIRA, L. A. Produtividade de água de chuva em culturas de subsistência no semiárido pernambucano. **Engenharia Agrícola** 32(1) 2012: 102-109.

CAMILO, J. A.; ANDRADE, C. L.T.; AMARAL, T. A.; CHOU, S. C.; TIGGES, C. H. P.; MELO, M. L. A.; GARCIA, A. G. **Mudanças Climáticas Futuras Afetarão a Produtividade de Milho em Minas Gerais**. Embrapa Milho e Sorgo: Boletim de pesquisa e desenvolvimento, 2018, p.180.

CAMPELLO, F. C. B. O consumo específico de lenha como índice técnico para o ordenamento florestal no Araripe em Pernambuco. **Revista dos Mestrados Profissionais**, v. 2, n. 1, p. 23-43, 2013.

CESANO, D.; ROVERE, E. L. L.; MARTIN, O.; CORRAL, T.; SANTOS, L.; COELHO, N. S.; NEVES, C. G. As experiências da coalizão adapt Sertão na disseminação de tecnologias e estratégias de adaptação à mudança climática para o agricultor familiar do Semiárido Brasileiro. **Revista Brasieira de Geografia Física**, v. 6, n. 1, p. 1336-1350, 2012.

EMBRAPA. Corn Production in Family Agriculture. **Circular técnica**. Sete Lagoas: Embrapa Maize and Sorghum, 2011. p. 42.

FREIRE FILHO, F. R.; RIBEIRO, V. Q.; ROCHA, M. de M.; SILVA, K. J. D.; NOGUEIRA, M. S. R.; RODRIGUES, E. V. **Feijão-caupi no Brasil: produção, melhoramento genético, avanços e desafios**. Teresina: Embrapa Meio-Norte, 2011. p. 84.

FUKUDA, W. M. G.; SAAD, N. **Pesquisa participativa em melhoramento de mandioca com agricultores do Nordeste do Brasil**. Cruz das Almas: Embrapa Mandioca e Fruticultura, 2001. p. 48.

GABRIEL, L. F.; STRECK, N. A.; OHLMANN, L. O.; SILVA, M. R.; SILVA, S. D. Climate change e seus efeitos na cultura da mandioca. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v. 18, n. 1, p. 90-98, 2014.

GIODA, A. Characteristics and provenance of firewood used in cooking in Brazil. **Estudos Avançados**, v. 33, n. 95, p. 133-150, 2019.

GRANJA, C. V. A.; CAVALCANTE, E. P.; CAFFÉ FILHO, H. P.; SIQUEIRA, M. S.; NASCIMENTO, W. Environmental degradation: exploration of gypsum in the Araripe Gypsum Complex. Id On Line. **Journal of Psychology**, v. 11, n. 36, p. 1-29, 2017.

IBGE - IBGE Automatic Recovery System - **SIDRA**. Produção Agrícola Municipal. Available at: https://www.sidra.ibge.gov.br. Accessed on: 20 jan, 2021.

JALIL, L.; CAVALCANTE, M. C.; VEJA, G. C.; XENOFONTE, G.; MARTINS, G. Território SertSo do Araripe. In: LONDRES, F.; PETERSEN, P.; MARTINS, G. **Olhares agroecológicos: análise econômico-ecológica de agroecossistemas em sete territórios brasileiros**. 1. ed. Rio de Janeiro: AS-PTA, 2017. Chap. 3, p. 60-91.

JARVIS, A.; RAMIREZ-VILLEGAS, J.; HERRERA CAMPO, B. V.; NAVARRO-RACINES, C. E. Is Cassava the Answer to African Climate Change Adaptation? **Tropical Plant Biology**, v. 5, n. 1, p. 9-29, 2012.

LACERDA, F. F.; NOBRA, P.; SOBRAL, M. C.; MAGELLA, G.; ASSAD, E. Tendência do clima do Semiarid facing the prospects of global climate change: the case of Araripina, Pernambuco. **Journal of the Department of Geography**, v. 31, n. 1, p. 132-141, 2016

LINDOSO, D.; EIRÓ, F.; ROCHA, J. D. Desenvolvimento Sustentável, Adaptação e Vulnerabilidade à Mudança Climática no Semiárido Nordestino: Um estudo de caso no Sertão do São Francisco. **Revista Econômica do Nordeste**, v., n. 1, p. 301-332, 2013.

MAGALHÃES, B. G. **Simulação de estratégias de manejo da cultura do milho para mitigar efeitos de mudanças climáticas.** Master's dissertation. Programa de Pós-Graduação em Ciências. Universidade Federal de São João de -Rei, 2017.

MARINHO, R. C. N.; NÓBREGA, R. S. A.; ZILLI, J. E.; XAVIER, G. R.; SANTOS, C. A. F.; AIDAR, S. T.; MARTINS, L. M. V.; FERNANDES JÚNIOR, P. I. Field performance of new cowpea cultivars inoculated with efficient nitrogen-fixing rhizobial strains in the Brazilian Semiarid. **Pesquisa Agropecuária Brasileira**, v. 49, n. 1, p. 395-402, 2014.

MARTINS, L. M. V.; XAVIER, G. R.; RANGEL, F. W.; RIBEIRO, J. R. A.; NEVES, M. C. P.; MORGADO, L. B.; RUMJANEK, N. G. Contribution of biological nitrogen fixation to cowpea: a strategy for improving grain yield in the semi-arid region of Brazil. **Biology and Fertility of Soils**, v. 38, n. 1, p. 333-339, 2003.

MARTINS, J. C. R; MENEZES, R. S C.; SAMPAIO, E. V. S. B.; SANTOS, A. F.; NAGAI, M. A. Productivity of biomass in agroforestry and traditional systems in Cariri Paraibano. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v. 17, n. 6, p. 581-587, 2013.

MAY, A.; SILVA, D. D.; SANTOS, F. C.. (Eds.). **Cultivo do sorgo biomassa para a cogeração de energia elétrica**. Embrapa Milho e Sorgo, 2013. p. 65.

NAIR, P. K. R. **Introduction to agroforestry**. Dordrecht: Kluwer Academic Publishers, 1993. p. 499.

NWAIWU, I. U. O.; OREBIYI, J. S.; OHAJIANYA, D. O.; IBEKWE, U. C.; ONYEAGOCHA, S. U. O.; HENRI-UKOHA, A.; OSUJI, M. N.; TASIE, C. M. The Effects of Climate Change on Agricultural Sustainability in Southeast Nigeria - Implications for Food Security. **Asian Journal of Agricultural Extension, Economics & Sociology**, v. 3, n. 1, p. 23-36, 2014.

OLIVEIRA, A. F.; PELLEGRINO, G. Q.; CUADRA, S. V.; BARIONI, L. G.;

VICTORIA, D. C. National policies, plans and strategies to combat climate change. In: CUADRA, S. V.; HEINEMANN, A. B.; BARIONI, L. G.; MOZZER, G. B.; BERGIER, I. (Eds.). **Action against global climate change: Embrapa's contributions**. Brasília, DF: Embrapa, 2018. Chap. 4. p. 49-58.

PARRELLA, R. A. C. Cultivars. In: MAY, A.; SILVA, D. D.; SANTOS, F. C. **Cultivo do sorgo biomassa para cogeração de energia elétrica**. Embrapa Milho e Sorgo, 2013. p. 65.

PAUL, C.; WEBER, M.; KNOKE, T. Agroforestry versus farm mosaic systems - Comparing land-use efficiency, economic returns and risks under climate change effects. **Science of The Total Environment**, v. 587-588, n. 1, p. 22-35, 2017.

RIBEIRO, C. S.; OLIVEIRA, G. G. A questão hídrica no semiárido baiano: conflitos pelo uso da água e as tecnologias sociais de aproveitamento de água de chuva. **Del CESLA. International Latin American Studies Review**, v. 23, n. 1, p. 355-381, 2019.

ROMERO, V.; ZUGMAN, F. Princípios, metas e governança nas políticas públicas de mudança climáticas no Brasil. In: RAMOS, D. P.; LÁZARO, L. L. B. **Public Policies for Mitigation and Adaptation to Climate Change: Financing the Transition to a Low Carbon Economy**, 2010. p. 166.

SANS, L. M. A.; ASSAD, E. D.; GUIMARÃES, D. P.; AVELLAR, G. Zoneamento de riscos climáticos para a cultura de milho na Região Centro Oeste do Brasil e para o Estado de Minas Gerais. **Revista Brasileira de Agrometeorologia**, v. 9, n. 3, p. 527-535, 2001.

SANTANA, A. F.; LIMA, M. C.; SOUZA, E. C. A. Valor nutritivo da mandioca brava (*Manihot* sp.). **PUBVET**, v. 2, n. 13, p. 1-8, 2008.

SEBRAE-PE. Webinar: **Dialogues with the mineral sector: environmental solutions for the sustainability of the energy matrix of mineral-based APL**. 2020. Available at:https://www.youtube.com/watch?v=2R58S1HcVB0&feature=youtu.be. Accessed on: 8 Oct. 2020.

SILVA, V. P. **Sistemas Silvipastoris Embrapa Florestas**. Centro Nacional de Pesquisa de Flores-tas. Colombo, PR, Brazil, 2004. Available at: www.cnpf.embrapa.br/pesquisa/safs/index.htm. Accessed on: 15 Sep. 2017.

SILVA, K. J. D.; ROCHA, M. M.; MENEZEZ JÚNIOR, J. A. N. Socioeconomia. In: BASTOS (Coord.). **The culture of cowpea**. Embrapa Meio Norte, 2016. p. 71.

SIMEONE, M. L. F.; PARRELLA, R. A. C.; MAY, A.; SCHAFFERT, R. E. Production and characterization of sorghum biomass pellets. **Brazilian Applied Science Review**, v. 2, n. 5, p. 1682-1695, 2018.

SINDUSGESSO. **Potencialidades do Polo Gesseiro do Araripe: Simpósio Polo Gesseiro do Araripe: potencialidades, problemas e soluções**. Recife: Agronomic Institute of Pernambuco, 2014. p. 22.

SITÔNIO, R. **MPT e OIT apresentam no TRT projeto para a promoção do trabalho decente no Polo Gesseiro**. 2019. Available at: ttp://www.prt6.mpt.mp.br/informe-se/noticias-do-mpt-go/1426-mpt-e-oit-apresentam-no-trt-projecto-para-promocao-do-trabalho-decente-no-polo--plasterer. Acesso em: 15 jul. 2019.

SUAREZ, R.; WONG, A.; RAMIREZ, M.; BARRAZA. A.; OROZCOMDEL, C.; CEVALLOS, M. A.; LARA, M.; HERNANDEZ, G.; ITURRIAGA, G. Improvement of drought tolerance and grain yield in common bean by overexpressing trehalose-6-phosphate synthase in rhizobia. **Molecular Plant-Microbe Interactions Journal**, v. 21, n. 1, p. 958-966, 2008.

CHAPTER 5

Public policies for adaptation to prolonged drought in the Northeast: The role of PRONAF and the Crop-Insurance Program

Joacir Rufino de Aquino, Maria de Fátima Vidal, Maria Odete Alves

Introduction

In the second decade of the 21st century, the Brazilian Northeast was hit by a devastating drought in recent history. The "Great Drought" lasted for five uninterrupted years (2012–2017), somewhat impacting all states of the Brazilian Northeast region. It was another climatic episode of which such intensity had only been registered in the mid-eighteenth century (LIMA; MAGALHÃES, 2018). However, despite its severity, no scenario of exacerbated social crisis existed, and family farming resisted the water shortage, which currently remains in the region.

The greater resilience of family farming in the Northeast is explained by the improved water infrastructure network developed in the region and the social protection network composed of social security policies and conditional cash transfers for the poor and extremely poor. Moreover, the several public policies to support production and mitigate the risks of agricultural activities that have been strengthened or implemented since the 2000s were crucial (AQUINO; ALVES; VIDAL, 2020; GRISA; SCHNEIDER, 2015; NUNES et al., 2014; MELLO, 2015; MIRANDA; TORRENS; MATTEI, 2017; SILVEIRA et al., 2016).

Accordingly, this chapter analyzes the evolution between 2010 and 2019 of two of the main policies of productive support to the segment, the National Program for the Strengthening of Family Farming (PRONAF) and the Crop-Insurance Program (CIP). It demonstrates that the volume of resources applied by credit and rural insurance instruments was vital to adapting family farming to drought, although these public policies must be scaled up and improved to enhance their results.

Hence, we reviewed relevant literature on the topic and systematized official statistics on the government programs analyzed in this paper. We also collected data on family farmers from the IBGE's 2017 Agricultural Census. We follow the normative criteria of the Law nº. 11.326/2006 regulated by Decree nº. 9.064/2017, where family farmers are all producers that: i) have land areas of up to 4 (four) fiscal modules; ii) use at least half of the family labor force in the productive process and income generation; iii) obtain at least half of the family income from economic activities on their site; and iv) run the establishment or enterprise strictly with their family (DEL GROSSI, 2019; IBGE, 2019).

Excluded farmers were typified by IBGE as non-family or employers. That is, they had areas larger than four fiscal modules and produced predominantly using wage labor. Further, their farm management was conducted by hired administrators or foremen.

The structure of the paper is organized into three main sections, in addition to the Introduction and the Final Considerations. The first section discusses aspects of family farming in the Brazilian Northeast in the context of the Great Drought that struck the region in the second decade of the 21st century. The next section presents the budgetary performance of PRONAF and Crop-Insurance in the 2010-2019 period. The third section analyzes and discusses the importance of the credit and rural insurance instruments for adapting family farming in the Northeast during the prolonged drought.

Northeastern family farming in the context of the Great Drought (2012–2017)

The Northeast Region of Brazil, the focus of this study, occupies an area of 1.6 million km² (over 18% of the national territory) and is home to about 57.4 million inhabitants (IBGE, 2018; 2019). From the political-administrative perspective, it comprises nine states: Alagoas (AL), Bahia (BA), Ceará (CE), Maranhão (MA), Paraíba (PB), Piauí (PI), Pernambuco (PE), Rio Grande do Norte (RN), and Sergipe (SE).

In physical terms, Andrade (2005) highlights that the northeastern territory is divided into four natural sub-regions: Mid-north, Sertão, Agreste, and Zona da Mata. The largest portion of the regional space (64,8%) is in the Brazilian semi-arid region.

Sheltering a population of 26.2 million inhabitants (IBGE, 2019), the Northeastern semi-arid encompasses two municipalities of the State of Maranhão and other states of the Region, of which four have more than 80% of their territories located in this specific natural environment. As per the institutional delimitation

currently in force (BRASIL. MIN, 2018), they are: CE (98.7%), RN (93.0%), PB (90.9%), and PE (87.8%).

Among the characteristics that describe the predominant edaphoclimatic picture in most of the rural areas of the Northeast, the following stand out (ANDRADE, 2005; MAIA GOMES, 2001): low and irregular rainfall, with periodic droughts; high temperatures, with high rates of evapotranspiration; poorly permeable soils subject to erosion; and the predominance of caatinga vegetation.

The socio-economic changes in recent decades have positively impacted the well-being of the rural population of the Northeast (BACELAR, 2014; CARVALHO, 2014). However, droughts continue to occur, and their magnitude has increased. Chart 1 shows that the region was hit by one of the greatest droughts in its recent history, whether for its duration (2012–2017) or its effects in increasing regional water shortages, warranting the designation, "Great Drought."

The Great Drought strongly affected regional agriculture and livestock, especially family farming, predominantly in rain-fed areas. The segment lost part of its cattle herd, and traditional food crops were severely impacted (MARTINS; MAGALHÃES, 2015; SANTANA; SANTOS, 2020; VERNER, 2016). However, several public policies maintained the sector, despite losses suffered and the historical shortcomings faced by most producers, such as limited access to land.

Indeed, Table 1 shows 2,322,719 rural establishments in the Northeast in 2017, of which 1,838,846 (79.2%) were family farmers. That is, of every 100 rural farms registered in the region, at least 79 were small and predominantly family-run, covering 47.2% of the total category in the country. The same relevance is observed regarding occupied people, considering that family units absorb the labor force of over 4.7 million people (73.8% of the regional total).

Regarding the ratio of producers in the area occupied by their farms, the data show an inversion of representation because the large quantity of family farmers in the Northeast holds only 36.6% of the area of over 70 million ha occupied by farms. Meanwhile, the non-family farmers sector, represented by only 20.8% of surveyed producers, occupies 63.4% of the total area, indicating the persistence of a marked inequality in the distribution of natural resources associated with land ownership.

Chart 1. Drought years recorded in Northeastern Brazil in the 16th to 21st centuries

XVI Century	XVII Century	XVIII Century	XIX Century	XX Century	XXI Century
1553	1603	1709-1711	1803-1804	1900	2001-2002
1559	1606	1720-1727	1808-1810	1903-1904	2005
1583	1614-1615	1730	1816-1817	1907	2007-2008
1587	1645	1732	1824-1825	1909-1910	2010
	1652	1734-1737	1827	1914-1915	2012-2017
	1692-1693	1744-1748	1830-1833	1917	
		1751	1835-1837	1919	
		1754	1842	1921-1922	
		1760	1844-1847	1930	
		1766	1877-1879	1932-1937	
		1771-1772	1888-1889	1941-1945	
		1776-1778	1891	1951-1954	
		1782-1784	1898	1958-1959	
		1790-1794		1962-1964	
				1966	
				1970	
				1976	
				1979-1983	
				1986-1987	
				1992-1993	
				1997-1999	

Source: Lima and Magalhães (2018, p. 203). Adapted by the authors.

Table 1. Number of establishments, total area, and occupied personnel in the different types of agriculture in the Northeast region - 2017

Farmer Types	Establishments (*)		Total Area (ha)		Staff Occupied	
	Number	%	Hectares	%	Number	%
Family	1.838.846	79,2	25.925.743	36,6	4.708.670	73,8
Non-family	483.873	20,8	44.968.122	63,4	1.668.094	26,2
Total	2.322.719	100,0	70.893.865	100,0	6.376.764	100,0

Source: Agricultural Census 2017 (IBGE/SIDRA, 2019).
(*) Each agricultural establishment is equivalent to a family or non-family unit.

From the above, it is clear that family farming in the Brazilian Northeast is quite representative in the last year of the prolonged drought. The result stems from the resistance and daily struggle of producers and their families, the collective effort of their class organizations, and the institutions and public policies created in the last 25 years to support the group and guarantee coexistence with the regional physical environment. Among the policies are programs for rural security, creating agrarian reform settlements, credit, income transfer, water storage, government purchases, and rural insurance (GRISA; SCHNEIDER, 2015; MELLO, 2015; MIRANDA et al., 2017; SILVEIRA et al., 2016).

The financial resources from these policies and emergency actions adopted during the period are fundamental to reproducing family farming in the Northeast during the Great Drought. However, as noted, from the productive perspective, two policies deserve special emphasis for their scope and strategic content: the PRONAF and CIP. Thus, the next sections are dedicated to an in-depth study of the programs to analyze their evolution, limits, and importance in the regional context.

Budget performance of rural credit and crop-insurance policies for regional family farming

Evolution and scope of PRONAF's applications (2010–2019)

The PRONAF was officially established via Presidential Decree Nº. 1,946, of June 28 of 1996 to support rural development, strengthen family farming as a generator of employment and income, and "establish a new pattern of sustainable development that aims to achieve levels of satisfaction and welfare of farmers and consumers, regarding economic, social and environmental issues, producing a new national agricultural model" (BRASIL, 1996, p. 11).

The potential audience of PRONAF comprises settlers in agrarian reform programs and all family forms of production and work in the Brazilian countryside. Farmers must prove that they fit into the generic category of "family farming" through a PRONAF Aptitude Declaration (DAP) to access its resources. The DAP format classifies family farmers into beneficiary groups: B and V. Group B comprises the poorest and most vulnerable segment. However, Group V integrates producers in the intermediate range of the category.

Since its creation, PRONAF has become the main public policy of productive support to family farming in operation in Brazil and among the main government actions of this kind in Latin America. Currently, it operates in all the municipalities via agricultural funding for costing and investment in special payment terms

(AQUINO; SCHNEIDER, 2015). According to Wesz Jr. (2021), from 1996 to 2018, the program performed 30.9 million credit contracts and applied R$ 350.7 billion (in constant 2018 values).

In the specific case of the Northeast, between 2010 and 2019, PRONAF's budget performance was also quite representative. As shown in Table 2, even with the advent of the Great Drought, there were no interruptions in applying this special modality of financing in the region. During prolonged drought, the contracts increased relative to 2011, despite being a regular rainfall year. More than 7.9 million contracts accumulated over time were signed in the region's nine states.

Still in Table 2, it is observed that the volume of resources applied has been increasing, reaching an accumulated total of R$ 36.5 billion at the end of the series, with variations. During the drought, the loan amounts ranged from R$ 3.5 to R$ 4.5 billion, representing a positive result given the scenario of uncertainty during the climate crisis. Notably, the credit operations were distributed in low average value contracts, given, in part, the profile of the PRONAF public in the Northeast.

Table 2. Evolution of contracts and resources applied by PRONAF in the Northeast (2010– 2019)

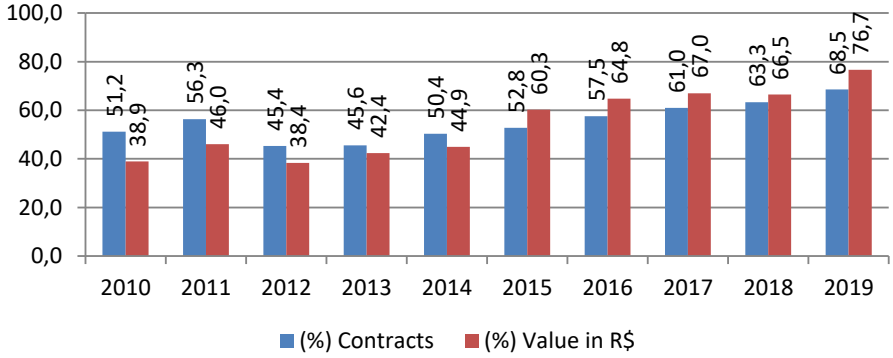
Year	Contracts (A)	Value in R$ (B)*	Average Value in R$ (B/A)
2010	643.163	2.627.587.510	4.085
2011	650.984	2.662.081.591	4.089
2012	826.616	3.561.098.534	4.308
2013	923.874	4.158.501.503	4.501
2014	806.772	4.557.177.964	5.649
2015	848.779	3.809.098.019	4.488
2016	836.854	3.454.121.692	4.128
2017	850.920	3.882.986.249	4.563
2018	798.586	4.038.119.138	5.057
2019	723.101	3.793.000.490	5.245
Total	7.909.649	36.543.772.690	4.620

Source: BCB (2020).
*Values in R$ updated by the IGP-DI for 2019.

Indeed, most family farmers in the Northeast are poor or extremely poor, with low debt capacity with the banks. A special microcredit line called PRONAF B was created for them in the 1999–2000 period (AQUINO; BASTOS, 2015).

Since 2005, this line of financing began to be operated by the AGROAMIGO Program of the Banco do Nordeste do Brasil (BNB). This program has the differentiated service of a team of microcredit advisors and has substantially increased its participation in PRONAF operations (Graph 1), being a factor responsible for its expansion in the region.

The numbers were made possible, mainly, by the successive renegotiations and forgiveness of part of the debts incurred by producers before and during droughts. Such measures were included as priorities in the scope of the emergency actions of the Federal Government and comprised the demands of the rural union movement. Practically, implementing such measures was strategic because it allowed insolvent producers, given the losses from the drought, to pay off their debts and take out new loans with subsidized interest rates.



Graph 1. Percentage of contracts and value contracted by AGROAMIGO under PRONAF in the Northeast, 2010-2019

Source: BNB (2020a).

However, despite the performance presented, the Northeast maintained its historical marginal position in distributing PRONAF resources. Since the program was created, it has presented a very strong concentrating bias by region, producer type, and product (AQUINO; SCHNEIDER, 2015; SOUZA; BARBÉ, 2014; TROIAN; MACHADO, 2020). This trend remained in the period analyzed (Table 3): family farmers in the Northeast, representing almost half the national total (47.2%), obtained only 14.2% of the resources applied.

Table 3. Distribution of the number of family establishments and resources applied by PRONAF in the regions of Brazil (2010–2019)

Regions	Family establishments (2017)	%	PRONAF Value (R$)*	%	Average PRONAF value (R$)*
North	480.575	12,3	18.051.193.051	7,0	24.988
Northeast	1.838.846	47,2	36.543.772.690	14,2	4.620
Southeast	688.945	17,7	50.614.651.966	19,7	20.988
South	665.767	17,1	133.647.793.024	52,0	26.997
Midwest	223.275	5,7	18.120.488.417	7,1	36.147
Brazil	3.897.408	100,0	256.977.899.149	100,0	15.579

Source: BCB (2020) and IBGE/SIDRA (2019).
*Values in R$ updated by the IGP-DI for 2019.

Notably, PRONAF's operations in the Northeastern territory *vis-à-vis the* Brazilian average and other regions have low values. In the Northeast, where producers need more resources to structure their properties, the average value of the operations (R$ 2.5 million) is R$ 4,620.00, representing 17.1% of the average contracts of the pronafianos in the South Region (R$ 26,997.00), which received more than half the resources of the program in the 2010–2019 period.

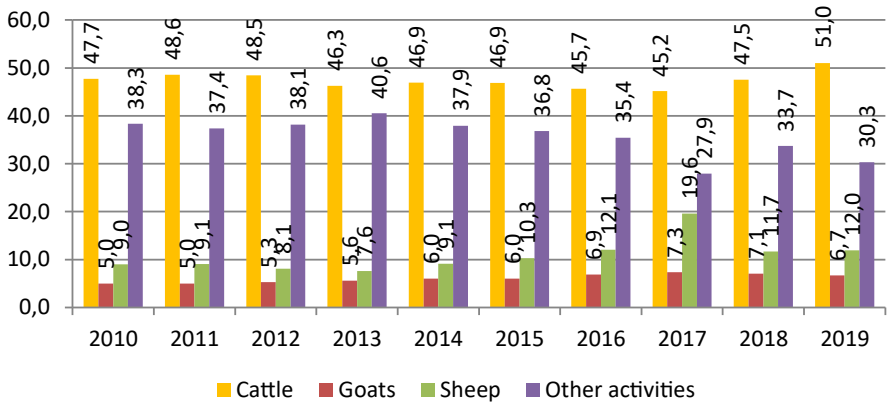
Regarding the profile of financed activities, the Northeast follows a trend reversed in Brazil because most PRONAF loans are dedicated to costing operations of agricultural production and livestock in the country (SILVEIRA et al., 2016; WESZ JR., 2021). Among family farmers in the Northeast, Table 4 show that the contracts and amounts applied are concentrated in the investment mode, especially livestock. Most of the financing in the region does not have official protection since only costing operations are compulsorily linked to Family Farming Insurance (SEAF).

Table 4. Distribution of modalities and types of activities financed by PRONAF in the Northeast (2010–2019)

Modality/Activity	Contracts	%	Value (R$)*	%
Agricultural costs	280.968	3,6	3.029.939.327	8,3
Livestock costs	351.081	4,4	3.158.224.803	8,6
Agricultural Investment	1.644.830	20,8	7.378.249.006	20,2
Livestock Investment	5.632.770	71,2	22.977.359.553	62,9
Total	7.909.649	100,0	36.543.772.690	100,0

Source: BCB (2020).
*Values in R$ updated by the IGP-DI for 2019.

A wide variety of activities exist among the agricultural and livestock segments supported by PRONAF in the Northeastern countryside. However, over time, the program has concentrated its operations on cattle farming. From Graph 2, the percentage of financing for this activity by the BNB, the main operating agent of this credit line in the region, has always remained at high levels, close to half the contracts before and after the Great Drought. Even so, there has been a slight growth in operations focused on the financing of small animals, especially loans for goat and sheep farming, which increased their participation from 2010 to 2019.



Graph 2. Distribution of the types of activities contracted by PRONAF via BNB, with FNE resources, in the Northeast, 2010–2019 (In %)

Source: BNB (2020b).

The PRONAF strategy in the Northeast, focusing on cattle ranching, has been questioned as to its effectiveness as an instrument to adapt family farming to prolonged droughts. Notably, as Andrade (2005) posits, animal husbandry is part of the local culture, and expanding herds is an important strategy. However, the main issue is that investments are mostly not accompanied by integrated actions aimed at providing rural properties with the minimum infrastructure conditions to ensure the maintenance of animals during periods of drought, which makes investments in the sector quite risky (AQUINO; BASTOS, 2015; FREITAS, 2019; FREITAS; CASTRO, 2020).

The noted problem could be circumvented, at least partially, by expanding alternative credit lines of the program to improve productive infrastructure and disseminate environmentally sustainable productive systems, such as semi-arid and agroecology PRONAF. These credit modalities, however, have shown low performance in the region. For example, from 2013 to 2019, only 148,259 semi-arid PRONAF and 1,530 Agroecology PRONAF contracts were signed (BCB,

2020). This result contrasts sharply with the 5.8 million operations in the region in the same period (Table 2), showing that the program has many challenges ahead, beyond expanding its scale of assistance.

Therefore, even given the prior considerations, family farmers in the Northeast evidently had their livestock activities encouraged through PRONAF during the prolonged drought. However, farming received less stimulus from rural credit in funding or investment. In any case, many producers could compensate for part of their losses and continue to their plantations, given the support of another critical public policy in the regional context (the CIP), analyzed below.

Evolution and scope of the applications of the Crop-Insurance Program (2010–2019)

The Crop-Insurance Fund and Benefit, henceforth referred to as the CIP, was created via Law Nº. 10.420 of April 10, 2002, to guarantee "minimum conditions of survival to family farmers of municipalities systematically subject to loss of harvest given the phenomenon of drought or excess water [...] in the area of action of the Superintendence of Development of the Northeast - SUDENE, defined by Complementary Law Nº. 125, January 3, 2007" (BRASIL, 2002, p. 1).

The legal framework of the program covers mainly the poorest and most vulnerable part of family farmers, with income of up to R$ 1.5 monthly minimum wage and areas of up to four fiscal modules where between 0.6 and 10 ha of beans, maize, rice, cassava, cotton or other prioritized agricultural activities are planted.

Therefore, the CIP is a novelty in policies supporting rural production in the Brazilian semi-arid Northeast because the focus of government intervention for the region during extreme climate crises has long had an emergency character. Thus, despite a historical delay of several decades, after the successive droughts in Chart 1, the program is a concrete attempt to implement a permanent adaptation action in the regional context with a focus on populations at the base of the social pyramid.

This policy seeks to link the social protection provided by the partial payment of losses incurred by producers, given prolonged droughts to other measures, to improve the sustainability of agricultural production in the long term by introducing coexistence technologies, training, stimuli to associations and cooperatives, and increased access to credit (BRASIL, 2002).

Furthermore, the operational structure of the CIP is innovative because it seeks to adopt a shared institutional arrangement involving three federative entities (Federation, states, and municipalities) and farmers. Notably, the Guarantee

Fund, which provides the resources to make payments to beneficiaries in critical situations (e.g., Great Drought [2012–2017]), is formed by contributions from these actors.

The Table 5 furnishes the noted relevant information. It shows the evolution of benefit amounts and contributions of various agents in the CIP dynamics. To apply for insurance, farmers must register at the local level before planting each year's crop. If selected, per the established legal criteria, they join the scheme after paying their contribution via a bank slip. Insurance payments are made in fixed installments in the event of losses from drought or excessive rainfall equal to or greater than 50% of the plantations (e.g., starch, rice, beans, and maize) in the participating municipality where their crops are located.

Table 5 – History of the percentage and value of contributions from farmers, municipalities, states and the Union to the Crop-Insurance Fund, 2010-2019

Harvest	Amount of Benefit (R$)	Number of installments	Amount of installment (R$)	Farmer's contribution (%)	Farmer's contribution (R$)	Municipal contribution (%)	Municipal contribution (R$)	State contribution (%)	State contribution (R$)	Federal Contribution (%)	Federal Contribution (R$)
2009/10	600,00	4	150,00	1	6,00	3	18,00	6	36,00	20	120,00
2010/11	640,00	4	160,00	1	6,40	3	19,20	6	38,40	20	128,00
2011/12	680,00	5	136,00	1	6,80	3	20,40	6	40,80	20	136,00
2012/13	760,00	5	152,00	1,25	9,50	3,75	28,50	12,5	95,00	25	190,00
2013/14	850,00	5	170,00	1,5	12,75	4,5	38,25	15	127,50	30	255,00
2014/15	850,00	5	170,00	1,75	14,88	5,25	44,630	17,5	148,75	35	297,50
2015/16	850,00	5	170,00	2	17,00	6	51,00	20	170,00	40	340,00
2016/17	850,00	5	170,00	2	17,00	6	51,00	20	170,00	40	340,00
2017/18	850,00	5	170,00	2	17,00	6	51,00	20	170,00	40	340,00
2018/19	850,00	5	170,00	2	17,00	6	51,00	20	170,00	40	340,00

Source: DGR/SPA/MAPA (2020).

Regarding the performance of the CIP in the SUDENE area (including the states of the Northeast and part of northern Minas Gerais), between the 2009–2010 and 2018–2019 harvests, Table 6 shows a significant evolution in the number of participating or "adhering" municipalities. Evidently, the frequency increased in the years of prolonged drought, indicating that municipal administrations have incorporated the policy as a strategic instrument to "live with" and no longer "combat" the historical, predictable, and inevitable droughts of the regional territory. Similarly, the numbers of accredited farmers and those who received the benefit also grew significantly during the period, although a significant percentage remained without payment.

Table 6 – Evolution of the Crop-Insurance Program (CIP) in the SUDENE* area, 2010-2019

Harvest	Adhered Municipalities (A)	Paid Municipalities (B)	%B/A	Adhered Family Farmers (C)	Paid Family Farmers (D)	%D/C	Value (R$ 1,00)
2009/2010	860	801	93,1	661.802	639.227	96,6	383.536.200
2010/2011	989	261	26,4	737.917	166.935	22,6	106.838.400
2011/2012	1035	1015	98,1	771.343	769.023	99,7	1.384.241.400
2012/2013	1.118	980	87,7	977.552	865.319	88,5	969.043.020
2013/2014	1.263	894	70,8	1.177.452	909.444	77,2	773.027.400
2014/2015	1.248	1010	80,9	1.162.086	975.822	84,0	829.448.700
20152016	1.220	1035	84,8	991.853	864.894	87,2	735.159.900
2016/2017	1.096	704	64,2	884.062	566.996	64,1	481.946.600
2017/2018	1.215	560	46,1	903.452	522.425	57,8	444.061.250
2018/2019	1.141	480	42,1	801.522	425.404	53,1	361.593.400
TOTAL	--	--	--	--	--	--	6.468.896.270

Source: DGR/SPA/MAPA (2020).
*Includes the nine states in the Northeast and part of the north of Minas Gerais.

The discrepancy between the total number of "adhered" municipalities and farmers and those effectively "paid" has multiple explanations. One explanation regards variations and loss of intensity of the drought in certain areas of the region. Note that even with the adherence of many municipalities to program rules, rain reduces crop losses and disqualifies the location and its farmers from the list of potential recipients of the CIP premium. Another explanation regards the default of municipalities with the crop guarantee fund, making it impossible for registered farmers to receive the benefit. Alves (2009) notes that this behavior by municipal managers occurs during droughts and, mainly, in regular rainfall years. It is facilitated by the program's legislation, which does not have efficient

collection mechanisms and can only suspend operations in the event of non-payment of contributions from the municipalities.

Regarding the volume of resources applied, the CIP injected more than R$ 6.4 billion into the economy of the Brazilian semi-arid region during the period analyzed (Table 6). The periods with the highest amounts of benefits paid were 2011–2012 and 2012–2013, the initial years of the Great Drought when additional installments were released to the program's beneficiaries through the edition of provisional measures of 587 and 635 (DGR/SPA/MAPA, 2020). The Figure 1 shows the distribution of the amounts paid in the region's municipalities when the prolonged drought was beginning to wane for an in-depth view of the case of the Northeast. Despite the differentiation in the value ranges, varying from R$ 2,550 to more than R$4 million, this policy has acquired a marked capillarity in the geography of the semi-arid territory.

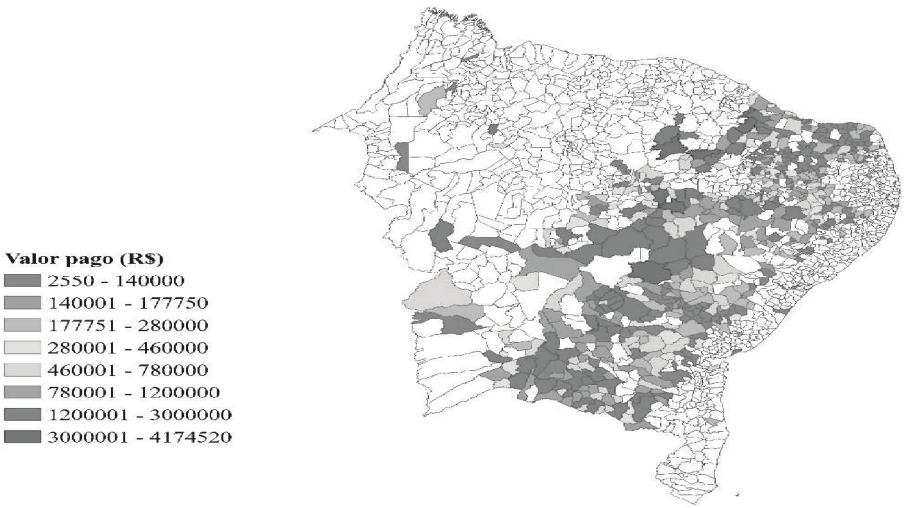


Figure 1. Amount paid by the Food Security Guarantee in Northeastern municipalities in the 2016–2017 crop year

Source: Santana and Santos (2019, p. 112).

Despite the results and the innovative institutional organization of the CIP, an analysis of its budget performance highlights limits that deserve attention. Initially, the program does not cover the entire regional family farming public, much larger than the number of beneficiaries served annually (AQUINO; ALVES; VIDAL; 2020; SILVA et al., 2020). Moreover, its capacity to compensate producer losses is reduced since the fixed value of the benefits does not consider the real dimensions of losses of individual production units, functioning more as an emergency cash transfer than insurance for production (ALVES, 2009).

In addition, questions about the role of the CIP in strengthening the adaptive capacity of low-income family farmers remain (KÜHNE, 2020). The problem is that, similarly to PRONAF, which has focused on supporting extensive livestock farming, CIP actions have contributed little to induce structural changes in rain-fed agriculture in the region. The benefit payments are not accompanied by compliance with conditionalities and other actions provided for in its legal framework, which stimulate the adoption of collective organization practices and productive technologies for coexistence with the semi-arid region before droughts occur. The territorial coverage of the program in drought years indicates success in guaranteeing a minimum income for family farmers in the Northeast. However, by partially compensating for non-conditionality losses, it encourages them to continue "doing more of the same," developing productive systems highly vulnerable to recurrent droughts.

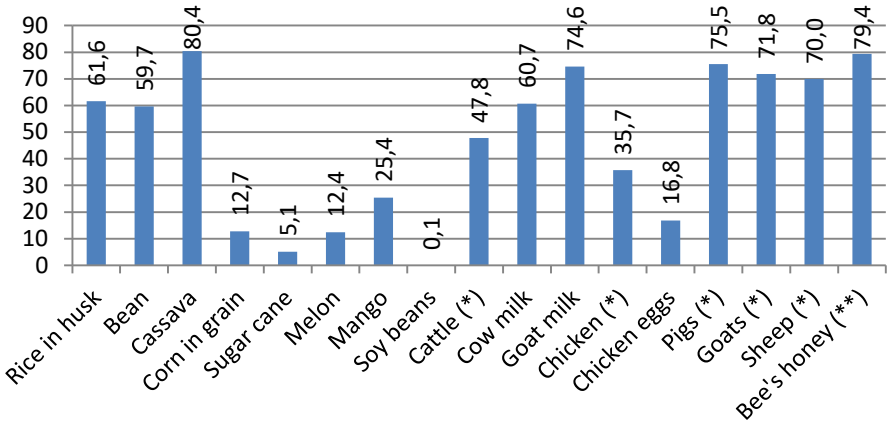
Without disregarding the relevance of the limits presented, emphasizing that the CIP is an important part of the social protection network is necessary. In addition to directly impacting the productive units, it injects income into local economies during extreme climate shocks. Thus, its permanent implementation and articulation with PRONAF have been fundamental for the social reproduction of family farming in the Northeast that survived the Great Drought.

The role of the PRONAF and Crop-Insurance Program in adapting family farms in the Northeast to prolonged drought

As discussed, PRONAF and CIP in the Northeast had a relevant budgetary performance during the period studied and maintained the dynamics of their operations during the Great Drought (2012–2017). Consequently, the resources released by such policies generated multiple socio-economic impacts. Studies show that access to rural credit through AGROAMIGO enables poor farmers to improve their chances of market insertion and stimulates increased production (ABRAMOVAY et al., 2013; GUEDES; ALMEIDA; SIQUEIRA, 2021). Regarding the CIP, recent research indicates its effectiveness in reducing food insecurity in the field since the beneficiary farmers use 80.1% of the money received to buy food for the family (BARBOSA, 2019).

Thus, the programs contribute to maintaining family farming and the continuity of productive activities. Given the destructuring effects of the prolonged drought, when the IBGE went into the field at the end of 2017 to conduct the Agricultural Census, it should have found family farming "without production." However, that is not the case.

Surprisingly, census takers identified some type of production in 95.5% (1,755,995/1,838,846) of the small family properties visited (IBGE/SIDRA, 2019). Together, they accounted for a significant share of the production of various Northeastern agriculture and livestock segments (Graph 3), which would hardly have been possible without the rural credit and crop insurance.



Graph 3. Participation of family farming in the main agricultural and livestock products of the Northeast (2017) (In %)

Source: Agricultural Census 2017 (IBGE/SIDRA, 2019).
(*) Percentage share (%) of family farming in the number of heads in 2017. (**) Quantity of honey sold.

However, poverty and vulnerability of family farming in the Northeast are far from being solved because there is a marked inequality within the regional family farm, with a large contingent of poor and vulnerable producers still predominating in the so-called PRONAF Group B.

Accordingly, Table 7 shows that the intermediate and consolidated part of the segment is tiny (11.3%) but generates 62.3% of the wealth produced by the segment, emphasizing the impressive average value by the non-pronafianos (R$ 811.744,00). Alongside this more capitalized fraction is a large mass of poor family farmers (88.7%). These producers, in aggregate, generated wealth for the regional economy of more than R$ 5.9 billion in 2017. However, given their large contingent, this amount guaranteed an extremely low average value per year (R$ 3,839.00).

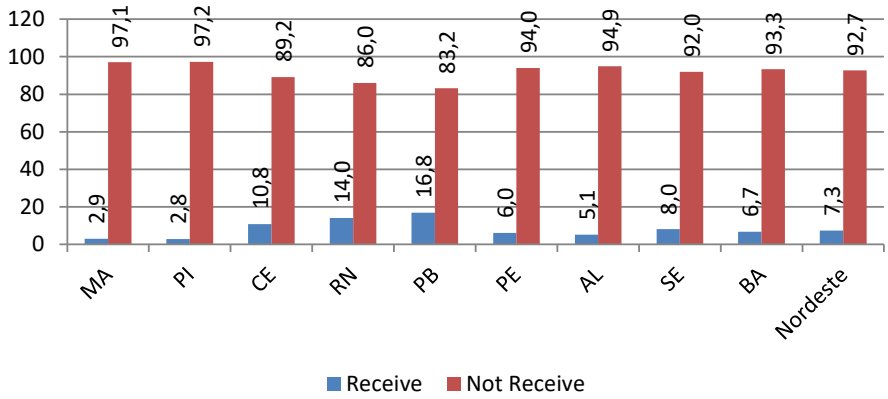
Table 7. Distribution of the Total Production Value (VTP) of family farming in the Northeast by classification of PRONAF groups (2017)

Categories (*)	Establishments with production	%	VTP (R$1.00)	%	Average VTP (R$ 1,00)
Group B	1.558.106	88,7	5.981.777.000	37,7	3.839
Group V	196.262	11,2	8.576.500.000	54,0	43.699
No Pronafiano	1.627	0,1	1.320.708.000	8,3	811.744
Total Family	1.755.995	100,0	15.878.992.000	100,0	9.043

Source: Agricultural Census 2017 (IBGE/SIDRA, 2019).
(*) Group B (poor) = with gross income up to R$ 20 thousand; Group V (intermediate) = with gross income from R$ 20 thousand to R$ 360 thousand; Non-Pronafiano (consolidated) = with gross income above R$ 360 thousand.

Thus, the expansion of PRONAF and CIP continues to be an important strategy to strengthen family farming in the Northeast. This expansion of scale, however, faces several bottlenecks, such as the limitation from the lack of technical assistance.

The Graph 4 highlights the limit as a serious shortcoming faced by local family farmers, given that 92.7% did not receive any technical guidance to improve the management of their enterprise, the performance of their crops and livestock, and their access to public policies. This bottleneck is evident in all states, being more serious in Maranhão and Piauí. It demonstrates the weaknesses of the regional TARE system regarding insufficient personnel, resources, and support structures, compromising the expansion and quality of services.



Graph 4. Access to technical assistance by Northeastern family establishments (2017) (In %)

Source: Agricultural Census 2017 (IBGE/SIDRA, 2019).

Evidently, it is not all about scale. It is necessary to adjust the focus of the policies studied to increase the adaptive capacity of family farmers to climate change. Initiatives such as PRONAF cannot focus only on agriculture and livestock (AQUINO; BASTOS, 2015). Note that the seasonal nature of agricultural activities in the Northeast makes the income from agriculture uncertain in time and space. Hence, it is important to recognize and bet on the inherent multifunctionality of family farmers to enable them combine the practice of agricultural and non-agricultural activities inside and outside the rural establishment as a complementary or compensatory strategy.

As Alencar Jr. and Alves (2006) note, some strategies for non-agricultural income generation in the northeastern region, focused on the domestic market and proximity, are noted. They range from small and family agro-industries to rural-ecological and religious tourism; handicraft (e.g., straw, clay, and wood); construction services; expansion and repair of public works; production and repair of parts, utensils, machinery, tires, and equipment; and small and medium manufacturing of articles, such as hammocks, clothing, and metallurgical products.

Thus, choosing to direct a portion of rural financing to take advantage of this potential and helping generate a wider range of income opportunities for families can reduce the pressure on natural resources, reducing environmental degradation, thus preventing intensification and expansion of the desertification observed in various parts of the region.

Furthermore, it is necessary to exert a major effort to articulate public policies for social protection with those for productive inclusion (AQUINO et al., 2017; MELLO, 2015; SILVEIRA et al., 2016). The poverty and socio-environmental vulnerability that characterizes normal family farming are multidimensional. Given its complexity and magnitude, it is challenging to expect that a credit or income guarantee policy can increase the adaptive capacity of the segment. In fact, any action directed to this public, in isolation, will have little chance of success. As Alves (2009, p. 298) explains:

> An integrated action strategy is needed from production (with training programs) and an effective technical assistance system and rural extension suited to the region (with financing and protection of production) and commercialization process (with incentives and training to add value and guarantee sales at fair prices) is needed. However, even these actions will be insufficient if the structural problem is not solved: access to land. Otherwise, there will be no change in the unfavorable conditions for peasants in the Northeast, who will remain in constant socio-economic precariousness, subject to the scourges of drought.

Therefore, considering the spending cuts and the "dismantling" of some rural development public policies in recent years (MATTOS, 2018; SABOURIN; CRAVIOTTI; MILHORANCE, 2020), the scenario of family farming in the Northeast is challenging. The segment has withstood one of the biggest climatic shocks in its recent history, but its future remains strongly linked to State intervention. Despite the advances achieved, regional productive activities remain vulnerable to the droughts native to the region and lack more support and diversification. Moreover, the situation of most of the segment may have worsened with the advent of the COVID-19 pandemic. Thus, further research may reveal whether PRONAF and CIP have suffered discontinuities or managed to maintain their stabilized trajectory during the analyzed period.

Concluding remarks

This briefly reviews two main public policies supporting family farming in Brazil: the PRONAF and CIP. The research focused on the Northeast of Brazil in the 2010–2019 period. It examines the performance of the policies and their role in adapting family farming to prolonged droughts.

The study shows that droughts are a historical problem in the Northeast Region. The last major drought occurred from 2012 to 2017, directly impacting regional productive activities. Despite the losses caused, family farming resisted and continued to be the main form of work and production in the countryside at the end of the second decade of the 21st century. This observation has been strengthened via a set of public policies since the 2000s, including a broad water and social protection network and policies to support production.

Regarding PRONAF, the program's operations were maintained throughout the period analyzed, injecting R$ 36.5 billion into the local economy and distributing almost eight million loans mainly to support livestock. The CIP showed great growth during the drought, applying more than R$ 6.4 billion in the regional economy and other municipalities of the Brazilian semi-arid region, thereby showing great geographic capillarity.

The resources applied by the policies have generated various productive and socio-economic impacts. Their most important effects regard increased production and improved food security for low-income family farmers. Investments have also contributed to maintaining the participation of family farming in the main production chains of the regional agricultural sector. Even so, most of the family segment remains very poor, with low production capacity.

The results indicate the need to maintain and expand credit and rural insurance policies in the region. However, this expansion has limits, such as the lack of

technical assistance. Beyond the need for scale expansion, integrating and diversifying activities financed is a challenge.

Therefore, as droughts and their intensity in the Northeastern territory worsen, given global warming, the future of local family farming increasingly depends on integrated rural development policies for income generation to adapt productive activities to climatic shocks. Within such initiatives, PRONAF and CIP are fundamental. However, such policies must overcome their sectoral bias and focus on a broader strategy of coexistence with the regional environment.

References

ABRAMOVAY, R. et al. **Cinco anos de AGROAMIGO**: retrato do público e efeitos do programa. 2. ed. rev. atual. ampl. – Fortaleza: BNB, 2013.

ALENCAR JR., J. S.; ALVES, M. O. O subespaço Semiárido no contexto de uma estratégia de desenvolvimento para o Nordeste. In: BERNAL, C. (Org.). **A economia do Nordeste na fase contemporânea**. Fortaleza: Banco do Nordeste do Brasil; Universidade Federal do Ceará, 2006. p. 235-259.

ALVES, F. O Programa Garantia-Safra no Semiárido brasileiro. In: IPEA. **Brasil em desenvolvimento**: Estado, planejamento e políticas públicas. Brasília: IPEA, 2009. p. 281-302. (Série "Brasil: o estado de uma nação", vol. 2).

ANDRADE, M. C. **A terra e o homem no Nordeste**: contribuição ao estudo da questão agrária no Nordeste. 7. ed. São Paulo: Cortez, 2005.

AQUINO, J. R. et al. Articulação de políticas para a superação da pobreza rural: um estudo das interfaces entre o Programa Bolsa Família e as políticas de inclusão produtiva no Nordeste e no Sul do Brasil. **Revista Econômica do Nordeste**. Fortaleza, v. 48, n. 4, p. 155-173, out./dez., 2017.

AQUINO, J. R.; ALVES, M. O.; VIDAL, M. F. Agricultura familiar no Nordeste do Brasil: um retrato atualizado a partir dos dados do Censo Agropecuário 2017. **Revista Econômica do Nordeste**. Fortaleza, v. 51, suplemento especial, p. 31-54, ago. 2020.

AQUINO, J. R.; BASTOS, F. Dez anos do Programa Agroamigo na região Nordeste: evolução, resultados e limites para o fortalecimento da agricultura familiar. **Revista Econômica do Nordeste**. Fortaleza, v. 46, suplemento especial, p. 139-160, jul./2015.

AQUINO, J. R.; SCHNEIDER, S. O Pronaf e o desenvolvimento rural brasileiro: avanços, contradições e desafios para o futuro. In: GRISA, C.; SCHNEIDER, S. (Org.). **Políticas públicas de desenvolvimento rural no Brasil**. Porto Alegre: Ed. da UFRGS, 2015. p. 53-81.

BACELAR, T. Nordeste: desenvolvimento recente e perspectivas. In: GUIMARÃES, P. F. et al. (Orgs.). **Um olhar territorial para o desenvolvimento**: Nordeste. Rio de Janeiro: BNDES, 2014. p. 540-560.

BANCO CENTRAL DO BRASIL. BCB. **Matriz de Dados do Crédito Rural - Contratações**. BCB, 2020. Disponível em: <https://www.bcb.gov.br/estabilidadefinanceira/micrrural>. Acesso em: 04 jan. 2021.

BANCO DO NORDESTE DO BRASIL. BNB. **AGROAMIGO**: publicações, relatórios e resultados. Fortaleza: BNB, 2020a. Disponível em: <https://www.bnb.gov.br/agroamigo/relatorios-e-resultados>. Acesso em: 22 fev. 2021.

BANCO DO NORDESTE DO BRASIL. BNB. **Contratações do FNE**. Fortaleza: BNB, 2020b. Disponível em: <https://www.bnb.gov.br/bnb-transparente>. Acesso em: 11 mar. 2021.

BARBOSA, W. F. **Intempérie climática e política de proteção social no Brasil**: uma avaliação multidimensional do impacto do Programa Garantia-Safra. 2019. 99f. Tese (Dourado em Economia/CAEN) – Universidade Federal do Ceará (UFC), Fortaleza, 2019.

BRASIL. Ministério da Agricultura e do Abastecimento. **PRONAF – Programa Nacional de Fortalecimento da Agricultura Familiar**. Brasília, maio de 1996.

BRASIL. Ministério da Integração Nacional - MIN. **Nova delimitação do Semiárido**. Brasília: SUDENE, 2018. Disponível em: http://sudene.gov.br/images/arquivos/semiarido/rquivos/Rela%C3%A7%C3%A3o_de_Munic%C3%ADpios_Semi%C3%A1rido.pdf. Acesso em: 10 jul. 2019.

CARVALHO, C. P. O. O novo padrão de crescimento no Nordeste semiárido. **Revista Econômica do Nordeste**. Fortaleza/CE, v.45, n. 3. p. 160-184, jul./set. 2014.

DEL GROSSI, M. E. **Algoritmo para delimitação da agricultura familiar no Censo Agropecuário 2017, visando à inclusão de variável no banco de dados do censo, disponível para ampla consulta**. Brasília: FAO/SAF-MAPA/Finatec, 2019.

DGR/SPA/MAPA. Garantia Safra: benefício condicionado da agricultura familiar. **Relatório Geral 2019**. Brasília: DGR/SPA, 2020. Disponível em: <https://www.gov.br/agricultura/pt-br/assuntos/politica-agricola/garantia-safra/arquivos/dados-consolidados.pdf>. Acesso em: 18 de fev. 2021.

FREITAS, R. E. O PRONAF no Semiárido: diagnósticos do programa e observações para o futuro. In: MATA, D.; FREITAS, R. E.; RESENDE, G. M. (Eds.). **Avaliação de políticas públicas no Brasil**: uma análise do Semiárido. Brasília: IPEA, 2019. p. 251-266.

FREITAS, R. E.; CASTRO, C. N. O PRONAF no Nordeste. In: VIEIRA FILHO, J. E. R.; GASQUES, J. G. (Orgs.). **Uma jornada pelos contrastes do Brasil**: cem anos do Censo Agropecuário. Brasília/DF: IPEA-IBGE, 2020. p. 311-322.

GRISA, C.; SCHNEIDER, S. (Orgs.). **Políticas públicas de desenvolvimento rural no Brasil**. Porto Alegre: Ed. da UFRGS, 2015.

GUEDES, I. A.; ALMEIDA, A. T. C.; SIQUEIRA, L. B. O. Efeitos do microcrédito rural sobre a produção agropecuária na região Nordeste: evidências do Programa Agroamigo. **Revista de Economia e Sociologia Rural**. Brasília, 59(1), p. 1-19, 2021.

KÜHNE, E. Building climate resilience through social protection in Brazil: the Garantia Safra public climate risk insurance programme. **IPC-IG Policy Research Brief n. 70**. Brasília: Centro Internacional de Políticas para o Crescimento Inclusivo, 2020.

IBGE. Áreas dos municípios. 2018. Disponível em: https://www.ibge.gov.br/geociencias/ organizacao-do-territorio/estrutura-territorial/15761-areas-dos-municipios.html?=&t=o-que-e. Acesso em: 20 jan. 2020.

IBGE. **Censo Agropecuário 2017**: resultados definitivos. Rio de Janeiro: IBGE, 2019.

IBGE. **Estimativas da População 2019.** Rio de Janeiro: IBGE/SIDRA, 2019. Disponível em: <https://www.ibge.gov.br/ estatisticas/sociais/populacao/9103-estimativas-de-populacao.html?=&t=o-que-e>. Acesso em: 21 fev. 2020.

IBGE/SIDRA. **Censo Agropecuário 2017**: resultados definitivos. Rio de Janeiro: IBGE, 2019. Disponível em: https://sidra.ibge.gov.br/pesquisa/censo-agropecuario/censo-agropecuario-2017. Acesso: 20 jan. 2020.

LIMA, J. R.; MAGALHÃES, A. R. Secas no Nordeste: registros históricos das catástrofes econômicas e humanas do século 16 ao século 21. **Parcerias Estratégicas**. Brasília/DF, v. 23, n. 46, p. 191-212, jan./jun. 2018.

MAIA GOMES, G. **Velhas secas em novos sertões**: continuidade e mudanças na economia do semi-árido e dos cerrados nordestinos. Brasília: IPEA, 2001.

MATTOS, L. M. Desestruturação das políticas públicas voltadas para a agricultura familiar brasileira. In: ROSSI, P.; DWECK, E.; OLIVEIRA, A. L. M. (Orgs.). **Economia para poucos**: impactos sociais da austeridade e alternativas para o Brasil. São Paulo: Autonomia Literária, 2018.

MARTINS, E. S. P. R.; MAGALHÃES, A. R. A seca de 2012-2015 e seus impactos. **Parcerias Estratégicas**. Brasília, v. 20, n. 41, p.107-128, jul./dez., 2015.

MELLO, J. (Org.). **A inclusão produtiva rural no Brasil sem Miséria**: o desafio da superação da pobreza no campo. Brasília: MDS/SAGI, 2015. (Caderno de Estudos, nº 23).

MIRANDA, C.; TORRENS, J.; MATTEI, L. (Orgs.). **O legado das políticas públicas de desenvolvimento rural para a inclusão socioprodutiva no Brasil**. Brasília: IICA, 2017. (Série Desenvolvimento Rural Sustentável; v. 24).

NUNES, E. M. et al. Políticas agrárias e agrícolas no contexto do desenvolvimento do Nordeste: evolução, desafios e perspectivas. **Planejamento e Políticas Públicas**. Brasília/DF, n. 43, p. 91-126, jul./dez. 2014.

SABOURIN, E.; CRAVIOTTI, C.; MILHORANCE, C. The dismantling of family farming policies in Brazil and Argentina. **International Review of Public Policy**. (Online), v. 2, n. 1, p. 1-25, 2020.

SANTANA, A. S.; SANTOS, G. R. Avaliação das políticas de mitigação de riscos da agricultura nordestina. **Revista de Política Agrícola**. Ano XXVIII, n. 1, p. 102-114, jan./fev./mar. 2019.

SANTANA, A. S.; SANTOS, G. R. Impactos da seca de 2012-2017 na região semiárida do Nordeste: notas sobre a abordagem de dados quantitativos e conclusões qualitativas. **Boletim Regional, Urbano e Ambiental (IPEA)**. Brasília, v. 22, p. 119-129, jan./jun. 2020.

SILVA, R. M. A. et al. Características produtivas e socioambientais da agricultura familiar no Semiárido brasileiro: evidências a partir do Censo Agropecuário de 2017. **Desenvolvimento e Meio Ambiente**. Curitiba, v. 55, Edição especial - Sociedade e ambiente no Semiárido: controvérsias e abordagens, p. 314-338, dez. 2020.

SILVEIRA, F. G. et al. **Políticas públicas para o desenvolvimento rural e de combate à pobreza no campo**. Brasília: IPC-IG/PNUD, 2016.

SOUZA, P. M.; BARBÉ, L. C. Desigualdades regionais na distribuição dos financiamentos do PRONAF: análise do período de 1998 a 2012. **Revista Econômica do Nordeste**. Fortaleza, v.45, suplemento especial, p. 31-43, 2014.

TROIAN, A.; MACHADO, E. T. L. O Programa Nacional de Fortalecimento da Agricultura Familiar no Brasil: análise da evolução e distribuição entre 1999 e 2017. **Revista Desenvolvimento em Questão**. Unijuí, ano 18, n. 50, p. 109-128, jan./mar. 2020.

VERNER, D. Vozes do povo: impactos socioeconômicos da seca no Nordeste do Brasil. In: NYS, E; ENGLE, N. L.; MAGALHÃES, A. R. (Orgs.). **Secas no Brasil**: política e gestão proativas. Brasília: CGEE/Banco Mundial, 2016. p. 133-163.

WESZ JR., V. J. O PRONAF pós-2014: intensificando a sua seletividade? **Revista Grifos**. Chapecó/SC, v. 30, n. 51, p. 89-112, 2021.

CHAPTER 6

The role of street-level bureaucrats in implementing cross-sectoral policies: combining social and water access strategies in Brazil's semi-arid region[1]

Patricia S. Mesquita, Carolina Milhorance, Louise Cavalcante

Introduction

Increasing the rural population access to water has been the central objective of development strategies implemented in the Brazilian semi-arid region for the past decades. In the 1990s, a policy paradigm known as the "coexistence with the semi-arid" emerged as a response to the inability of historical public interventions centered on deploying large dams and transposition of watersheds to reduce the vulnerability of rural populations to the impacts of drought (MACHADO; ROVERE, 2017). This paradigm was consolidated through a long process of learning and mobilization of civil society that led to the formation of the ASA network (*Articulação do Semiárido*). It advocated ideas that social factors aggravated the impacts of drought, and living and producing in the semi-arid region is possible by maintaining environmental resilience and using stocks of resources during periods of scarcity. Thus, access to water began to be promoted per a decentralized logic, characterized by the construction of cisterns to collect and store rainwater for human consumption and productive activities.

This perspective was institutionalized as a public policy of the federal government in 2003, following the *One Million Cisterns Program* (P1MC).

The P1MC is part of a broader strategy to reduce poverty and food insecurity (the Zero Hunger Program), coordinating the federal government's social and productive inclusion actions (LIMA, 2007; NOGUEIRA, 2017). Led by the

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former Ministry of Social Development and implemented by ASA, the P1MC promoted training, education, and mobilization initiatives for rural families to build cisterns. In addition to household cisterns for human consumption ("first water"), other social technologies were gradually considered to meet the various demands for water for food production ("second water"), such as modified cisterns and dams, and others to meet the water demand in schools (SANTANA; ARSKY; SOARES, 2011). The dissemination of cisterns is catalytic in coordinating other rural development programs in the semi-arid region, which justifies the focus of this article on this strategy.

In 2011, the federal government launched another major poverty reduction plan— the *Brazil Without Poverty Plan* (*Plano Brasil sem Miséria, BSM*). This plan promoted universal access to water in rural areas (CAMPOS; MELO ALVES, 2014). As a cross-sectoral plan, it covered technical assistance, water and electricity access, and marketing support. Beyond setting more ambitious goals for disseminating decentralized water infrastructures, the plan highlighted the need to increase policy coordination for poverty reduction, a multidimensional and multifaceted challenge. Water access composed the plans' productive inclusion strategy. This goal was mainly promoted through a program established in 2011—the Water for All Program (*Água para Todos*, APT)—managed by the Ministry of National Integration and implemented by a series of public and private agents.

The establishment of the abovementioned policy framework changed the decision-making process in disseminating rainwater catchment cisterns. It limited the role of civil society organizations in implementing the P1MC, which attracted criticism. Thus, the federal government created a new institutional framework for collaboration between the state and civil society to disseminate water cisterns in 2013. Developed by the Ministry of Social Development, it was called the Cisterns' Program, representing a bricolage between P1MC and Water for All (NOGUEIRA; MILHORANCE; MENDES, 2020). It promoted water access for human supply and productive use (first and second water cisterns). These "production-oriented cisterns" were disseminated by ASA's members since 2007 through the project called *One Land and Two Waters* (*Uma Terra Duas Águas*, P1+2).

Although most water and social policies were promoted through an integrated approach, the multiplication of programs with distinct implementation logics has increased the level of fragmentation of the strategies. Studies provide different explanations of the causes of public policy fragmentation. A first perspective mobilizes administrative rationalities, such as institutional differences, communication problems, and lack of clarity about the competencies of each sector (LUNDQVIST, 2004; REICHARDT; ROGGE, 2016; UNDERDAL, 1980).

However, several studies highlight the need to analyze policy incoherence through the lens of negotiation processes between interest groups (ADELLE; RUSSEL, 2013; ALLOUCHE; MIDDLETON; GYAWALI, 2014; JORDAN; LENSCHOW, 2008; REICHARDT; ROGGE, 2016; STEVENS, 2018). Accordingly, programmatic conflicts are considered inherent to cross-sectoral public action and not merely the result of administrative bottlenecks (WEITZ et al., 2017). This study builds on the second perspective, understanding cross-sectorality as a political coordination process between programs and actors with different perceptions, interests, and implementation practices. Moreover, it innovates by discussing the informal role of state managers and technical extensionists in coordinating actions during program implementation.

Hence, the study combines the literature on policy integration and street-level bureaucrats, which addresses the influence (and discretion) of local actors in policy implementation (LIPSKY, 2010; SONG, 2018). Lipsky (2010) argues that these actors play key roles as public policy implementers and act as decision-makers in many circumstances, influencing policy outcomes. Furthermore, different bureaucratic layers may have distinct policy perceptions as they experience distinct relationships and challenges in the implementation process (OLIVEIRA; LOTTA; FREITAS, 2019)the Bolsa Família Program (PBF. There are several advances in understanding the role of street-level bureaucrats in implementing health (LOTTA, 2014), education (NOVATO; NAJBERG; LOTTA, 2020), and social (EIRÓ, 2019) policies in Brazil. However, the influence of these actors on rural development policy outcomes has been overlooked. Moreover, though recent studies point to the influence of mid-level bureaucracy in promoting cross-sectorality (OLIVEIRA; LOTTA; FREITAS, 2019)the Bolsa Família Program (PBF, the role of street-level bureaucrats deserves more attention regarding policy integration. This study bridges these gaps by analyzing the articulation of the Cisterns Program with other rural development programs in the Semi-arid.

The text is divided into four sections. The introduction is followed by the methodology, which describes the study setting. We interviewed federal, state, and municipal managers and technicians involved in implementing the Cisterns Program and other rural development programs in the Semi-arid. The third section critically analyzes the instruments for coordinating poverty reduction programs at the federal level. The fourth section presents informal mechanisms of integration at the local level, considering the perception of federal managers of the Cisterns' Program and the pragmatic role of extension workers in implementing and integrating the programs. It also discusses the importance of establishing institutionalized spaces for territorial coordination.

Study Area and Methodology

The study was conducted in two locations in the Brazilian semi-arid region (Figure 1). Beyond the impacts of recurring droughts, the rural populations of the region face challenges of land regularization and competition for water use for different purposes (e.g., energy, agriculture, and urban supply) (MARENGO et al., 2019; MILHORANCE et al., 2019). Between 2012 and 2017, a long period of drought caused socio-environmental and economic impacts, such as decreased agricultural production, significant loss of livestock, and reduced levels in water reservoirs for human needs, animal feed, and energy generation (DE NYS; ENGLE, 2014)an area that is defined by both a minimal amount of annual rainfall (i.e., 800 millimeters per year on average. Recent studies also examine the contribution of cisterns and other rural development strategies to reduce drought vulnerability (LEMOS et al., 2016; MILHORANCE et al., 2020)poor agricultural households in less developed regions rely on different types of assets that define their overall adaptive capacity (AC. Figure 2 illustrates the main types of cisterns disseminated by these programs.

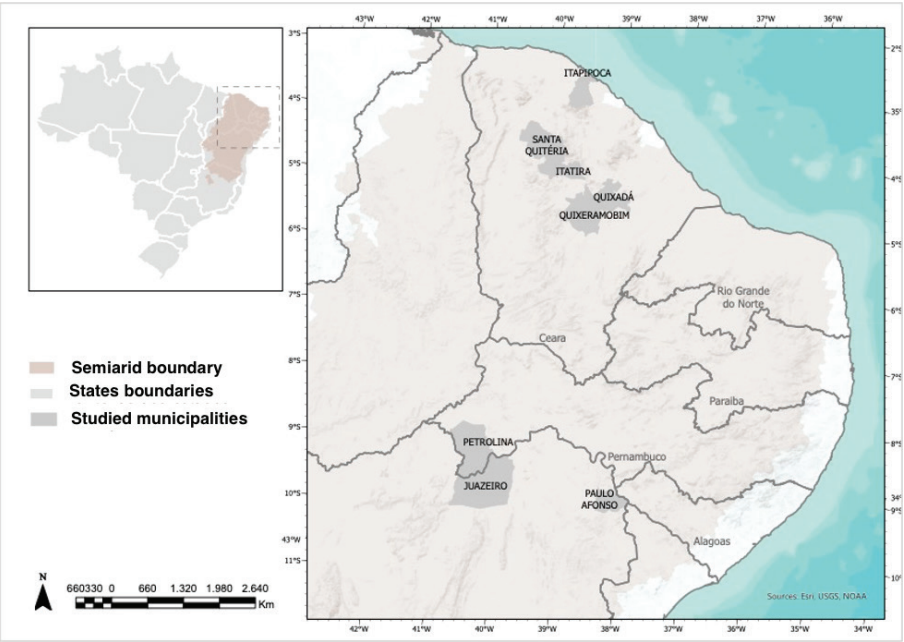

Figure 1. Study area in the Brazilian semi-arid region.

Source: Carolina Milhorance

Figure 2. Main types of cisterns disseminated by the program

Source: Patrícia Mesquita, Paulo Afonso - October/2017
*On the left, cistern for domestic consumption; on the right, for small production.

A total of 59 semi-structured interviews were conducted in three stages. The first stage was conducted in the Paulo Afonso, Juazeiro, and Petrolina municipalities in Bahia and Pernambuco (October 2017 - October 2018). The second was conducted in Itapipoca, Santa Quitéria, Itatira, and Quixeramobim in Ceará (September 2018). Such interviews were conducted in the company of technicians or coordinators of institutions responsible for implementing the analyzed programs. The interviews addressed topics such as policy implementation, coordination, and institutional conflict challenges, family farming in the region, drought management strategies, cistern installation processes, and drought impacts in rural households. The last stage was conducted in Brasilia to interview the federal-level stakeholders and implementation partners (November 2018). Moreover, official documents, such as government plans and program regulatory instruments, were analyzed qualitatively.

Coordinating Social Policies and the Cisterns' Program at the national level

Coordination instruments and political disputes

In Brazil, recent poverty reduction strategies were established following a transversal approach to policy design and implementation. For instance, the Zero Hunger Program promotes cross-sectoriality as a founding principle (TAPAJÓS; RODRIGUES; COELHO, 2010). Likewise, the National Policy on Food and Nutrition Security incorporated the promotion of universal access to water as a guideline and defined policy integration to promote human rights and adequate food (Decree No. 7.272/2010). Finally, the Brazil Without Poverty Plan

reinforced the need to combine income generation and initiatives and improve living conditions, including universal water access (Decree No. 7.492/2011).

In this context, procedural instruments contributed to coordinating the social programs: i) beneficiary databases (e.g., the Unified Registry for Social Programs – *CadUnic*o), ii) the cash transfer programs' magnetic card, iii) coordination councils, and iv) territorial development plans.

The mainstreaming of the food and nutrition security approach into the Unified Health System represents an additional effort to integrate broad social development strategies. Nevertheless, inter-ministerial coordination related to specific actions, geographical influence, and budgetary resources remains a challenge.

Regarding the Cisterns' Program, *CadUnico* is among the main instruments for coordination with other poverty reduction strategies. Managed by the Ministry of Social Development, this instrument corresponds to a large database that assembles and characterizes low-income households in Brazil. It has been used to guide the design of major social policies in the country, including beneficiaries' selection by the Cisterns' Program, cash transfer, productive inclusion (*Programa Fomento*), rural electrification, and social protection initiatives (BARTHOLO et al., 2010). For instance, note that the Cisterns' Program beneficiaries include rural low-wage families who meet the eligibility criteria for cash transfers. Although being registered in the CadUnico is not conditional for selecting beneficiary families, the Ministry of Social Development guidelines recommends increasing coordination between initiatives (Operational Instruction 01/2009 Senarc/Sesan).

Furthermore, government officers leading the Cisterns' Program at the national level mentioned the CadUnico as an instrument for i) coordination with the health sector's food and nutrition surveillance system, ii) identification of beneficiaries to productive inclusion initiatives (*Fomento Program*), and iii) installation of production-oriented cisterns. According to one interviewee, the surveillance system provides a national food insecurity map to target families benefiting from productive inclusion initiatives, including cistern installation. Another example of cross-sectoral collaboration was noted, as community health agents have been key actors in monitoring the water quality of household cisterns. However, these integration objectives face challenges and territorial differences given an insufficient involvement of the Ministry of Health.

Finally, the universalization goals of the Water for All Program induced a significant increase in the number of implementing agents and consequent dispersion of financial resources. Moreover, the program contrasted with its previous version—the P1MC—and included all the cistern types, such as the non-locally-produced plastic-made ones. It meant a major change in policy implementation

as the main partners of the national government to the P1MC were ASA civil society organizations. These organizations lost their implementation role to municipal governments and regional public companies (*Development Company of the Valleys of São Francisco and Parnaíba, Codevasf, and the National Department of Works Against Droughts, Dnocs*) that established bidding agreements with private companies. In the first bidding process, two multinational companies won the agreement, inducing strong criticism regarding the program's inability to develop the local economy and disseminating infrastructures adapted to the region's environment (ASA, 2011; PEREIRA, 2016).

Given these conflicts, the Cisterns' Programs emerged to stabilize the model for contracting civil society implementing partners. A new legal framework was established to simplify the processes for contracting and accountability of civil society organizations (Law No. 12,873/2013). The framework formalized service provision agreements between the state and private non-profit entities accredited by the Ministry of Social Development, based on a public call for proposals and a standardized call for proposals (with exemption from bidding). They included rules for the design of the implementation project, quotation of items used in training and construction materials, publication of calls for proposals, and formalization of contracts with implementing organizations (SANTANA; ARSKY, 2016). From the interviews, the same model later contaminated the Water for All Program; however, given its high institutional complexity and leadership committed to universalization rather than social participation objectives, the adjustments resulted in an institutional bricolage. The two strategies survived simultaneously in two different ministries, with a low coordination level (NOGUEIRA; MILHORANCE; MENDES, 2020). This case highlights political divergences between state bureaucracies and between executing agents. From the policy integration literature, disagreements over policy priorities and implementation strategies are key drivers of institutional and programmatic fragmentation, especially concerning programs in different sectors (BIESBROEK; CANDEL, 2020).

Operational barriers to policy coordination

In addition to the political challenges described above, operational barriers contribute to policy fragmentation. The *Fomento Program* constitutes a key example. It combines social protection and productive inclusion by directing cash and equipment transfer to vulnerable rural families. Notably, this program was implemented by the same unit that coordinated the Cisterns' Program (the National Secretariat for Food Security and Nutrition in the Ministry of Social Development). The beneficiary families are identified, given that the CadUnico and transfers rely on previously established cash transfer magnetic cards. Moreover, these

families benefit from technical assistance to increase their agricultural production. Further, they are included in another nationwide database to identify family farmers—the declaration of aptitude to the National Program for Strengthening Family Farming. It corresponds to an additional instrument for targeting rural development strategies.

The interviews indicated that the fact that the same unit managed Cisterns' and Fomento programs favored the informal coordination between the initiatives. However, divergent implementation procedures hindered the coordination objective. In 2015, the installation of production-oriented cisterns became officially associated with technical assistance and cash transfers for investment in productive projects. For instance, the complementarity principle posits that the beneficiaries of the Fomento Program should benefit from production-oriented cisterns or another source of water for production. A pilot project combining these initiatives was conducted in the late 2010s. According to a government officer:

> "The idea behind the fusion of the Cisterns and the Fomento Programs was [to] combine the cistern installation, design of an implementation project, and technical assistance for up to a year and a half. Sometimes the beneficiary receives the technology [the cistern], but if [the beneficiary] does not have support, [the beneficiary] gets lost in the way." With technical assistance, "the possibility that [farmers] will succeed is greater."

Finally, there is a perceived need to combine the distribution of water infrastructures for production with other productive inclusion initiatives within the Ministry of Social Development, particularly those promoting the marketing of agricultural products. For instance, public food purchases became major strategies for promoting agricultural commercialization. The *Food Purchase* and the *School Meals* programs purchase food produced by family farmers, with exemption from bidding procedures, and allocate it to populations in a situation of food and nutrition insecurity and public institutions such as schools and hospitals. These initiatives can leverage the results of the actions of access to water for production (MESQUITA; BURSZTYN, 2016; MESQUITA; MILHORANCE, 2019; MILHORANCE; SABOURIN; MENDES, 2019)due to the reliance on rain-fed production systems and the limited capacity to cope with and adapt to impacts. The Brazilian Food Acquisition Program (PAA. The interviewees noted that they advocated for increased coordination between the initiatives, which, together, can ensure products produced by beneficiaries from the Cisterns' and Fomento programs are directly supplied to public markets. Despite the inexistence of formal

instruments for integration between the strategies, coordination has been promoted informally at the local level.

Mechanisms for informal coordination at the local level

Despite the perception of the managers interviewed on the progress of social policies toward integration at the national level, the instruments described above are recent or not very effective. Despite the objectives of procedural simplification by the Cisterns' Program, it remained a complex strategy whose implementation involved a broad network of state and non-state actors. Furthermore, public funds are insufficient to promote universal access to water, especially water for agricultural production. Therefore, state actors at the implementation level attest to a certain pragmatism and autonomy in defining the criteria for combining policy support. The results indicate that municipal-level officers and technical assistance technicians play an active role in coordinating instruments at the local level. The perception that the *de facto* national program coordination occurs at the subnational level is shared by various actors:

> "In my interpretation, it is the [national] government that disconnects things by theme: water, health, food, nutritional security… When it gets to the local level, their timing is the same. There is only one reality: the organizations and municipal council […] benefit from all the policies and have the perception of the entire municipality. The organizations that [assure] technical assistance, water access... make the connection because they are at the front. [...] the higher [the government levels], the more the coordination is not very concrete."

Street-level bureaucrat studies discuss the often-discretionary role of local actors in implementing public policies. Lipsky (2010) describes the role of local public service officials, teachers, social workers, police officers, doctors, health workers, and a range of actors in determining service provision eligibility. This role reinforces the rights of some citizens to public goods and services at the expense of general taxpayers and those whose claims have been denied. Relatively high degrees of discretion and autonomy from organizational authority are the sources of these actors' power in policymaking. Much of their behavior has developed in via routines and simplifications to cope with complicated tasks and insufficient financial resources.

In the Brazilian semi-arid region, technicians actively define the eligibility criteria for different kinds of supports (agroecology technical assistance,

production-oriented cisterns, marketing programs). Therefore, they act as direct agents coordinating policies at the local level in implementation processes (MILHORANCE et al., 2020). Local state officers and implementing organizations play a leading role in combining territorial actions. This process is conducted via different mechanisms: i) guidance for municipal managers to combine actions considered complementary, ii) the active role of technical assistance agents in the dissemination of information and support (often informal) to farmers to participate in related initiatives, and iii) coordination between local organizations and state managers in municipal and territorial committees.

Individual action of local agents through the Cisterns Program

The attempt by municipal public agents to set access to productive and consumption water cisterns as an eligibility criterion for other rural development initiatives has been constant. For example, the interviews indicated that ASA members used the mapping of production-oriented cisterns to select beneficiaries for agroecology support initiatives. From the perspective of local agents and technicians, the Cisterns Program has facilitated access to other policies such as public food procurement, the Fomento Program, and other technical assistance initiatives. Further, per an interview, the Cisterns Program is a gateway to other social and productive policies. Civil society representatives in Pernambuco shared the same perspective, officially including public purchases as marketing opportunities in the business plans for family farmers as a condition to benefit from local projects (MILHORANCE; SABOURIN; CHECHI, 2018).

Individual action was also observed. For example, a municipal agent of the Cisterns Program sought specific microcredit funding for farmers who benefited from cisterns installation in Alagoas. Another interviewee in Bahia highlighted the attempt to informally coordinate the Cistern Program with actions by subnational authorities (Bahia Superintendence of Technical Assistance and Rural Extension). According to this interviewee, integration occurs at the municipal level per the sensitivity of the state officers and secretaries. In Ceará state, a desalinization project selected only beneficiaries who disposed of cisterns. Moreover, the entities implementing this project directed the organization of weekly fairs to those benefiting from the Cisterns Program.

The need for coordination between different municipal departments is a major challenge, presupposing a dialogue between bureaucracies guided by different references, logics, and modus operandi. Coordination at the municipal level depends on the relational capacity of the bureaucracy (OLIVEIRA; LOTTA; FREITAS, 2019)the Bolsa Família Program (PBF. However, this study showed the relevance of municipal agents' decisions in promoting coordination between

programs. According to Lipsky (2010), municipal agents have some autonomy in implementing public policies, though to a lesser extent than frontline actors like technical assistance providers. Unlike extensionists, the actions of these managers are more strongly guided by program results. Both communicate in an implementation network beyond normative decisions at the federal level and treat the implementation process as an ongoing elaboration process and an arena in which different actors interact and use their resources (SONG, 2018). Within this network, the role of local councils is also relevant.

Pragmatic role of technical assistance providers

Field technical assistance providers in civil society and public agencies play an important role in coordinating programs at the local level (Figure 3). This observation confirms the results of other studies illustrating how information about the different modalities of rural credit and the purchase rules from public institutions is disseminated through technical assistance (MILHORANCE; SABOURIN; MENDES, 2019).

According to managers of the Cisterns Program, in some cases, farmers produced satisfactorily but did not market their products, a challenge that technical assistance can address. In disseminating production-oriented cisterns, technical providers are essential, given their proximity to the beneficiaries. Interviews illustrate this relationship:

> "We conduct training and technical assistance sessions in which the families are informed about the importance of crop insurance, that they should contract the insurance, participate in the rural development councils, and ask the municipalities to join the insurance framework. In some cases, we prepared the credit project [such] that the families could [access] credit. In other cases, we encouraged families to access public food purchases."

Another interesting point is the fact that the Cisterns Program acts as a gateway for promoting agroecological practices, though outside its initial objective:

> "We have a very interesting experience in the semi-arid region, namely the public calls for agroecology technical assistance. In these calls [are] the organizations that won the lots. . . In the semi-arid, […] one of the strategies we set up [was to] to work with those families […] already involved in the agroecological transition process [through] P1+2 project. That is, these […] families […] have already received the first water cistern and gone through the whole process of capacity-building, training, and mobilization [and] received the second water cistern, which included capacity-building

> on water management, […] production with micro-irrigation systems, [and] agroecological production and all this perspective. [...] So we expect that these families will continue the work…"

The same strategy was adopted by other implementing agencies, as demonstrated by Milhorance et al. (2018). For example, in 2014, the former Ministry of Agrarian Development launched a call for proposals to provide agroecological technical assistance. An implementing agency in Pernambuco reported having selected rural communities that had already undergone productive training during the installation of cisterns, which facilitated the interest of producers in agroecological practices. According to the technician reports, most of the production promoted with support from the agroecological support was marketed in agroecological fairs and public purchases (MILHORANCE; SABOURIN; CHECHI, 2018). Regarding agroecology, beyond individuals and informal strategies, the coordination process is part of a political project developed in the scope of ASA and coordinated with the National Agroecology Articulation. As per a representative, "a shared understanding by the National Agroecology Articulation is this perspective that the calls for agroecology support contributed to the convergence of public policies for territorial development. Agroecological support can include even broader debates of a global nature such as desertification and climate change."

In the case of the cash transfers, the interviews indicated that technical providers coordinate social and productive inclusion. The interviewees noted the potential synergy of an integrated arrangement between the Cisterns, Fomento, and technical assistance programs: it was not feasible to support actions in the semi-arid region that did not include water access.

Notably, technical assistance and training for cistern construction and water quality control are included in the methodological design of the Cisterns Program, which ensures greater appropriation of the technologies and agricultural practices by beneficiaries and the potential for linkages with other programs given the long-term collaboration of technicians with farmers. Under the Water for All Program, other institutions distribute plastic-made cisterns, including private companies. In this program, the training component for construction and maintenance of the cisterns and social mobilization is absent. Hence, in addition to the criticisms initially raised on the program's lower capacity to promote local development, the potential for its coordination with other social strategies at the local level is reduced. The plastic-made cisterns are delivered to the beneficiaries without involvement or training.

Finally, public rural extension services have fewer human resources to meet the demand. The lack of financial resources for transport to the communities adds

challenges. In this context, the technicians' discretion in defining the coverage of their actions is even greater and is sometimes influenced by the degree of access of the technicians to farmers and their personal relationship with local leaders.

Municipal councils and territorial development committees

In addition to the role of technical assistance providers and municipal agents, the role of municipal rural development councils and territorial committees in integrating a series of public actions at the local level should also be highlighted. They establish platforms to coordinate actors and initiatives for productive inclusion (technical assistance, development, and marketing support) and water access on the territory (MILHORANCE; SABOURIN; CHECHI, 2018). Technical experts interviewed stated that all policies are somehow discussed in these councils. In Pernambuco, it was noted that the Cisterns Program contributed to strengthening and empowering the municipal council and territorial committees as an instance of public policy debate.

The creation of local councils is based on the territorial approach to development based on the idea that territories are spaces for actors' coordination and proximity ties between agents in development initiatives (BACELAR, 2010; CARON, 2017). Notably, the rural sectoral essence of territorial policies in Brazil is not addressed (ECHEVERRI, 2010). Studies show more juxtaposition than territorial public policy integration (LOTTA; FAVARETO, 2016). However, the importance of these mechanisms for coordinating actions at the local level has been demonstrated. According to agents of the Cisterns Program, a project with 1,500 families in the *Sertão do Pajeú*, Pernambuco state, coordinated a set of other initiatives that impacted the territory, helping to consolidate a regional perspective.

Moreover, the councils contribute to ensuring greater stability and transparency in the work of street-level bureaucrats by making public the targeting of some programs to certain regions or communities. For example, the distribution of household cisterns has the prerogative of universalization, unlike production-oriented cisterns. Although access to water has been incorporated as a basic component of the human right to adequate food, the financial resources available have not been sufficient for universalization. In this context, the definition of beneficiary regions and communities has been based on objective metrics, such as the food insecurity map and the profile of the target public established in a decree (9.606/2018). However, subjective criteria are also used, such as the productive potential of the families.

In a study on street-level bureaucrats in the health area, Lotta (2018) demonstrated that the discretionary actions of health community agents are highly

influenced by their professional trajectories and relation with the community where they work and reside. Thus, the results of policy implementation can be partially explained by the relationships established by bureaucrats. Accordingly, beneficiaries of cash transfer programs are subject to the judgments of social workers to maintain their registration. This personal value judgment exceeds the program's rules, which should be based on the beneficiary's profile and other conditionalities. Thus, the social right would be compromised (EIRÓ, 2019). Therefore, as personal values of these bureaucrats can limit the expansion of potential benefits of social programs; hence, their judgments must also be considered in the implementation of public policies.

Strengthening local councils as spaces for coordination can ensure greater transparency in allocating public benefits and reduce the negative effects of discretion. However, these councils have faced budget cuts since 2016, and many have been rendered unviable (SABOURIN; CRAVIOTTI; MILHORANCE, 2020). Finally, if this exercise can induce a process of exclusion of some individuals, it can adapt public policies to local demands, pragmatically integrating actions. Thus, to evaluate how these interferences happen in practice, it is necessary to consider the dimension of agency and the judgments of bureaucrats as central elements in the design, analysis, and management of policies that aim to promote social inclusion, and that can be influenced by these actors (PIRES; LOTTA; TORRES JUNIOR, 2018).

Conclusion

The Cisterns Program has come a long way in learning and reformulation since its launch in 2003. Implementation challenges have made it necessary to adapt the program at various stages, as with any strategy that covers a wide geographical area, with ambitious objectives such as promoting access to water and reducing poverty. The multidimensional perspective of poverty requires integrated strategies that combine actions for productive inclusion, marketing, sustainable production, food security, and access to water. Among the various challenges, coordinating the Cisterns Program with other social and productive inclusion programs remains limited, despite the ambition to strengthen cross-sectorality, reiterated since the Zero Hunger Program and the launch of the Brazil Without Poverty Plan. Several national-level coordination instruments have been promoted, but their results remain incipient or ineffective.

This study contributed to this debate by discussing the role of municipal and rural extension agents in the often-informal process of linking programs and actors at the local level. Many of these actors defined the participation of rural families in the Cisterns Program as an informal requirement for participation in

other strategies for technical assistance, development, public procurement, and credit. While such an approach can help leverage the program's impacts, it also risks concentrating benefits and excluding non-participants from the rural development process based on subjective criteria.

In this context, the concept of street-level bureaucrats is useful to analyze the results of implementing cross-sectoral strategies. While most studies show the contributions of this concept in evaluating public policies on an individual basis, this study emphasizes the less addressed aspect of its contribution to analyzing the coordination between programs during the implementation process. The influence of the bureaucrats on the political process and choice of beneficiaries was discussed in certain discretionary cases. Moreover, combining the institutional-administrative dimensions of the integration process of public policies with the mechanisms of decision-making on their implementation was possible. The horizontal or vertical integration of public policies requires a constant learning exercise.

Therefore, the level of influence and the perception of local actors on operational decisions should be considered in the design, analysis, and management of social policies. Further, a rural poverty reduction strategy on strengthening local coordination spaces, sustained by a rights-based approach, can curb the risks of discretionary exclusion of beneficiaries. Therefore, in a climate change scenario, with an expected increase in periods of water shortage in the Brazilian semi-arid region, and especially given the recent budget cuts in social programs, attention should be increasingly focused on inclusive strategies with the potential for complementarity, which ensure a greater impact in the long term.

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References

ADELLE, C.; RUSSEL, D. Climate Policy Integration: a Case of Déjà Vu? **Environmental Policy and Governance**, v. 23, n. 1, p. 1–12, jan. 2013.

ALLOUCHE, J.; MIDDLETON, C.; GYAWALI, D. **Nexus Nirvana or Nexus Nullity? A dynamic approach to security and sustainability in the water-energy-food nexus**: Water and the Nexus. Brighton: STEPS Centre, 2014.

ASA. **Cisternas de PVC: solução ou armadilha?** Recife: Articulação do Semiarido, 2011.

BACELAR, T. Pensando o futuro das políticas de desenvolvimento territorial no Brasil. In: GUIMARÃES, L.; BACELAR, T. (Eds.). . **Políticas de desenvolvimento territorial rural no Brasil: avanços e desafios**. Série Desenvolvimento rural sustentável. Brasília: Instituto Interamericano de Cooperação para a Agricultura-IICA, Representação do IICA no Brasil, 2010. p. 197–218.

BARTHOLO, L. et al. Contribuições e potencialidades do Cadastro Unico para a implementação de politicas sociais no Brasil. In: ARANHA, A. V. (Ed.). . **Fome Zero: uma história brasileira**. Brasília: Ministério do Desenvolvimento Social e Combate à Fome, 2010. v. IIIp. 12–24.

BIESBROEK, R.; CANDEL, J. J. L. Mechanisms for policy (dis)integration: explaining food policy and climate change adaptation policy in the Netherlands. **Policy Sciences**, 2020.

CAMPOS, A.; MELO ALVES, A. O Programa Agua para Todos: ferramenta poderosa contra a pobreza. In: CAMPELLO, T.; FALCÃO, T.; COSTA, P. V. DA (Eds.). . **O Brasil sem miséria**. 1a edição ed. Brasília: Ministério do Desenvolvimento Social e Combate à Fome, 2014. p. 467–492.

CARON, P. Why and how the concept of "territory" can help in thinking rural development. In: CARON, P. et al. (Eds.). . **Living territories to transform the world**. Versailles: éditions Quæ, 2017. p. 15–22.

DE NYS, E.; ENGLE, N. L. **Convivência com o Semiárido e Gestão proativa da seca no Nordeste do Brasil: Uma nova Perspectiva**. [s.l.] The World Bank, 1 maio 2014. . Acesso em: 18 abr. 2017.

ECHEVERRI, R. Emergência e evolução do programa de desenvolvimento sustentável dos territórios rurais e nos Territórios da Cidadania. In: GUIMARÃES, L.; BACELAR, T. (Eds.). . **Políticas de desenvolvimento territorial rural no Brasil: avanços e desafios**. Série Desenvolvimento rural sustentável. Brasília: Instituto Interamericano de Cooperação para a Agricultura-IICA, Representação do IICA no Brasil, 2010. p. 81–114.

EIRÓ, F. The Vicious Cycle in the Bolsa Família Program's Implementation: Discretionality and the Challenge of Social Rights Consolidation in Brazil. **Qualitative Sociology**, v. 42, n. 3, p. 385–409, set. 2019.

JORDAN, A.; LENSCHOW, A. **Innovation in Environmental Policy?** [s.l.] Edward Elgar Publishing, 2008.

LEMOS, M. C. et al. Linking development to climate adaptation: Leveraging generic and specific capacities to reduce vulnerability to drought in NE Brazil. **Global Environmental Change**, v. 39, p. 170–179, jul. 2016.

LIMA, S. M. V. Avaliação de impacto social do programa de cisternas. **In: VAITSMAN, J.; PAES-SOUSA, R. (Org.). Avaliação de políticas e programas do MDS: resultados. Brasília, DF: MDS: SAGI, 2007.**, 2007.

LIPSKY, M. **Street-level bureaucracy: dilemmas of the individual in public services**. 30th anniversary expanded ed ed. New York: Russell Sage Foundation, 2010.

LOTTA, G.; FAVARETO, A. Desafios da integração nos novos arranjos institucionais de políticas públicas no Brasil. **Revista de Sociologia e Política**, v. 24, n. 57, p. 49–65, mar. 2016.

LOTTA, G. S. Agentes de implementação: uma forma de análise de políticas públicas. **Cadernos Gestão Pública e Cidadania**, v. 19, n. 65, 23 dez. 2014.

LUNDQVIST, L. **Sweden and ecological governance: straddling the fence**. Manchester ; New York: Manchester University Press, 2004.

MACHADO, L.; ROVERE, E. The Traditional Technological Approach and Social Technologies in the Brazilian Semiarid Region. **Sustainability**, v. 10, n. 2, p. 25, 22 dez. 2017.

MARENGO, J. A. et al. Increase Risk of Drought in the Semiarid Lands of Northeast Brazil Due to Regional Warming above 4 °C. In: NOBRE, C. A.; MARENGO, J. A.; SOARES, W. R. (Eds.). . **Climate Change Risks in Brazil**. Cham: Springer International Publishing, 2019. p. 181–200.

MESQUITA, P.; BURSZTYN, M. Integration of social protection and climate change adaptation in Brazil. **British Food Journal**, v. 118, n. 12, p. 3030–3043, 9 nov. 2016.

MESQUITA, P.; MILHORANCE, C. Facing food security and climate change adaptation in semi-arid regions: lessons from the Brazilian Food Acquisition Program. **Sustentabilidade em Debate**, v. 10, n. 1, 2019.

MILHORANCE, C. et al. O desafio da integração de políticas públicas para a adaptação às mudanças climáticas no semiárido brasileiro. **Revista Brasileira de Climatologia**, v. 24, n. 0, 2019.

MILHORANCE, C. et al. Unpacking the policy mix of adaptation to climate change in Brazil's semiarid region: enabling instruments and coordination mechanisms. **Climate Policy**, n. 5, p. 1–16, 22 abr. 2020.

MILHORANCE, C.; SABOURIN, E.; CHECHI, L. **Adaptação às mudanças climáticas e integração de políticas públicas no semiárido pernambucano**: Série Working Papers. Brasília: Universidade de Brasilia, 2018.

MILHORANCE, C.; SABOURIN, E.; MENDES, P. **Implementação e coordenação das políticas de adaptação às mudanças climáticas no semiárido baiano e pernambucano**: Artimix-INCT Odisseia. Brasília: Universidade de Brasilia, 2019. Disponível em: <http://inct-odisseia.i3gs.org/wp-content/uploads/2020/04/WP4.pdf>.

NOGUEIRA, D. Segurança hídrica, adaptação e gênero: o caso das cisternas para captação de água de chuva no semiárido brasileiro. **Sustentabilidade em Debate**, v. 8, n. 3, p. 22, 29 dez. 2017.

NOGUEIRA, D.; MILHORANCE, C.; MENDES, P. Do Programa Um Milhão de Cisternas ao Água para Todos: divergências políticas e bricolagem institucional na promoção do acesso à água no Semiárido brasileiro. **IdeAs**, n. 15, 1 mar. 2020.

NOVATO, V. DE O. L.; NAJBERG, E.; LOTTA, G. S. O burocrata de médio escalão na implementação de políticas públicas. **Revista de Administração Pública**, v. 54, n. 3, p. 416–432, jun. 2020.

OLIVEIRA, V. E. DE; LOTTA, G. S.; FREITAS, M. N. Desafios da implementação de uma política intersetorial e federativa: as burocracias de médio escalão do Programa Bolsa Família. **Revista do Serviço Público**, v. 70, n. 3, p. 458–485, 26 set. 2019.

PEREIRA, M. C. G. **Água e convivência com o semiárido: múltiplas águas, distribuições e realidades**. Thesis—[s.l: s.n.].

PIRES, R.; LOTTA, G.; TORRES JUNIOR, R. Burocracias implementadoras e a (re)produção de desigualdades sociais: perspectivas de análise no debate internaciona. In: **Burocracia e políticas no Brasil: interseções analíticas**. [s.l.] Instituto de Pesquisa Econômica Aplicada (IPEA), 2018. p. 247–266.

REICHARDT, K.; ROGGE, K. How the policy mix impacts innovation: Findings from company case studies on offshore wind in Germany. **Environmental Innovation and Societal Transitions**, v. 18, p. 62–81, 2016.

SABOURIN, E.; CRAVIOTTI, C.; MILHORANCE, C. The Dismantling of Family Farming Policies in Brazil and Argentina. **International Review of Public Policy**, v. 2, n. 1, p. 1–24, 2020.

SANTANA, V.; ARSKY, I. DA C.; SOARES, C. C. Democratização do acesso à água e desenvolvimento local: a experiência do Programa Cisternas no semiárido brasileiro. **Anais do I circuito de debates acadêmicos**, Área Temática: Desenvolvimento e Espaço: ações, escalas e recursos. 2011.

SANTANA, V. L.; ARSKY, I. DA C. Aprendizado e inovação no desenho de regras para a implementação de políticas públicas: a experiência do Programa Cisternas. **Revista do Serviço Público**, v. 67, n. 2, p. 203–226, 30 jun. 2016.

SONG, X. Implementation Network Approach: A New Theoretical Framework. In: SONG, X. (Ed.). . **Implementing Sure Start Policy**. Singapore: Springer Singapore, 2018. p. 79–113.

STEVENS, C. Scales of integration for sustainable development governance. **International Journal of Sustainable Development & World Ecology**, v. 25, n. 1, p. 1–8, jan. 2018.

TAPAJÓS, L.; RODRIGUES, M.; COELHO, M. F. Desafios sociais no Brasil em 2003: da exclusão à cidadania. In: SILVA, J. F. G. DA; DEL GROSSI, M. E.; FRANÇA, C. G. DE (Eds.). . **Fome Zero: a experiência brasileira**. Série NEAD especial. Brasília: Ministério do Desenvolvimento Agrário, 2010. p. 42–53.

UNDERDAL, A. Integrated marine policy. **Marine Policy**, v. 4, n. 3, p. 159–169, jul. 1980.

WEITZ, N. et al. Closing the governance gaps in the water-energy-food nexus: Insights from integrative governance. **Global Environmental Change**, v. 45, p. 165–173, 2017.

CHAPTER 7

Cross-views at the relationship between gender, water security, and adaptation: the case of cisterns for rainwater harvesting in the semi-arid regions of Paraiba and Pernambuco1

Daniela Nogueira, Carlos Hiroo Saito

Introduction

Brazil is privileged with large water resources. However, water availability in the national territory is not uniform, and water distribution presents contrasts and asymmetries. The supply of treated water is even more unequal, even within regions and the same city, whose aspects are associated with the national development process and the resulting social and regional inequalities.

According to Rebouças (2001), the quantity of water per inhabitant in the Brazilian average places the country in a comfortable situation between 10 thousand and 100 thousand m3/year/inhabitant, while the Northeast Region of the country would have between 1,000 and 2,000 m3/year/inhabitant, classified as regular.

The Northeast Region covers an area of 1,561,177 km2, of which 1,127,953 km2 make up the so-called Brazilian semi-arid region. This region is historically marked by the occurrence of droughts which, according to the Intergovernmental Panel on Climate Change (IPCC) (2014), may intensify in the coming years, further aggravating its socio-environmental impacts.

1 This chapter mobilizes results from the ARTIMIX (Articulating policy mixes across scales & sectors to address adaptation to climate change challenges in vulnerable tropical agricultural landscapes - ANR-17-CE03-0005), TYPOCLIM (Typology and assessment of policy instruments to promote agricultural adaptation to climate change -MUSE-ANR-16 IDEX- 0006) and INCT Odisseia (Observatory of socio-environmental dynamics - CNPq) projects.

This diagnosis delineates a scenario of water insecurity for family farming verified by Nasuti et al. (2016), given that many producers plant their crops only in rainfed areas, depending entirely on rainwater for their production.

Insecurity in subsistence food production also reminds us about the water insecurity in daily consumption for housekeeping in the semi-arid region, resulting in the search for access to water at greater distances. This fact is aggravated by the low potability conditions of water used for domestic consumption, increasing the waterborne diseases among children and family members (NOGUEIRA, 2009).

Many transformations have occurred in recent decades in the region, given a more inclusive development project, with initiatives such as Fome Zero and Plano Brasil sem Miséria (Water for All - P1MC and P1+2 -, Light for All). Even so, much improvement to the living conditions of women and girls is needed, highlighting the existence of a previously recognized interrelationship between poverty, income inequalities, gender, and access to basic services (BRASIL, 2011).

Thus, incorporating a gender perspective in formulating and implementing more sustainable water policies emerges as a key political strategy for reducing vulnerability and regional development (BISILLIAT; VERSCHUUR, 2007). This relationship had already been identified in 1992 at the Dublin Conference in Ireland, recognizing that women are central to the provision, management, and protection of water in the third principle in the final document of the conference (The Dublin Statement on Water and Sustainable Development).

Thus, to analyze the incorporation of a gender perspective in the formulation and implementation of more sustainable water policies for the Brazilian semi-arid region, this chapter reflects on the contribution of the One Million Cisterns Program (P1MC) as an adaptation strategy to reduce the impact of drought on rural family lives in the Brazilian semi-arid region, particularly women.

This focus is justified by the water insecurity of families who did not have access to water until rainwater harvesting tanks were obtained and the fact that this adaptive program has prioritized families headed by women since its inception.

Hence, this study presents a cross-analysis from the gender, water security, and climate emergency adaptation perspectives of P1MC formulation and implementation to analyze the main program impacts on reducing the vulnerability of women beneficiaries and their families to climate change, fulfilling the goals and targets in the 2030 Agenda.

Public policies and access to water in rural communities of the Brazilian semi-arid region

In the semi-arid region, the history of access to and the use of water is in the various conceptions of development adopted in the formulation of regional public policies and the cycles of economic development that marked the region (OLIVEIRA, 2014/2015).

According to Nogueira (2017), the economic development strategy based on aspects of the region's economic structure produced only proposals inspired by external solutions disconnected from more rooted actions and can generate autonomy. Thus, the initiatives could not represent transformative actions of the social and economic structure. These past strategies continued to be present in the Federal Government's responses to the 1998–1999 drought, marked by the complementarity between traditional actions for water, food, and income distribution, and other initiatives to transform existing material conditions, such as literacy and training programs for young people and adults. The responses to the drought also included creating a special line of credit by Banco do Nordeste for rural producers in areas affected by the disaster. However, these actions remained limited to the perspective of emergency measures, and rural credit for providing water infrastructure only privileged large and medium-sized landowners (NOGUEIRA, 2017). Recognizing limited results of policies to combat drought in improving the living conditions of the population boosted the emergence and action of new actors in the search for alternatives toward sustainable development in the semi-arid region.

The emergence of these new actors provoked ruptures by including strategies for local economic restructuring in formulating development policies for the region. However, a closer look shows that the initiatives are limited in reducing existing inequalities among and within different social groups.

According to Nasuti et al. (2016), some of the initiatives can be classified as "support policies," such as the National Program for Strengthening Family Farming (PRONAF), rural extension, the Food Acquisition Program (PAA), and the National School Feeding Program (PNAE). These support programs help adapt farmers to production conditions without directly implying a change in the production structure. Other initiatives, such as social security programs, promoted government cash transfers and social security, ensuring a constant income flow, regardless of production results, to favor the financial adaptive capacity of the producer. Notably, the initiatives classified as structural policies (P1MC, P1+2, Sisar and Luz para Todos) physically modify systems to promote definitive transformations in the adaptive capacity of family production.

Although the actions of these structuring programs are essential for family farmers to live in the semi-arid region, they are insufficient (Nasuti et al., 2016).

Rainwater harvesting as an adaptive strategy

If the historical context reinforced links with mechanisms of reproduction of existing inequalities in the region, historical changes since the re-democratization of the country and strengthening of social mobilizations have allowed for greater protagonism by new social actors. Thus, in 1999, during the Third Conference of the Parties of the United Nations on Combating Desertification and Mitigating the Effects of Drought (COP 3) in Recife, Pernambuco, the Declaration of the Semi-arid emerged on the political scene, produced by representatives of rural workers' unions, social movements, religious organizations, and NGOs. This declaration promoted its central vision that adapting to the physiographic conditions of the Brazilian semi-arid region is possible (SILVA, 2014). Cognition of the semi-arid region in public policies underwent a perspective change from "combating droughts" to "coexistence with the semi-arid region."

The coexistence perspective requires strategies focused on the sustainable management of disaster risks, thus demanding more integrated planning and mitigation actions in the environmental and socioeconomic spheres. These represent a replacement of emergency strategies guided by decisions characterized by momentary and assistentialist reactions to drought and its impacts (ANDRADE et al., 2015).

A premise of the perspective of "coexistence with the semi-arid" is to ensure access to water autonomously, ensuring water and food security. These conditions can ensure people's permanence in the region, given that a family life project in which the semi-arid and the relationship of families with the semi-arid are valued.

Hence, to facilitate access to water, especially in rural areas, policymakers define rainwater harvesting as a privileged action precisely because it guarantees water for domestic consumption and, consequently, family water autonomy. Rainwater harvesting is an old practice adopted as an alternative adaptation in various world regions where the minimum conditions to ensure the human right to water do not yet exist (ROSADO; MORAIS, 2010). In the Brazilian semi-arid region, rainwater harvesting for water security focused on domestic consumption, implemented through the One Million Rural Cisterns Program (P1MC). This program has stood out given its methodological design, social and geographical scale, capillarity degree, complexity, and, consequently, transformation potential, with great acceptance by the rural population of the Brazilian semi-arid region and various civil society organizations (GANDURE; WALKER; BOTHA, 2013).

It comprises an integrated program of training, education, and people and institution mobilization coordinated by the Articulação do Semiárido (ASA). This program goes beyond the cistern as a technological artifact for water storage, thus triggering a movement for a sustainable coexistence with the semi-arid region. Its pillar is the strengthening of civil society in cistern constructions. According to data from the Ministry of Social Development (now the Ministry of Citizenship), 1,257,670 cisterns had been built by 2017, giving an average of 3.5 million people access to water for domestic consumption (NOGUEIRA et al., 2020).

Among the main advantages of this infrastructure are the water quality, proximity to homes (Figure 2), and low cost. However, the possibility of water contamination, given the lack of care during collection and the appearance of cracks if the cistern is not built and maintained correctly, is notable. Furthermore, it is important to recognize the possibility of the cisterns becoming unsustainable during prolonged droughts or in places where the volume of rainfall is so low that the cistern cannot be filled considering the average surface area of the roofs.

Notably, cisterns must be used exclusively for human consumption since residential cisterns are insufficient to meet other water needs during dry periods. Cisterns represent an alternative to the high cost of water trucks and the lack of quality assurance of water from other sources of supply or even water trucks (ANDRADE et al., 2015; NÓBREGA et al., 2013).

Methods

The analysis of incorporating a gender perspective in formulating and implementing the P1MC and its main impacts requires a look at the local scale, where the voice of families benefiting from the P1MC program can emerge. Thus, we present a case study anchored in a set of 50 interviews guided by a semi-structured script, conducted between July 2007 and September 2008. Among the interviewees were trainers and managers of the policy (23) and women contemplated by the policy (27). The beneficiary families of 15 of the latter interviewees also participated.

The interviewees were in four groups: i) Group 1 (G1) - Formulators and Managers External to the Program; ii) Group 2 (G2) - Formulators and Managers Internal to the Program; iii) Group 3 (G3) - Benefiting Women; and iv) Group 4 (G4) - Benefiting Families, as per Nogueira (2017).

Each identified group represented a specific system function, whether linked to its formulation and implementation or as program beneficiaries. Thus, each represented different practices and discourses, presenting the diversity and complexity necessary for the investigation. Notably, considering the specificities of practices and discourses, the use of two differentiated interview scripts appeared

as a methodological requirement. G1 comprises people or organizations close to or connected with implementing the P1MC and cisterns at the site as external actors; they may be the federal government or NGO representatives. Since they are not directly linked to the organizational structure of the ASA-P1MC, these actors relate to the program's proximity and relative distance, such as the Secretariat of Water Resources and Urban Environment (SRHU) of the Ministry of the Environment (MMA) and the National Secretariat for Food Security and Nutrition (Sesan) of the Ministry of Social Development (MDS), which was extinguished by the Law 13,844, as of 18 June 2019. Its functions were assigned to the Ministry of Citizenship, in addition to Oxfam and the Esquel Foundation.

G2 comprises individuals or organizations directly linked to ASA-P1MC. They are among the staff of partner organizations or representatives in various existing bodies as members or employees. Thus, these actors speak as ASA-P1MC, keeping an organic relationship with the program. This situation includes members of Caritas or even any of the Rural Workers' Unions involved.

The G1 and G2 interviews employed a script comprising five questions to uncover the process of formulating and implementing the P1MC, including its methodological design and more concrete results.

G3 and G4 are the target group of the policy, its direct beneficiaries. G3 comprises women, beneficiaries per the testimonies of informants located in the various groups. They are also the protagonists of this analysis, given that the P1MC was designed to be implemented through the women of the families. G4 comprises families of informants that make up G3. The interview script for G3 and G4 was based on eight questions, organized according to thematic blocks on socioeconomic profile, mode of access to water, time spent fetching water before and after the program, and changes in the quality of life of P1MC beneficiaries.

The definition of the territorial sample cut-off was based on the information collected from the first interviews conducted in Brasília and Recife with internal and external managers (G1 and G2) of the P1MC. Thus, the territorial cut-off that led to the local analysis defined the target locations of the interviews for G3 and G4 as follows: Sítios Minador and Colônia, near the municipalities of Jupi and São Bento do Una, in the rural zone of Pernambuco, and the Sítios Lagoa do Gravatá, Campinoti de Baixo, Alvinho, Torre and Cafula, in the proximities of Lagoa Seca and Massaranduba, rural area of Paraíba. After presenting the study purpose and question scripts and the subsequent obtention of informed consent by the interviewees, the interviews based on semi-structured scripts were recorded, transcribed, and analyzed via content analysis (BARDIN, 1977).

The One Million Rural Cisterns Program and the institutionalization of the gender perspective

From the interviews, it was possible to uncover the process and confirm the incorporation of the gender perspective in the program's formulation and implementation, based on a methodology to obtain infrastructure given to families headed by women.

G1 respondents were the main providers of information on the P1MC target audience and adopting a gender perspective as a pillar of the program's institutional design. From the interviewees, the program targets families living in rural areas of municipalities in the Brazilian semi-arid region with no source of nearby drinking water or with precarious existing sources. From the survey, families were selected based on the following criteria: 1) families headed by women, 2) families with children aged 0 to 6 years, 3) families with children or adolescents attending school; 4) families with adults aged 65 or over, and 5) families with physically or mentally disabled people. The criteria enable us to think about the interface between Sustainable Development Goal (SDG) 5 (Gender Equality) and SDG 6, with the additional linkage with SDG 4 (Education) of the 2030 agenda, expanding the interdependencies among the SDGs provided by this program.

According to interviewed policymakers and managers, the definition of the program's criteria for benefiting families under the P1MC considered evidence of the role of women in any development process in the semi-arid region and the "empirical reality" that water supply policies in rural areas would "naturally" benefit women, the Wallace and Coles (2005) notion about water being a gender issue in any society.

It recognizes the vulnerability of many families comprising women migrating husbands, causing them to remain in the countryside and take responsibility for the family's survival. Regionally, women in this condition are known as "drought widows" (BRANCO, 2000).

Another aspect that emerged because of the interviews in Group 1 is the perception on the part of policymakers and managers that, because women occupy a central place in household water management, they value the cistern more highly. According to the program formulators, the focus on women is also strategic to the durability of the program's effects, thus reducing the possibility of land being sold because of the value added by the improved access to water.

However, the participation of women is not specifically required in the design of the program, despite being originally in the emergence of the gender issue in the P1MC implementation strategy. However, the fact that the program's tie-breaker criterion is the selection of female-headed households, together with the requirement for the head of household to participate in community meetings

and training courses, induces a potential increase in the demand for women's participation in community affairs, strengthening the achievement of the goals of SDG 10 (Reduction of Inequalities) by 5 (Gender Equality).

Although the theme of gender inclusion has been present in the political debate since the 1990s, it was only at the VI Enconasa, in 2006, that the gender issue was formalized and materialized in concrete proposals for affirmative actions that became part of ASA's social organization methodology. The event represents a turning point in systematic gender inclusion issues in ASA and, consequently, the P1MC.

The fact that the P1MC requires the participation of the person in charge of a household in community meetings and training courses enables the methodology of social organization that guides this program to articulate social transformations based on the dialogue between the public and private spheres of families. Moreover, since the P1MC knows that the families headed by women are priority criteria for winning a cistern, this fact can be a catalyst for women's participation in community affairs. This potential catalyst can be exemplified by the emergence of women cistern builders (MORAES; ROCHA, 2013), highlighting an innovative connection with SDG 8 on decent work and economic growth.

Hence, it is possible to group actions into different categories per their respective formal properties, dynamics, and impacts on gender relations: institutional gender, autonomy-generating, and empowerment actions.

Institutional gender actions refer to creating political and administrative strategies to incorporate gender equity within the organizational structure of ASA-P1MC, acting transversally in production-reproduction and public-private domains. These institutional strategies include the creation of the Gender Commission and guaranteeing budget resources.

Autonomy-generating actions transform production-reproduction relations to meet practical needs from gender inequalities. Its impact predominantly focuses on income generation, appreciating women's productive capacity, and increased self-esteem, exemplified by the denaturalization of existing sexual divisions of labor. Thus, it affirms the relationship of the sexual division of labor with the material basis of gender inequalities and appreciates productive and commercialization actions of women in the semi-arid region.

Finally, empowerment actions regard redesigning power relations, ensuring women's participation in various decision instances to advance the decisions via collaboration. They are strategic and transformative actions, whose impact predominantly regards women's information and training access, with the underlying assumption that women's participation qualifies them, providing positive feedback for formulating programs focused on women, their children, and

families, based on their experiences. The P1MC actions with an empowerment profile correspond to gender parity in decision-making bodies and strengthening women's self-organization within such bodies. This action group strengthens the connection with SDG 10 to reduce inequalities.

However, these groupings or typologies of actions should be analyzed as a whole, especially in their interconnections and interdependencies: the articulation of the institutional gender actions with autonomy-generating and empowerment actions should be analyzed in light of how the gender perspective has been incorporated into the P1MC implementation. In general, the main thread of the P1MC policy implementation with a "gender perspective" is built from the family sphere together with husbands, daughters, and sons. Moreover, more sophisticated strategies are added to these actions by which political organization and production are closely parallel (Nogueira, 2017).

This typology of actions makes it possible to analyze their predominance, crucial for understanding the impact of the P1MC on the adaptive capacity of women and their families in the context of vulnerability to prolonged droughts as an expression of climate emergencies.

As per the IPCC (2014), vulnerability to climate change is the propensity of a system (population or territory) to suffer damage; it can be analyzed per three components: i. exposure, referring to the nature and intensity of the environmental (biophysical and climatic) or socio-political stress experienced by a system; ii. sensitivity, corresponding to the intensity with which a system can suffer damage or be affected by perturbations, being determined by the intrinsic susceptibilities of the system; and iii. adaptive capacity, referring to the ability of a system to introduce changes to accommodate environmental stresses or political changes and manage consequences in the best possible way. Thus, considering vulnerability from a gender perspective, exposing female-headed households to long periods of drought induces more sensitivity and vulnerability (IPCC, 2014), requiring gender-specific actions on coping-capacity responses.

The impact of the P1MC and gender vulnerabilities

The socioeconomic profile of the interviewed families shows the percentage of females (50.7%), those under 25 years (44.1%), and those with incomplete basic education (25.6%). The illiteracy rate among the heads of household (66.6%) and the proportion of families in miserable conditions (94.4%) was higher than the national average, as per Bolsa Família Program criteria: monthly per capita income below US$ 45.

None of the visited households had access to treated water distribution as expected, considering that this is a condition for a family to benefit from the program. Only one household lacked a cistern to capture rainwater.

Among the interviewees, 86.7% indicated that a female (housewife, daughter, and granddaughter) was responsible for fetching water for domestic use. The average time spent to fetch water from the nearest source and return home was two hours per day (Table 1).

Thus, given that those conducting such work are mostly women, gender inequalities take on even clearer features. Moreover, as the women involved in the search for water include young people and children (daughters and granddaughters), the time spent on this work takes them away from the school and the time dedicated to studies, making the connection with SDG 4 even more relevant.

Table 1. Time spent to fetch water from the nearest source.

Time	**Observations**	**Percentage (%)**
Up to 1.5 hours	7	25.9
2 hours	14	51.8
3 hours	1	3.7
Between 4 and 5 hours Total	5	18.5
Total	27	100

Source: Nogueira, 2017.

The interviews conducted with the families and women of the beneficiary household show the importance of the notion of time associated with access to water in their lives: the past-present distinction is marked by the material existence of the cistern, enabling them to have access to water. This conclusion hinges on answers provided to questions in the thematic blocks regarding access to water, time spent fetching water before and after the program, and changes in the quality of life of beneficiaries (Table 2). Notably, the existence of the cistern is a time marker in the discourse of all 27 interviewees.

Considering the cyclical temporal structure of productive activities in the semi-arid region and the conditions of production of this social space, linked to a meteorological and climatic calendar (NASUTI et al., 2013), water, for its presence and scarcity, is like a time marker and calendar, thereby organizing the daily life and memory of the population.

Hence, the metaphors used to characterize the lived and perceived time before and after the cistern reveal an association with the continuity of the relief or rest from water near the house. Meanwhile, one can recognize elements of discontinuity of this new situation or feeling, expressed as insufficient or even

non-existent water to fill the cistern. That is, the continuity of access to the water by the cistern, even if it is interrupted, reveals an appreciation of continuity over discontinuity, given that the interruption can be resumed when the cistern is filled up by water trucks from the most diverse sources. Further, although dependence on water trucks and the political power associated with this dependence continues, the population sees the arrival of the cisterns as a process of rupture relative to the prior way of life. The filling of the cistern by water trucks whose water collection does not obey any control or supervision can notably induce health problems for family members, creating additional work for women.

However, cisterns have induced a major change in the way of life of women and their families. It is an infrastructure that considerably reduces daily work, as water becomes something visible and close by, and the time spent is much less: cisterns around the house have granted women greater autonomy over their time; they no longer have to walk long distances. Moreover, the improved health of the family, especially children, was highlighted because of the access to better quality water.

Data obtained in interviews with women beneficiaries coincide with information raised by the evaluation of the Court of Audit of the Union (TCU) (BRASIL, 2007c) on the qualitative impacts of the P1MC: transformations of practical order in daily life understood as more health (49.70%), money (18.60%), and time (53.10%).

Table 2. Women's lives before and after cisterns.

Informant	**Profession**	**Before the Cistern**	**After the Cistern**
EBL	Quarry	"Hail Mary, I do not even [want] to remember".	"For me, it was a renewal."
AQ MESN	Health Agent Housewife	"We used to get water from the rest of the cattle's drink"; "I had to buy."	"The agony of water is over"; "When there's no water, the Army fills the cistern."
EFS	Agriculture	"I used to buy; I ordered a water truck from city hall; it never came; it's been two years."	"I'm very pleased; my water stays there, covered."
CAF	Housewife	"I did not attend the meetings."	"I go to all the meetings, and I intend to keep going. You learn things; you get to know the stories."
SFO	Housewife	"I was so tired of going uphill, but I was ashamed to ask for a bucket."	"It is a rest; it is my retirement."
SALT	Farmer	"We used to put water on the donkey."	"The boys have stopped having health problems more."

Source: Nogueira, 2017.

The use of rainwater made via the One Million Rural Cisterns Program (P1MC) is framed as a climate change adaptation strategy for semi-arid regions. It is an important resource for achieving water security and the Human Right to Water, associated with SDG 13.

The realization of this right is based on sustainable access to water in quantity, quality, and regularity to meet basic needs, ensuring the minimum conditions for the supply of the population (KAHINDA; TAIGBENU; BOROTO, 2010; SAITO, 2018).

Regarding the impact on daily life, the issue of access to education is recurrent in the discourse of the family beneficiaries of the program. With water closer to home, women and children can attend school more regularly, and mothers can monitor their children's studies more closely, converging with SDG 4. Thus, girls of different ages are notably the first to leave school during periods of drought (Nogueira, 2009).

The findings draw attention to the fact that the P1MC acts directly on a historical situation of greater asymmetry of the domestic work sexual division from the challenge of access to water. This challenge and need to search for water prevented many from attending school (BRASIL, 2011).

Regarding the impact of the program's implementation, its effect on changes in the social status of women should also be highlighted. By prioritizing families headed by women (SUÁREZ; TEIXEIRA, 2012), the program reaffirms the recognition of the importance of their work and knowledge regarding water management, removing them from the social invisibility in which they find themselves via new productive skill achievement (MORAES; ROCHA, 2013). It also establishes the connection between the P1MC and SDG 8.

Further, two aspects emerging from the P1MC that go beyond the planned objectives are notable: the first aspect is the possibility (from access to water) for women to have small productions, whether of animals, vegetables, or fruit. These activities allow them to enter a new cycle of integration into the formal economy (SDG 8) and social life, reducing poverty rates (SDG 1) and, consequently, gender inequalities (SDG 10, SDG 5). Regarding the second aspect, given the first, these new activities allow women to participate in the family income, changing the power relations in the domestic space (SDG 5 and SDG 10). Their partners and family view them as productive and capable based on different materials and symbolic logic (NOGUEIRA, 2013).

It is important to highlight that men and women have different patterns of access to financial sources, and these challenges are even greater in periods of drought when access to available sources becomes even more restricted (UNSRID, 2016; NOGUEIRA, 2009).

These two aspects are worth highlighting given that the Brazilian semi-arid region, despite its great environmental and human diversity, has historically evidenced the deepening of different dimensions of gender vulnerabilities from long periods of drought. Thus, access to water through small-scale water infrastructure at the doorstep of households changes a vicious (often violent) cycle in the region's history, aligning directly with SDG 10, reduction of inequalities.

The use of cisterns to collect rainwater is not new to the region. However, it has been improved to change the focus of policies and the population perception from fighting the drought to coexistence with the semi-arid region. The technology has become more complex in its use as a vehicle for social organization (NOGUEIRA, 2009). Its societal rooting was noted by Saito (2006) when analyzing its presence in the popular Cordel literature of the region.

Among the dimensions of daily life linked to gender and directly associated with vulnerability during periods of drought, the relationship between food security and water security should be highlighted, considering the number of daily meals and the amount of water available for human consumption, animal watering, and small crops as variables, justifying the interdependencies with SDG 2. Regarding cultural and eating habits, it is common for women to skip meals to ensure food for their children. This fact, noted only via careful observation of daily family life or an interview (in this study), indicates the existence of gender vulnerability that makes women more susceptible to malnutrition in adulthood, thus reinforcing the need to review the common sense that malnutrition does not exist in rural areas, as warned by Graebner (2007) in a study on the Brazilian Cerrado applicable to Caatinga.

Another dimension to consider on gender vulnerability regards health standards: the increase in the number of diseases, problems during pregnancy and postpartum, and infant mortality rates (GRIGOLETTO et al., 2014). This dimension directly highlights SDG 3.

A third gender dimension of vulnerability is the workload on women, which in normal periods is greater than that of men when considering paid and unpaid work. These differences become even greater during periods of drought when the time dedicated by men to productive agricultural and ranching activities decreases but does not generate any compensation in domestic relations. However, considering the domestic division of labor and women's responsibility to fetch water, during periods of drought, the hours dedicated by women to fetch the water necessary for the family's minimum consumption increases because the amount of water needed increases during this period, as does the distance to the nearest sources because the prior sources often lost water. Another aspect of this

dimension is the increased demand for care by the family as the number of sick people increases. This situation highlights SDG 10.

Finally, the P1MC showed the potential of the SDGs and how the gender perspective associated with the struggle for access to water highlighted the interdependence among the SDGs. Similarly, this integrated analysis reinforces the importance of water security and the human right to water, which justifies the centrality and primacy of the water issue on the international agenda, as Saito (2017) highlighted.

Final considerations

A community's vulnerability to climate emergencies, such as prolonged and worsening droughts, can be strongly impacted and positively reduced by community or government programs.

The impact of the P1MC and the presence of the cistern should be analyzed based on the material and symbolic transformations it brings. The arrival of cisterns goes beyond their existence as water infrastructure, as they represent an instrument for transforming the structures of social reproduction and should be analyzed from its dual aspect: water infrastructure that allows for decentralized access to water and a social strategy based on which issues such as rights, sexual division of labor, and women's empowerment are articulated.

Regarding cisterns, despite its benefits, it is not a sufficient condition to guarantee water access because there may not always be enough water to fill it, considering the location of the cistern, its volume, variations in the rainfall regime of the different micro-regions that make up the semi-arid region, and the number of beneficiary family members. The use of the cistern as a reservoir to store water from sources other than rainwater while disallowing a break in the power structure of the distribution of water by water trucks or even a change in the level of risk regarding the quality of the water represents gains for women. The shortcomings of this initiative should be considered against the big picture of the program's transformative potential.

A central aspect of the advent of the P1MC in the historical and political context of the region refers to the paradigm shift from combating drought to coexistence with the semi-arid region in public policy formulation and implementation, allowing for the consideration of issues related to water security and adaptive capacity to climate emergencies, in addition to circumscribing public policies to comply with the SDGs. Regarding the SDGs, this study has shown how the P1MC can articulate different SDGs synergistically to simultaneously achieve their objectives and targets. Thus, P1MC is vital to achieving the articulated goals and targets of SDG 1, 2, 3, 4, 5, 6, 8, 10, and 13. Domestically, among the

material and symbolic contributions from cisterns and their consequent impact on women's lives, time-saving stands out: time gain is progressive for women conducting activities, granting them greater autonomy over time management, with repercussions on issues such as food, household economy, health, and education. These situations confirm the importance of P1MC to reinforce the interdependencies among the SDGs.

The experience of the P1MC shows that public policies to reduce family vulnerability in the Brazilian North-East semi-arid must incorporate the gender perspective, recognizing its central role in the family organization and development of adaptive capacities.

Given that the results are based on interviews conducted in communities located in only two municipalities in Paraíba and Pernambuco, they are not readily generalizable and cannot be considered to portray the program implementation in these states or the P1MC as a whole. However, this study could indicate elements of analysis that can be considered in the program evaluation, especially linking it to the more recent context of the SDGs.

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References

ANDRADE, J. A. de; NUNES, M. A. Acesso à água no Semiárido Brasileiro: uma análise das políticas públicas implementadas na região. **Revista Espinhaço**, v. 3, n. 2, p. 28-39, 2014.

ANDRADE, T. N. et al. Estratégias de adaptação e gestão do risco: o caso das cisternas no semiárido brasileiro. **Climacom Cultura Científica – Pesquisa, Jornalismo e Arte**, a. 2, v. 2, 2015.

ARTICULAÇÃO NO SEMIÁRIDO BRASILEIRO – ASA. Disponível em: <http://www.asabrasil.org.br/portal/Default.asp>. Acesso em: 20 jul. 2017.

ASSIS, T. R. DE P. Sociedade civil e a construção de políticas públicas na região semiárida brasileira: o caso do Programa Um Milhão de Cisternas Rurais (P1MC). **Revista de Políticas Públicas**, v. 16, n. 1, p. 179-189, jan./jun. 2012.

BARDIN, L. **L'analyse de contenu**. Paris: Presses Universitaires de France-PUF, 1997.

BISILLIAT, J.; VERSCHUUR, C. LE GENRE: UN OUTIL NÉCESSAIRE – INTRODUCTION À UNE PROBLÉMATIQUE. **Cahiers Genre et Développement.** L`Harmattan, 2000.

BLAIKIE, P. ET AL. **At Risk: natural hazards, people's vulnerability and disasters**. 2. ed. London: Routledge, 2014.

BRANCO, A. **Struggle and Visibility in Face of a Disaster Situation.** João Pessoa: Editora Universitária, 2000.

BRASIL. AGÊNCIA NACIONAL DE ÁGUAS. **Conjuntura dos Recursos Hídricos no Brasil.** Brasília: ANA, 2013.

BRASIL. INSTITUTO DE ECONOMIA APLICADA. **Retratos das Desigualdades de Gênero e Raça**. Brasília, 2011.

BRASIL. Ministério do Desenvolvimento Social e Combate à Fome. **Metodologias e instrumentos de avaliação de programas do MDS**: Bolsa Família, Assistência Social, Segurança Alimentar e Nutricional. Rômulo Paes Sousa (Org.); Jeni Vaitsman (Org.). Brasília: MDS/SAGI, 2007.

BRASIL. Tribunal de Contas da União. **"Avaliação do Tribunal de Contas da União da Ação Construção de Cisternas para Armazenamento de Água"**, 2007c.

BRASIL. Ministério da Integração Nacional. **Nova delimitação do Semiárido**. Brasília: MI/SDR, 2005.

CARDOSO, G. **A Atuação do Estado no Desenvolvimento Recente do Nordeste.** João Pessoa: Editora Universitária, 2007.

GANDURE, S.; WALKER, S.; BOTHA, J. J. Farmers' perceptions of adaptation to climate change and water stress in a South African rural community. **Environmental Development**, v. 5, p. 39-53, 2013.

GNADLINGER, J. How can rainwater harvesting contribute to living with droughts and climate change in semi-arid Brazil? **Waterlines**, v. 33, n. 2, p. 146-153, 2014.

GOMES, U. A. F.; HELLER, L. Acesso à água proporcionado pelo Programa de Formação e Mobilização Social para Convivência com o Semiárido: um milhão de cisternas rurais – combate à seca ou ruptura da vulnerabilidade? **Engenharia Sanitária e Ambiental**, v. 21, n. 3, p. 623-633, 2016.

GRAEBNER, Ivete Teresinha. **Níveis plasmáticos de vitamina A, ações pedagógicas e segurança alimentar: estudo em escolares rurais do Distrito Federal.** Tese (Doutorado em Ciências da Saúde). Brasilia, Universidade de Brasília, Faculdade de Ciências da Saúde, 2007

GRIGOLETTO, J. et al. Gestão das ações do setor saúde em situações de seca e estiagem. **Ciência & Saúde Coletiva**, v. 2, n. 3, p. 709-718, 2016.

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE – IPCC. **Climate Change 2014:** impacts, adaptation, and vulnerability. Summaries, Frequently Asked Questions, and Cross-Chapter Boxes. A Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Ed. FIELD, C. B. et al. Geneva, Switzerland: World Meteorological Organization, 2014. Disponível em: <http://www.ipcc.ch/report/ar5/wg2/docs/WGIIAR5-IntegrationBrochure_FINAL.pdf>. Acesso em: 18 jun. 2017.

KAHINDA, J. M.; TAIGBENU, A. E.; BOROTO, R. J. Domestic rainwater harvesting as an adaptation measure to climate change in South Africa. **Physics and Chemistry of the Earth, Parts A/B/C**, v. 35, n. 13, p. 742-751,

MORAES, A.F.J.; Rocha, C. 2013. Gendered waters: the participation of women in the 'One Million Cisterns' rainwater harvesting program in the Brazilian Semi-Arid region. **Journal of Cleaner Production** 60, 163-169, 2010.

NASUTI, S.; ROCHA, J.D.; VIANA, C.; SAITO, C.H.; SOUZA, C.R.; CHACON S.S. Estudos de caso – Semiárido. In: BURSZTYN, M.; RODRIGUES-FILHO, S. **O Clima em Transe**: vulnerabilidade da agricultura familiar. Rio de Janeiro, Garamond, pp. 115-137, 2016.

NASUTI, S.; CURI, M.V.; SILVA, N.M.; ANDRADE, A.J.P.; IBIAPINA, I.; SOUZA, C.R.; SAITO, C.H. Conhecimento Tradicional e Previsões Meteorológicas: Agricultores Familiares e As "Experiências de Inverno" no Semiárido Potiguar. **Rev. Econ. NE**, Fortaleza, v. 44, n. especial, p. 383-402, 2013.

NELSON, D.R.; FINAN, T.JPraying for drought: persistent vulnerability and the politics of patronage in Ceará, Northeast Brazil. **American Anthropologist**, vol.111, n.3, p302-316. . 2009.

NIMER, E. Desertificação: realidade ou mito? **Revista Brasileira de Geografia**, v. 50, n. 1, p. 7-39, 1988.

NÓBREGA, R. L. B. et al. Água de chuva para uso doméstico. In: GALVÃO, C. O. et al. **Recursos hídricos para a convivência com o semiárido:** abordagens sobre o semiárido por pesquisadores no Brasil, Portugal, Cabo Verde, Estados Unidos e Argentina. Porto Alegre: ABRH; Recife: Editora Universitária UFPE, p. 377-394, 2013.

NOGUEIRA, D. et al. Do Programa Um Milhão de Cisternas ao Água para Todos: divergências políticas e bricolagem institucional na promoção do acesso à água no Semiárido Brasileiro. ***IdeAs*** [Online], 15, 2020, posto online no dia 01 março 2020, consultado o 23 março 2020. URL:http://journals.openedition.org/ideas/7219; DOI:https://doi.org/10.4000/ideas.7219.

NOGUEIRA, D. Segurança hídrica, adaptação e gênero: o caso das cisternas para captação de água de chuva no semiárido brasileiro. **Sustentabilidade em Debate**, 8, (3):22-36, 2017.

NOGUEIRA, D. Femmes et eau dans le Sertão. Le Programme Un Million de Citernes. Le Nordest de Lula. **Cahiers des Amériques Latines**, v. 63-64, p. 63-79, 2013.

NOGUEIRA, D. **Gênero e Água – Desenhos do Norte, Alternativas do Sul**: **análise da experiência do semiárido brasileiro na construção do desenvolvimento democrático.** Tese de Doutorado. Universidade de Brasília. Instituto de Ciências Sociais, Departamento de Sociologia. Brasília, 2009.

OLIVEIRA, L.B. Uso e manejo da água na região semiárido do nordeste do Brasil. **Anais da Academia Pernambucana de Ciência Agronômica,** Recife, vols. 11/12, p.50-64. 2014/2015.

PONTES, E. T. A Estreita Relação entre Mulher e Água no Semiárido: o caso do programa um milhão de cisternas rurais. **Revista Latino-Americana de Geografia e Gênero**, v. 4, n. 1, p. 14-21, 2012.

REBOUÇAS, A.C.Água e desenvolvimento rural. **Estudos Avançados**, 15(43), 327-344, 2001

REBOUÇAS, A.C. Água Doce no Mundo e no Brasil. In: REBOUÇAS, A. C., BRAGA Jr., B. P. F., & TUNDISI, J. G. Águas doces no Brasil: capital ecológico, uso e conservação. São Paulo: Escrituras. pp. 1-35, 2006

ROSADO, J., and MORAIS, M. M. Estratégias de Gestão da Água em Situação de Escassez: Regiões Semiáridas e Mediterrânicas. **Sustentabilidade em Debate** 1(2):31-46, 2010.

SAITO, C. H. Segurança hídrica e direito humano à água. In: Aloisio Ruscheinsky; Cleide Calgaro; Thadeu Weber. (Org.). Ética, direito socioambiental e democracia. 1ed.Caxias do Sul: Educs, pp. 94-108, 2018.

SAITO, C. H. Quais seriam as Questões Globais que desafiam a Educação Ambiental? Para além do modismo, uma análise sistemática e uma visão sistêmica. **Revista Eletrônica do Mestrado em Educação Ambiental**, v. Especial: 4-24. https://doi.org/10.14295/remea.v0i0.7138, 2017.

SAITO, C. H. (Eds.). **Educação Ambiental PROBIO: livro do professor**. Brasília-DF: Departamento de Ecologia da Universidade de Brasília. 136p, 2006 .

SCOTT, R. P. Ruralidade e mulheres responsáveis por domicílios no Norte e no Nordeste. **Revista Estudos Feministas**, v. 15, n. 2, Florianópolis, Mai/Ago, p. 425-436, 2007.

SILVA, D. **Combate à desertificação e a COP dos Pobres**. Terceiro incluído, NUPEAT–IESA–UFG, v. 4, n. 1, Jan./Jun., p. 1-23, 2014.

SILVA, R. **Entre o Combate à Seca e a Convivência com o Semiárido:** transições paradigmáticas e sustentabilidade do desenvolvimento. Fortaleza: Banco do Nordeste, 2008.

STILES, D. Desertification is not a myth. **Desertification Control Bulletin**, n. 26, p. 29-36, 1995.

SUÁREZ, M.; TEIXEIRA, M. O Programa Bolsa Família e o enfrentamento das desigualdades de gênero: o desafio de promover o reordenamento do espaço doméstico e o acesso das mulheres ao espaço público. **Cadernos de Estudos – Desenvolvimento Social em Debate**. Brasília: AGENDE/NEPEM, 2012.

UNITED NATIONS RESEARCH INSTITUTE FOR SOCIAL DEVELOPMENT - UNRISD. **The Gender Dimensions of Drought in Fedis Woreda District, Etiopia.** Working Paper. Genebra: UNRISD, 2016.

UN-WATER (The United Nations Inter-Agency mechanism on all freshwater related issues, including sanitation). **Water security**, **2013**. Disponível em: <http://www.circleofblue.org/2013/world/un-agency-proposes-a--common-definition-for-water-security/>. Acesso em: 25 set. 2016.

VEIGA, L.B.E.; Magrini, A. The Brazilian Water Resources Management Policy: fitted years of success and challenges. **Water Resources Management**, 27(7): 2287-2302, 2013, https://doi.org/10.1007/s11269-013-0288-1.

WALLACE, T., COLES, A.. Water, gender and development: an introduction. In: COLES, A.; WALLACE, T. (Eds.), **Gender, Water and Development**. Berg Publishers, Oxford, UK. 2005.

CHAPTER 8

Challenges of constructing and implementing the Agroecology and Organic Production Policy in the State of Sergipe

Flaviane Canavesi, Edson Diogo Tavares, Mário Lúcio Ávila

The agroecological movement in Sergipe, organized as a multi-institutional network such as the Sergipean Agroecology Network (RESEA), promotes transition in agriculture, thereby discussing, systematizing, and applying principles and practices of living with the semi-arid.

Farmers experience recognition or agroecological transition based on inclusion and social justice with sustainable management of nature, especially soil, water, and agrobiodiversity. Examples of socio-technical networks can be observed in the experience of Embrapa Tabuleiros Costeiros, Emdagro (Sergipe Agricultural Development Company), and the Articulation of the Brazilian Semi-arid (ASA) in the semi-arid region of Sergipe in Alto Sertão, with agroecology as a paradigm in the development of techniques, management, and coexistence with the semi-arid region (OLIVEIRA et al., 2017).

Thus, to expand in production scale, commercialization, and political articulation to strengthen the agroecological transition processes, it was necessary to build a political agenda such as that created by the State Policy of Agroecology and Organic Production (PEAPO) in 2011.

Thus, this chapter presents the agroecology policy agenda that has formed at the subnational level in the state of Sergipe, presenting historical-political context, coalitions, and dynamics of public action in the institutionalization of the State Policy of Agroecology and Organic Production (PEAPO) and the unfolding of this policy in the State Plan for Agroecology and Organic Production (PLEAPO).

Hence, public action is characterized by a gradual, ascending process of achievements in the legal framework, though originating from the civil society coordinated by the Sergipan Agroecology Network between 2011 and 2021. The analyses capture the representation and understanding of public policy

instruments, given that the instruments are not neutral and reveal historical singularities in the structuring relations between rulers and the ruled (Lascoumes & Le Galès, 2012).

The study gathers the main observations of the process of articulation and social mobilization around the agroecology agenda in the state, portraying the prospects in the current context, considering the effectiveness of the execution of PEAPO in the face of retractions in federal public policies in the most recent period of executing the agenda.

This study employs a bibliographic and documentary survey and conducts 10 semi-structured interviews with key informants in November 2018 in the Aracaju and São Cristóvão municipalities. The interviews were conducted per the Terms of Free and Informed Consent (TCLE). The script was applied within collective groups, social movements, socio-technical networks, councils, research and educational institutions, and government bodies, covering many perceptions and the history of action in implementing the State Policy on Agroecology and Organic Production.

Some data were updated in January 2021 in semi-structured interviews with key informants to analyze the policy developments after the installation of the management council and the prioritization of actions in an executable Plan. An earlier version of this study was published in GUÉNEAU et al. (2019) and SABOURIN et al. (2019).

We structured the chapter focusing on the procedures through which the legal framework, the agroecology policy agenda, and the networks and public action were formulated. It was possible to perceive the protagonism of the organizations articulated in a network, RESEA, in the negotiations and elaboration of public policies for agroecology and organic production and the challenges continually posed in the formation of the public policy agenda, still under construction of actions.

The political agenda of Agroecology in Sergipe and recent developments

The PEAPO emerged in Sergipe regarding the national level and Decree No. 7,794 of 20 August 2012, which established the National Policy on Agroecology and Organic Production (PNAPO). The effervescence of discussions in the country, led by social movements, had representations from Sergipe. This articulation puts agroecology on the agenda of the State and, consequently, furnishes the bases for the elaboration process of the State Law Project presented by the then state representative João Daniel, which became Law 7.270/11, sanctioned by the

then governor Marcelo Déda even before the PNAPO was promulgated at the federal level.

The discussion in social movements about a national policy regarded forwarding a bill at the subnational level in Sergipe and other experiences, such as the experience of the state of Paraná.

It took seven years for the law to be regulated; the experience with the Paraná Decree and discussions around the Law of native seeds (Law No. 8.167 of 12/01/2016) in Sergipe feed propositions and social movements in Sergipe to build an agroecological perspective from practices slowly being institutionalized in a continuous set of actions.

Therefore, an inter-relationship exists between State and society in constructing policies to promote agroecology, whose scenario demarcates the accumulation of actions undertaken by social movements, such as state meetings, caravans, discussion, and presentation of bills such as that on native seeds. The favorable scenario experienced by family farming via public policies, established and strengthened by the federal government between 2003 and 2015, contributed to the accumulation.

Thus, to reinforce the argument that the building process of the PEAPO-SE was mirrored in the national building process of the PNAPO, the mobilizing action organized mainly by the movements that make up the National Articulation and Agroecology (ANA) is considered relevant. It demanded the creative process of the III National Meeting of Agroecology (III ENA) held in Juazeiro, Bahia, in 2014.

Farmers have become more visible given the systematization of experiences, and the Agroecological Caravans strengthen the group before this meeting.

The National Agroecology Meetings are considered catalysts of the movement; methodologically, it is not limited to the days it takes place but generates a mobilizing dynamic relevant to the training of actors.

From a legal perspective, the PEAPO was only regulated in 2018, which justified constant mobilizations. An explanation for this lethargy may stem from the territorial influence of national public actions. To date, there has been no evaluation of the national policy; however, the weakening of the national policy has created reactions in the subnational spheres and rekindled the need for state policies.

The PEAPO seems to be more a response to the crisis than concrete motivation expressions to support an agroecological transition. This argument is supported by the fact that there were no significant resources for concrete actions in the 2018 Annual Budget Law (LOA), nor were agreements signed to guarantee programs for the 2019 budget.

In 2020, the theme appeared in Law 8.645 of 8 January 2020, with some goals and actions in the Pluriannual Plan of the State Government (PPA 2020-2023) that reinforce the implementation of initiatives connected with PEAPO and its instruments. Though still timid, the 2020 budget secured R$150,000 for the Support for Organic and Agroecological Agriculture project to serve 60 families in international partnership projects such as Dom Távora, which serves 12,000 families and considers the agroecological approach as a benchmark.

The financial and human resources allocated to technical assistance and rural extension in the state cannot guarantee satisfactory coverage. Of the more than 90 thousand existing agricultural and livestock establishments, 97% are family farms, but only 27% were served by official Technical Assistance and Rural Extension (ATER). In the PPA 2020-2023, the goal of technical assistance is to serve 50 farmers (in the Central Agreste and South-Central territories) for the concession of agroecological or organic production certificates.

Beyond the initiatives, organizational articulation culminated in the choice of Sergipe to host the Brazilian Congress of Agroecology (CBA) in 2019. Parliamentary amendments from the action of parliamentarians and advisors engaged with PEAPO were mobilized and exhausted to enable the main Brazilian Congress in the area, which also relied on other sources of funds.

Thus, the XI Brazilian Congress of Agroecology was held in November 2019 in Sergipe by the Brazilian Association of Agroecology (ABA) and had the local partnership of the Sergipan Agroecology Network. Accordingly, since the end of 2017, various activities have been carried out by RESEA, to mobilize potential organizations, institutions, agroecology clusters, collectives, and individuals in Sergipe and the Northeast Region to participate in the organization of this great event.

The decision to have a popular congress in a public space (on the campus of a public university), involving art, science, culture, and food, demanded meticulous planning and articulating various organizations and collectives strengthened in this process.

Meetings and seminars were held, and a decision effectively mobilized the agroecological family farmers of Sergipe; the food served during the four days of the Congress was produced by the same farmers (16,000 meals were provided: breakfast, lunch, and dinner). Thus, it was necessary to match what would be possible to produce with the demand for a varied menu and at the same time typical of a northeastern state.

More than 30 innovations were shared in the Terreiro de Inovações Camponesas, an environment for expressing popular knowledge central to the construction of agroecology, including technologies for coping with drought and

the processing of agricultural products by farmers from almost all states of the Brazilian semi-arid region.

During the XI CBA, popular and scientific knowledge dialogued horizontally to advance the democratization of agrifood systems (TAVARES; DALMORA; GONÇALVES, 2020).

The Sergipean Agroecology Network was challenged and strengthened by congress.

Despite a strong articulation of RESEA, the State Commission for Agroecology and Organic Production (CEAPO), created on December 19, 2018, by Ordinance 147/2018 of the Secretary of State for Agriculture, Agrarian Development, and Fisheries, is structured but without forceful continuity to the mission of legitimizing a State Plan (PLEAPO) and linkage to the intersectional resources in the Sergipan state.

The challenges that followed, with the COVID-19 pandemic affecting everyone, remain. Before this period, social movements made several demands in forums and events. Consultation workshops established an innovation plan that was ignored; however, this action enabled the expansion of the public that was being articulated, such as quilombolas, women, and shellfish gatherers.

In the period preceding the regulation, the Sergipe State Government's Law No. 8,167 of 1/12/2016 was sanctioned, establishing the concept of native seeds and encouraging agrobiodiversity conservation. Farmers baptized creole seeds in Sergipe as "Seeds of Freedom," a baptism that occurred during the II State Meeting on Agroecology in the municipality of Estância in December 2015. Between the sanction of the Agroecology Law in 2011 and its regulation in 2018, there were important actions around seeds creole seeds. A State Seminar on Legislation of Creole Seeds was held in 2015 with an exchange of experiences at more advanced stages in the Northeast, such as the Alternative Agriculture Project Services Advisory (AS-PTA) in Paraíba and the Cooperative of Smallholder Agricultural Producers of Community Seed Banks (COPPABACS) in Alagoas. A process then began that culminated in Law No. 8,167 of 1/12/2016, which institutes the concept of native seeds and the incentive to conserve agrobiodiversity in the state of Sergipe.

Agroecological caravans began in 2014, prior to the III ENA, and have been held periodically. These meetings have served to give visibility to agroecology and motivate farmers to continue with their practices, always working to create a government agenda.

The actors: a public action network

This study considers the main network that articulates the promotion of agroecology among social movements, non-governmental organizations, other networks on different scales, associations, cooperatives, and federations in the field of civil society, teaching, research, and extension institutions and executors of certain actions or sectors of the state.

It is important to consider that the Sergipe Agroecology Network stems from the history of the agroecological movement in Sergipe and experiences not previously articulated. A constant methodological process affirms, strengthens, and maintains this network.

RESEA was created in 2006 to strengthen the agroecological dynamics in Sergipe through the participatory construction of knowledge. It articulates 35 municipalities and is organized in working groups, plenary meetings, and an operational nucleus.

As one interviewee explained, "RESEA is a great convergence and construction of affinities, and those who thought they could have a more solid result are interacting in there."

RESEA emerged from the 1st State Meeting on Agroecology of Sergipe (EEA/SE), which took place on May 19 and 20, 2006, and became a field of articulation in public action in favor of agroecology.

Its official account (facebook.com/redesergipanadeagroecologia) notes that RESEA aims to stimulate the protagonism of the peasants of Sergipe, foment a space for the exchange of agroecological knowledge, give visibility to the traditional peoples of the state, intensify and strengthen the agroecological debate, list the challenges of the peasantry in the state, foment a space for discussion and proposition of solutions to the challenges of the peasantry, stimulate the debate on gender and youth in the countryside, draw a panorama of the state's citizenship territories, and strengthen the Network.

A form of communication and employed methodology strengthens it as a network for negotiation with the State via practice mapping, recognition, and systematization (JARA, 1998). The bottom-up process allows for capillarity in the agendas discussed while the experiences subsidize the priority action fronts. The Network maintains this continuous communication and systematization, moving toward the construction of exchanges of experiences, agroecological caravans, and implementing the Farmer to Farmer (CaC) methodology, as per Holt-Giménez (2008), studied in Sergipe by Fontes et al. (2013), Rabanal (2015), and Siqueira et al. (2014).

The following statement reinforces this role:

> Having popular education as its guiding basis, the Network has discussed methodology and actions that strengthen participation. Among the principles that give movement to RESEA, we highlight those of horizon, collective construction, respect for peasant culture, and knowledge that synthesize the vision of its pedagogical responsibility in constructing the processes. (DE OLIVEIRA, 2017, p. 2)

Thus, one public action that strengthened the mobilization processes concerns the performance of networks of technicians in interaction with peasants that resulted in greater involvement in networking.

> In 2013, when the principles and activities of the Peasant-to-Peasant Network were incorporated into the Social and Environmental Technical Assistance services in the areas of Agrarian Reform (ATES), significant logistical and professional support was provided, which led to advances in the formation of the Network. The aim was to strengthen the identification, systematization, and exchange of experiences, in addition to the possibility of printing primers and building a Continuing Agroecology Training Program (PFA). (RABANAL, 2015 p. 68)

From the interviews, the effective participation of RESEA representatives in national discussion spaces was mentioned, mainly with the influence of ABA and ANA. Regarding the participation of the organicity of women's movements in RESEA, experiences were articulated, as is the case of the Peasant Women's Movement (MMC) from the Baixo São Francisco territory, the Association of Women Rescuing their History from the municipality of Porto da Folha in the territory of Alto Sertão Sergipano, gender collectives from the Landless Rural Workers Movement and Small Farmers Movement, Rural Women Workers Movement (MMTR) of the Southern Sergipe territory, and systematization of women's knowledge.

Youth participation is achieved via the integration of the diffuse actions of each movement and the participation of the only agricultural family school in the state, the Associação Mantenedora da Escola Família Agrícola de Ladeirinhas (AMEFAL), and a cultural group, the Associação Cultural Raízes Nordestinas (ACRANE). Young people are also present with the participation of undergraduate students from the Agroecology Centers of UFS and IFS.

Processes and instruments: the articulations of the network

The agroecology network is articulated from the experiences of various actors and gathered social movements, farmers, and researchers in July 2016 to reflect on the strengthening of family farming in its identity and agroecological diversity in Sergipe for the construction of the State Plan for Peasant Agriculture and Agroecology. It was the main force articulated in favor of agroecology as public policy in the state.

A relationship exists between the state agroecological and national movements and regional movements, as is the case of the relationship with the states of Paraíba (mainly the Polo of Borborema and Alagoas and the Network of Agroecology Central of the Northeast [RENDA], based in Pernambuco). Moreover, there are reflections of practical experiences on the process of building the PEAPO, showing that the set of strategies of articulation of different scales has an importance that falls on the articulated action such that the need for an agroecology agenda guides the states.

Thus, RESEA, beyond articulating diverse actors, also articulates scales ranging from local, regional, to national processes.

For territorial articulation, as a mobilization methodology, Agroecological Caravans were held throughout 2014 and 2015 in the Sergipan territories, and the 2014 Caravan was a preparatory process for the III ENA (DE OLIVEIRA, 2017). It was a strategy to promote interaction, fostering learning moments and the protagonism of rural people in the production of healthy food. The peasant experiences are recorded to reflect on the realities, challenges, and potentialities of each place visited. Spaces are created to diagnose reality and construct agroecological knowledge based on peasant knowledge.

This process brings together actors to elaborate the I State Plan for Agroecology and Organic Production (PLEAPO), an instrument from the regulation of the PEAPO, which is being elaborated by the civil society of Sergipe, involved in the agroecology discussions to develop specific policies under the institutional coordination of the Secretary of State for Agriculture, Agrarian Development, and Fisheries.

After the decree that regulated the PEAPO, the PLEAPO was constructed. Starting in 2018, 28 organizations representing civil society participated in the elaboration. The Plan materializes in instruments and measures (credit, technical assistance, promotion, monitoring, and research) the ideas and proposals in the policy. It is the executive document of the policy for the period (generally four years).

Some state institutions were also present. However, there is a strong presence of technicians, researchers, extensionists, and teachers involved with the dynamics of the agroecological movement in Sergipe, whose commitment and protagonism of participation grants them a prospection of demands beyond an institutional representation that should serve for professional performance and institutional guidance in the environments in which they operate. In this category, we can consider the Federal University of Sergipe (UFS), the Sergipe Agricultural Development Company (Emdagro), the Brazilian Agricultural Research Company (Embrapa Tabuleiros Costeiros), and the Federal Institute of Sergipe (IFS).

Currently, PLEAPO actions have gained priority, as indicated in the 2019 document "emerging and priority."

At the national level, the subnational level also brings together and articulates various policies to promote agroecology in an agenda for discussing I PLEAPO. Notably, each network, movement, or experience in RESEA contributes to executing various I PLANAPO policies.

Articulation of the Brazilian Semiarid (ASA) has a history of elaborating, implementing, and monitoring public policies, such as the One Million Cisterns Program of the former Ministry of Social Development. It was involved in the training and social mobilization program for living with the Semi-Arid: Management of Agrobiodiversity, Semi-Arid Seeds. Some areas implement a unit to recover degraded areas developed with international cooperation.

However, since 2016, there has been a deconstruction of federal policies to support family farming (MATTOS, 2017; SABOURIN et al., 2019) and the emergence of subnational actions in states and municipalities that seek to maintain, replace, or complement initiatives.

In Sergipe, in the 2019 elections, RESEA conducted an activity with candidates for municipal elections to commit them to actions in support of agroecology. This action was carried out in partnership with the National Agroecology Coordination and obtained the commitment of 26 candidates, as per information on the RESEA page.

A survey was also conducted in the municipalities to survey local public policy initiatives. In the survey, nine different types of instruments were found in 16 of 75 municipalities (LONDRES, 2021).

In the area of marketing, the support for municipal fairs is noteworthy. The interviewees identified an advance about institutional market policies, but a previously mentioned observation regards the low access of RESEA's participating groups to PAA and PNAE. The low number of farmers registered as organic products with the Ministry of Agriculture, Livestock, and Supply (MAPA) was also noted. This evidence, provided by RESEA members, led to the questioning of

the proper insertion of its farmer base in existing public policies. None of the 16 entities participating in RESEA in 2017 accessed PAA and PNAE, and only two had organic registration. This fact demonstrates the contradiction of the effective mobilization of actors to construct a state policy not expressed in the access to the public policies that make up the I PLANAPO.

As an emergency measure, in 2020, to find a way out of the market for family farming production, specific instruments for institutional purchases were created, limiting state action to an instrument that would respond to the crisis imposed by the COVID-19 pandemic.

The finalization of the Technical, Social, and Environmental Assistance Program (ATES) in 2016 had a strong impact, as per the interviews, bringing innovation via the Peasant-to-Peasant methodology.

An important moment of Resea's interface with public policies was preparing the project for the Public Selection Notice no. 2017/030 - ECOFORTE Networks. The project entitled "Strengthening the Sergipe Network of Agroecology" was not approved. However, according to its creators, it was an experience of much articulation, strengthening the network.

The main movements proposed an integration of actions based on what was already happening at the grassroots level. Thus, the experiences of agroecological rice, the systematization of Embrapa/NEVA experiences, the experience of the Peasant Production Unit (UPC) of the MPA, the MCP with the seed banks, and the networks for the exchange of experiences in the Peasant-to-Peasant methodology were integrated.

The project proposed actions for the following: Network of Guardians of the Seeds of Freedom, processing and marketing creole couscous flour and its derivatives, exchange and systematizing agroecological experiences, processing and marketing agroecological rice and its derivatives, potentializing productive arrangements in the Ladeirinhas Family Agricultural School; minimum processing units of agricultural production, strengthening solidarity marketing networks; developing actions for living with the semi-arid; dissemination of social technologies, Sergipe Agroecological and Cultural Caravan, and the Sergipan Cultural Fair.

The main themes brought up in the PLEAPO discussion thus far identified relate to the following: agroecological production; solidarity transport; commercializing agroecological products; broad supply of inputs and processing; food, genetic, water, energy, and territorial sovereignty; agroecological transition of rice farming in the Baixo São Francisco territory; use and conservation of biodiversity; valorization of socio-biodiversity, especially of mangaba, umbu, and murici;

strengthening agroecological backyards; social technology for peasant farming; and implementation of a Participatory Guarantee System (SPG).

Mobilizations and ideas around a coalition

The agroecological movement in Sergipe, articulated in RESEA, has as its coalition identity in the opposition to agriculture from the modernization of the Brazilian countryside that today constitutes an almost hegemonic political actor in agro, agribusiness. According to Mendonça (2013), the notion of what we now call agribusiness has organized and instrumentalized a powerful commercial and financial complex that gives it financial and, above all, political importance.

In counter-hegemony, RESEA proposes a process of agroecological transition that distances rural development from frameworks of the hegemonic pattern of agriculture, which, for example, affects the production of criollo corn in the state. According to the data from the interviews with movements and the Federal Institute that monitor seeds, criollo corn seeds are contaminated, given the growing cultivation of transgenic seeds in the state.

This problem is demonstrated by a participatory study on the custodians of native seeds in Sergipe. Dalmora et al. (2018) show the importance of the diagnosis of traditional farmers that preserve native seeds free from adversity such as genetic erosion from agribusiness and note that the advance of this problem in Alto Sertão directly interferes with the agrobiodiversity loss.

The problem of native seed contamination demonstrates how the concept of agroecology involves, considerably, a denunciation of an agricultural model that limits the expansion of experiences and agroecological ideas and risks reproduction strategies, given the genetic erosion identified. Thus, agroecological and how it suffers a limitation by the expression of agribusiness should ideas be understood in public action in Sergipe, which makes the collective subjects stronger in their denunciation and counter-hegemonic action. Therefore, a public reaction to the State's promotion of agribusiness exists when public action in favor of agroecology is built.

The I PLEAPO, debated in 2018 and 2019, works in a coalition between civil society and sectors of the State that promote agroecology and organic production. Thus, it connects different conceptions with common interests and defends a broad vision of the concept of agroecology, considering the environmental, economic, cultural, social, and political dimensions. It considers urban and peri-urban actions and rural ones, with popular participation. It establishes intersectoral fronts between health, education, environment, food, and nutritional security in strategies to create agroecological territories. Although a concept of agroecology can bring together different dimensions, the PEAPO enacted in 2018

does not demonstrate such a tendency; it is restricted. It approaches the concept of organic agriculture operated by the Organic Law, Law No. 10.831 of 23rd December 2003, regulated by Decree No. 6.323/07 that, under the coordination of the Ministry of Agriculture, Livestock, and Supply of the federal government, keeps the national register of organic producers whose certification is given by the attendance of normative instructions.

According to Law 7.270/2011, which institutes the PEAPO in Sergipe, "agroecological production system is considered the proposal of agriculture that is socially just, economically viable, ecologically sustainable and [and] includes forms of organic production, biodynamic, or other styles of ecological basis." Decree 40.051/2018, in its Art. II, considers an Agroecological Production System to be that which seeks to optimize integration between productive capacity, use, and conservation of biodiversity and other natural resources, ecological balance, economic efficiency, and social justice, covered (or not) by the control mechanisms addressed in the Organic Law and its regulations.

The state policy is closer to the PNAPO when it seeks an approach to the theme of organics to gain support and extended legitimacy. Similarly, it avoids confronting historical problems, such as access to land and water and confrontations with pesticides. This strategy was adopted in other states of the federation to reduce resistance in the legislative sphere. The design of the Plan that emerged later retrieves a broader concept of agroecology than that mobilized in the Policy. The perception about the importance of agroecology can be more technicist or socio-technical per the proximity of the processes that occur from RESEA.

> [Agroecology] is an important aspect of an agricultural production mode; it is a significant demand from society. [Thus,] it is our duty as an institution to provide resources and strategic direction to it [and] meet other demands of so-called conventional models. (Interviewee 4, interview held in November 2018)

One interviewee also emphasized that it is necessary to take action

> . . . seeking input reduction, producer independence, self-sufficiency, [and] maximizing […] self-sufficiency... In terms of managerial vision, it is necessary to go beyond the exchange of experiences, seeking a more solid performance in […] generating agroecological technologies for reality. [Beyond] raising awareness or seeking to disseminate existing […] rescuing knowledge, it is also necessary to generate knowledge adapted to local conditions. It is necessary to generate assets. (Interviewee 4, interview conducted in November 2018).

Despite the recognition by the research institution, the form of movement of agroecology as a "significant demand of society," understood as the movements for agroecology, undertake various actions in the state.

There is also a tendency to treat agroecology only as technology, "a mode of agricultural production," which differs from what has been treated by PLEAPO in a broader context and is closer to the definition of the Law. For researchers involved more directly with actions toward agroecology, there is a broader notion of what can be understood by agroecology, in which greater importance is given to the concept of territory and the distinct dynamics that occur in it:

> There is no need for a concept [of agroecology]; building the concept marks the end for us because reality covers more than we cover in the concept. The concept of agroecology is always under construction; it will never stop being under construction. (Interviewee 3, interview conducted in November 2018)

Demarcating a methodological performance of collective construction of knowledge in Sergipe, the exchange movements start from what farmers participating in the Peasant-to-Peasant Movement conceptualize, conducted from 2013 to 2016 on agroecology. According to Rabanal (2015), when defining the concept of agroecology, the concept collectively constructed in the 1st Exchange of Peasant Experiences of the Peasant-to-Peasant Network was "plant, harvest and eat without harming nature" (RABANAL, 2015, p. 74).

Final considerations

The agroecological agenda in the political environment of the state of Sergipe is largely being built by mobilizing different individual and collective actors. It has found a favorable environment given the role of RESEA and the different arrangements that constitute a movement firmly anchored in the national strategies of ANA and the support of parliamentarians involved in food security, rural development, technical assistance, and environmental issues.

Agroecology allows for the analysis of a wide range of dimensions of the reality of farming (or farming), largely related to rural development, the production of food without pesticides, urban agriculture, and relations of production, marketing, and consumption. Thus, the debate undertaken by the Sergipe Agroecology Network provides a broad reflection on the reality of rural development in the state of Sergipe.

With the National Agroecology Policy as inspiration, the movement to demand a state agroecology policy and the effective approval demonstrated an

articulation of RESEA based on what had been proposed on a national scale. Hence, advances and setbacks at the national level also influence what occurs at the state level.

The common identity of the agroecological field reflected in the opposition to agribusiness, the common agendas, and the recognition of regional differences also allow for actions to be articulated from a regional perspective, with dialogue with other networks with political action, such as ASA and ANA.

The constitution of RESEA as a network that integrates social movements, workers' organizations, NGOs, public research, and education institutions reveals a dynamic that integrates different actors in the same forum and actions coordinated by the Network. Thus, it constitutes an organizational innovation that can facilitate the implementation of agroecology or related policies, such as the Agrobiodiversity policy (Law No. 8.167 of 1/12/2016), which institutes the concept of creole seeds and the incentive to the conservation of agrobiodiversity in the state of Sergipe.

Finally, a legal framework in the state strengthens agroecological family farming. However, analyzing the Multi-Year Plan (PPA 2020–2023) reveals a derisory amount allocated to family farming and agroecology policies. The analysis of this gap between what policies propose and what managers execute must be addressed such that this significant social segment can participate more effectively in the sustainable rural development of the state.

References

DALMORA, E.; CURADO, F.; SANTOS, A.; TAVARES, E. Participatory diagnosis of the custodians of creole seeds of Sergipe: exchanges, multiplication and exchanges of seeds and knowledge **Cadernos de Agroecologia,** v. 13, n. 1, jul. 2018. 7p.

DE OLIVEIRA, L. C. L. et al. RESEA em movimento: as caravanas agroecológicas e culturais de Sergipe construindo o conhecimento agroecológico. **Cadernos de Agroecologia,** v. 12, n. 1, jul. 2017.

FONTES, M.; RABANAL, J. E. M.; RAMOS FILHO, E. S. A roça do futuro: a construção da metodologia de campesino a campesino no sul de Sergipe. **Geonordeste,** Ano XXIV, n. 1, p. 102-127, 2013.

GUÉNEAU, S.; SABOURIN, E.; NIEDERLE, P.; COLONNA, J.; STRAUCH, G.; PIRAUX, M.; LAMINE, C.; ASSIS, W.; ÁVILA, M.; CANAVESI, F.; TAVARES, E.; BARBOSA, Y.; SCHMITT, C. A

construction of state policies for agroecology and organic production in Brazil. **Revista Brasileira de Agroecologia,** n. 14, 2019. 15p.

HOLT-GIMÉNEZ, E. **Campesino a Campesino**: Voces de Latino América, movimiento campesino a campesino para La agricultura sustentable. Managua, 2008. 294p.

JARA, O. **Para sistematizar experiencias**. San José (Costa Rica): ALFORJA, 1998. 128p.

LASCOUMES, P.; LE GALÈS, P. A ação pública abordada pelos seus instrumentos. **R. P**ós **Ci. Soc,** v. 9, n. 18, p. 19-44, 2012.

LONDRES, F. et al. (Org.). **Municípios agroecológicos e políticas de futuro**: iniciativas municipais de apoio à agricultura familiar e à agroecologia e de promoção da segurança alimentar e nutricional. 2. ed. Rio de Janeiro: Articulação Nacional de Agroecologia - ANA, 2021, 40p.

MATTOS, L. Austeridade fiscal e desestruturação das políticas públicas voltadas à agricultura familiar brasileira. Friedrich Ebert Stiftung. **Brazil. Analysis No. 39**. November 2017. 43p.

MENDONÇA, S. R. Agricultural policies and agroindustrial patronage in Brazil (1909-1945). **História Econômica & História de Empresas,** v. 16, n. 1, p. 73-100, 2013.

OLIVEIRA, T. C.; TAVARES, E. D.; CAPORAL, F. R.; CURADO, F.; COLLADO, A. C. Dialogues Between education-research-extension: counterpoint to the conventional process of technology transfer in the Territory of Alto Sertão Sergipano. **Cadernos de Agroecologia,** v. 12, 2017. 13p.

PARANÁ (State). Decree no 12.431 of 23/10/2014 **Institui o Programa Paraná Agroecológico**, 2014.

RABANAL, J. **Campesinato, territory and agrarian reform settlements: weaving networks of agroecological knowledge**. Dissertation (Master's in Geography) - Federal University of Sergipe, 2015.

RESEA. Strengthening of the Sergipan Agroecology Network. Notice of Public Selection no 2017/030 – **ECO-FORTE** Networks, 2017.

SABOURIN, E.; GUÉNEAU, S.; COLONNA, J.; SILVA, L. R. T. **Construction of State Agroecology and Organic Production Policies in Brazil:** advances. obstacles and effects of sub-national dynamics. Curitiba: CRV, 2019. 272p.

SERGIPE (State). Secretary of State of Agriculture, Agrarian Development and Fisheries. Portaria 147 of December 2018. **Creates the State Commission on Agroecology and Agricultural Production** – CEAPO of the State of Sergipe.

SERGIPE (State). Law no 8.354 of 20/12/2017. Annual **budget law** 2018.

SERGIPE (State). Law no 8.167 of 1/12/2016. **Institutes the concept of Creole seeds and the incentive to the conservation of Agrobiodiversity in the State of Sergipe**. Published in DOE on 20 Dec. 2016.

SERGIPE (State). **State Plan of Agroecology and Organic Production** - PLAEAPO (Emergente and priority). Aracaju/SE, January 2019.

SERGIPE (State). **State Plan of Agroecology and Organic Production** – PLAEAPO (Preliminary version). Aracaju/SE, December 2018.

SIQUEIRA, P. Z. R.; RABANAL, J. E. M.; FONTES, M.; SOUZA, H. C.; SIQUEIRA, E. R. A experience of the Peasant to Peasant methodology in rural identity territories in Northeast Brazil, **IX Latin American Congress of Rural Sociology**. 6-11 October/2014. Mexico. Available at: https://ainfo.cnptia.embrapa.br/digital/bitstream/item/112440/1/Resumo-Expandido-Pedro--ALASRU-2014-1.pdf.

SIQUEIRA, E. R.; SILVA, M. A. Proposta de um estilo de agricultura familiar para os assentamentos rurais de Sergipe. In: CURADO, F.; LOPES, E. S.; SANTANA, M. (Orgs.). **Do plural ao singular**: dimensões da reforma agrária e assentamentos rurais em Sergipe. Aracaju: Embrapa Tabuleiros Costeiros, p. 51-70, 2008. 250p.

TAVARES, Edson Diogo; DALMORA, Eliane; GONÇALVES, Gláucia Baretto. Encontro festivo da ciência, cultura e arte para democratização dos sistemas agroalimentares. **Cadernos de Agroecologia**, v. 15, n. 2, 2020.

TAVARES, E. D.; SIQUEIRA, E. R.; SILVA, M. A. Agricultura e uso sustentável dos recursos naturais. In: ALBUQUERQUE, A. C. S.; SILVA, A. G. (Eds.). **Tropical agriculture**: four decades of technological, institutional and political innovations. Brasília: Embrapa Informação Tecnológica, 2008. p. 23-62.

CHAPTER 9

On seeds, land, water, and public policies: stories, translations, and practices in the constitution of Casas de Sementes in Ceará

Helena Rodrigues Lopes, Claudia Job Schmitt

Introduction

"The Bank was never just about seeds" is one of the sayings in the report of the First Meeting of the Ceará Seeds Network, held in the municipality of Madalena, in the sertão[1] of Quixeramobim, in 1992. Repeated by farmers, technicians, pastoral agents of the Catholic Church, and Rural Workers Union (STTR) representatives, this statement lives on today and refers to the vitality of seeds. This vitality is present in the multiple relationships woven by semi-arid farmers involving seeds, land, water, and public policies and the distinct ways the seed banks (or seed houses)[2] are organized and interpreted at different historical periods in the collective becoming of these populations.

This chapter treats seed banks as collective dispositives, defined in their broadest sense as sets of heterogeneous elements (material and symbolic), capable of articulating and coordinating actors, resources, and practices, mobilizing different modes of agency (CHOCHOY, 2014). The term device highlights the mediation role played by certain arrangements (material, technical, and symbolic) (BEUSCART; PEERBAYE, 2006, p. 9), also referring to how social actors, faced with problematic situations, organize practices and structure certain sequences of action through the solidary combination of different elements (DODIER and BARBOT, 2017).

1 In Brazil the word "sertão" refers, generically, to the hinterland or backcountry. In the Brazilian Northeast, the "sertão" corresponds to the dry interior region, covered by Caatinga vegetation.

2 In Portuguese, Casas de Sementes.

In reviewing the history of seed banks in Ceará, with special attention to actions implemented by the Seed Exchange Network (RIS) in the Sobral region, we reflect on the dynamics of nature-society co-production (PLOEG, 2018; TAYLOR, 2015), historically developed by peasant communities in the Brazilian semi-arid region in a struggle not limited to an effort to adapt to climate adversity, waged in a territory marked by "a particularly perverse agrarian structure" (AB'SÁ- BER, 1999, p.7-8).

As we demonstrate throughout the text, the collective seed storage strategies developed by rural communities make it possible to coordinate a wide range of practices that promote diversity of life and habitability of the semi-arid region. Much more than just a physical space where certain genetic materials are selected and stored, the seed houses operate as a nucleus to boost a diversified web of relationships, enhancing the productive use of water and its transformation into biomass and guaranteeing access to locally adapted and "just in time" seeds, thereby expanding and diversifying the supply of food and strengthening social organization processes, the affirmation of rights, and articulation between different public policies.

The reconstruction of the historical trajectory of community practices for the rescue, production, multiplication, storage, and circulation of seeds in the semi-arid region, developed in the context of the RIS, aims to draw attention to the importance of the living collection of experiences of social organization built by rural populations in this territory. Faced with projections that highlight a scenario of "water shortage" (SANTOS et al., 2018), resulting not only from natural, physical, and climatic limitations, but also from the way natural resources have been appropriated and used throughout history in this region, we revisit in this chapter the dynamics of collective action associated to the construction of solutions socially and ecologically rooted in the ways of life of populations of the Brazilian semi-arid. These practices are part of an effort to adapt to a whole set of climatic restrictions generically associated with "drought." They also reflect an exercise in confronting persistent and lasting inequalities that permeate the relationships established between different social categories among each other and with public authorities. Looking back at these experiences seems even more relevant considering that the semi-arid region has been identified as one of the most vulnerable areas in a scenario of climate change, especially regarding the rise in temperature and the intensification of drought periods (MARENGO et al., 2017).

The geographical area referred to here as the "Sobral region" is located in the Northwestern mesoregion of Ceará. The first records of collective initiatives developed by peasant communities in these municipalities in the structuring of seed banks date back to the 1980s. The dissemination of these practices resulted

in the constitution of the RIS Sobral, which currently integrates 81 Seed Banks with over 2,000 associates, including farmers, quilombolas[3] and rural workers. The network is also composed of collective organizations such as cooperatives, associations, Rural Workers' Unions (STTRs), and the Diocesan Cáritas of Sobral -an entity forming part of Cáritas Brasileira, affiliated to the National Conference of Brazilian Bishops.

Since 2017, as an offshoot of a consultancy work developed within the scope of the Project Redes de Agroecologia para o Desenvolvimento dos Territórios, coordinated by the Articulação Nacional de Agroecologia (ANA), we have started a dialogue with members of the RIS Sobral (SCHMITT et al., 2020). These interactions unfolded into the development of a study using ethnographic methods, seeking more in-depth knowledge of the network, its history, and configurations and understand the daily practices of farmers associated with the seed houses. This chapter presents preliminary results of the research work developed by the first author in the scope of the Graduate Program in Social Sciences in Development, Agriculture, and Society at the Federal Rural University of Rio de Janeiro (CPDA/UFRRJ), under the guidance of the second author, focused in the preparation of a doctoral thesis.

Importantly, the exercise of historical reconstitution here presented is not limited to the Sobral region or the experience developed by RIS in its regional context. The network of interdependencies to which the RIS experience is associated reaches different times and spaces, connecting initiatives implemented in different regions of the state of Ceará and organizational processes contextualized in the Brazilian semi-arid at a regional scale.

The discussions presented in the text are based on empirical data produced during different field visits, incorporating results generated through literature review and documentary research with the support, particularly, of the collection of materials made available by the Documentation Center of Esplar Research and Advisory Center. The Esplar is a non-governmental organization (NGO) founded in 1974, based in Fortaleza, and which is currently working on different themes related to *coexistence with the semi-arid*.[4]

Following the trajectory of collective seed storage in Ceará over time, this chapter articulates three historical plans associated with the structuring of the Casas de Sementes. The first takes us to the hinterlands of Inhamuns and Crateús,

3 In Brazil, according to the Decree nº 4887, remnants of quilombo communities are legally considered to be "ethnic-racial groups, according to self-attributed criteria, with their own historic trajectory, and with specific territorial relations. They also carry the presumption of a black ancestry related to resistance to the historic oppression suffered." Decree n. 4887. Available at: http://www.planalto.gov.br/ccivil_03 /decreto/2003/ d4887.htm. Access: 12/05/2021.

4 The concept of *coexistence with the semi-arid* emerges from the action of a wide network of civil society organizations and research institutions, asserting themselves, especially from the 1990s, as a reference for public action guided by principles of social justice and sustainability in opposition to the paradigm of the "fight against drought", institutionalized from the first decades of the 20th century.

in the 1970s, where farmers, STTRs, and pastoral agents connected to the Catholic Church structured what social organizations identify as "the first seed banks." These initiatives emerged as part of a strategy to adapt to droughts, confront the domination exercised by the *patrões*,[5] and fight for land.

The following section attempts to reconstruct the initiatives related to collective seed storage developed in the 1980s and 1990s, a period in which these practices were given new meanings through their interactions with international cooperation projects coordinated by NGOs, such as Esplar, that provided technical advice to farmers, in conjunction with other partners. In this new phase, the seeds managed at the community level and the organizational arrangements involved in their aggregation and distribution are translated into the encounter between different social grammars developed by communities, grassroots organizations, technical assistance NGOs, international cooperation agencies, and the State. The appreciation of "native" seeds and criticism of seeds produced by "companies" - poorly adapted to the soil and climate conditions of the semi-arid region - became important references in structuring practices related to the collective storage of seeds from that period.

The third plan takes us to the Sobral-CE region. In daily life, farmers inhabit the Casas de Sementes, mobilizing a broad set of practices that extend beyond the local, linking seeds in multiple ways to a collective project anchored in the idea of *coexistence with the semi-arid*.

Throughout the text, we highlight not only the technical and managerial aspects related to these symbolic and material arrangements, but also the support they offer to individual and collective action, transforming the relations established by farmers with each other and with nature in the Semi-arid. We also understand that the choice of the seed houses as an entry point in the reconstitution of the multiple chains of "agencements" that link seeds, land, water, and public policies in the Semi-arid complexifies our view of the processes of adaptation to climate adversities. This methodological choice helps us to break with the climate-society dichotomy, exploring the different ways in which social energies, biological processes, and meteorological forces interact in a permanent process of co-production (TAYLOR, 2015). Power asymmetries and inequalities stand as a central axis in this framework. Our inquiries are not limited therefore to problems related to the incorporation of technologies or the efficient management of certain resources. The guarantee of rights is understood in this work as a central component of the processes of social and ecological change anchored in principles of sustainability.

5 In this text, the word "patrões", is used in the sense of designating social actors recognized as owners of the land where peasants work or live, reinforcing that the domain exercised by these agents over families is not often restricted to the universe of work and economic activities, assuming political dimensions and being extended to different spheres of everyday life.

The text has been organized in three different sections, corresponding to each of the three historical plans, followed by the final considerations.

"The Battalion managing the emergency and disorganizing the people all the time": the struggles for rights, land, and seeds in the 1970s

Referring to the genesis and evolution of community seed banks in Brazil, Almeida and Cordeiro (2002) mention the organization of community seed stocks in different dioceses and parishes in the Northeast of Brazil, starting in the 1970s, through the initiative of the Base Ecclesial Communities (CEBs). This historical record takes us to the Ceará hinterlands of Inhamuns and Crateús and the materials preserved in the Esplar Documentation Center. We accessed the report of the First Meeting of the Ceará Seeds Network in 1992. In a photographic record of this meeting are Father Bernardo Holmes and a blackboard that reads: "1 - Why did it start? Tauá - 1970."

Tauá is a municipality located in the hinterland of Inhamuns-CE. Father Holmes, born in Ireland in the 1940s, was ordained a Redemptorist Missionary of the Catholic Church in 1970 in that same country. Later he was transferred to Brazil and participated in the structuring of the Base Ecclesial Commissions (CEBs) in the state of Ceará. His speech, transcribed in the same report, helps us answer his question about the origin of the seed banks: "I would like to remind you that we are in the region of Tauá, and we are in 1970. Tauá is perhaps the driest area in Brazil. It is also the area with the greatest concentration of land in the hands of large landowners. Many people work on the land without owning anything. Working on leased land; residents; but without land ownership" (ESPLAR, 1992, p. 14).

As far as access to land is concerned, the reality of Northern Ceará has not changed significantly since then. According to the RIS partners, more than 90% of farmers in the Network live on "the *patrões*' land," reproducing relations of dependency that persist to this day. A farmer woman affiliated to RIS explains in an interview registered in July 2019: "any paper we need, to prove that we are farmers, we first need to talk to the *patrão*, because the land is in his name. Some *patrões* are very good and always help, others are not…".

The dominance of "the *patrões*" over the land encompasses refined forms of control and subordination, involving labor relations and access to inputs necessary for production, including seeds. These rules are established by agreements, usually informal, that structure the work regime. Seeds have historically served

as a bargaining chip for the work performed or debt to be paid off (in money or labor), structuring relationships from which many farmers could not escape.

From an ecological perspective in the semi-arid region, it is necessary to understand that "when it rains, you have to plant; you cannot wait." In the *sertão*, the low rainfall, unevenly distributed over time, is concentrated in a short period of the year, with rainfall levels in the rainy season, in the case of Ceará, between 500 and 600 mm per year, although with variations (HIERA et al., 2019). For this reason, some farmers preferred to contract a debt by getting seeds from their "patrões" or acquiring this input in local markets to sow the seed in the soil "at the right time." The "race" to find seeds was necessary and urgent to guarantee subsistence production (i.e., food for the family).

Note that the 1970s, when these collective strategies for seed storage began to be structured, were marked by the repressive actions of the Brazilian state, which sought, often violently, to politically deflate the struggle for land (MARTINS, 1984). The action of progressive sectors of the Catholic Church, particularly the Base Ecclesial Communities (CEBs) and the Pastoral Land Commission (CPT), was decisive for social organizations to continue acting at the local level, rooting their actions in the daily worker problems.

In the words of Father Holmes, "the 1970 drought was very strong in Ceará, causing humiliation". "The Battalion managed the emergency and disoriented the people all the time". The Battalion was involved in emergency actions developed by the Federal Government to combat drought in collaboration with state and municipal governments, often with the Army's engineering services. When the droughts worsened, the rural population of the semi-arid region was employed in work fronts and activities such as the construction of roads and dams, often implemented inside private properties benefiting medium and large farmers.

This governmental presence was also translated at the local level, into constant pressure on rural worker organizations at a time when the so-called "combative" unions, committed to the defense of rural worker rights, were more the exception than the rule. The testimonial of a farmer, a union delegate in Tauá in that period, registered in a report preserved in the Esplar Documentation Center, is quite illustrative: "we had a time when things were complicated (...) If you were going to hold a meeting, you had to be hidden. We even had to dig some holes in the weir spillway to hide and discuss these problems. Then, it became very difficult to follow up with the workers" (ESPLAR, 1992, p. 17). At that time, in response to the approval of the new legislation that regulated sharecropping relations and dwelling on the land of the *patrões*, especially the Land Statute, the unionization of rural workers often resulted in their expulsion from the land (BESERRA, 2015).

Despite the obstacles, religious agents and peasant leaders believed it was necessary to continue the process of social organization. The challenges in accessing seeds, given the relations of dependence established with the *patrões*, were keenly felt in the daily lives of farming families, serving as a discrete pretext for the organization of farmers at the grassroots level. This political translation of seeds into social organization tools expanded farmers' autonomy, allowing them to "escape dependence from the *patrões* (...), thus breaking that short halter that the *patrões* had on the workers' necks" (ESPLAR, 1992, p. 14). The stocks organized in the banks allowed the seeds to survive the dry season and be planted when the rains returned, even in periods of great food shortage when people or animals consumed domestic stocks.

As mentioned in the Report of the 1st Meeting of the RIS Ceará (ESPLAR-1992), the union delegate of the Barra Nova district in Tauá bought the first vegetable seeds for collective storage, acquired in the local market through a partnership with the Diocese of Crateús.

Recounting the bi-monthly meetings of the seed bank, Father Holmes recalls:

> The meetings were almost always on Saturdays. They were in a discreet little room in Alto Brilhante; each one brought a little bit of beans, *jerimum*[pumpkin], whatever they had to share at lunchtime. And it always started with each one telling stories, exchanging experiences [about] the concrete situation in the communities. All these questions, returning [the seeds to the bank], where we are going to store [them], the question of seed selection and other problems [...], everything came in [...]. We did a whole survey of who the landowners around us were. So we made […] a land map of the municipality, based on the information that each worker brought. And the union? Everything was up for debate. The subject of seed banks came up but from there it opened.

The seed banks operated at the intersection between the political struggle and access to food in that first period. Though land and water were subjugated to the power of the *patrões* because of the current land model, access to seeds and organizational practices developed through the banks such that the farmers learned to "organize themselves in the community," sit down and hold meetings," "coordinate conversations," and "make decisions and hold them together" (ESPLAR, 1992, p. 16).

Conservation, rescue, and management of agricultural and food diversity in the semi-arid region: the new translations of the Seed Houses

Reflecting on the emergence of biodiversity conservation as a global problem, Escobar (1998) calls attention to the dual nature of this phenomenon. From a biological perspective, the diversity of plants, animals, and microorganisms on the planet reflects the complexity of living systems and their evolution. From a discursive perspective, however, biodiversity is a technical-scientific construction that burst into the international public debate in the 1980s and 1990s through the action of a diverse set of actors, including multilateral organizations, international research institutions, governments, environmentalists of various shades, development NGOs, and social movements. The identity of each of these actors "is affected by and affects the network" (ESCOBAR, 1998, p. 55). However, although the effects of this global network can trigger a series of processes of translation, mediation, appropriation, and subversion, the local and territorial dynamics related to biodiversity are not influenced solely by extra-local factors. Thus, each place "can be the basis of its own network" (ESCOBAR, 1998, p. 55–56).

The establishment of genetic diversity banks for agricultural and food use in different countries has gained visibility at the international level, initially through the work of NGOs in different continents. Vernooy et al. (2015) analyze the origin and evolution of these initiatives and show the multiple factors that drove their emergence: the loss of local seed supplies used by farmers during famines, droughts, or floods and the interest in accessing new cultivars developed through participatory breeding techniques. They also call attention to the multiple activities developed by the banks, such as the structuring of community germplasm stocks, participatory experimentation, improving cultivars, and implementing networks to exchange genetic resources. In the case of Ceará, the work developed by Esplar, together with the solid partnership established with Cáritas, the STTRs, and different grassroots organizations, was of fundamental importance such that the different seed bank actions could be articulated. In this movement, new capacities were developed, expanding the functionality of seed houses as collective devices.

Esplar was originally founded as an office providing different services, such as project evaluation, and technical advice. These activities allowed the organization team members to know the collective storage actions developed in the Tauá region. From 1984, this office became a non-profit institution affiliated to the Alternative Technology Project Network (Rede Projeto Tecnologias Alternativas

- PTA Network), initially linked to the Rio de Janeiro-based non-governmental organization called Federação de Órgãos de Assistência Social e Educacional (FASE). Over time, the PTA Network brought together different Centers for Alternative Technologies (CTAs), set up in the North, South, and Southeast regions of the country (DIAS, 2004).

Through this partnership, the Quixeramobim Center for Alternative Technologies (CTAQ) was founded, working in technical support for agricultural production and the development of alternative technologies operating, also, as a training center. In his doctoral thesis, Dias (2004:131) retrieves the testimony of a technician who participated in the creation of the CTAQ on the meaning of the work to be developed by the recently founded institution: "We have this idea of making a more productive unit because it is a form of reinforcing the struggle of the workers. It is in this sense that we will make an effort to organize this set of techniques to be an alternative agriculture, which is the proposal that we want to put into practice at the Quixeramobim center".

It is important to highlight that Esplar's work has been historically linked to the fight for the land (BESERRA, 2015). The institution actively participated in the National Campaign "Agrarian Reform Now" in 1985, operating in strong synergy with the actions developed by the STTRs and other social movements in defense of the rights of rural populations.

With the foundation of CTAQ and the connections established between Esplar and the PTA Network, assistance to the seed banks took on new contours, with important advances from a technical perspective. A research project developed by Esplar allowed for better identification of the main challenges faced by farmers working with the seed banks, including (i) the guaranteed access to seeds, (ii) replenishment of stocks, and (iii) management of the banks. The technical qualification of the recovery and multiplication of new varieties was becoming increasingly important in the advisory work. It was observed that, in the flow of lending and returning seeds, the stored stock was becoming more diverse, not always in a planned manner, generating concerns regarding the preservation of varieties adapted to the ecological conditions of the semi-arid region. The preservation of seeds "adapted to regional conditions" as well as the "custom of saving seeds" and the knowledge associated with these practices became increasingly prominent in the entity's report.

It is important to note that from the 1980s onwards, the erosion of genetic diversity in agriculture, including plants for agricultural and food use and animal breeds, gained visibility in the international arena and among the networks and organizations that worked to defend an alternative agriculture in Brazil. In 1987, the book *The Seed Scandal: Domination in Food Production* written by

Pat Mooney was published in Portuguese (MOONEY, 1987). The author is a researcher, activist, and co-founder of the Rural Advancement Foundation International, today called the Action Group on Erosion, Technology, and Concentration. The negative effects of post-war modernization regarding agricultural and food diversity became an object of discussion, at least in some circles composed of environmentalists and agricultural science professionals critical of the so-called Green Revolution.

In the early 1990s, the passage through the National Congress of a bill that sought to implement a system of industrial patents in Brazil mobilized a broad range of civil society organizations, including those linked to peasants and rural workers, in the struggle against the patenting of plants, microorganisms, and other living beings and in defense of the right of farmers and traditional people and communities to save, use, exchange and sell their seeds. In this same period, the thematic network of seeds associated to the PTA Network began to coordinate, in partnership with researchers working on the Brazilian Agricultural Research Corporation (Embrapa), among other institutions, the National Trial of Crioulo Maize Varieties, with the implementation of experimental fields aimed at the participatory improvement of this crop in different regions of Brazil. In this context, in the early 1990s, the Ceará Seed Exchange Network (RIS-CE) was created. In 1993, during the 2nd RIS Meeting, the network structured a coordination body composed by representatives from various regions of Ceará. The event also consolidated the use of the expression "Casa de Sementes," based on the argument that collective storage is more directly related to the management of a house than the administration of a bank, with its system of debits and credits. We had the opportunity to hear "in Ceará it is Casa" several times during fieldwork.

According to the report of the PTA Network Seeds Seminar held in Vitória, Espírito Santo, in July 1994, RIS Ceará articulated, in 1994, 67 seed banks in 12 municipalities, involving 2,000 people (Rede PTA, 1994). With the support of different projects funded by international cooperation agencies, the network sought to face the weakening stocks of seeds from community banks resulting from a long period of drought in the early 1990s.

However, this state-level articulation process had its roots in a varied set of experiences developed at the local and regional level. In the case of the Sobral region, the experiences of collective seed storage date back to the 1980s, when the first seed bank was created in 1983 in the community of Bulandeira, municipality of Santana do Acaraú. The work of pastoral organizations linked to the Catholic Church was fundamental to this process in a context where rural communities faced a "very challenging situation" given prolonged droughts. Through an international cooperation project, it became possible to acquire the seeds that

gave rise to this first seed bank, initially installed in a farmer's house. However, RIS Sobral was only made official in 2003 and is now one of six regional seed networks currently in place in Ceará.

The new connections established by the seed houses in the context of political re-democratization and the emergence on the global political scene of different discourses on biodiversity have broadened the scope of these experiences. The preservation of the biological diversity associated to peasant agriculture in the semi-arid region gained prominence as a collective goal. However, it is not only a matter of preserving the seeds that circulate through the Casas. Domestic seed banks, the diversity cultivated in the fields, and reproductive materials exchanged with neighbors daily or on special occasions, such as religious festivals, are also relevant. Meanwhile, through a series of mediations, peasant organizations established political alliances to advance the defense of rights, combining socially and ecologically contextualized innovation processes (technical, organizational, institutional) with continued action in the field of public policies.

Seed Houses, daily practices, and policies for coexistence with the semi-arid

This section considers the different ways the Casas de Sementes are inserted into the daily lives of farmers in the municipalities where the Sobral RIS operates and analyzes the links established between these collective devices for the storage and circulation of seeds and different public policies.

In 2019, 50 municipalities, 231 seed houses, and 5,023 partners were integrated into the seven micro-regional divisions of RIS Ceará. The Sobral RIS developed actions in 11 municipalities with more than 2,000 members. The "RIS in Numbers" document made available by Cáritas Diocesana of Sobral, makes it possible a better approximation of the RIS composition. Approximately 47%members (1,149) are women, 46% are men (1,121), 3.3% are young women up to 29 years old (82), and 3.4% are young men (84) up to 29 years old. Notably, women occupy most of the management and coordination spaces in the seed houses.

The fabric of relations structured within the RIS, its connections, and arrangements (extending beyond the network) is an essential component in the functioning of the seed houses. This network structure includes municipal-based organizations, such as the STTRs, the state RIS, the micro-regional divisions of RIS, the Semi-arid Seeds Training and Social Mobilization Program, among other forums and articulations. The RIS stimulates the exchange of genetic materials between the seed houses, diversifying stocks and ensuring their replenishment in

times of crisis, usually associated with prolonged droughts. It is also essential in promoting agroecological practices, systematizing knowledge, training farmers, and accessing public policies. Some relationships are formalized and regulated by the Seed Exchange Network Management and Organization Manual (Mangoris). Others involve interactions that are organized through informal rules in the day-to-day operations of the network. The provisions contained in the Manual reinforce the importance of RIS. A representative of the Massapê-CE STTR warned that "it is no use just building seed houses", organization is necessary. At planting time, 80% of the total amount of seeds stored by members can be withdrawn, and 20% of reproductive material originally made available by each associate remains in the house to guarantee the stock longevity, preventing eventual risks, especially droughts, that may jeopardize the harvest and seed replacement.

The withdrawal of seeds generates a "loan receipt". After harvesting, the total volume loaned should be increased by an amount of seed, equivalent to 20%, generating the "return receipt." According to the Manual, the person responsible for receiving the seed is called a "selector." His or her main attribution is to verify if the seeds received are of good quality and healthy, with no signs of disease, hydric stress, or holes.

The composition of the stocks in the seed houses somewhat reflects their importance for the food and nutritional security of families and the conservation of agricultural and food biodiversity in the semi-arid. A survey conducted through a partnership established between RIS Sobral and Embrapa, involving 76 of the 81 existing seed houses in 2018, counted 13,087 liters of seeds (the unit of measurement used by RIS is the liter of PET bottle where seeds are stored), divided into 12 categories: beans, corn, fava beans, sorghum, sesame, rice, *jerimum* (pumpkin), cucumber, okra, watermelon, cotton, and native and fruit species. Maize and beans stand out, accounting for 98% of the bottles stored. These crops have a dual function, being used to feed families and animals. The category "native plants and fruit trees" is also noteworthy. Among the 22 types of seeds included in this category, 18 were considered native by the farmers. These type of seeds are stored to "preserve nature, taking care of the plants of the Caatinga."[6] The native species are used for the extraction of firewood, building fences, mud houses, roofs, and can also serve as food for the animals. It is interesting to note, in the universe of action of the Sobral RIS, the links established by the seeds in their circulation, with different public policies. These connections are organized through a framework of action structured around the idea of living with the semi-arid, encompassing (from the perspective of social organizations) the following

6 Seasonally dry land vegetation that has the Brazilian Northeast as its area of occurrence. The word Caatinga is also used to designate the ecoregion where this vegetation occurs.

elements: the decentralized supply of water for consumption and production, the management of plants and animal breeds adapted to semi-arid conditions, stockpiling, the sustainable management of the Caatinga, technical assistance guided by the principles of agroecology and, above all, by the participation of the populations that work and live in the semi-arid in the construction of public policies (BAPTISTA; CAMPOS, 2013).

The importance of the decentralized water supply for human consumption ensured through the cisterns implemented through the One Million Cisterns Program (P1MC) was highlighted repeatedly during visits to farmers linked to RIS, and the first thing offered to visitors was ice-cold water. In many of the home gardens visited, the second-water cisterns (for production and animal consumption) that had been installed through the One Land and Two Waters Program (P1+2) enabled the production of a wide diversity of food throughout the year. Managed usually by women, home gardens are shelter to a wide diversity of plants (fruit trees, medicinal plants, vegetable gardens, and crops), making it possible to raise small animals. The symbiosis established between the Casas de Sementes, political participation, and home gardens strengthened the organization of productive groups of women, such as the group organized in the Cajazeiras Community in the Forquilhas-CE municipality. This group used the collective space available for seed storage as a kitchen for processing bread, cake, and sweets, marketed through public procurement programs such as the National School Meals Program (PNAE) and the Food Acquisition Program (PAA).

We were also surprised that the loan receipts issued by the Seed Houses were used by farmers as proof of their entitlement to retirement pension. The capacity of local organizations to face a series of political and institutional discontinuities, articulating different public policies and adapting them to the reality experienced by farming families stands out. Through interaction with government programs and actions, the organizational structure of the seed banks was expanded and qualified promoting initiatives such as the Semi-arid Seeds program, coordinated by ASA and operated at the biome level, and the Ecoforte Program, funded by the Banco do Brasil Foundation (FBB) and the National Bank for Economic and Social Development (BNDES). However, it is important to highlight that the social fabric built by RIS and, more broadly, the networks of social organizations mobilized around a project for *coexistence with the semi-arid* over the past decades was of fundamental importance for the collective initiatives for seed storage to remain active over time, through droughts. Rebuilding stocks remains as a significant practice for farmers in their daily lives.

Final considerations

Throughout their trajectory, the Seed Houses have affirmed themselves as a collective device capable of expanding the resistance capacity of farmers in the semi-arid region of Ceará to droughts and inequalities regarding access to land, water, and biodiversity. The collective storage of seeds constitutes a socially and ecologically contextualized alternative that emerges in a collective process of struggle for autonomy.

It has become commonplace to say that the strengthening of social organizations contributes to climate change adaptation. We break with a mere managerial view of adaptation dynamics, valuing the struggles, experiences, and meanings attributed by social actors to the continuity of life in the semi-arid region by adopting a historical perspective on the processes of social organization. The expansion of a decentralized water supply and the collective management of biodiversity stocks are decisive elements in the lives of populations. However, issues related to access to land, discussed by farmers in that discrete little room in Alto Brilhante in the 1970s, remain important. "The Bank was never just about seeds. The subject of the seed bank keeps opening up."

References

AB'SÁBER, A. N. Sertões e sertanejos: uma geografia humana sofrida. Dossiê Nordeste Seco. **Revista Estudos Avançados,** v. 13, n. 36, p. 7-59, 199l.

ALMEIDA, P.; CORDEIRO, A. **Semente da paixão**: estratégia comunitária de conservação de variedades locais no semi-árido. AS-PTA, 2002.

BAPTISTA, N. Q.; CAMPOS, C. H. A convivência com o Semiárido e suas potencialidades. In:

CONTI, I. L.; SCHROEDER, E. O. **Convivência com o Semiárido brasileiro:** autonomia e protagonismo social, Brasília: Editora IABS, 2013. p. 51-58.

BESERRA, B.L. R. **Movimentos sociais no campo do Ceará (1950-1990)**. Imprensa Universitária, 2015.

BEUSCART, J.S.; PEERBAYE, A. Histoires des dispositifs (introduction). **Terrains & Travaux,** v. 11,p. 3-15, 2006-2.

DIAS, M. M. **As ONGs e a construção de alternativas para o desenvolvimento rural:** um estudo a partir da Assessoria e Serviços a Projetos em Agricultura Alternativa (AS-PTA). Tese de Doutorado, Curso de Pós-Graduação em Desenvolvimento, Agricultura e Sociedade – CPDA. Universidade Federal Rural do Rio de Janeiro, 2004.

DODIER, N.; BARBOT, J. La force des dispositifs. **Annales HSS,** v. 2, p. 421-448, 2016.

ESCOBAR, A. Whose knowledge, Whose nature? Biodiversity conservation and the political ecology of social movements. **Journal of Political Ecology,** v. 5, p. 53-82, 1998.

ESPLAR. **Relatório do I Encontro da Rede de Intercâmbio de Sementes (RIS-CE)**. Esplar, 1992.

HIERA, M. D.; LIMA JÚNIOR, A. F.; ZANELLA, M. E. Tendência da precipitação no estado do Ceará. **Revista Brasileira de Climatologia**, v. 15, n. 24, p. 300-321, 2019.

MARENGO, J. A.; TORRES, R. R.; ALVES, L. M. Drought in Northeast Brazil – past, present and future. **Theoretical and Applied Climatology,** v. 129, p. 1189-1200, 2017.

MARTINS, J. S. **A militarização da questão agrária no Brasil**. Editora Vozes, 1984.

PLOEG, J. D. van der. **The new peasantries:** Rural development in times of globalization. Earthscan/Routledge, 2018.

REDE PTA. **Seminário de Sementes da Rede PTA:** estratégias para a autonomia na produção de sementes. AS-PTA, 1994.

SANTOS, A. P. S.; ALBUQUERQUE JR., D. M.; BRAGA, R. A. P.; LIMA, R. A. et al. **O encolhimento das águas:** o que se vê e o que se diz sobre crise hídrica e convivência com o semiárido. INSA, 2018.

SCHMITT, C. J.; PORTO, S. I.; LOPES, H. R.; LONDRES, F. et al. **Redes de agroecologia para o desenvolvimento dos territórios – aprendizados do Programa Ecoforte**. Articulação Nacional de Agroecologia, 2020.

TAYLOR, M. **The political ecology of climate change adaptation:** livelihoods, agrarian change and the conflicts of development. Earthscan/Routledge, 2015.

VERNOOY, R.; SHRESTHA, P.; STHAPIT, B. The rich but little known chronicles of community seed banks in: VERNOOY, Ronnie; SHRESTHA, Pitambar. STHAPIT, Bhuwon. (Eds). **Community seed banks:** origins, evolution and prospects, London/ New York: Earthscan/Routledge, 2015. p. 1-7.

CHAPTER 10

Agroecological transition in the Mandacaru settlement, Petrolina/ Pernambuco, and Brazilian semi-arid region: collective action, organic production, and socio-technical networks

Helder Ribeiro Freitas, Lúcia Marisy Souza Ribeiro de Oliveira, Rita de Cássia Rodrigues Gonçalves-Gervásio, Cristiane Moraes Marinho, Denes Dantas Vieira, Elson de Oliveira, Lucas Ricardo Souza Almeida

Introduction

This text describes and analyzes the agroecological transition process of the Mandacaru settlement, located in the municipality of Petrolina - Pernambuco, in the semi-arid region of the São Francisco sub-medium. It is a rereading and updating of the analysis of the publication in the *journal Extramuros* (FREITAS et al., 2015) that reported the advances observed in that agrarian reform settlement from the implementation of the community organic garden to the different socio-productive activities and their links with other enterprises and social networks.

The occupation of the area where the population of Mandacaru is settled today took place in 1999; it was established on a farm adjacent to the Senador Nilo Coelho Irrigated Perimeter (PINC). Later, in 2001, the area was officially recognized by the National Institute of Colonization and Agrarian Reform (INCRA) as a settlement, with its first organic production initiative in 2009 and the implementation of the community organic garden. Thenceforth, the settlement became a space for learning and experimentation of various practices and socio-organizational processes on agroecological transitions in family farming in the context of the irrigated perimeters of the Sertão do São Francisco. Living with drought in the settlement has also been a constant learning process in the context

of socio-technical adaptations of the families from the context of PINC water access limitations to their recent achievement. A landmark was the partnership established in 2005 with the Federal University of São Francisco Valley (UNIVASF), where teachers and students from various courses at the University began to provide training in various areas of knowledge to seek appropriate solutions to various problems. In 2013, the Center for Studies in Agroecology - NEA Sertão Agroecológico of UNIVASF began to discuss with farmers actions to promote agroecology in the territory in a network context, together with other institutions and organizations that make up the Rede Territorial de Agroecologia do Sertão do São Francisco Baiano e Pernambucano.[1]

This articulation has been added to other initiatives of socio-technical articulation in the field of agroecology and organic production in the territory, among which the creation of the Association of Organic Producers in the São Francisco Valley (APROVASF) stands out and through which the settlement has participated in this network action that promotes agroecological transition in the territory. We can highlight the implementation of certified organic produce fairs in Petrolina and Juazeiro and various articulations for the commercialization of organic food and other products produced by the Mandacaru settlement and other partner communities around the settlement via public policies for food security and access to markets for family farming products.

The partnership between the agrarian reform settlement and UNIVASF has generated relationships of trust and collaboration, enabling the execution of participatory research in agroecology, horizontal discussions between academia and popular social movements, thematic seminars; and fairs for the commercialization and dissemination of organic products to the population and various courses demanded by the families of the settlement. Thus, this chapter describes and critically analyzes the experience from the collective construction perspective and articulation of the initiative with the socio-technical networks operating in the local and regional context, its achievements, obstacles, lessons, and challenges in dialogue with other agroecological transition initiatives in the Sertão do São Francisco.

Accordingly, the text was organized into five sections. The first addresses the foundations and concepts that guide the analysis of the experience, such as agroecological transition, collective action, organic production, and socio-technical networks.

1 This network was proposed by the NEA Sertão Agroecológico and constituted during the III National Agroecology Meeting (ENA) organized by the National Agroecology Articulation held at UNIVASF in 2014. The proposal for the formation of the Territorial Network of Agroecology of the Sertão do São Francisco came from a self-managed workshop that "aims […] to create a space for dialogue and convergence for the construction of agroecological knowledge from the ongoing experiences in various locations in the Sertão do São Francisco"(ENA, 2014: 148p).

In the following section, the territory and the context in which the experience was developed are described. The third section noted the methodological aspects of the analysis of the experience and its stages to enable the construction of the fourth section, which described the socio-historical trajectory of the experience.

In the final section of the paper, the experience was analyzed in the light of the central concepts on which the work is based, qualifying the main lessons and the challenges faced by settlers during the experience for the agrological transition in the space of work and life.

Agroecological transition: from concept to experiences

Different studies try to explain the multiple proposals for agriculture, ranging from industrial, focused on economic productivity, to the so-called alternative agriculture, incorporating organic, natural, biodynamic, ecological, permaculture concepts (KHATOUNIAN, 2001; GLIESSMAN, 2015). Agroecology is linked to ecological-based agriculture, recognized as a science since the 1980s to promote socio-environmental changes and improve the quality of life of the population using it. It aims to gradually substitute agrochemical production models for agricultural styles based on sustainable principles, methods, and technologies (CAPORAL; COSTABEBER, 2001).

The concept of agroecological transition encompasses various stages and degrees of evolution (HILL, 1985) and considers different scales, from local (plot/farm), through territorial, to global, social, economic, and environmental dimensions (CAPORAL; COSTABEBER, 2004; GUZMÁN, 2013; GLIESSMAN, 2015; TITONELL, 2019).

According to Gliessman (2015), this process has a dynamic character and originally comprises three levels: gain in system efficiency, substitution of inputs, and redesign of the agro-ecosystem (HILL, 1985). Gliessman (2015) proposes two more levels for this same process based on new studies. Level 4 promotes the (re)connection between consumers and farming families through alternative local/territorial food networks. Level 5 of the transition highlights the construction of a global agri-food system based on equity, participation, democracy, and social justice that promotes the restoration and protection of life support systems on Earth.

The concept of transition has been changing throughout its constitution. Initially, this process was perceived as an evolutionary "conversion" of the system; it soon after became conceptualized as "transition" (GUADAR- RAMA-ZUGASTI; TRUJILLO-ORTEGA, 2019).

In more recent formulations, this understanding goes beyond the processes of redesigning agroecosystems whose duration is indefinite, becoming understood as a process of constant transformation. As stated by farmers and technical advisors, "it is a constant learning."

The perspective of conversion remains very present, especially in the organic production certification regulations with technical itineraries protocolarily fulfilled per the Normative Instructions - IN 17 (BRASIL, 2014) published by the Ministry of Agriculture, Livestock and Supply (MAPA).

However, the transition is a complex process that crosses local, territorial, and global scales, presenting various challenges. For Titonell (2019), these challenges include the construction of socio-organizational autonomy based on ecosystem services and promoting self-regulation processes of the socio-technical system. The author also highlights that overcoming the state of "niches," as verified in isolated successful experiences, involves transforming "regimes" of hegemonic agri-food systems with socio-technical innovations that promote equity of access to quality food, providing answers to challenges faced by farmers, organizations, public and private institutions, and governments from local to global scales. The main challenges faced at the local and territorial scale include the lack of technical advice, the lack of scientific references on socio-technical processes, the isolation of farmers, the lack of group and collective process experience, organizational and socio-technical action, and articulation networks.

Expanding agroecological transition experiences and overcoming initial challenges are only possible with the construction of new values of socio-environmental coexistence and agroecological training processes horizontally, such as the perspective of the Peasant to Peasant (CaC) methodology by Val and Rosseti (2020). It makes the learning of practices directly effective, from realizing exchange activities that promote the dialogue of knowledge between farmers through practices to educational processes, especially non-formal ones, to build new knowledge and consolidate the sustainable management of the agroecosystems.

Sertão do São Francisco Baiano and Pernambuco: social processes, development, and challenges to the agroecological transition in the Brazilian semi-arid region

Public and private investments supported by Brazilian state institutions intensified economic development actions in the semi-arid region, beginning in the second half of the twentieth century, thereby highlighting the construction of large dams for hydroelectric power generation along the São Francisco river.

The Sobradinho dam was inaugurated in the 1970s, completely transforming the social and economic dynamics of the region. With the Sobradinho lake, the Sertão do São Francisco focused its economic dynamics on implementing irrigated perimeters dedicated to fruit farming for export (SIQUEIRA, 2017).

The reality experienced in these perimeters contrasts with the riverine ways of life and the so-called "dryland" environments. Most family farming communities in the Brazilian semi-arid region are located in this environment, with restricted access to water for human consumption and production. In 2017, data from the agricultural and livestock census indicated that 79% of the population comprised family farmers (FORTINI, 2020). In rain-fed areas, agriculture and livelihoods depend on rainfall and are, therefore, more subject to climatic adversity. According to the 2017 agricultural census, in the Northeastern semi-arid region, 76.2% of families have access to water, 73.71% of which indicated that they have such access through cisterns, mostly built through the One Million Cisterns Program - P1MC (FORTINI, 2020). In the Brazilian semi-arid region, water availability is an aspect that conditions and limits various production processes. According to the 2017 agricultural census, 10.1% of rural establishments in the semi-arid North-East indicated that they had some form of irrigation.

In rain-fed areas and traditional communities, agroecological transition processes have been evidenced mainly in agro-extractive initiatives, such as umbu (BIANCHINI, 2018) and crops adapted to edaphic and climatic conditions marked by rainfall scarcity.

The irrigated perimeters are presented to society as "islands of development." However, they are associated with numerous and serious problems of socio-environmental order.

These enterprises hide several unsustainable rural development processes, such as the indiscriminate use of pesticides, extremely harmful to human health and the environment in their surroundings (CARNEIRO et al., 2015). However, important initiatives also emerge, even if punctuated, such as those developed by CODEVASF in encouraging a group of irrigating farmers from Petrolina and Juazeiro to make the agroecological transition (AMARIZ, 2020). This CODEVASF initiative led to the articulation of different profiles of farmers practicing organic agriculture at different transition levels, culminated in the constitution of APROVASF, of which the group from the Mandacaru settlement has been part since its constitution. According to Germino et al. (2017), in 2016, APROVASF had 25 families from agrarian reform settlements as members, 19 irrigators from irrigated perimeters, and 12 peri-urban farmers. They are members of APROVASF, mostly from Petrolina and Juazeiro, producing a diversity of vegetables and fruits mostly sold in local markets.

Methodological process in the analysis of the experience

Location of the settlement and agro-environmental characterization

The Mandacaru settlement is in the rural area of the municipality of Petrolina, semi-arid region of Pernambuco (S 09º16'18" - W 040º35'54"), on the margins of the BR 407 highway in a dryland area marginal to the PINC. The settlement is approximately 18 km from the urban center of Petrolina, with a total area of 482 ha, in which 70 families were settled and make up the Associação dos Agricultores(as) Familiares do Assentamento Mandacaru (AAFAM). The municipality of Petrolina and the region has a BSh (Semi-arid) climate, as per the Köppen classification. The characteristic vegetation is caatinga, consisting basically of xerophytic species.

Throughout occupying the settlement, the families implemented social infrastructure (e.g., houses, plots, roads, and environmental preservation) and organized agroecosystems currently at different levels of agroecological transition or in conventional exploitation (Figure 1).

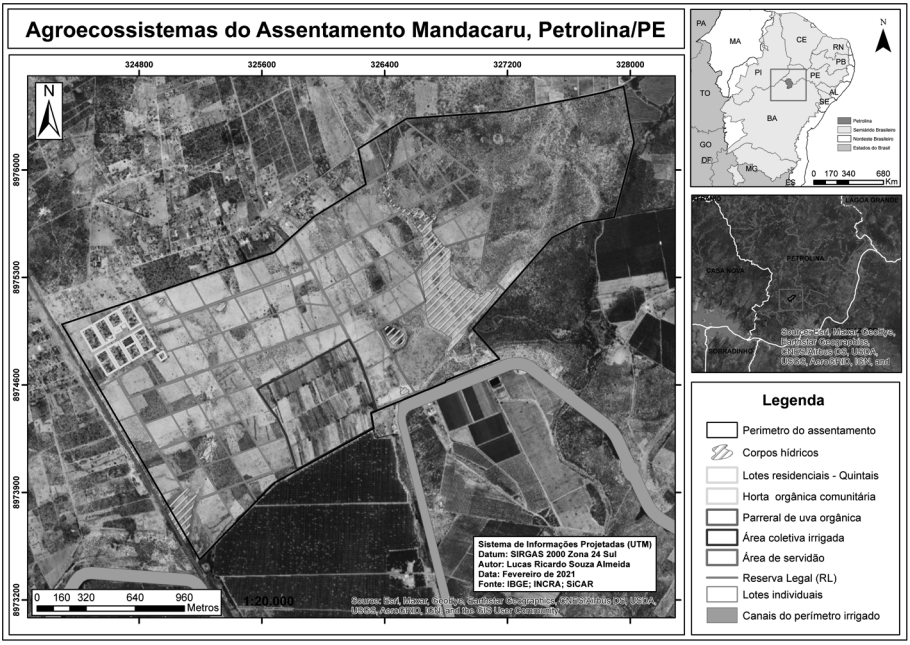

Figure 1. Agroecosystems map of the Mandacaru settlement, Petrolina, PE. Source: Authors' file

Methodological Course of the Research

The entire evaluation process of the agroecological transition was based on action research, defined by Thiollent (2002) as research with intervention such that researchers and participants are directly involved. This study incorporates the perspective of action and participatory research developed throughout the interventions conducted with the settlement families. It initially focused on the actions of the group involved in the activities of the community organic garden and, later, extended to different initiatives of agroecological transition. The involvement in participatory research actions allowed for participant observation and evaluation of socio-environmental processes by farmers and researchers (HOCDÉ, 1999).

The analysis also included exchange activities and guided visits of various groups of farmers and students of different educational levels to the agroecological transition experiences and initiatives underway in the settlement. In these activities, guided by the dialogue of knowledge (LEFF, 2009), planning interactions always prioritized the protagonism of the settlement's farmers in conducting demonstrations, reports, and expositions of practices and strategies in their historicity and particularities as families become involved and expand organic production activities.

Steps employed by the research

- **Successive approximation with the garden group and the community** - Through the interventions proposed throughout the teaching, research, and extension actions, in the period between 2013 and 2019, various actions were developed by the Sertão Agroecológico and socio-technical networks with which the social actors and institutions integrated and interacted. Some of these actions include (i) visits to the settlement's socio-productive spaces and agroecosystems; (ii) individual conversations and collective conversation circles, meetings, and discussions; (iii) identifying community organizations and socio-productive management processes; (iv) mapping sociocultural dynamics and articulations; (v) planning courses and thematic workshops pertinent to agroecological practices and exchanges; (vi) reports of meetings, surveys of real research demands, semi-structured interviews, and participatory research actions in development with families of the settlement; (vii) holding practical classes led by the farmers, with undergraduate and postgraduate classes of UNIVASF.
- **Planning and Development of Actions** – It is conducted with the families directly involved in different agroecological transition initiatives in the

settlement, in addition to groups of UNIVASF students, other agroecological farmer groups, and partners in the context of socio-technical networks, and territorial articulations for promoting agroecology.

- **Consultation of records of activities and report of the developed and systematized actions** - The records on various actions developed throughout the intervention actions of this action research were consulted to subsidize the planning of ongoing actions and enable the systematization of records and information produced.
- **Systematization, triangulation, and analysis of the data** - This step concerned the historical process of the constitution of agroecosystems in transition, collective action, processes, and socio-technical articulations in which the settlement is inserted.

The last stage of the research allowed for evaluating data quantitatively and qualitatively by systematizing and subsequently triangulating the information (TRIVIÑOS, 1987).

Reconstituting the transition experience in the settlement

The occupation of the farm area by the families occurred in 1999, and the regularization of possession by INCRA occurred in 2001, officially creating the Mandacaru settlement, as termed by the 70 families of settled sertanejos. Most of these families lived in the peripheral neighborhoods of Petrolina and Juazeiro and originated in the local rural exodus from the Brazilian semi-arid region, attracted by the possibility of finding work in the irrigated areas of the Sertão do São Francisco in Bahia and Pernambuco.

In the **first phase (1999-2003)**, which preceded the settlement, the accounts of life in the camp reveal challenges associated with the absence of basic infrastructure, such as decent housing, water, sewage, and electricity. It was two and a half years of lacking protection and uncertainty. However, in 2001, with the decree of expropriation of the area by INCRA, the old farm was declared for agrarian reform and, in 2003, the demarcation of the lots and parceling out of the land was conducted, defining the areas for rain-fed cultivation, irrigated cultivation, and communal areas. The construction of houses also began in 2003, but the solution to the problems of these families remained far away. Without income and resources for planting and food maintenance, the settlers were forced to look for work outside their locus in the surrounding irrigated farms as hired

labor since the opportunities were seasonal and without any labor guarantees. The following statements are representative of this reality.

> In the beginning, it was very difficult to maintain the families; [some] people […] donated food, and we said that we would still have [much] production to take to the fair. So when we arrived at the fair with the product of our first large production, the people who donated food were surprised. (Female farmer 1, President of the Association of the Mandacaru Settlement 05/06/2013)

> There is a dam that was full of water at the time we occupied the settlement, so we prepared a collective area for cultivation; we produced a lot and took it to the city to sell. (Farmer 2, member of the community organic garden, 05/06/2013)

With the beginning of implementing social infrastructure in the Mandacaru settlement, from 2003 onwards, crops were grown in a 35-ha area, identified as the "irrigated collective area" (Figure 2) for irrigated production in the settlement. Each settled family was given a 0.50 ha portion of this area that became cultivated.

In the second phase (2003/2004-2008), settlers identify their vocations and group themselves by affinities. Until this period, even with the initial agroecosystems, many farmers still worked on the farms to earn income and support their families. During this period, the families had the support and partnership of UNIVASF teachers who, in 2005, conducted a series of interventions and university extension actions, sowing socio-productive ideas and proposals to overcome poverty and food security, in addition to generating employment and income in the settlement.

With the establishment of the community housing nucleus (from 2003/2004) and the definition of rain-fed areas and areas of small irrigated plots in the then collective area (0.5 ha/family), the families started to implement production proposals in the different areas of the settlement, creating productive nuclei. The initial production proposals involved occupying the collective irrigated area with production systems that reproduced the logic of conventional production systems experienced on farms producing fruit for export (intensive use of pesticides and chemical fertilizers).

However, per reports from the settlers, the high financial cost and dependence on these inputs, associated with cases of poisoning of people in the settlement, given direct exposure to pesticides in irrigated fruit farms, induced families to establish safer, more autonomous, and healthier production processes. Thus, given the levels of transition as a reference, a small group of families from the

settlement proposed to experience the agroecological transition by initially experimenting with the substitution of inputs as indicated in level 2 (GLIESSMAN, 2015). Reports highlight the concern with health and the challenges perceived regarding the alternative path to the use of pesticides in the cropping systems under implementation:

> Our health improved a lot when we left the farms. In the beginning, I did not believe that without poison, we would be able to produce anything because even using poison was already difficult; imagine without it. (Farmer 2, member of the community organic garden, 05/06/2013)

Using an eminent and committed socio-technical network comprising organizations and groups that support family farming, such as the Rural Workers Union (STR) of Petrolina and researchers from UNIVASF, partners, such as PRORURAL (Pernambuco Secretary of Agriculture), and CODEVASF technicians, the settlement managed to establish an organic garden in the community area of the settlement's housing nucleus between 2008 and 2009. Meanwhile, community leaders needed to seek other partners, such as SEBRAE and SENAR, which provided courses and initial training in organic production practices. In the articulation to make this action feasible, leaders of the settlement managed to involve the group interested in implementing the garden (still in formation) in project proposals prepared by PRORURAL called "Organic Gardens and Shed," which enabled the initial infrastructure of the garden for establishing productive processes. From 2010, with the technical support of CODEVASF and, subsequently, financial support from SEBRAE, the community organic garden began to be audited and certified by the Chão Vivo Certification Body, becoming part of the Organic Group of the Valley, which later became APROVASF in 2014.

Families reported that they began to work to promote experimentation and direct observation of the dynamics of the settlement's agroecosystems and vegetable garden and the effects of the practices and management techniques adopted in the latter. Thus, the settlers began to identify the best irrigation techniques and systems to promote efficient water use in the settlement's irrigated productive processes. They also learned the practices of fertilizing the beds, alternative pest and weed control, and selecting varieties more adapted to the agroecosystems. The families report that the agroecological management of the agroecosystems involves constant observation and analysis of the practices adopted in the production system, reinforcing the perception that agroecology and transition are constant learning processes.

Of the group of 33 families who started the productive activities of the vegetable garden, only 16 remained until 2015 and today. The reasons for the initial reduction, as per members who remained in the group, are diverse: the inadequacy to work with agroecological production and identification with other productive activities (goats, fruit farming, handicrafts, candy production, and others), developed within and outside the settlement; the impossibility of reconciling with other activities, such as public service and paid work on neighboring farms and other spaces; challenges in group and community work for some members; and health problems. Regarding the health issue, a significant number of the members of the vegetable garden and settlement are in their old age, and the work demands much physical effort.

In the whole experience of the community organic garden, collective action prevailed, which, according to Olson (1999), cannot be based on individualism. Collectivity must prevail, emphasizing that the action of a set of individuals with common interests does not always result in collective action. With the consolidation of the group involved in organic production at the Mandacaru settlement, the vegetable garden has become a learning unit and an exchange of agroecological experiences for families from the settlement and groups from Petrolina and the region with which the settlement interacts. These processes of knowledge exchange occur within the social relationships and socialization spaces in the settlement, such as association meetings, work and family conviviality, established inside and outside the settlement in the set of networks of relationships in the social networks of exchange and reciprocity (SABORIN et al., 2018). For the families of the Mandacaru settlement, some spaces show the constitution of socio-technical networks that enable the exchange of knowledge and values, in addition to material exchanges, through marketing at the organic fairs organized by APROVASF. The association's collective has enabled closer ties with different social actors and market agents at different levels, enabling relationships of exchange and commercialization of organic products at the local and territorial levels. Moreover, the settlement has been involved in collective public policy processes such as the Food Acquisition Program (PAA) and the National School Meals Program (PNAE), the latter being in conjunction with four other settlements in its surroundings.

In 2015, the organic garden produced more than 20 varieties of vegetables, including herbs, tubers, fruits, and medicinal and dietary plants.

Given the initial water scarcity limitation, the organic production experiment was expanded to the backyards (Figure 1) of the families involved in the organic community garden experiment. The use of land in backyards enabled the expansion of the productive potential of families using water available to families.

Concomitantly with the organic garden initiative and the expansion of backyard cultivation, some families already work in the collective irrigated area on 0.5 ha family plots for agroecological management, using sustainable fertilization practices to manage spontaneous plants, pests, and diseases. However, the area configuration in very small plots has an exploitation perspective, predominantly guided by conventional production practices. This situation (associated with the proximity of the irrigated area to fruit-growing farms with intense use of pesticides) made it challenging to obtain organic certification of the products from these plots.

The prices of organic products set by the farming families of the settlement and the other APROVASF members are compatible with the prices of conventional products or even cheaper. It is observed for direct purchases by families in the settlement and surrounding communities and commercialization and delivery points in Petrolina and Juazeiro. The families from the settlement involved in the various agroecological transition initiatives evaluate a big improvement in their quality of life, income, and access to quality food, referring to the experience of the community organic garden:

> After […] working in the garden, our financial conditions have improved a lot because we stopped working for others on farms where we were in contact with pesticides all the time. [Moreover,] we are earning more than before. (Female farmer 3, community leader and President of APROVASF, interview notes- July 2014).

In 2015, seeking to expand the areas of organic production, part of the families involved in the garden group and other people interested in organic fruit production implemented 0.5 ha of organic grapes in the settlement (Figure 1) with support from Petrolina. In this area, collective management with respect for individualities was implemented in the management and handling of the successful grape crop. Thus, the area was divided into spaces and activities to manage the practices and production results individually.

However, in this 0.5-ha area, several activities are managed collectively and must be worked on within the group, such as irrigation management, pruning periods, and organic input acquisition.

Thus, the settlement became the first supplier of organic grapes to the two organic produce fairs of Petrolina and Juazeiro, local supermarkets, and eventually other markets outside these municipalities. This initiative also promoted the self-esteem of settled families. Other families from the settlement began to visualize this agricultural practice to improve their living conditions without wage labor on the irrigated fruit farms in the region. In the settlement itself,

experiences of organic production and family farming have emerged, with possibilities for building autonomy and further development. The settlement has been much sought after to share its organizational experience, knowledge, and social capital in agroecological transition and organic production in the community and family farming context. The agroecological transition initiatives of the settlement have received many visits and exchanges, encouraging and supporting several other agroecological transition initiatives in the territory, thus constituting a space for teaching, research, and development institutions operating in the territories of the Sertão do São Francisco in Pernambuco and Bahia and training farmers, technicians, and socio-technical advisory organizations.

The role of the social organization and settlement leaders in promoting effectively participatory collective action was fundamental to the success of initiatives in the vegetable garden, grape production, expansion of irrigated areas, and processing and commercialization of organic produce in different local circuits. Thus, collective action is being strengthened, with legitimacy inside and outside the settlement. Thus, since its implementation, the settlement association has filed numerous requests with CODEVASF to release water from the perimeter for irrigation the settlement's dryland areas, recognizing the area as irrigable. In 2019, after political articulation and legal action, the right to water from the irrigated perimeter to meet all dryland plots of 4 ha was won by each of the 70 families. Currently (early 2021), these plots implement irrigated areas fully. Of the 70 families in the settlement, approximately 40 are in the implementation process, 12 of them aiming for organic irrigated production, with diverse, productive proposals. Among them, diversification in foodstuffs produced throughout the implementation of different agro- and ecosystems stands out, as does the implementation of orchards for organic fruit production.

Final considerations

The experience of the collective struggle for Agrarian Reform, the challenges of the initial years in the encampment and settlement, and the successful experience with the organic garden implementation allowed for various collective action processes that led to the construction of a successful practice and rich social capital. The management of the collective and individual spaces and activities in the garden and other socio-productive activities stem from an entire experience of collaboration and search for consensus in the projects accredited by the families, who have strongly experienced community exchange as an empowerment strategy, in addition to using the socio-technical networks within the context of the Mandacaru settlement.

Beyond the first three levels of agroecological transition, the settlement experience has promoted proximity and reciprocity between producers and consumers of products at the local and territorial levels. The practice of organic agriculture guided by the principles of Agroecology at the Mandacaru settlement has enhanced the efficient use of water and other natural resources via the internal efficiency of the agroecosystems under construction at the settlement.

The settlement experience demonstrates that group actions strengthen the collective interests in the transition process. Moreover, the transition process is strengthened by the insertion of the Mandacaru settlement in socio-technical networks, such as the one organized around the extension actions of UNIVASF, APROVASF, and the settlement, which involved institutions, groups of farmers, entrepreneurs, and consumers. Therefore, this trajectory of struggle, resistance, learning, and achievements problematizes a rich and dynamic process of internal organization and cohesion of the settlement families to resist the limitations and challenges of resource scarcity and productive infrastructure conquered throughout the trajectory of settlement families. These transition processes have been based on the actions of socio-technical networks of learning and collaboration, including the protagonism of the farming families, policies to support family farming, public education, research, extension and development institutions, civil society organizations, and social movements.

References

AMARIZ, K.R.S. **Promoção da Agroecologia e Produção Orgânica em Projeto Público de Irrigação: análise da experiência de Assistência Técnica e Extensão Rural no Sertão do São Francisco Pernambucano**. Dissertação (Mestrado Profissional em Extensão Rural), Universidade Federal do Vale do São Francisco, Juazeiro, 2020. 88p.

BARBOSA, E.M. Crítica ao modelo atual de desenvolvimento agrícola à transição agroecológica no semiárido. Encontro Nacional de Agroecologia (Rio de Janeiro/RJ) Encontro nacional de agroecologia: **Anais.** Osvaldo Santana Alves [ilust.] - Rio de Janeiro: AS-PTA, 2002. 25-32.

BIANCHINI, F. **Umbu (spondias tuberosa) produto da sociobiodiversidade nos Territórios Fundo de Pasto.** Dissertação (Mestrado Profissional em Extensão Rural), Universidade Federal do Vale do São Francisco, Juazeiro, 2018. 128p.

BRASIL. **Lei 11.326, de 24 de Julho de 2006.** Estabelece as diretrizes para a formulação da Política Nacional da Agricultura Familiar e Empreendimentos Familiares Rurais. 3p. Disponível em: <https://www2.camara.leg.br/legin/fed/lei/2006/lei-11326-24-julho-2006-544830-normaatualizada-pl.pdf>. Acesso em: 15 de Fev 2021.

BRASIL. MINISTÉRIO DA AGRICULTURA, PECUÁRIA E ABASTECIMENTO. **INSTRUÇÃO NORMATIVA Nº 17, de 18 de junho de 2014.** Estabelecer o Regulamento Técnico para os Sistemas Orgânicos de Produção, bem como as listas de substâncias e práticas permitidas para uso nos Sistemas Orgânicos de Produção, na forma desta Instrução Normativa e de seus Anexos I a VIII. Publicado no Diário Oficial de União, Brasília, 20 de junho de 2014. Seção 1, p. 22p.

BRASIL. MINISTÉRIO DA AGRICULTURA, PECUÁRIA E ABASTECIMENTO. **INSTRUÇÃO NORMATIVA Nº 46, de 6 de outubro de 2011.** Estabelecer o Regulamento Técnico para os Sistemas Orgânicos de Produção, bem como as listas de substâncias e práticas permitidas para uso nos Sistemas Orgânicos de Produção, na forma desta Instrução Normativa e de seus Anexos I a VIII. Publicado no Diário Oficial de União, Brasília, 20 de junho de 2014. Seção 1, p. 22p. (Regulada pela IN 17-2014 dada a alterações na IN Nº 46)

CAPORAL, F. R.; COSTABEBER, J. A. **Agroecologia:** alguns conceitos e princípios. 24 p. Brasília: MDA/SAF/DATER-IICA, 2004.

CAPORAL, F. R.; COSTABEBER, J. A. **Agroecologia e sustentabilidade.** Base conceitual para uma nova extensão rural. Botucatu, SP: 2001.

CARNEIRO, Fernando Ferreira; AUGUSTO, Lia Giraldo da Silva; RIGOTTO, Raquel Maria.et.al. (Org.). **Dossiê ABRASCO: um alerta sobre os impactos dos agrotóxicos na saúde**. Rio de Janeiro: EPSJV; São Paulo: Expressão Popular, 2015.

Encontro Nacional de Agroecologia. **Anais.** III Encontro Nacional de Agroecologia. Juazeiro, BA. Rio de Janeiro: Articulação Nacional de Agroecologia - ANA, 2014. 148p. Disponível em: https://agroecologia.org.br/wp-content/uploads/2015/02/anais-do-iii-encontro-nacional-de-agroecologia-ena.pdf Acessado em: 15 de Fev 2021.

FAIDEN, A. Agroecologia: Introdução e Conceitos. In: AQUINO, A. M. de; ASSIS, R. L. de. **Agroecologia: princípios e técnicas para uma agricultura orgânica sustentável.** Brasília - DF, Embrapa Informação Tecnológica, 2005. 51-70p.

FORTINI, R.M. **Um novo retrato da agricultura familiar do semiárido 2020 nordestino brasileiro a partir dos dados do censo agropecuário 2017.** Viçosa, MG : IPPDS, UFV, 2020. 105p. Disponível em: <https://aksaam.ufv.br/wp-content/uploads/2020/09/Um-novo-retrato-da-agricultura-familiar.pdf> Acesso em: 14 de Fev 2021.

FREITAS, H.R; GERVÁSIO, R. de C.R.G.; LIMA NETO, I. da S; CARVALHO NETO, M.F. de; MARINHO, C.M. Análise da Transição Agroecológica a partir da Experiência da Horta Orgânica Comunitária do Assentamento Mandacaru, Petrolina-PE, Semiárido Brasileiro. **Extramuros**, Petrolina-PE, v. 3, n. 3, p. 65-84, edição especial, 2015. Disponível em: <https://www.periodicos.univasf.edu.br/index.php/extramuros/article/view/768/530>. Acesso em: 10 de Fev 2021.

GERMINO, J. F. de S; FREITAS, H.R; MARINHO, C.M. **Certificação orgânica: a experiência da Associação dos Produtores e Produtoras Orgânicos do Vale do São Francisco - APROVASF - PE/BA.** Extramuros, Petrolina-PE, v. 5, n. 2, p. 39-63, 2017. Disponível em: <https://www.periodicos.univasf.edu.br/index.php/extramuros/article/view/805/568>. Acesso em: 14 de Fev 2021.

GLIESSMAN, S. R. Chapter 22. Converting to Ecologically based Manegment. IN: GLIESSMAN, S. R. **Agroecology: The Ecology of Sustainable Food Systems.** Boca Raton: CRC Press. 2015. 275-285.

GLIESSMAN, Stephen R. **Agroecologia:** Processos ecológicos em agricultura sustentável. Porto Alegre: Ed. Universidade/UFRGS, 2001. 653 p.

GUADARRAMA-ZUGASTI e TRUJILLO-ORTEGA. Revisando el enfoque evolutivo de la transición agroecológica. In.: **Pesquisa em Agroecologia: conquistas e perspectivas.** Davi Lopes do Carmo... [et al.] editores técnicos e vários autores. Viçosa, MG : Furnabe, 2019. p. 29-43.

GUZMÁN, G.I. **Transición agroecológica: donde confluyen la investigación y la acción. Laboratorio de Laboratorio de Historia de los Agroecosistemas,** 1-12, 2013.

HILL, S. B. Redesigning the food system for sustainability. **Alternatives**, v. 12, p. 32–36, 1985.

HOCDÉ, H. **A lógica dos agricultores experimentadores:** o caso da América Central. Metodologias Participativas. Rio de Janeiro: AS-PTA, 1999.

KHATOUNIAN, C. A. **A reconstrução ecológica da agricultura**. Botucatu: Agroecologia, 2001. (recorte de leitura entre as páginas 17 a 42).

LEFF, E. Complexidade, Racionalidade Ambiental e Diálogo de Saberes. **Educação e Realidade.** V.34, n. 3. P. 17-24 set/dez 2009.

OLIVEIRA, F de. **Elegia para uma re(li)gião**: SUDENE, Nordeste: planejamento e conflitos de classes. 3ª. ed. Rio de Janeiro: Paz e Terra, 1981.

OLSON, M. **A Lógica da Ação Coletiva.** Trad. Fabio Fernandez. São Paulo. Edusp, 1999. pp. 13-64.

SILVA, D. P. **Agricultura urbana e periurbana: um estudo de caso de duas hortas comunitárias no município de Petrolina-PE.** Petrolina, 2015. 49 p. Trabalho de Conclusão de Curso (Graduação em Engenharia Agronômica), Universidade Federal do Vale do São Francisco, Petrolina, 2015.

SIQUEIRA, R. Caravana Agroecológica do Semiárido Baiano: um relato do contexto histórico e contemporâneo dos caminhos das águas do Rio São Francisco. **Extramuros,** Petrolina-PE, v.5, n.2, p.5-21, 2017. Disponível em: https://www.periodicos.univasf.edu.br/index.php/extramuros/article/view/801/562 Acesso em: 10 de Fev 2021.

SILVA, R. M. A. da. **Entre o combate à seca e a convivência com o semiárido**: transições paradigmáticas e sustentabilidade do desenvolvimento. reimp. Fortaleza: Banco do Nordeste do Brasil, 2010.

THIOLLENT, Michel. **Metodologia da pesquisa-ação**. São Paulo: Cortez, 2002.

TITONELL, P. Las transiciones agroecológicas: múltiples escalas, niveles y desafíos. **Revista de La Facultad de Ciencias Agrarias UNCuyo**, v. 51, n. 1, p. 231-246, 2019. Disponível em: http://revistas.uncu.edu.ar/ojs3/index.php/RFCA/article/view/2448. Acesso em: 2 fev. 2020.

TRIVIÑOS, A. N. S..**Introdução à pesquisa em ciências sociais**: pesquisa qualitativa em educação. São Paulo: Atlas, 1987. 173 p.

VAL, V; ROSSET, P.M. Campesina a Campesino: Educación campesi na para la resistência y la transformación agroecológica. **Rev. Bras. Educ. Camp.**, Tocantinópolis, v. 5, 2020. Disponível em: <https://sistemas.uft.edu.br/periodicos/index.php/campo/article/view/10904>. Acesso em: 10 de Fev 2021.

CHAPTER 11

Fartura tem de montão[1]: Public policies and socio-ecological resilience in traditional communities of pastureland in the Sertão do São Francisco, Bahia

Denis Monteiro, Luciano Silveira, Paulo Petersen

Introduction

Having consolidated in the political-institutional environment and the world of civil organizations as the "paradigm of living with the semi-arid" (SILVA, 2008), agroecology was pioneered as a theoretical and methodological basis for rural and agricultural development in the Caatinga Biome in the 1980s through the action of Non Governmental Organizations (NGOs) in partnership with grassroots communities, especially peasant organizations. After more than two decades of public policies and programs designed and executed with the effective participation of civil society organizations, the Brazilian semi-arid region is currently configured as a rich "laboratory" for "Political Agroecology" (GONZALEZ DE MOLINA et al., 2020), a field dedicated to the study of institutions and policies aimed at promoting the socio-ecological sustainability of agri-food systems.

Given the consensus in the international community on the important role played by modern agri-food systems as a driving force for climate change and other biophysical transformations on the planet, such as accelerated desertification, loss of biodiversity, and depletion and degradation of water bodies, debates have multiplied in sub-national, national, and international public arenas on the need to renew the focus of policies and programs for agriculture and food. These discussions have intensified with the United Nations (UN) officialization of the

1 "Fartura tem de montão" is an expression used in the very popular song "Último pau de arara". The expression literally means "there is too much abundance." Luiz Gonzaga, its author, seeks to contrast the generalized view of the Brazilian semiarid as a place of precariousness condemned to poverty.

Sustainable Development Goals (SDGs), an integrative political agenda of goals related to social, economic, environmental, cultural and institutional dimensions of development. As part of these multilateral debates, the Food and Agriculture Organization of the United Nations (FAO) convened an International Symposium on Agroecology in 2018 to discuss experiences of public policies aimed at increasing the scale of agroecology as a strategy for achieving the SDGs.

This chapter contributes to these debates via the description and analysis of rural development processes driven by the convergent action between the State and civil society organizations in the territory of Sertão do São Francisco, Bahia. It employs the trajectory of 12 agroecosystems linked to networks of agroecological innovation structured in the territory as an empirical reference to highlight the multidimensional effects generated by the socio-technical transformations promoted. It also highlights the centrality of the territorial approach as a reference for the design and implementation of public policies and programs, breaking with the sectoral perspectives that remain dominant in the intervention of the State. From this perspective, it demonstrates how and under what institutional and political conditions the agroecological approach makes it possible to reconcile in the dynamics of rural and agricultural development the challenge of adapting to climate change with other SDGs, in particular the structural overcoming of poverty, the promotion of food and nutritional security, and the conservation of biodiversity and soils.

Recognize to redistribute

The period of re-democratization in Brazil saw the emergence in the national public arena of many debates and social forces repressed during the military dictatorship. The Federal Constitution of 1988 accepted part of the demands for civil rights previously denied to large contingents of the population, including rural workers. The resulting victories were primarily the result of recognizing the role of social subjects historically marginalized from the actions of the Brazilian state.

The social movements in the countryside denounced the precarious conditions of social reproduction of the then called "small producers," demanding State intervention in constructing specific public policies for this public, particularly agrarian reform and subsidized rural credit. According to Grisa and Schneider (2015), the confluence between social pressure and academic contributions based on the experience of developed countries created favorable conditions for family farming to also be affirmed in Brazil as the bearer of positive specificities for food production and job demand, boosting rural economies.

Despite this important recognition, most public policy instruments created since the 1990s have remained guided by the foundations of agricultural modernization, disregarding the diversity of forms of work organization and the multiple identities and projects for the social reproduction of rural and forest peoples. The political and ideological hegemony of agribusiness groups ended up prevailing in allocating the largest portion of public resources redistributed to agriculture and rural areas. It meant subordination to agribusiness chains and the financial system for large portions of family farming.

Grisa and Schneider (2015) identify the first generation of policies for family farming as those oriented by the agricultural and agrarian referential, implemented from the 1990s onwards, with emphasis on the National Program for the Strengthening of Family Farming (PRONAF), and the implementation of rural settlements in response to the pressure exerted by land occupations organized by social movements.

It is also worth highlighting the increasing social security coverage for rural workers, including rural wage earners and family farmers (as of 1988), the right to maternity wages for female family farmers (as of 1994), and income guarantee policies, such as the "Bolsa Família Program." Identified as policies guided by the social and welfare referential, these initiatives were boosted, either in the volume of redistributed resources or the number of beneficiaries, from 2003 onwards, with the Lula and Dilma governments. According to the authors,

"in the last two decades, the most impoverished rural areas of Brazil have experienced undeniable improvements in their conventional development indicators (e.g., income increase) that, perhaps, would not have been achieved only through the agricultural and agrarian actions analyzed in the first generation of policies" (GRISA; SCHNEIDER, 2015, p. 36, translated from Portuguese).

The creation of the National Council for Food and Nutrition Security (CONSEA) and the Zero Hunger Program at the beginning of the Lula government in 2003 are important milestones in the recent history of public policies for family farming. They meant the creation of institutional spaces for civil society actors identified with agroecology and mobilizations against hunger and poverty to influence the design of State actions. Women's movements also began to occupy these and other institutional spaces, denouncing the enormous challenges faced by rural women in accessing public policies and demanding the construction of adequate instruments.

The creation of spaces for the co-management of public policies represented the recognition of the role of civil society organizations in the formulation and execution of public policies. One of the main examples of policies formulated based on this recognition were those guided by the notion of "Living with the

Semi-Arid" (vs. "Fight Against Drought") inspired by the actions of civil society organizations (Catholic parishes, trade unions, and NGOs) with resources from international cooperation.

These actions multiplied with public resources in the first years of the 2000s, becoming de facto comprehensive programs after the re-creation of CONSEA in 2003. The internationally awarded Training and Mobilization Program for Living with the Semi-Arid—One Million Rural Cisterns (P1MC)— made it possible to build slab cisterns to store water captured from the roofs of houses, and the One Land and Two Waters Program (P1+2) focused on the construction of water storage infrastructure for food production (see www.asabrasil.org.br/).

Many innovations in public policies stem from recognizing the multifunctionality of family farming, breaking away from the economic productivist bias that predominated in the first generation of policies. One of the highlights in this regard is the potential of family farming as a producer of healthy and diversified food for sale in local markets or to be purchased through government purchasing policies. This recognition led to the Food Acquisition Program (PAA), which began in 2003, and the law of 2009 that allocates a minimum of 30% of federal funds from the National School Meals Program (PNAE) to direct purchases from family farmers. Other examples are the programs to support the conservation and use of native seeds and value sociobiodiversity products, including initiatives such as the Policy to Guarantee Minimum Prices for Sociobiodiversity Products (PGPM Bio), created in 2008, and the Semi-Arid Seeds Program.

The institution of the National Policy on Agroecology and Organic Production (PNAPO) in 2012 was a key fact recognizing agroecology as an alternative approach to agricultural and food policies. In the context of the National Commission on Agroecology and Organic Production (CNAPO), a body with parity participation between the State and civil society, public policy instruments, consistent with the agroecological perspective, were created or strengthened. We highlight the Ecoforte Program to Support Territorial Networks of Agroecology, Extractivism and Organic Production as a relevant institutional innovation, financed with resources from the Banco do Brasil Foundation (FBB), the Social Fund of the National Bank for Economic and Social Development (BNDES) and the Amazon Fund (SCHMITT et al., 2020).

Effects of public policies from an agroecological perspective

One of the biggest challenges posed to the necessary reorientation of the approaches of rural and agricultural development policies to achieve the SDGs

refers to overcoming the theoretical and conceptual frameworks and metrics used in planning and evaluating the effects of public intervention. Based on the foundations of neoclassical economics and the precepts of technological diffusionism, the dominant scientific and political-institutional guidelines are characterized by universalizing and homogenizing concepts to describe, categorize, and plan development trajectories focused on achieving economic goals in the short to medium term. Thus, they make invisible or delegitimize the multiple and heterogeneous social experiences that deviate from officially projected trajectories. It is, therefore, a "production of institutionalized ignorance" (PLOEG, 2003) such that it makes invisible "deviations of route" that potentially inspire virtuous development dynamics capable of reconciling several dimensions and goals enshrined in the SDGs.

This imposition of reductionist lenses to interpret agricultural and agrarian realities generate what Boaventura Sousa Santos (2002) has called the "waste of experience." In this case, the waste of creative initiatives of family farmers and their organizations characterized by valorizing territorial resources (material or immaterial) in reproducing their means and ways of life.

As an approach to overcoming the paradigm of agricultural modernization (PETERSEN, 2013), agroecology is distinguished from the latter by the adoption of socio-technical innovation perspectives based on dialogue between scientific and popular knowledge to identify and develop the ecological and socio-cultural potentials of the territories to promote fair and sustainable patterns of social and economic organization of agrifood systems.

By employing an endogenous development orientation, the trajectories of agroecological innovation increase the productive efficiency of agroecosystems without creating structural dependence on the financial system and external markets for inputs and services, generally controlled by corporate agribusiness groups.

Two ideas are central to the endogeneity of development: local resources and local control. In this sense, rural development oriented by the agroecological paradigm can be defined as that in which the economy of agroecosystems and food systems is anchored predominantly in the valorization of local resources, organized by local patterns of combining these resources, and continuously strengthened by the local reinvestment of locally produced wealth.

Accordingly, the investment of external resources, such as those provided by public policies, should progressively expand and improve the base of local resources self-controlled by farming families and communities. From this perspective, it contrasts head-on with the conventional logic of public investment, essentially guided by short-term production bias. Beyond increasing dependence on external resources, this conventional orientation of public action makes

obsolete and compromises the integrity of territorial resources essential for the local and global SDG implementation.

The need to broaden the perspectives for assessing the multidimensional and multiscale effects of rural development trajectories guided by the agroecological approach has motivated different analytical frameworks over the last decades. Regarding the initiative of a working group composed by FAO after the International Symposium on Agroecology (2018), a review of these methods was conducted to synthesize a proposal to be tested in different world regions in search of new analytical references officially recognized by UN countries. Given such effort, the Tool for Agroecology Performance Evaluation (TAPE) method (MOTTET et al., 2020) was proposed and is being tested and adjusted. One of the analytical references considered in the TAPE development was the "Lume method: economic-ecological analysis of agroecosystems" proposed by AS-PTA (PETERSEN et al., 2017; 2020). As the name implies, its main objective is to shed light on economic-ecological relations essential to the socio-technical reproduction strategies of family farming but actively invisible in the analytical frameworks derived from the modernization paradigm.

The analysis of the effects of public policies on the economic-ecological *performance* of the 12 agroecosystems was conducted based on the theoretical and methodological references proposed in the Lume method.

Methodological procedures

This study was conducted in 12 agroecosystems managed by farming families. The families were integrated into socio-technical innovation networks stimulated by the Pro-Semiárido Project (PSA) in rural communities in seven municipalities of the Sertão do São Francisco Territory: four in Juazeiro, two in Sento Sé and Remanso and one each in Sobradinho, Casa Nova, Campo Alegre de Lourdes, and Uauá.

The 12 families accessed various public policies. The selection met the criterion of active participation of at least one person from the family in PSA activities. Between April 2019 and February 2020, semi-structured interviews with the families were conducted by technical advisors from the Regional Institute for Appropriate Smallholder Agriculture (IRPAA); the Socio-Environmental Assistance Service in the Countryside and the City (SAJUC); the Canudos, Uauá, and Curaçá Family Farming Cooperative (COOPERCUC); and the Advisory Service to Rural Popular Organizations (SASOP); advisory organizations responsible for PSA implementation in the communities. Technicians from the Regional Development and Action Company (CAR), the public agency linked to the government

of Bahia; AS-PTA; and other NGOs operating in the semi-arid region of Bahia were also involved in the studies.

The following methodological tools were used to collect and record information in the field:

a) Transect (walks) through the establishments to identify the production subsystems and the agrarian capital;

b) Participatory mapping of agroecosystem;

c) Explanatory models to represent the trajectories of agroecosystems over time (timelines);

d) Models to identify the origins of inputs consumed and destinations of products generated in the agroecosystems (flow diagrams of products and inputs);

e) spreadsheet for recording quantitative information on the agroecosystem economy in the 2018 annual cycle (hours worked, quantities produced, production destinations, income generated, production costs with inputs and payment for services, own production of inputs, inputs received through reciprocity, services received through reciprocity). The spreadsheet also records hours worked and income earned through non-agricultural activities (pluriactivity) and income earned through social policies. Hours dedicated to domestic and care work and social participation were also recorded.

For each agroecosystem, the following sustainability attributes were analyzed: autonomy; responsiveness; social integration; gender equity and women's empowerment; youth empowerment. Each attribute was evaluated based on qualitative judgments of a set of parameters, taking as reference changes recorded in the timelines. Each parameter was evaluated regarding the configuration of the agroecosystem at two moments in its trajectory (in 2019 and another reference year), following the following grades: very low, low, medium, high, and very high. Justifications for the scores were recorded in a table. Radar-type graphs were composed from the scores, generating a visual representation of the qualitative changes identified between the two periods analyzed. Synthetic indices (from zero to one) were produced to represent the relative level of the attribute at different moments in the agroecosystem trajectory.

The reference years adopted correspond to the years in which families began to participate in innovation dynamics, especially those driven by PSA. In eight agroecosystems, the reference year was 2015. Each of the other four

agroecosystems was analyzed based on the following reference years: 2013, 2010, 2009, and 2006.

The quantitative data collected in the field were introduced into the Lume *online* platform and generated indicators, graphs, and indices on the economy of the agroecosystems. Thus, to measure the PSA effects on the economy of the agroecosystems, a comparative exercise was conducted between the indicators generated from the actual data collected in the interviews and those generated from the simulation of data corresponding to the levels of production obtained if the changes provided by the socio-technical innovations incorporated since the family's participation in the program had not occurred.

A changing economic and socio-ecological reality

The Sertão do São Francisco territory is located in the extreme north of Bahia under the domain of the Caatinga Biome. It is one of the 27 identity territories established by the State Law that created the Territorial Development Policy of the State of Bahia. With an area of 61,609.7 km^2, corresponding to 11% of the state (Figure 1), the territory comprises 10 municipalities: Campo Alegre de Lourdes, Remanso, Casa Nova, Sento Sé, Pilão Arcado, Sobradinho, Juazeiro, Curaçá, Uauá, and Canudos. IBGE estimated a population of 530,215 inhabitants in 2018, 64% in urban areas and 36% in rural areas.

The average HDI of the 10 municipalities advanced between 1991 and 2010 from 0.291 to 0.585. The average rainfall is between 400 and 700 mm, with uncertain and irregular rainfall in time and space, concentrated between October and March. However, the variations between years are large, with frequent consecutive years of severe drought, as occurred between 1979 and 1983 and 2012 and 2018.

The 2017 Agricultural and Livestock Census reveals the existence of 33,442 family farming establishments, which corresponds to 80% of the total number of agricultural establishments in the territory. The census also showed that 64% of the establishments have cisterns for rainwater storage.

Two contrasting patterns of socio-technical organization of agriculture are identified in the territorial landscape. Irrigated agriculture with intensive use of agrochemicals are generally integrated into agribusiness chains to export or supply large urban centers: fruit farming (e.g., mango, grape, and guava) on large farms and the cultivation of tomato, onion, watermelon, and melon in small plots in rural settlements or communities near the São Francisco River or on the banks of the Sobradinho Lake.

Figure 1. The 10 municipalities of the Territory Sertão do São Francisco and their location in northern Bahia.

Source: Schmitt et al. (2020)

Moreover, rain-fed agriculture practiced by peasants is often organized in communities known locally as "fundo de pasto" (common-use pastureland). In these community arrangements, goat, sheep, and cattle raising predominate in communal grazing areas and spaces of exclusive appropriation by the family units; there are fields of cassava, corn, and beans; beekeeping; chicken raising; and vegetable and fruit tree cultivation around the house.

Traditional communities of pastureland

The system of animal husbandry in common-use pastureland is a traditional form of work organization that enables the appropriation of vast extensions of land through mechanisms of mutual aid and collective management of the areas of caatinga destined for animal grazing. In this case, access to land is regulated by customary norms, and labor is mobilized through reciprocity mechanisms. It means that land and labor are not mobilized for the productive process as commodities. They are "commons" regulated according to tacit agreements established in the communities. Struggles for official recognition of this economy associated with traditional forms of land appropriation are part of the history of peasant movements in the region (SABOURIN et al., 1999; MORIMURA, 2015; GERMANI; OLIVEIRA, 2020).

Public policies and programs for family farming in the territory

The four key elements of rural development processes identified by Schneider (2004) are present in the territory's public agenda: eradication of poverty, empowerment of social actors and their political participation, territory as a reference unit, and environmental sustainability concerns.

A series of federal public policies, listed in the second section of this article, have strongly impacted the territory since the early 2000s. Several policies have been implemented in communities in partnership with NGOs active in the territory since the late 1980s. These organizations and others created subsequently worked in close partnership with grassroots organizations and were responsible for implementing federal policies such as the P1MC, the P1+2, and the National Policy for Technical Assistance and Rural Extension (ATER). This process created a strong social network dynamic oriented toward promoting technical and socio-organizational innovations for "living with the semi-arid," emphasizing the empowerment of rural communities and the mediating role of advisory organizations.

With the institutional dismantling that began in 2016, the budgets of federal policies for rural development focused on family farming saw a significant reduction. However, relevant public investments were continued in the territory with the policies and programs of the state government of Bahia, such as the state ATER policy. As of 2015, the state government established offices of the Territorial Service for the Support of Family Farming (SETAF), part of the State Policy for Territorial Development instituted the previous year.

The Pro Semi-Arid Project (PSA), the result of a loan agreement between the government of Bahia and the UN's International Fund for Agricultural Development (IFAD), is among the public actions established. Coordinated by the Secretariat of Rural Development (SDR) through CAR, the project has been implemented since 2016 in partnership with NGOs. Its implementation is conducted through participatory planning and combines technical advisory activities, training, and financial resources to structure agroecosystems and communities. Among the investments directly supported by the project in the communities are economic beds for vegetable production, cisterns and water tanks, aviaries, beekeeping equipment, construction or renovation of goat and sheep pens, and the acquisition of forage machines.

The project also supports agro-industrialization and the commercialization of production. The PSA is applying R$ 300 million – U$ 55,3 million (up to August 2021), involving 70,000 families in 32 municipalities in five identity

territories of Bahia's semi-arid region: Sertão do São Francisco, Bacia do Jacuípe, Piemonte da Diamantina, Piemonte Norte do Itapicuru and Sisal.

As in the next section, the federal and state policies and programs have been crucial for socio-technical innovations to have unfolded at the level of family units and rural communities, with positive effects for the economy and food security of families and the territory.

Capturing change: when redistribution boosts autonomous and resilient economies

"Here is a very dry region, but we are always living here, you know? Only that the means for us to survive are better than before." Gracinha Gomes de Almeida, farmer in the municipality of Remanso, Bahia

This section synthesizes the economic-ecological analysis of the 12 agroecosystems studied in the territory. Initially, we present the analysis of the economic effects generated by the integration of families into socio-technical innovation networks promoted or stimulated by public policies and programs, with emphasis on PSA. We then present and discuss the effects on the systemic attributes of agroecosystem sustainability.

Changes in economic performance

Table 1 presents the 12 agroecosystems analyzed. Beyond identifying the municipality of location, it presents the composition of the Social Nucleus of Agroecosystem Management (SNAM) and the age of each member of the nucleus. It also presents indicators and information on the annual economic production of agroecosystems.

Table 1: Characterization of the analyzed agroecosystems - composition and economic data corresponding to the 2018 annual cycle (Agroecosystems 1 to 5: analyzed cycle February/2018 to January/2019; Agroecosystems 6 to 12: October/2018 to September/2019).

Agroecosystem and municipality	Number of people and age members of SNAM (February 2020)	Size of the area (ha)	Agricultural income (reais)	MAI/AI (%)	Endogeneity index (AV/GI)	Monetary profitability	AI/ TI (%)	ISP /TI (%)	PI/TI (%)	Non-agricultural income sources	Main productions sold
AE 1 - Juazeiro	(3 persons) M: 40 and 8; W: 28	3 + CUP	37.732	87	0,75	1,82	62	3	35	School transport, social policies	Tomatoes, goat meat and sheep meat
AE 2 - Juazeiro	(6) M: 35, 19, 18, 13 W: 35 and 6	5 + CUP	9.128	6	0,79	0,19	38	11	51	Cleaning services, masonry, per diems, social policies	Goat meat and eggs
AE 3 - Juazeiro	(4) M: 58, 32 and 30 W: 54	97 + CUP	29.008	58	0,86	2,94	55	22	23	Mason, social policies	Poultry, meat of goats and sheep, eggs
AE 4 - Juazeiro	(4) M: 38 and 46 W: 39 and 80	18 + CUP	13.922	72	0,73	1,53	52	18	30	Sale of handicrafts, per diems, remittance of relatives, social policies	Eggs, coriander, palm and paprika
AE 5 - Sobradinho	(3) M: 18 W: 76 and 19	11,5	16.901	46	0,94	4,36	58	42	Zero	Retirement	Goats, vegetables and chickens
AE 6 - Casa Nova	(3) M: 63 W: 30 and 31	41 + CUP	9.131	32	0,88	1,88	25	36	39	Retirement, civil service, seamstress, lunch lady	Cattle, pigs and sheep
SA 7 - Sento Sé	(3) M: 70 W: 59 and 94	50 + CUP	22.240	65	0,81	2,33	40	47	13	Sale of bakery products, retirement, social policies	Lettuce, cabbage, umbu and mango pulp, cheese
SA 8 - Sento Sé	(4) M: 45, 15 and 10 W: 40	67 + CUP	6.656	30	0,93	2,17	31	14	55	Civil service, mechanical, social policies	Goats and cheese
SA 9 - Remanso	(4) M: 28 and 26 W: 72 and 52	58 + CUP	9.783	58	0,89	3,07	39	61	Zero	Retirement, social policies	Forage and silage seedlings
AE 10 - Remanso	(4) M: 58, 28 and 22 W: 31	30 + CUP	5.888	27	0,76	0,64	20	49	31	Mechanic services, mason, fence construction, retirement	Honey, goats, sheep and cattle
AE 11 - Uauá	(3) M: 69 and 35 W: 62	35 + CUP	48.460	55	0,93	5,12	68	32	Zero	Retirements	Umbu, yuca and coriander
SA 12 - Campo Alegre	(4) M: 45 W: 44, 23 and 21	82 + CUP	34.506	53	0,94	2,48	62	21	17	Diary, social policies	Cattle, honey, watermelon and corn
Average	**3,75 (persons/AE)**		**20.280**	**49**	**0,85**	**2,38**	**46**	**30**	**24**		

Legend – SNAM: Social Nucleus of Agroecosystem Management; CUP: Common-Use Pastureland; AI: Agricultural Income; MAI: Monetary Agricultural Income; AV: Added Valeu; TI: Total Income (agricultural income + income from social policies + income from pluriactivity); ISP: Income from social policies; PI: Pluriactivity income; GI: Gross Income (excluding non-farm income); M: men and boys; W: women and girls. Prepared by the authors.

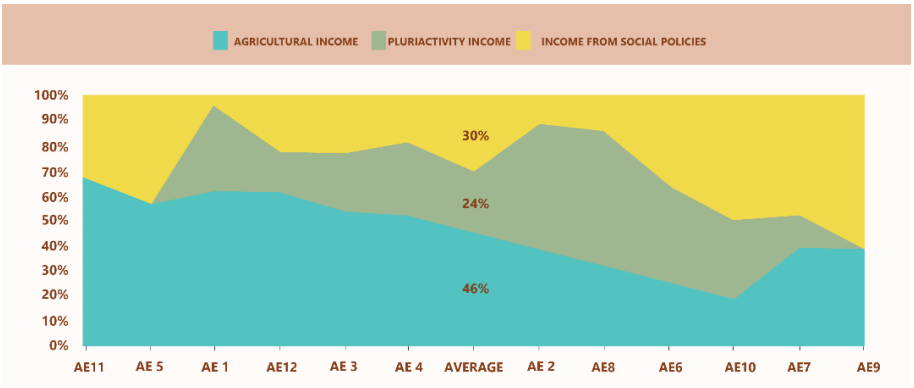

Figure 2. Proportional contributions of agricultural income, pluriactivity, and social policies for farming families.

Sertão do São Francisco Territory, Bahia.

The average agricultural income in the annual cycle analyzed was R$ 20.280 (U$ 3,738), representing 46% of the total income of the families. The lowest percentages were 25% and 31% and the highest, 68% and 62%. In half of the agroecosystems analyzed, agricultural income was higher than 50% of the total income. The average income from social policies corresponded to 30% of the total income and pluriactivity, 24% (Figure 2). The data reveals the recurring importance of pluriactivity for the total income of families, although with great variation between the cases. They converge with Wanderley and Favareto (2013); thus, pluriactivity does not necessarily mean abandoning agricultural activities. As became clear in the elaboration of the agroecosystem timeline, resources mobilized by pluriactivity reinforce the economic-ecological reproduction strategies of agriculture. Therefore, they are largely invested in the expansion of the self-controlled resource base (family assets), contributing directly to increasing the autonomy and resilience of the agroecosystems. Notably, part of this income from pluriactivity is from services provided in the rural communities, such as bricklaying, carpentry, and sewing. Hence, these jobs are invested in strengthening the working conditions of neighbors and the community.

The same applies to resources from retirement, pensions, and other social policies. As noted below, the agroecosystems produce a significant proportion of the food consumed by families, freeing up pension resources for investment in expanding family assets. From this perspective, these resources redistributed by the State as a vested social right induce rural development dynamics, particularly through the strengthening of family farming.

This diversity of incomes is essential in strengthening the agroecosystem resilience by ensuring the continuity of income in periods of prolonged droughts, a condition that worsens with global climate change. This stabilization of income levels reduces the risks of subsystem deactivation or migration in search of work, as was prevalent in the 20th century. However, diversity increases the investment capacities of households when the rains return to normal after periods of drought. Figure 3 shows the composition of gross product (average of the 12 agroecosystems) in the analyzed annual agricultural cycle (2018).

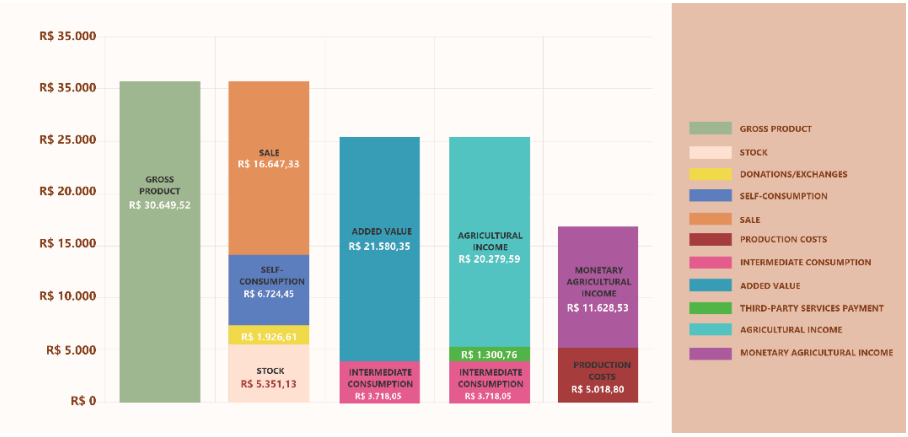

Figure 3. Composition of Gross Product (average of the 12 agroecosystems) in the 2018 annual cycle. Territory of Sertão do São Francisco, Bahia.

The average gross non-monetary agricultural income corresponded (in 2018) to the amounts produced for self-consumption and donated by the families (R$8,651.06, 78% for self-consumption and 22% for donations). This data shows the contribution of diversified production in agroecosystems to the food security of families and rural communities. Some donations go to children living in urban areas or even distant cities. Though unquantified, food donations from relatives and friends reinforce food security levels and strengthen economies of reciprocity in the territory.

Part of the production was not consumed or marketed in the annual cycle analyzed, becoming stocks of resources to be realized as income in subsequent production cycles. On average, these stocks amount to R$ 5,531.13 and mainly comprise goat and sheep meat and, in some cases, cattle. This stockpiled resource produced in 2018 results from increased biodiversity in agroecosystems, community management of pasture land, increased water storage capacity, and good rainy seasons in previous years. These saved resources confer economic and productive stability to the subsequent production cycle. The average production

costs were R$ 5.018,80, of which 26% were used to pay third-party services, and the rest, purchase inputs. The average annual expenditure of the 12 families for third-party services was equivalent to 1.3 minimum wages, representing a significant contribution to the territory's economy, given that most of this expenditure is allocated to the remuneration of local workers.

The average added value of the 12 agroecosystems was R$21,580.35. Discounting the payment to third parties yields an average agricultural income of R$ 20,279.59, representing 20.3 minimum wages per family nucleus in the study period. The average monetary agricultural income was R$ 11,628.53 (11.7 minimum wages).

Effects of the Pro-Semiárido Project

When sizing the variation between the real economy of agroecosystems with the simulated economy by subtracting the economic-ecological effects generated by innovations incorporated from the incidence of PSA, the study identified that the program contributed to the average increase of 17.7% in the gross product (from R$26.050.36 to R$ 30,649.52), 22.7% in agricultural income (R$ 16,529.74 to R$ 20,279.59), and 33.9% in monetary agricultural income (R$ 8,681.93 to R$ 11,628.53).

The simulation also indicates the significant role of innovations to increase production for self-consumption and donations (average variation of 10.2%). There was also a 24.1% increase in income generated from produce sales, an increase made possible by proximity markets, such as door-to-door sales (for families and local businesses), fairs in the municipalities, the vigorous local market for goats and sheep, and the sale of processed fruit pulp, especially umbú (*Spondias tuberosa*). These increases in agricultural monetary and non-monetary income show that the significant contribution of PSA to the increase in families' monetary income did not happen at the expense of food production for self-consumption and donations. In addition to the quantity, the diversity of self-consumed food also increased. This aspect reveals the importance of public policies and programs recognizing and valuing the productive diversity of family farming and its economic strategies.

By adopting a systemic approach to guide actions, the program is a clear counterpoint to the dominant logic of public investment, generally focused on a few production chains that often induce families to increase their dependence on input and food markets. Although average increases in production costs of around 6% were identified, the average endogeneity index (value-added/gross income) was 0.85. The simulation showed that without the socio-technical innovations provided by PSA, this index would be 0.80. The PSA also increased labor

productivity (in the 2018 cycle, it was R$7.86 per hour worked; without the innovations, it would be R$7.07). The high endogeneity indices and the increase in labor productivity show that the economic performance of the agroecosystems is based on the intensification of labor and not the high consumption of capital.

Changes in systemic qualities

The radar graph (Figure 4) represents the average of the changes related to the autonomy attribute of the 12 agroecosystems. The autonomy index (a composition of the variations identified in the parameters related to this attribute) varied from 0.67 in the baseline year to 0.76 in 2019.

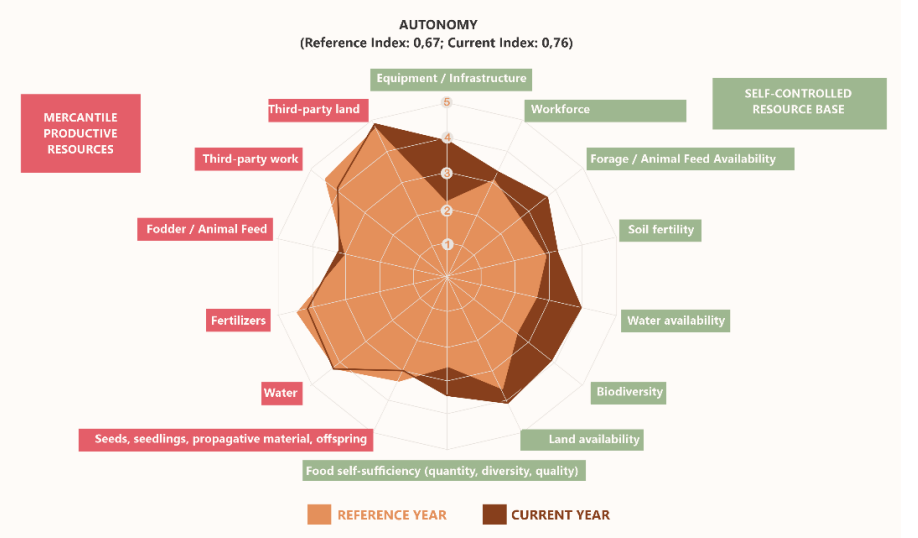

Figure 4. Visual representation of qualitative changes related to the sustainability autonomy attribute - average of the 12 agroecosystems.

The chart reveals that, in general, there has been no significant increase in dependence on market productive resources (parameters on the left). A small reduction in autonomy was identified in the "third-party work" parameter, a fact associated with the increased complexity of managing agroecosystems. It is also possible to identify that families resorted (and resort) to markets to buy animal feed and seeds. Regarding "seeds and seedlings," there was a slight increase in the dependence on markets, mainly given the demand for vegetable seeds and fruit tree seedlings with the installation of economic garden beds and the expansion of backyards. Regarding fodder, there was a slight reduction in market purchases.

The survey showed changes in all parameters of the resource base self-controlled by the families (parameters on the right of the graph). The most significant changes were identified in the "equipment/infrastructure" (with average variation from 2.17 to 3.92), biodiversity (2.58 to 3.83), and water availability (2,67 to 3,92) parameters. The average scores attributed to the parameter "Forage / Animal Feed Availability" evolved from 2.67 to 3.67, and that for "Food self-sufficiency," from 2.58 to 3.42.

The study of the trajectories of the agroecosystems shows that the construction of infrastructure and acquisition of equipment were made possible, above all, by the programs for "living with the semi-arid region," implemented by ASA's member organizations (P1MC and P1+2), other federal policies, such as the Luz para Todos (Light for All) Program, and the PSA. They were also built or purchased with the families' own accumulated resources.

The greater water availability increased biodiversity, whether of fruits, vegetables, and medicinal plants in the backyards or fodder species. The PSA increased the self-controlled resource base by providing families with access to cisterns, aviaries, economic beds with shaded nurseries, fodder machines for collective use, boxes for beekeeping, and beekeeping equipment. In some cases, it allowed for renovating goat and sheep shelters (apriscos) and setting up fodder production areas. The "Brasil sem Miséria (Brazil Without Misery) Plan" also contributed to the expansion of biodiversity by enabling the planting of forage species and the purchase of animals, including breeding stock.

Innovations have led to an increase in and diversification of production for families' consumption. The "land availability" parameter changes regard the families' greater engagement in networks that mobilize to defend the recognition and guarantee of the territories of the traditional pastureland communities, the certification of some of the communities by the government of Bahia as traditional pastureland communities, and, in some agroecosystems, the acquisition (purchase or donation) of plots of land in the study period.

The integration of families into socio-technical learning networks was crucial for the qualification of the workforce. However, the analysis shows limitations to this parameter, associated with the dedication of members of many of the 12 families to non- and off-farm work and, in some cases, the recent migration of young people.

Figure 5 presents qualitative changes in the parameters related to the social integration attribute (average of the 12 agroecosystems). The synthetic index ranged from 0.43 (reference year) to 0.70 (2019).

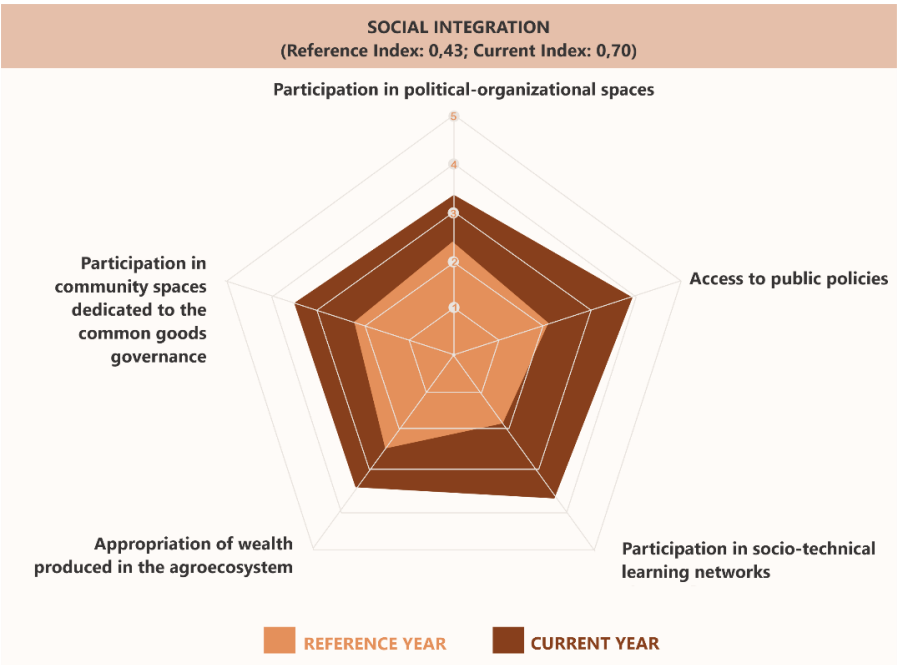

Figure 5. Representation of qualitative changes related to the sustainability social integration atribute - average of the 12 agroecosystems

All parameters show positive changes. Changes related to the parameter participation in community spaces dedicated to the common goods governance (2,17 to 3,42) refer, for example, to the intensified involvement of families in the management of areas of community use, such as pasturelands, water infrastructure, and fences. Some families also manage collective equipment, such as forage machines and beekeeping equipment.

Greater appropriation of the wealth produced in agroecosystems results from families' increased participation in direct sales initiatives, engagement in associations and cooperatives that market the production of the communities, and integration to events where the production is sold, creating their own clientele.

Positive changes were identified in the participation of families in political and organizational spaces, such as rural workers' unions, community associations, articulations of pastureland communities, and women's networks and groups. Families also engaged in PSA instances in rural territories, such as social control commissions.

The most significant qualitative changes in the "social integration" attribute refer to "access to public policies" (average range from 2,08 to 3,92) and "participation in socio-technical learning networks" (1,75 to 3,58).

In recent history, families accessed a significant set of public policies, such as P1MC, P1+2, and ATER. Moreover, many communities have benefited from the Luz para Todos Program. Access to social policies, mainly retirement, and public education, such as access to university and high school, were also identified. Some communities had projects executed with public institutions, such as the Brazilian Agricultural Research Company (EMBRAPA) Semi-Arid and the Federal University of the São Francisco Valley (UNIVASF). Others benefited from projects supported by the Ministry of Environment, such as initiatives for the recovery of degraded areas and the construction of toilets and ecological stoves in Sento Sé, or from projects supported by Petrobras (Brazilian Petroleum Company), such as native vegetation recovery initiatives by the NGO IRPAA.

The significant changes regarding "access to public policies" in recent years are mainly because of the participation of families in the PSA. Its implementation in the semi-arid region of Bahia, starting in 2016, coincided with the period when several federal public policies, such as the Cisterns Program and the National Technical Assistance Policy, began to be dismantled. Currently, the PSA is among the most comprehensive public programs aimed at rural communities in the territory. Beyond access to infrastructure and equipment, it has provided many opportunities for exchange among families, their interaction with the CAR's technical teams and the NGOs responsible for technical assistance, and participation in project management.

The program also invests in productive inclusion policies of food safety, such as the territorial Municipal Inspection Service (SIM) (a sanitary inspection service for food of animal origin). It directly supports local markets of family farming production, such as fairs and other marketing venues.

The public policies and programs identified in the trajectories of all the families (P1MC, P1+2, ATER, and PSA) have something common: the actions conducted directly in the communities were (are) developed by NGOs working in the communities for many years (IRPAA, SASOP, SAJUC, and COOPERCUC), given the significant changes in the "participation in socio-technical learning networks" parameter. Although the communities are recent members, these networks date back to the 1980s. The public policies that gained greater scale from the 2000s expanded and densified socio-technical innovation networks. All the families of the agroecosystems dedicated time to participate in meetings, exchanges, courses, workshops, mutual aid activities and to receive visits from the technical teams.

The radar graph (Figure 6) represents the qualitative changes regarding the responsiveness attribute. The synthetic index of this attribute varied from 0.46 in the reference year to 0.68 in 2019.

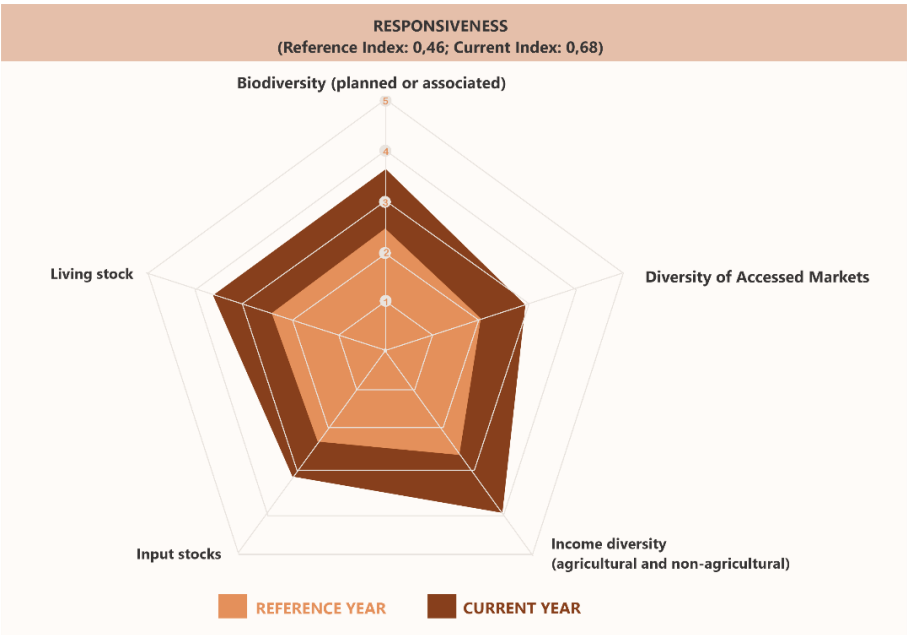

Figure 6. Visual representation of qualitative changes related to the sustainability responsiveness attribute - average of the 12 agroecosystems

Responsiveness is related to the internal mechanisms that give the agroecosystem the ability to respond to changes in its social, economic, and environmental system beyond the control of the SNAM, which may negatively or positively affect its economic-ecological performance. It is an attribute that incorporates four systemic qualities: stability, flexibility, resistance, and resilience (PETERSEN et al., 2017).

The capacity to store inputs (water and fodder) and live stocks increased, mainly given the increase in goats, sheep, chickens, the acquisition of cattle and diversification, and the area cultivated with forage species. The management work of the pastureland areas also contributed to the increase in live stocks.

Families accessed a greater diversity of markets, with the expansion of chicken farming, cultivation of vegetables, and their selling in local markets directly to consumers. They never ceased valuing other traditional markets, such as meat from goats, sheep, and cattle, or conventional markets to which they already had access, such as the honey market.

Significant changes regarding the parameter "income diversity" were also identified. Innovations in managing agroecosystems and access to markets, social policies, and income from pluriactivity gave the agroecosystems a greater capacity to resist the effects of the great drought between 2012 and 2018. The drought

warned families about the importance of investing in forage and water storage. Many infrastructures were built during the driest years with public policies, notably the P1+2 and Brazil Without Misery Plan. These innovations induced the rapid recovery of the productive capacity of these agroecosystems with the good rainy seasons that began in 2018.

The radar chart in Figure 7 indicates the qualitative changes related to gender equity and women's empowerment. The synthetic index of 0.45 in the reference year, increased to 0.58 in 2019.

Women's participation in socio-organizational spaces and as direct beneficiaries of public policies evolved, directly reflecting their increased participation in agroecosystem management and the appropriation of the wealth generated.

The changes mainly regard innovations in subsystems to which women dedicate more working time and whose products are marketed or used for self-consumption and donations, such as vegetables, fruit, and chicken production. Social spaces created or strengthened through the PSA promoted new interactions that contributed to the emancipatory struggles of women and addressed situations of isolation to which they are often subjected by the social relations established within families.

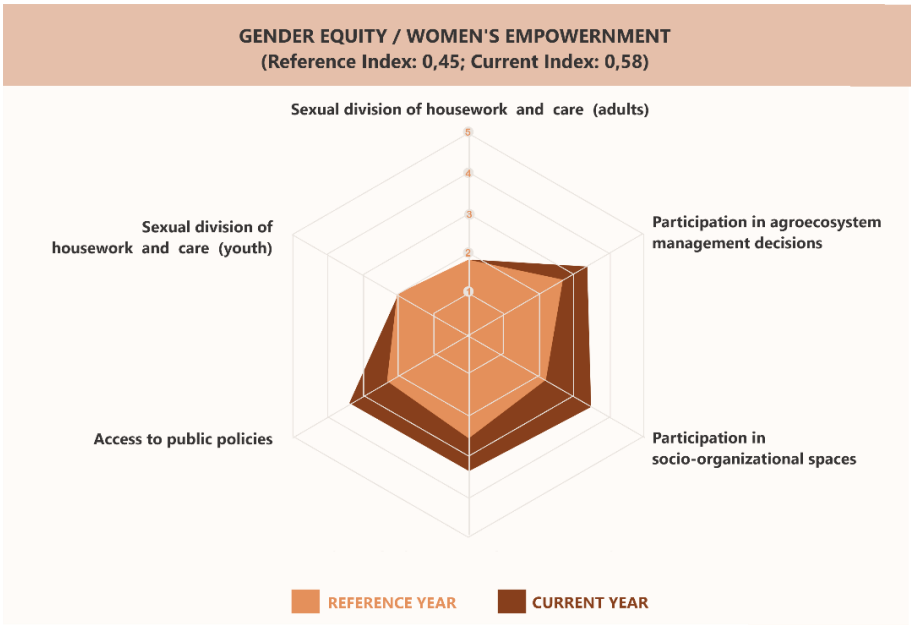

Figure 7. Visual representation of qualitative changes related to the sustainability gender equity and women's empowerment attribute - average of the 12 agroecosystems.

The increased social participation of women provides access to knowledge, greater self-confidence in decision-making, and opportunities to establish new business relationships.

Women spend 23 times more hours on domestic and caregiving work than men; thus, they are overloaded, and there is an unequal division of tasks. The fact that there have been no qualitative changes in the "sexual division of domestic and care work" parameter in the study period shows the persistence of the socio-cultural characteristics associated with patriarchy, indicating the importance of intensifying the spaces for critical reflection on this issue to the organizations of the territory.

Moreover, for the 12 agroecosystems, men dedicate more time (on average) to paid activities outside their farms (three times more than women). Women also dedicate more time (twice that of men) to social participation.

Furthermore, women work in various subsystems that make up the agroecosystems, and there are no marked differences between the time invested by women and men in the sphere of work for market and self-consumption.

The Lume method assumes domestic and care work and the time dedicated to social participation are equivalent to the tasks dedicated to production for market or self-consumption. Hence, as per Feminist Economics (CARRASCO, 1999), all spheres of work make an equivalent contribution to the generation of wealth in the agroecosystem. Accordingly, the analysis of the 12 agroecosystems reveals that women contribute 87.4% more than men in generating the annual income of the families (excluding income from social policies).

The women's agroecological booklet (Cadernetas Agroecológicas) has contributed to removing from spotlighting and valuing the work and production by women. The booklet, a methodology developed by the Women's Working Group of the National Agroecology Network (Articulação Nacional de Agroecologia - ANA), has been successfully taken up by the PSA, highlighting the importance of unveiling the determining role of women as a strategy for strengthening their struggles for economic and political emancipation.

Thus, gender inequalities become an object of political debate to be incorporated into strategies to change the social, economic, and cultural reality in the rural world.

New markets built from the intensification of women's social participation and investments from public programs, such as P1+2 and PSA, in subsystems in which they play a leading role, such as vegetables and fruit production close to their homes and rearing chickens are innovations that contribute to agroecosystem resilience. In the last great drought, given short production cycles, families

rapidly increased the supply of food for their consumption and sale as soon as rainy seasons regularized or when market opportunities arose.

Final considerations

The changes in the living and working conditions of the rural communities of the Brazilian semi-arid region have been significant since the 1980s, given the re-democratization. The study of the trajectories of socio-technical innovation of agroecosystems in the Territory of Sertão São Francisco revealed deep transformations in the logic of management in family farming over the last decades. This process intensified over the last 20 years with innovative and comprehensive public policies. The transformations have increased the resilience and autonomy of family farming, helping overcome the structural conditions of poverty reproduction.

It was possible to identify a determining role for public policies created after the 1988 Constitution. The official recognition of the specificities of family farming from the second half of the 1990s onwards inaugurated a virtuous circle of political-institutional innovation. This process intensified in the 2000s, recognizing family farming as a central, social, and economic agent for promoting food and nutritional security and the fight against poverty, which are central points on the political agenda of the Lula and Dilma governments.

Thus, recognizing the role of family farming as a promoter of rural and agricultural development, this cycle brought new relationships between the State and civil society, with the establishment of spaces for social participation in the co-management of public policies. It was a determining condition for the State, at the federal level, to become more permeable to proposals from social experience. In the wake of this process, spaces for the co-management of public policies were also created in some federation states, such as Bahia. Through the initiative of the state government in interaction with civil society organizations, the territorial development policy created at the national level was incorporated and improved, becoming a reference for allocating and managing public policy resources for the rural world of Bahia.

We analyzed the combined effects of the federal and state policies on the trajectories of the 12 agroecosystems and identified a recurring pattern of dynamics of socio-technical transformation. The following aspects of this pattern are as follows:

- A significant increase in the participation of family members in associative and cooperative processes within their communities and territories. Through different collective action mechanisms promoted by public policies, cooperative processes have been created or improved, strengthening local networks

for the management of common goods. The improvement of pastureland management practices, the associative management of equipment and artisanal processing practices, the construction of new markets, as well as the creation of circuits for the production and circulation of knowledge based on the valorization of experiences and exchanges between farming families are examples of the greater integration of families in socio-technical networks at territorial level. In the study, this greater integration of families managing agroecosystems was captured by the evaluation parameters proposed by the Lume method. According to this evaluation, the Social Integration Index varied from 0.43 to 0.70 (on a scale of 0 to 1) over the last few years as a result of the involvement of these families in rural development programmes with a territorial focus carried out by NGOs in the region with public policy resources.

- Encouraging productive diversification by valuing agrobiodiversity (plant and animal) and the maintenance and ecological integration between subsystems. In addition, the recognition and valorization of common use pasturelands allows the maintenance of agricultural landscapes that conserve native biodiversity, fulfilling important economic and ecological functions for family farming. This orientation towards the development of agroecosystems allows for the continuous regeneration of soil fertility and animal feed through the management of locally produced biomass. It also makes it possible to maintain the health of crops and livestock through the effect of biotic self-regulation. Finally, it contributes to the strengthening of family autonomy in relation to the genetic resources used in production processes.
- Financing (refundable and non-refundable funds) essentially structures production units and communities, contributing to the appropriation and storage of ecological goods and increasing labor productivity. Water infrastructure; fencing areas for recovery of native vegetation (*recaatingamento*); structuring backyards, facilities and equipment for animal breeding; fostering beekeeping; equipment for family or collective use for processing, transportation and production commercialization are examples of public investments that allow for productive intensification of agroecosystems without structural dependence on banks and suppliers of industrial inputs.
- Support the construction of local markets, bringing together producers and consumers in the territory, boosting the economy of family farming based on the revaluation of the local food culture and, therefore, of agrobiodiversity. At the same time that these short commercialization circuits supported by the policies allow greater retention of the added value by farming families,

it provides access to healthy food for the local population at fair prices. As markets that absorb the diversity of production, these marketing circuits generate reverse effects on production systems by encouraging productive diversification, an aspect already discussed above. It is worth highlighting the effect of these trajectories on the increase in the quantity and diversity of production self-consumed by families and donated through reciprocal relations established in the communities.

- Recognition and appreciation of the work of women farmers through the creation of specific spaces for their participation in the processes of knowledge construction and management of collective enterprises and by financing of economic activities carried out by women within agroecosystems. While the active participation of women in the dynamics of socio-technical innovation proved decisive in reconfiguring the economy of agroecosystems (with an increase from 0.45 to 0.58 in the index of women's empowerment), spaces were created for critical reflection on the blockages imposed by patriarchal culture on the transformation processes underway. It is clear that the transformation of gender relations in families and family farming organizations is a prerequisite for unblocking socio- technical and economic transformation trajectories in agroecosystems and territorial innovation networks. In this sense, the contributions of feminism have been fundamental in institutional innovation cycles, particularly in the creation of public policies for rural and agricultural development.

These aspects converge toward a pattern of development of agroecosystems and territorial economies based on the continuous increase of the local and self-controlled resource base. It means a pattern of endogenous development that recognizes and valorizes territorial resources, whether ecological assets or latent socio-cultural capacities. The innovation trajectories driven by public policies are characterized precisely by the mobilisation and combination of these endogenous resources in order to develop autonomous economies that value family farming work.

From this point of view, the policies that allowed the trajectories analysed in the study contrast head-on with the dominant public policies for agriculture and rural development. This contrast can be verified even in the territory analyzed. In this territory, there are trajectories in which intensification results in the deforestation of the native vegetation (*caatinga)* and the growing dependence of agriculture on exogenous resources mobilized through markets. These trajectories of intensification based on intensive use of capital lead to specialized

agroecosystems, predominantly for export and dependent on agrochemicals and intensive irrigation with water from the São Francisco River.

In the global climate change context, whose negative effects on agricultural systems will tend to be more pronounced in semi-arid regions, development trajectories that combine economic intensification with technical autonomy highlight promising paths for public policy designs. Instead of the economic productivism that continues to guide policy design, the approaches highlight the possibility of developing multifunctional agriculture that can combine structural poverty alleviation and the regeneration of the biophysical base of agricultural ecosystems with the promotion of more resilient economic-ecological systems.

The study verified that the innovations incorporated into the agroecosystems in the period considered in the trajectory analysis strengthened various systemic safety mechanisms, which resulted in an increase in the average responsiveness index of the 12 agroecosystems from 0.46 to 0.68.

The main lesson that can be drawn from the analysis of the trajectories studied for the design of public policies is that the territorial approach of rural development programs should be oriented toward recognizing and strengthening multi-actor socio-technical networks in the territories. The changes verified at the scale of the agroecosystems studied resulted directly from the structural linking of these units in the networks organized in the territory of Sertão do São Francisco. This finding indicates the need to substitute the preferential focus of public policies for rural development: from family units, conventionally assumed as individual enterprises vertically linked to commercial chains commanded by extraterritorial actors, to the dynamics of collective action led by networks of social organizations in the territory.

In this process of forming territorial networks, the role of mediation assumed by Technical Advisory organizations based on the principles of agroecology stands out. This mediation occurs in two main directions. Vertically, these organizations plays an important role in mobilizing and giving strategic coherence to the public policy resources of different functional sectors of the State.

As became evident in the trajectories of the agroecosystems, the resources mobilized from different policies were combined with each other and associated with the resources of the territory, gradually expanding the self-controlled resource base on which family and community economies are reproduced. Horizontally, the mediation of technical advisory public services is done in the sense of fostering environments for socio-technical innovation in the territory through methodological approaches that recognize the role of farmers as bearers of knowledge and that create bridges with academic institutions for the dialogue of knowledge related to the reality of the territory.

References

CARRASCO, Cristina. **Mujeres y economia: nuevas perspectivas para viejos problemas.** Barcelona: Icaria, 1999.

CAZELLA, Ademir A., BONNAL, Philipe e MALUF, Renato S. Multifuncionalidade da agricultura familiar no Brasil e o enfoque da pesquisa. In: CAZELLA, Ademir A., BONNAL, Philipe e MALUF, Renato S. (orgs.) **Agricultura familiar – multifuncionalidade e desenvolvimento territorial no Brasil.** Rio de Janeiro. Ed. Mauad. 2009. p. 47-70.

GERMANI, Guiomar; OLIVEIRA, Gilca G. de. (Coordenação). **Mapeamento das Comunidades de Fundo e Fechos de Pasto no Estado da Bahia: relatório técnico**. Salvador: UFBA/GeografAR/Sepromi, 2020, 750 p.

GONZÁLEZ DE MOLINA, Manuel; PETERSEN, Paulo. F.; PEÑA, Francisco G.; CAPORAL, Francisco R. **Political Agroecology: advancing the transition to sustainable food systems**. CRC Press: New York. 2020. 201 p.

GRISA, Cátia e SCHNEIDER, Sérgio. Três gerações de políticas públicas para a agricultura familiar e formas de interação entre sociedade e Estado no Brasil. p. 19-52 In: In: GRISA, Catia e SCHNEIDER, Sergio (organizadores). **Políticas públicas de desenvolvimento rural no Brasil.** Porto Alegre: Editora da UFRGS, 2015. 624 p.

MORIMURA, Michelle Midori. **Governança de Recursos de Base Comum e capacidade adaptativa de comunidades de Fundos de Pasto.** Brasília, 2015. 293 p. Tese de Doutorado. Centro de Desenvolvimento Sustentável. Universidade de Brasília. Brasília.

MOTTET, A.; et alli Assessing Transitions to Sustainable Agricultural and Food Systems: A Tool for Agroecology Performance Evaluation (TAPE). **Frontiers in Sustainable Food Systems.** 2020

PLOEG, Jan Dowe van der. **The virtual farmer**: past, present, and future of the Dutch peasantry. Assen: Royal van Gorcum, 2003.

PETERSEN, P. Agroecologia e a superação do paradigma da modernização agrícola. In: NIEDERLE, P.; ALMEIDA, L.; VEZZANI, F.M.. **Agroecologia**: práticas, mercados e políticas para uma nova agricultura. Kairós, São Paulo, 2013

PETERSEN, P.; SILVEIRA, L. M. da; FERNANDES, G. B.; ALMEIDA, S. G. de. Método de análise econômico-ecológica de agroecossistemas. Rio de Janeiro: AS-PTA, 2017. 246 p.

PETERSEN, Paulo (ed.) Agroecologia: pela democratização dos sistemas agroalimentares - **Revista Agriculturas: experiências em agroecologia**. v.14, n.1, p. 33, mar. 2018

SABOURIN, Eric; CARON, Patrick; SILVA, Pedro Carlos Gama da. O manejo dos "Fundos de Pasto" no nordeste baiano: um exemplo de reforma agrária sustentável. In: *Raízes*. Ano XVIII, Nº 20. Novembro/1999, p. 90-102

SANTOS, B. S. **A crítica da razão indolente contra o desperdício da experiência**. São Paulo: Cortez, 2000.

SCHMITT, Claudia J.; PORTO, Silvio I.; LOPES, Helena R.; LONDRES, Flavia; MONTEIRO, Denis; PETERSEN, Paulo; SILVEIRA, Luciano (org.) **Redes de agroecologia para o desenvolvimento dos territórios: aprendizados do Programa Ecoforte**. Rio de Janeiro: Articulação Nacional de Agroecologia — ANA, 2020. 304 p.

SCHNEIDER, Sergio. Situando o desenvolvimento rural no Brasil: o contexto e as questões em debate. **Revista de Economia Política**, vol. 30, n. 3 (119), jul/dez 2010. p. 511-531

SCHNEIDER, Sergio. A abordagem territorial do desenvolvimento rural e suas articulações externas. **Sociologias**, Porto Alegre, ano 6, n. 11, jan/jun 2004. p. 88-125.

SILVA, Roberto M. A. da **Entre o Combate à Seca e a Convivência com o Semi-árido**: transições paradigmáticas e sustentabilidade do desenvolvimento. Fortaleza: Bando do Nordeste do Brasil, 2008. 276 p.

WANDERLEY, Maria de Nazareth Baudel e FAVARETO, Arilson. A singularidade do rural brasileiro: implicações para as tipologias territoriais e a elaboração de políticas públicas. In: MIRANDA, Carlos e SILVA, Heithel (Org.) **Concepções da ruralidade contemporânea: as singularidades brasileiras.** Brasília: IICA, 2013. (Série Desenvolvimento Rural Sustentável; v.21) 476 p. p. 413-472

CHAPTER 12

Peasants, agroecology, and territorial policy in the "dry diagonal" of the semi-arid region of Paraíba: encounters, processes, and challenges

Márcio Caniello, Mireya Valencia Perafán

Introduction

Located in the heart of the Brazilian semi-arid region, Paraíba has a significant peasant population, whose formation dates back to the dawn of the XVIII Century. At the end of the 1950s, after centuries of socioeconomic exclusion and political under-mission forced by the dominant oligarchies, the peasants of Paraíba organized themselves politically in the Peasant Leagues, soon crushed by the military dictatorship and its acolytes. However, with the process of "political opening" initiated in the mid-1970s, farmers from Paraíba led social, political, and productive organizations through the articulation of social movements, rural unions, collectives, associations, and cooperatives of family farmers, with institutional partners such as NGOs, organized civil society, international cooperation organizations, and public universities as allies.

At the threshold of the 21st century, this interactive dynamic would result in consolidating the paradigm of "living with drought" and agroecology as strategies for survival and reproduction of the peasant population of Paraíba, notably in its extensive semi-arid portion. It is done through initiatives such as developing appropriate technologies and coping with drought, creative innovations in the production and storage of fodder for small livestock, diversifying plant and animal species in family production, disseminating creole seed banks, and multiplying organic crops, and small farmers' markets.

Given this organizational accumulation in the so-called "family farming," Paraíba was a key state in the conception, construction, and execution of the territorial development strategy in Brazil, an "institutional innovation" to improve

the lives of peasant populations and contribute to the food sovereignty of the Brazilian population and central objectives of the public policies implemented on a large scale by the governments of Luís Inácio Lula da Silva (2003-2010) and Dilma Rousseff (2011-2016).

This study reports on this historical construction and analyzes the dialectics between the Paraiban peasantry, their organizations, and allies with the territorial policy of the Federal Government (2003-2016) in the so-called "dry diagonal" of the Paraíba semi-arid region, which comprises the Rural Territories of Borborema, Western Cariri, Eastern Cariri, Curimataú, and Seridó, approved by the National Council for Sustainable Rural Development (CONDRAF). It analyzes the repercussions of the territorial policy and public policies of rural development, coexistence with the semi-arid, and agroecology in these territories during the Lula and Dilma governments. It also outlines challenges for their resumption given the dismantling of policies by the parliamentary-media coup of 2016, deepening under the current government.

Paraíba: territory, semi-aridity, rurality, and peasant presence

The state of Paraíba is located under the domain of hot climates of low latitudes, with average annual temperatures above 18°C (FRANCISCO, 2017). With a diversified relief and varied soils, it is crossed by the "dry diagonal" (COHEN; DUQUÉ, 2001, p. 48) at the height of the so-called "Compartimento da Borborema," which comprises a small part of the Paraíba Brejo and micro-regions of Cariri, Seridó, and Curimataú, located in the central portion of the state, where rainfall rates vary between 300 and 500 mm per year, in a regime marked by extreme irregularity (Figure 1).

Peasant presence is significant, with 125,489 farming establishments in Paraíba (77%) belonging to "family farming" in the last agricultural census (IBGE, 2017). The census excluded thousands of establishments that expanded their "pluriactivity" in the interim between its realization and the previous census in 2006 (DEL GROSSI et al., 2019), which counted 148,077 family farming establishments in Paraíba (88.5% of the total) (IBGE, 2006).

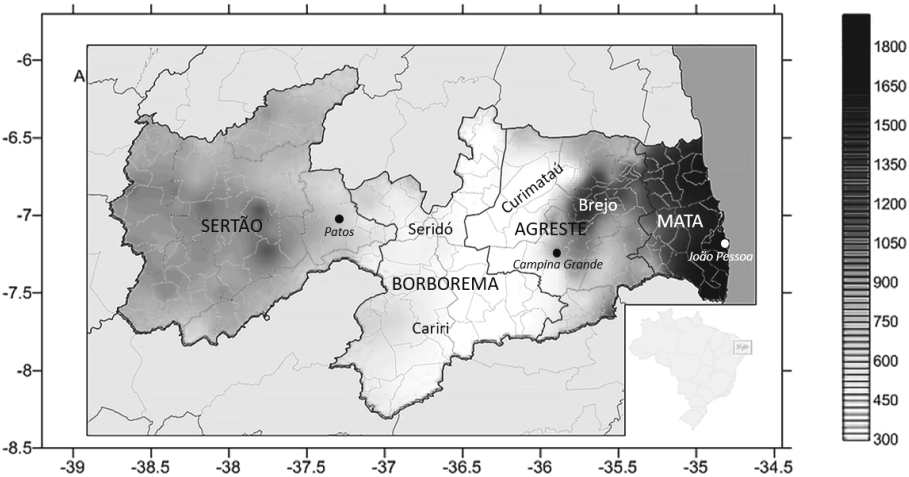

Figure 1. Average Annual Rainfall (mm), Paraíba and Mesoregions.

Source: adapted from FRANCISCO, 2017.

Considering that the articulation of agricultural activities with non-agricultural occupations by the members of the family productive unit is part of their "reproduction strategy" (SCHNEIDER, 2009) and reinforces the "peasant resistance" in the contemporary world (PLOEG, 2008), the 2006 Agricultural Census records the peasant presence in Paraíba more accurately.

Nevertheless, the peasantry is the most important actor in the Paraiban rural milieu because of its magnitude and, above all, longevity and resilience, given that the "peasantization" (PLOEG, 2008) of the Paraiban agrarian space began at the threshold of the eighteenth century, a trend observed in the "Brazilian Eastern Northeast" (PALACIOS, 1987, p. 327).

In three hundred years of peasant history, the state of Paraíba has experienced several processes of "de-pesantization" (PLOEG, 2008) of its agrarian spaces, always driven, with greater or lesser violence, by the economic interests of the ruling elites and large landowners. However, it has also experienced several processes of "re-pesantization," where the productive transitions were not in conflict with those interests but were conquered and maintained by the resilience of peasants.

Peasants of the "dry diagonal": union renewal and the encounter with the university

At the turn of the 1970s and 1980s, the Brazilian trade union movement began to regain its protagonism in an adverse context of legal casuistry,

violent repression, and cooptation of collaborationist leaderships (the so-called "pelegos") by the military dictatorship implanted in the country in 1964. Brazil was going through the "slow, gradual, and secure political opening" of General-President Geisel. The working class put pressure on the regime and the employers who benefited from it, from which emerged the so-called "new unionism" (LADOSKY; VÉRAS DE OLIVEIRA, 2014), having its turning point in the massive strikes of the metalworkers of the "ABC Paulista" led by Luís Inácio Lula da Silva.

The movement for union renewal in the cities was reflected in the countryside (FAVARETO, 2006), including in Paraíba (BERTOLAZZI, 1989), where the proprietary oligarchies, empowered by the military dictatorship and supported by the repressive state apparatus, decimated the Rural Leagues (CARNEIRO; CIOCCARI, 2011, p. 27), the first movement of political articulation of rural workers in Paraíba. The main ally of the rural workers in constructing the "new unionism" in the 1980s was the Catholic Church (BERTOLAZZI, 1989, p. 63). However, in the Compartment da Borborema, they would conquer another crucial ally: a group of professors of Marxist extraction hired in the mid-1970s to work in the Departments of Economics and Sociology and Anthropology of the UFPB, *Campus II* (now UFCG), where they would engage in an intense work of union advisory, train and form peasant leaders, and support staff to rural social movements (NOVAES, 2003, p. 133). 133) parallel to their regular teaching and research activities in an "accentuated moment of struggles and mobilizations" (BASTOS, 2010, p. 40).

The relationship between the Master in Rural Sociology and peasants and their organizations was quite organic (DUQUÉ, 2003, p. 136), with two very important "reinforcements": the Franco-Brazilian cooperation (1979/2010) and the NGOs that began to act with peasants and their organizations, such as the Popular Education Service (SEDUP) and the Program for the Application of Appropriate Technology to Communities (PATAC), which for many years was coordinated by Professor Ghislaine Duqué, an exponent of the Master's Degree in Rural Sociology of Campina Grande.

This interactive process contributed decisively to the "union renewal" in two strategic areas for the "new rural unionism" articulated by the CUT/PB since its foundation in 1984: the Brejo region of Paraíba and the then called "Agreste of Campina Grande," with a total of 39 unions of Rural Workers (STRs), 31 of which were "renewed" - or at least "shaken up" - by the action of the cultist "union oppositions" at the end of the 1980s (BERTOLAZZI, 1989 p. 127-132).

In Cariri, the dynamics of union renewal were different. The interaction with the Catholic Church was more punctual and less institutional, given that it

happened through the support of some "progressive" priests and not the CEBs. In Cariri, the process was unleashed "from within" the Federation of Agricultural Workers of the State of Paraíba (FETAG/PB), starting with the STR of São Sebastião do Umbuzeiro, among the first three to be created in the region (BERTOLAZZI, 1989, p. 246), which, unlike the other two established, was born "authentic," given that it was founded in 1974 by Luiz Silva, "a hired worker with sandals on his feet" (BATISTA, 1997, p. 41).

Thus, at the start of the 1990s, the Compartimento da Borborema had "authentic" leaders in the "renewed" unions interacting democratically with their increasingly participatory bases in the various agendas on moving reflections and struggles (BASTOS, 2010, p. 40). Leaders, unions, and bases tapped from the advice of NGOs and universities, often supported by international cooperation. The above is sufficient *background for the* "encounter" of the Borborema peasants with agroecology in the 1990s and, subsequently, territorial policy in the first decade and a half of the 21st century

Peasants of the "dry diagonal": the encounter with agroecology

At the beginning of the 1990s, the century-old ideology of "combating droughts" that had guided public policies for the semi-arid northeast began to crumble in the face of a new concept of "living with drought," formulated by EMBRAPA technicians in 1982 (SILVA, 2008, p. 71). In 1993, when another drought devastated the region, hundreds of rural workers throughout the Northeast occupied the SUDENE headquarters in Recife (DUQUÉ, 2008, p. 135-136). This public act prompted the creation of the *Northeast Forum*, formed by more than 300 entities, whose manifesto defended that "the coexistence of man with semi-arid conditions can be assured [with] agrarian and agricultural policies, appropriate technologies, and democratic and decentralized management of water resources and public affairs" (apud DINIZ, 2002, p. 44). It is the great milestone of the ideological, strategic, and tactical inflection of organized civil society in the Brazilian semi-arid region toward a process of economic, social, ecological, and cultural transformation linked to the "transition to agroecology" (NIEDERLE et al., 2019).

The mobilization triggered in Recife was immediately followed up in Paraíba, where it was "pulled" by CUT/PB, the STRs associated with it, and four other NGOs (DINIZ, 2002, p. 51). Two were in the Sertão, and the other two were based in Campina Grande. At the time, they comprised students, former students, professors, and others who gravitated to the orbit of the UFPB/Campus

II. The Center for Cultural Action (CENTRAC) was founded in 1987 to provide advisory services to the union opposition slates and directions of the "renewed" unions (BASTOS, 2010, p. 73). PATAC focused on the "diffusion of appropriate technologies for the semi-arid [in] two main lines of action: the recovery, conservation, and improvement of the soil and the capture and storage of water" (ARAÚJO, 1988, p. 45-46). Both NGOs were active in what is now the territory of Borborema, but PATAC had a broader scope of action, given that it also developed its actions in municipalities of the current territories of Curimataú, Seridó, Cariri Ocidental, and Cariri Oriental (ARAÚJO, 1988, p. 98).

The main repercussion of the *Northeast Forum* in Paraíba was the creation of the Articulation of the Semi-Arid (ASA) in an event held in Campina Grande in June 1993 (DINIZ, 2002, p. 51), a network that currently "involves more than three thousand civil society organizations of distinct natures" (ASA, 2021). In that same year, AS-PTA (Assessoria e Serviços em Projetos de Agricultura Alternativa) was installed in the Borborema Territory, "introducing, in a more systematic and organized way, the agroecological debate in the Paraíba Agreste" (DELGADO, 2009, p. 44).

"The attempt to build another model of development (...) for the Agreste region of Paraíba began through the articulation of two movements: union renewal and the agroecological movement" (idem, p. 44), which would become effective through the creation of the Polo Sindical da Borborema, articulated by the NGOs CENTRU, CENTRAC, and AS-PTA (BASTOS, 2010, p. 59; PIRAUX et al., 2012, p. 7), "with the participation of the union advisory promoted by the professors of the Graduate Program in Rural Sociology of the UFPB" (BASTOS, 2010, p. 73). Resulting from "a series of mobilized events" that began in 1996 (idem, p. 66), that "union renewal pole" (as the "renewed" STRs were known in certain regions, such as Cariri in Paraíba [BATISTA, 1997, p. 150]) would be founded in 1998. It was later renamed Polo Sindical e das Associações da Agricultura Familiar da Borborema (POAB) (Trade Union Pole and Associations of Family Agriculture of Borborema), following the "option" of rural unionism for Family Agriculture (BASTOS, 2010, p. 52, *passim*), which reflected the identity reconfiguration process of the Brazilian peasantry, triggered by the PRONAF (CANIELLO et al., 2013, p. 86).

Nonetheless, the territory of Borborema was characterized by "a relatively consolidated social capital" (CANIELLO et al., 2012, p. 17). It would constitute itself as the focal point of the "agroecological transition" in the rural areas of Paraíba after the construction of a "partnership device" in 1998 (SABOURIN et al., 2014, p. 19) involving "groups of farmer-experimenters" (idem, p. 19). They were mobilized by the Polo Sindical, AS-PTA, UFPB professors from the Areia

and Campina Grande *campuses (*now UFCG), and CIRAD researchers (idem, p. 18). It was the origin of the "encounter" of farmers of the semi-arid region of Paraíba with agroecology, later spreading to other regions of the state by ASA (PIRAUX et al., 2012, p. 8).

In the Cariri Territory, where ASA was not active at the beginning of the 2000s, the "encounter" of the peasantry with agroecology would be promoted by the Peasant University Project (UNICAMPO) (LEAL et al., 2004, p. 211; TONNEAU, 2004), implemented between 2003 and 2010 (COUDEL et al., 2009). This project would have important repercussions on the construction and dynamics of the Cariri Territorial Forum. The Forum was approved in 2003 by the MDA, given the actions of the Unicampo Students Association (AAUC), a technical assistance NGO created by the project's graduates (COUDEL et al., 2011, p. 84ff), which would practice "a perennial collective engagement of actors in territorial governance mechanisms" (COUDEL et al., 2017, p. 162). The Forum would be decisive for the creation of the UFCG *campus* in Sumé in 2009, hosting the Center for Semi-Arid Sustainable Development (CDSA), which has "the agroecological paradigm as a reference," as per its Academic Project (UFCG, 2008, p. 49).

Social actors, agroecology, and the articulation of public policies on a territorial scale

The territorial perspective for sustainable development is, above all, a coordination effort between government sectors and levels, various types of social actors, and actors (public and private) and activities (rural and urban) (BERDEGUÉ; FAVARETO, 2020). The groups mobilized around the principles of agroecology in a long process of struggles and claims and facilitated the articulation of different but focused policy instruments, though not all devices were designed for agroecological transition. This mobilization gained strength given the institutional and political context by the coalition governments led by the Workers' Party (2003–2016), guided by central themes, such as food and nutritional security (Fome Zero and Brasil Sem Miséria programs), the strengthening of spaces for interlocution between the State and civil society and a new generation of public policies for family farming (SCHMITT et al., 2017).

The National Policy of Agroecology and Organic Production (PNAPO) is the result of the confluence of interests, resources, and strategies (LASCOUMES; LE GALÈS, 2014) of a set of actors who, since the 1970s, led local initiatives in favor of agroecology and, in the 1990s, configured themselves as networks on a territorial scale for the management of agroecological knowledge (SCHMITT et al., 2017). The PNAPO, established in 2012, is an achievement of the agroecological

and organic movement in the Federal Government to expand actions for sustainable rural development (TROVATTO et al., 2017). As noted, the founding documents of ASA, beyond proposing the "construction of a new society in the semi-arid region," recommend actions that ensure "the conservation, sustainable use, and environmental recomposition of natural resources" such as "breaking the monopoly on access to water, land, and other means of production" (DINIZ; TAVARES DE LIMA, 2017, p. 7).

The One Million Cisterns Program (P1MC) and the One Land and Two Waters Program (P1+2) are examples of public policies implemented in a coordinated manner between organized civil society and the State that consolidated actions for living in the semi-arid region and favored the expansion of access to water resources for productive systems guided by the agroecological approach (SCHMITT et al., 2017). When comparing the last two agricultural and livestock censuses, it is possible to verify that the percentage of agricultural establishments with water resources in the Brazilian semi-arid region rose from a derisory 39.7% in 2006 to 75.7% in 2017. Thus, at the height of the greatest drought ever recorded in the region, it increased by 91% over the period (Figure 2). The semi-arid region of Paraiba, which, in 2006, presented a slightly better condition than the Northeast region and the Brazilian semi-arid region but was much worse than other regions, also showed a significant evolution in 2017 when the IBGE registered that 87.9% of its agricultural establishments had water resources. The figure equals that of the North (88.6%), Southeast (89%), and South (87.9%) regions (Figure 2).

The Ministry of Agrarian Development (MDA) also created the Rural Territories Sustainable Development Program (PRONAT) in 2003. Although its reference documents do not explicitly call for an agroecological approach, the principles addressing development processes are approximately based on the strategic conjunction between social, environmental, and economic issues and the struggle for rights and local actors' active involvement. Under the articulation, coordination, and cooperation assumptions, territorial public policies should "modify the territory by redrawing the characteristics of collective life, expanding the framework of opportunities and adding value to the production of the various social segments [and] actors of that territory" (BRASIL, 2005, p. 4).

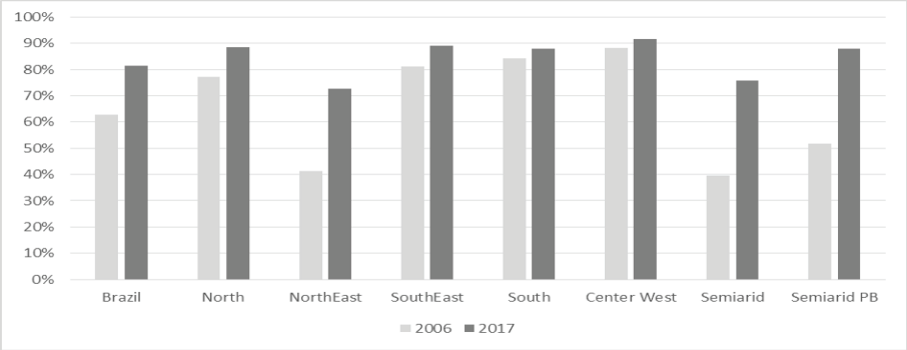

Figure 2. Agricultural establishments with water resources (%): Brazil, Regions, and Semi-arid. Source: Own preparation with data from IBGE, 2006 and 2017.

PRONAT funded infrastructure and service projects in the rural territories. It supports the creation of collegiate participation bodies that, in some cases, advance strategies and prioritize investments for agroecological promotion, such as marketing infrastructure, fairs, training, and product processing. However, this policy alone did not meet the expectations of a territorial-based articulation that could solve the "acute problem of coordination failures" among actors, institutions, resources, and capacities to advance a "territorial agenda [beyond] the sum of its parts" (BERDEGUÉ; FAVARETO, 2020, p. 29-30).

Even so, studies on the PNAPO show how, in Agreste da Borborema, local actors and their organizations and allies creatively adapt and articulate different government instruments, "expanding capacities and increasing levels of resilience and sustainability" (SCHMITT et al., 2017, p. 112). This process strengthened a network of farmer-experimenters, resulting in important gains in autonomy and the construction of alliances with research institutions and universities.

Peasants of the "dry diagonal": an encounter with territorial policy

Among the first 50 territories approved in the framework of PRO-NAT in 2003, four were in Paraíba, and two were located in the "dry diagonal": the territories of Borborema and Cariri (the latter later subdivided into Western and Eastern Cariri), later be joined by the territories of Curimataú and Seridó Paraibano, as ratified in 2007. Borborema was monitored by a UFCG research and extension team within the scope of the Cells Project (Public Call MDA/SDT/CNPq - Rural Territory Management No. 05/2009) between 2009 and 2014. The work would be taken up this year in that territory, Cariri Oriental, Curimataú, and Seridó

by two Extension Centers in Territorial Development (NEDETs) of the same university, selected in the Public Call CNPq/MDA/SPM-PR No. 11/2014. We have already shown elsewhere that the main results of PRONAT were qualitative (VALENCIA et al., 2020; PIRAUX; CANIELLO, 2019). Indeed, an opinion survey conducted in 2016 with 3,918 components of 146 territorial collegia from all units of the federation (WALTER, 2019, p. 2) showed that learning, creation of common goods, trust, ties between actors, and territorial identity were the results most valued by the respondents, a trend verified by careful statistical analysis (WALTER, 2019, p. 21-33; PIRAUX et al., 2020).

Evidently, the rural territories located in the "dry diagonal" of the semi-arid region of Paraíba did not escape the rule; it is necessary to analyze what "connected" the PRONAT territories: the preparation and implementation of investment projects under the Action "Support for Infrastructure Projects and Services" (PROINF), present in the Federal General Budget (OGU) between 2003 and 2016.

From Table 1, during the 13 years of implementation of PRONAT in Paraíba, 333 investment projects were approved with transfers, in current values, amounting to R$88 million. The territorial collegiates of the "dry diagonal" approved 41% of the projects, demonstrating their differential degree of mobilization, the Territory of Western Cariri being the most effective, with 51 approved projects (15% of the state total).

Many of these projects were not implemented given various factors (PIRAUX; CANIELLO, 2019, p. 373-4). The "choices" of the territorial collegia reveal the dominant concerns of farmers in the "dry diagonal" of the semi-arid region of Paraíba: poor road infrastructure, scarce water resources, low mechanization in the field, and challenges in accessing markets. However, they also show some of their greatest potentials: beef and dairy goat farming, for which fodder support is a major challenge in the semi-arid region, organic production, and agroecological markets.

Table 1. Proinf projects - Paraíba and selected territories (2003-2016).

Territory	Projects	%	Lending Amount (R$)	%
Borborema	36	11%	7.177.006,20	8%
Western Cariri	51	15%	9.973.494,32	11%
Eastern Cariri	25	8%	4.651.016,16	5%
Curimataú	19	6%	4.634.726,96	5%
Seridó Paraibano	5	2%	1.050.906,00	1%
Other	197	59%	60.526.241,68	69%
Total Paraíba	333	100%	88.013.391,32	100%

Source: Own preparation, with data from SICONV/CEF (2020).

PROINF: The case of Território da Borborema

The limits of this work do not allow for analyzing in-depth all the projects; we will consider the case of Borborema, where 18 projects were effectively implemented; that is, half of the approved proposals. In 2003 and 2004, when the territorial collegiate was still in formation, seven projects were submitted, whose resources were decentralized directly to the prefectures with the following objects: the construction of cisterns and underground dams, a Producer's Market, and the purchase of equipment and consumables for agroecological fairs. As these projects bypassed the social management cycle, they were not "appropriated" by actors but by the municipalities.

In 2005, the territorial collegiate approved three projects, the most important of which was the construction of the Mother Seed Bank, a bold proposal by the Polo Sindical, proposed by the state government. The case of the Mother Bank is instructive, for the project has a clear agroecological bias and reveals the actors' vision of the future. It was conceived to develop a very important territorial asset (native seeds) that had already been valued by a broad collective process led by ASA called "Seeds of Passion" (ANA, 2012).

However, the work progressed very slowly and presented many construction problems when completed in late 2013, making its use unfeasible. Over the years, these problems worsened until, finally, in 2019, necessary repairs were made, and the building could finally be used. Currently, the Mother Bank is overseen by a cooperative formed to manage it. Beyond being a kind of "central bank" of the network of community, seed banks spread throughout the state of Paraíba, producing an agroecological couscous, with the necessary equipment for large-scale

production of "flocão" cornmeal, which is widely accepted in the Northeastern market and could add much value to the production of agroecological corn.

Another major project approved in 2008 was the construction of a Family Agricultural School (EFA) in the municipality of Lagoa Seca, in a partnership between UEPB and the Landless Workers' Movement (MST), which faced a series of bureaucratic, design, and budgetary problems, but whose work was completed in late 2014 and currently houses the Elisabeth and João Pedro Teixeira Training Center, managed by the MST.

Among all projects developed in the territory of Borborema, the most emblematic, given its successes and failures, was the one idealized by the Polo Sindical and approved in 2005 by the Forum. It was extremely simple; it only required the acquisition of threshing and forage machines managed by the unions. It aimed at livestock food security via silage feed production from natural pasture and residues of crops traditionally planted by the region's peasants, corn and beans, using simple technology: the "trench silos."

However, when the machines were acquired, there was a movement by the municipalities, which demanded shared management of the machinery. Thus, an agreement was reached; the forage machines were transferred to the STRs, and the threshing machines, to the municipalities. In 2011, a team of researchers from UFCG sought this equipment to evaluate its use and found one threshing machine deposited in the garage of a deputy mayor. All of the forage harvesters were in full operation and managed by the STRs, which set up an agenda for using the machines and sharing the cost (in general, farmers pay for the fuel).

Even today, this dynamic persists. As per the farmers interviewed, the project is a great success because it guarantees forage support to the farms during dry periods, giving greater sustainability to the family production unit. The forage machines acquired with PROINF resources in 2006 have since produced an average of 2 tons/year of silage (Figure 3), an amount that oscillates, given frequent droughts, benefiting around 150 peasant families in the territory every year.

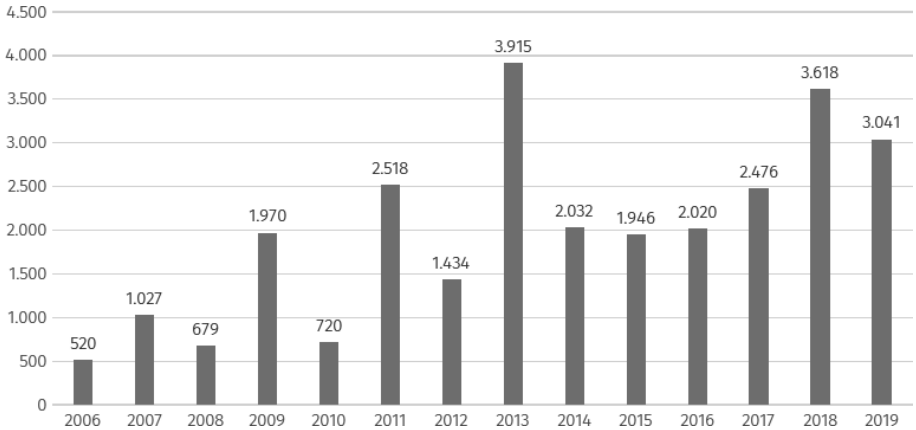

Figure 3. Evolution of silage production by the POAB, territory of Borborema (kg).

Source: Own preparation, with data from Polo Sindical da Borborema (POAB), 2021.

Thus, simple but well-designed projects with a viable management plan administered via the skills of organized and legitimized social capital have every chance of being sustained over time, benefiting territorial development actors. However, the deleterious effect of local power on territorial dynamics is evident because if threshing machines were available, much more silage could be produced.

The challenges of the new decade

The third generation of public policies for family farming (GRISA, SCHNEIDER, 2015; SABOURIN, 2018) comprises a *mix of* governmental instruments that combined mechanisms and approaches shared with actors historically marginalized from the public arenas. The significant number of public policies developed in the first decade of the 21st century addressed years of demands by family farming movements.

At the territorial scale, collective actors created synergies that enhanced the resources and results of the public actions, given their political articulations, capabilities, and territorial assets. Hence, they are configured as "territories of collective projects stimulated by the State" (MALUF, 2013, p. 73), where the interdependence between the state apparatus and social organizations for managing public policies was the highlight. In the Borborema Compartment, the construction of this "new socio-political practice" (DINIZ; LIMA, 2017) was guided by the paradigm of "living with the semi-arid," as opposed to the ideology of combating drought and agricultural modernization.

Despite this "environment of great social mobilization" (SCHMITT et al., 2017, p.117), the dismantling of public policies for family farming that began in 2016 generated a political-institutional context that restricted (and restricts) opportunities for collective actions (SILVA; SCHMITT, 2012). Thus, it is necessary to form broad coalitions (BERDEGUÉ; FAVARETO, 2020) and advance the construction of what Maluf (2013, p. 73) calls "territories-networks," where collective actors elaborate territorial projects thanks to "the sharing of ideas in the same territory or among non-overlapping territorial clusters."

The current scenario requires the search for innovative strategies with a true territorial strategy that is part of the reinvention models for the development of rural spaces (VALENCIA; FAVARETO, 2020, p. 124). This process returns to the idea of territories as "spaces of transformation" (idem, p. 123), where the emphasis on multidimensionality supersedes economic productivity, boosting all areas that generate and reproduce the ways of being and living in a territory. Hence, an intersectoral approach is necessary given that "multiple dimensions of territorial life cannot be achieved exclusively with agricultural policies, and fragmented investment from various areas of government is not sufficient; complementarity and coordination are required" (idem, p. 123). Institutionally, it is necessary to change the sectoral bias and the orientation of short-term investments. Thus, it is necessary to expand the capacities for planning and contractualization of projects that transform the territories. In this same dimension, it is important to note that it is not a matter of leaving the articulation of public policies to local actors because "if they are not designed in a complementary way from above, it is not possible to coordinate them from below" (idem, p. 124).

Final considerations

In any case, we believe that the territorial policy has left a good legacy in the territories of the "dry diagonal" of the semi-arid region of Paraíba:

- A territorial, social, and organizational identity reinforced by the creation of common goods, trust, and ties between actors and their organizations
- The positive impacts of successful investment projects and the learning emergent from the unsuccessful ones; the achievement of a UFCG *campus* in Cariri focused on the sustainable development of the semi-arid
- The construction of an MST Training Center in Borborema, which the UEPB's Agroecology Bachelor's Degree Course is running nearby; a Mother's Bank of Passion Seeds (what a beautiful name, indeed), articulating the

hundreds of community banks of native seeds that preserve the seeds of the survival of the peasants of Paraíba

- The thousands of trench silos full of fodder for small livestock, the "savings" of rural families
- The dissemination and strengthening of family farm fairs in several cities in these territories, reviving daily the message of agroecology among producers and consumers

Much more research must be done to evaluate the real weight of the public policies to combat poverty and misery, rural and territorial development, and coexistence with the semi-arid region implemented between 2003 and 2016 in Brazil by the Lula and Dilma governments. Nevertheless, one thing is certain: in the longest drought that this vast and long-suffering region has ever experienced (2012–2017), we did not see, as before, hunger and thirst raging in the fields, looting in markets and fairs, scorching "work fronts," legions of squalid and humiliated retirants dragging themselves like outcasts along the roads.

References

ARAÚJO, E. J. **O dilema camponês:** estudo de caso sobre a difusão de tecnologias apropriadas a pequenos produtores rurais do semiárido paraibano. Dissertação de Mestrado. Curso de Mestrado em Sociologia/UFPB/ *Campus II*. Campina Grande, 1988.

ANA (Articulação Nacional de Agroecologia). **Sementes da paixão:** legitimidade científica e reconhecimento histórico. Disponível em: https://agroecologia.org.br/2012/06/12/sementes-da-paixao-legitimidade-cientifica-e-reconhecimento-historico-jjj/. Acesso em 5 fev. 2021.

ASA (Articulação Semiárido Brasileiro). **Carta de Princípios da Articulação do Semiárido Brasileiro.** Igarassú (PE): 2000. Disponível em https://cedasb-asa.blogspot.com/2011/01/carta-de-principios.html. Acesso em 27 jan. 2021.

BASTOS, V. V. S. **Uma nova prática de ação sindical:** o caso do Polo Sindical da Borborema – Paraíba. Dissertação de Mestrado. Programa de Pós-Graduação em Ciências Sociais/UFCG. Campina Grande, 2010.

BATISTA, F. A. **Movimentos sociais no campo:** o caso do STR de São Sebastião do Umbuzeiro/PB (Trajetória política do dirigente Luiz Silva). João Pessoa: Imprell, 1997.

BERDEGUÉ, J.; FAVARETO, A. "Balance de la experiencia latinoamericana de desarrollo territorial rural y propuestas para mejorarla". In: Berdegué, J.; Christian, C.; Favareto, A. (Orgs.). **Quince años de desarrollo territorial rural en América latina. ¿Qué nos muestra la experiencia?** Buenos Aires: Teseo, 2020.

BERTOLAZZI, A. **Novo sindicalismo no campo paraibano:** continuidades e mudanças. Disser- tação de Mestrado. Curso de Mestrado em Sociologia Rural/UFPB, *Campus II*. Campina Grande, 1989.

BRASIL. Ministério de Desenvolvimento Agrário (MDA). Secretaria de Desenvolvimento Territorial (SDT). **Referências para uma estratégia de desenvolvimento rural sustentável**. Documentos Institucionais, Brasil, n. 1, 2005.

CANAVESI, F.; MOURA, I.; SOUZA, C. Agroecologia nas políticas públicas e promoção da segurança alimentar e nutricional. **Segurança Alimentar e Nutricional,** Campinas, 23, número especial, p. 1019-1030, 2016.

CANIELLO, M.; PIRAUX, M.; BASTOS, V. Capital social e desempenho institucional no Colegiado Territorial da Borborema, Paraíba. **Revista Raízes,** v. 32, n. 2, p. 11-31, 2012.

CANIELLO, M.; PIRAUX, M.; BASTOS, V. Identidade e participação social na gestão do programa Territórios da Cidadania: um estudo comparativo. **Estudos Sociedade e Agricultura,** v. 21, n. 1, p. 84-107, 2013.

CAPORAL, F.; COSTABEBER, J.A. Agroecologia e desenvolvimento rural sustentável: perspectivas para uma nova extensão rural. **Agroecologia e Desenvolvimento Rural Sustentável,** Porto Alegre, v. 1, n. 1, p. 16-37, 2000.

CARNEIRO, A; CIOCCARI, M. **Retrato da repressão política no campo – Brasil, 1962-1985:** camponeses torturados, mortos e desaparecidos. Brasília: MDA, 2011.

COHEN, M.; DUQUÉ, G. **Les deux visages du Sertão:** Strategies paysannes face aux sécheresses (Nordeste, Brésil). Paris: Éditions de l'IRD, 2001.

COUDEL, E.; SABOURIN, E.; TONNEAU, J-P.; CANIELLO, M. Dynamiques et apprentissages d'une première expérience de construction d'une université paysanne au Brésil. In : TURCKEIM, E.; HUBERT, B.; MESSÉAN, A. (Orgs.). **Concevoir et construire la décision:** Démarches en agriculture, agroalimentaire et espace rural. Versailles: Éditions Quae, 2009.

COUDEL, E.; CANIELLO, M.; SOUSA, M.L.R.; TONNEAU, J.P. Le projet pilote de l'Unicampo au Brésil. *In* CLAVEL, D. (org.), **Savoirs et développement rural** : Le dialogue au coeur de l'innovation. Versailles: Éditions Quae, 2011.

COUDEL, E.; TONNEAU, J-P.; BOUSQUET, F.; CANIELLO, M.; CHIA, E.; DARÉ, W.; GURUNG,T. R.; JANKOWSKI, F.; LEAL, F.; LE PAGE, C.; PIRAUX, M.; REY-VALETTE, H.; SABOURIN, E.; TRÉBUIL, G. Apprentissages sociaux pour le développement territorial. In : CARON, P.; VALETTE, E.; WASSENAAR, T.; D'EECKENBRUGGE, G. C.; PAPAZIAN, V. (Orgs.). **Des territoires vivants pour transformer le monde.** Versailles: Éditions Quae, 2017.

DEL GROSSI, M.; FLORIDO, A. C. S.; RODRIGUES, L. F. P.; OLIVEIRA, M. S. Comunicação de pesquisa: delimitado a agricultura familiar nos censos agropecuários brasileiros. **Revista NECAT,** v. 8, n. 16, p. 40-45, 2019.

DELGADO, N. G. Sociedade civil, estado e protagonismo institucional no desenvolvimento territorial: avanços e obstáculos no caso do Território Rural da Borborema/PB. **Revista Raízes,** v. 28, n. 1-2, p. 41-51, 2009.

DINIZ, P. C. O. **Ação coletiva e convivência com o semiárido**: a experiência da Articulação do Semiárido Paraibano. Dissertação de Mestrado. Programa de Pós-Graduação em Sociologia/UFPB/*Campus II*. Campina Grande, 2002.

DINIZ, P. C. O.; TAVARES DE LIMA, J. R. Mobilização social e ação coletiva no Semiárido Brasileiro convivência, agroecologia e sustentabilidade. **Redes (Santa Cruz do Sul),** v. 22, n. 2, p. 189-207, 2017.

DUQUÉ, G. A contribuição dos convênios para a pesquisa e capacitação. **Revista Raízes,** v. 22, n. 1, p. 136-137, 2003.

DUQUÉ, G. "Conviver com a seca": contribuição da Articulação do Semiárido/ASA para o desenvolvimento sustentável. **Desenvolvimento e Meio Ambiente,** v. 17, n. 1, p. 133-140, 2008.

FAVARETO, A. Agricultores, trabalhadores: os trinta anos do novo sindicalismo rural no Brasil. **Revista Brasileira de Ciências Sociais,** v. 21, n. 62, p. 27-44, 2006.

FRANCISCO, P. R. M. **Climatologia do estado da Paraíba**. Campina Grande: EDUFCG, 2017.

GRISA, C.; SCHNEIDER, S. Três Gerações de Políticas Públicas para a Agricultura Familiar e Formas de Interação entre Sociedade e Estado no Brasil. In: GRISA, C. SCHNEIDER, S. **Políticas Públicas de Desenvolvimento Rural no Brasil**. Porto Alegre: Editora da UFRGS, 2015. p. 19-50.

IBGE. **Censo agropecuário 2006**. Disponível em: https://sidra.ibge.gov.br/pesquisa/censo-agropecuario/censo-agropecuario-2006/segunda-apuracao. Acesso em 5 jan. 2021.

IBGE. **Censo agropecuário 2017**. Disponível em: https://censos.ibge.gov.br/agro/2017/. Acesso em 4 jan. 2021.

LADOSKY, M.; VÉRAS DE OLIVEIRA, R. O "novo sindicalismo" pela ótica dos estudos do trabalho. **Revista Mundos do Trabalho,** v. 6, n. 11, p. 147-170, 2014.

LASCOUMES, P.; LE GALÈS, P. **Sociología de la acción pública**. Traducción de Vicente Ugalde. 2. ed. México – DF: El Colegio de México, Centro de Estudios Demográficos, Urbanos y Ambientales, 2014.

LEAL, F.; CANIELLO, M.; TONNEAU, J-P.; LIMA, J. P.; ARAÚJO, A. E. Projeto Unicampo: uma experiência de extensão no Cariri paraibano. In: CORRÊA, J. E.; CUNHA, E. S. M.; CARVALHO, A.M. (Orgs.). (**Re) conhecer diferenças, construir resultados**. Brasília: UNESCO, 2004.

MALUF, R. Elementos para uma agenda pública de enfrentamento da pobreza e inclusão socioprodutiva no meio rural na ótica do desenvolvimento territorial sustentável. In: LEITE, S. **Políticas de desenvolvimento territorial e enfrentamento da pobreza rural no Brasil**. Brasília: IICA, 2013.

NOVAES, R. R. Memórias e imagens do Mestrado em Sociologia de Campina Grande (elementos de uma versão comprometida). **Revista Raízes,** v. 22, n. 1, p. 130-135, 2003.

PALACIOS, G. Campesinato e escravidão: uma proposta de periodização para a história dos cultivadores pobres livres no Nordeste Oriental do Brasil, 1700-1875. **Dados – Revista de Ciências Sociais,** v. 30, n. 3, p. 325-356, 1987.

PIRAUX, M.; CANIELLO, M. Reflexões retrospectivas e prospectivas sobre a governança territorial para o desenvolvimento rural no Brasil. **Revista Raízes,** v. 39, n. 2, p. 359-379, 2019.

PIRAUX, M.; SILVEIRA, L.; DINIZ, P.; DUQUÉ, G. Transição agroecológica e inovação socioterritorial. **Estudos Sociedade e Agricultura,** v. 20, n. 1, p. 5-29, 2012.

PIRAUX, M.; VALENCIA, M.; CANIELLO, M.; ROCHA, B. N. Avaliar a gestão social na governança territorial: bricolagem, aprendizagem e hibridação na construção do Índice de Gestão Social (IGS). **Redes (St. Cruz do Sul, Online),** v. 25, n. 3, p. 1071-1095, 2020.

PLOEG, J. D. van der. **Camponeses e impérios alimentares:** lutas por autonomia e sustentabilidade na era da globalização. Porto Alegre: Editora da UFRGS, 2008.

SABOURIN, E. Erosão, crise e desmonte de políticas para a agricultura familiar e agroecologia na América Latina. In: **Seminário: Políticas Públicas para o meio rural brasileiro no período recente: mudanças, continuidades e rupturas**. Rio de Janeiro: OPPA/UFRRJ, 2018.

SABOURIN, E.; SIDERSKI, P.; SILVEIRA, L. M.; HOCDÉ, H. Construção da inovação entre agricultores e pesquisadores: os grupos de agricultores experimentadores no Agreste da Paraíba. **Agricultura Familiar: Pesquisa, Formação e Desenvolvimento,** v. 10, n. 1, p. 17-30, 2014.

SCHNEIDER, S. **A pluriatividade na agricultura familiar**. 2. ed. Porto Alegre: Editora da UFRGS, 2009.

SILVA, M. K. S.; SCHMITT, C. J. Políticas em rede: uma análise comparativa das interdependências entre o Programa de Aquisição de Alimentos e as redes associativas no Rio Grande do Sul e na Bahia. In: **Anais do Encontro Anual da ANPOCS**, 36. Águas de Lindóia (SP): ANPOCS, 2012.

SILVA, R. M. A. **Entre o combate** à **seca e a convivência com o semiárido:** transições paradigmáticas e sustentabilidade do desenvolvimento. Fortaleza: Banco do Nordeste do Brasil, 2008 (Série BNB Teses e dissertações, n. 12).

SCHMITT, C.; NIEDERLE, P.; ÁVILA, M.; SABOURIN, E.; PETERSEN, P.; SILVEIRA, L.; ASSIS, W.; PALM, J.; FERNANDES, G. La Experiencia brasileña de construcción de políticas públicas en favor de la agroecología. In: SABOURIN, E.; PATROUILLEAU, M. M.; LE COQ, J. F.; VASQUEZ, L.; NIEDERLE, P. (Orgs.). **Políticas públicas a favor de la agroecología en América Latina y El Caribe**. Porto Alegre: Evangraf; Criação Humana/Red PP-AL; FAO, 2017.

TONNEAU, J.-P. **Pensar novos sistemas produtivos camponeses: fundamentos de agroecologia**. Campina Grande: UFCG/Projeto Unicampo, 2004 (Cadernos de Material Didático, n. 2).

TROVATTO, C.; BIANCHINI, V.; SOUZA, C.; MEDAETS, J. P.; RUANO, O. A construção da política nacional de agroecologia e produção orgânica: um olhar sobre a gestão do primeiro plano nacional de agroecologia e produção orgânica. In: SAMBUICHI, R.; MOURA, I.; MATTOS, L.; ÁVILA, M.; SPÍNOLA, P.; SILVA, A. P. **A política Nacional de Agroecologia e Produção Orgânica. Uma trajetória de luta pelo desenvolvimento rural sustentável**. Brasília: IPEA, 2017.

UFCG. **Projeto Acadêmico do Centro de Desenvolvimento Sustentável do Semiárido – *Campus* de Sumé.** Campina Grande: UFCG/Secretaria de Projetos Estratégicos, 2008.

VALENCIA, M.; CANIELLO, M.; BARONE, A. L.; PIRAUX, M.; CALVI, M. F.; TEIXEIRA, O. A.; OLIVEIRA, C. D. Doce años del Programa Desarrollo Sustentable de Territorios Rurales del Ministerio de Desarrollo Agrario de Brasil. ¿Cómo vamos? In: Berdegué, J.; Christian, C.; Favareto, A. (Orgs.). **Quince años de desarrollo territorial rural en América latina.** ¿Qué **nos muestra la experiencia?** Buenos Aires: Teseo, 2020.

VALENCIA, M.; FAVARETO, A. El enfoque territorial y su vigencia para el desarrollo rural en el Brasil. ¿Hacia una tercera generación de políticas públicas? In: PIZZIO, A.; ALMANZA, A.; RODRIGUES, W. (Orgs.). **Desarrollo Regional en perspectivas comparadas. Os casos de Brasil y México**. Brasília: Verbena Editora, 2020.

WALTER, M. I. M. T. **Análise de dados do Índice de Gestão Social – IGS em Territórios Rurais no Brasil em 2016**. Relatório de Pesquisa. Brasília: RETE, 2019.

About the authors

Allan Milhomens

Master's degree student at the Postgraduate Program in Environment and Rural Development of the Faculty of Planaltina, University of Brasilia (UnB). Environmental Analyst and anin the career of Environmental Specialist linked to the Brazilian Institute of Environment and Renewable Natural Resources. He works in the area of sustainable rural development under the Ministry of Environment. Bachelor in Journalism from the University of Brasilia. allmilhomens@gmail.com

Ana Paula Ferreira

Ph.D. in Natural Resources and Sustainability from the University of Córdoba, Spain, and Master's in Agroecology with a sustainable approach to agriculture from the International University of Andalusia, Spain. Consultant on governance and public policies at the UN-WOMEN, where she works on the themes of agroecology, food security, women's rights, feminism, black feminism, peasantry, and sustainable development. anapferreira1968@gmail.com

Anderson Ramos de Oliveira

Agronomic Engineer from the Federal University of Espírito Santo. Master's and Ph.D. in Plant Production from the Universidade Estadual do Norte Fluminense Darcy Ribeiro. Researcher at the Brazilian Agricultural Research Corporation and working at the Center for Agricultural Research in the Semi-Arid Tropics in the area of Agroenergy Systems. anderson.oliveira@embrapa.br

Carlos Hiroo Saito

Professor, with a dual assignment at the Department of Ecology at the Institute of Biological Sciences and the Center for Sustainable Development of the University of Brasilia, Brazil. Master's in Education from the Fluminense Federal University and Ph.D. in Geography from the Federal University of Rio de Janeiro. Chair of the Global Water Partnership-South America. carlos.h.saito@hotmail.com

Carolina Milhorance
Ph.D. in Political Science and Sustainable Development. Researcher at the Centre for International Cooperation in Agronomic Research for Development (CIRAD/ UMR Art-Dev). carolina.milhorance@cirad.fr

Claudia Job Schmitt
Sociologist. Professor at the Social Sciences Graduate Program in Development Agriculture and Society; Federal Rural University of Rio de Janeiro (CPDA/ UFRRJ). Team member of the Observatory of Public Policies for Agriculture (OPPA). claudia.js21@gmail.com

Cristiane Moraes Marinho
Professor at the Federal Institute of Sertão Pernambucano and collaborating lecturer in the Postgraduate Program in Rural Extension of UNIVASF. Pedagogy Graduate. Ph.D. Rural Extension. cristiane.marinho@ifsertao-pe.edu.br

Daniela Nogueira
Senior Researcher at the Center for Sustainable Development of the University of Brasilia. Professor of the Master's Program ProfÁgua - Management and Regulation in Water Resources. Ph.D. in Sociology from the University of Brasília/ Paris 8/Centre National de Recherche Scientifique. Post-Doctorate in Sustainable Development. Founder of the Latin American Women for Water Collective. danielanogueiracds@gmail.com

Denes Dantas Vieira
Professor at UNIVASF. Permanent Professor of the Postgraduate Program in Rural Extension of UNIVASF and Postgraduate Program in Agroecology and Territorial Development - Associação Ampla UNIVASF/UFRPE/UNEB. Bachelor in Social Sciences, Master's and Ph.D. in Social Sciences.
denes.vieira@univasf.edu.br

Denis Monteiro
Agronomist. Technical Advisor to AS-PTA Family Agriculture and Agroecology. Ph.D. from the Federal Rural University of Rio de Janeiro (UFRRJ). Member of the Coordinating Board of the National Commission on Agroecology and Organic Production (CNAPO) between 2012 and 2018. Executive Secretary of Articulação Nacional de Agroecologia (ANA) between 2009 and 2021. denisagroecologia@gmail.com

Edson Diogo Tavares

Researcher Ph.D. in Sustainable Development from the University of Brasilia. Master's in Agronomy from the Federal University of Lavras. Agronomic Engineering Graduate from the Federal Rural University of Rio de Janeiro. Researcher at the Brazilian Agricultural Research Corporation (Embrapa) from 1989 to 2019. Member of the Sergipan Network of Agroecology (Resea). edsondiogo@gmail.com

Eduardo de Lima Caldas

Economist (USP) with Masters in Political Science (USP) and Public Administration and Government (FGV). Ph.D. in Political Science (USP). Post-Doctorate in Territorial Management (Cirad). Post-Doctorate in Social Sciences (USP). Professor of Public Policy Management and Environmental Science at the University of São Paulo (USP). elcaldas@hotmail.com

Eduardo Sávio Passos Rodrigues Martins

Hydrologist with a Ph.D. from Cornell University. Adjunct Professor at the Federal University of Ceará. President of the Ceará Meteorology and Water Resources Foundation (FUNCEME). Collaborating Professor in the Graduate Program in Climate and Energy of the State University of Ceará. presidencia@funceme.br

Elson de Oliveira

Consultant and Rural Extensionist - CAR-Bahia. Degree in Agronomy. Master's in Rural Extension. Ph.D. student in Agroecology and Land Development at PPGADT/UNIVASF. elsonagro@gmail.com

Eric Sabourin

Anthropologist and Sociologist. Senior Researcher at CIRAD Montpellier (Umr ART- Dev); Collaborating Researcher at the Center for Sustainable Development and the PPG MADER Program, University of Brasília (UnB). eric.sabourin@cirad.fr

Flaviane de Carvalho Canavesi

Professor at the School of Agronomy and Veterinary Medicine at the University of Brasília. Ph.D. in Urban and Regional Planning from the Federal University of Rio de Janeiro. Master's degree in Development, Society, and Agriculture from CPDA/UFRRJ. Graduated in Agronomy from the Federal University of Viçosa.

Coordinates the Center for Studies, Research, and Extension in Agroecology at UnB. flavianecanavesi@unb.br

Francislene Angelotti

Agronomic Engineer. Master's and Ph.D. in Agronomy from the State University of Maringá. Researcher at the Brazilian Agricultural Research Corporation, working at the Center for Agricultural Research of the Semi-Arid Tropics, in the area of Climate Change. Member of the Teaching Staff of the Postgraduate Program in Environmental Science and Technology at the University of Pernambuco. francislene.angelotti@embrapa.br

Frédéric Goulet

Ph.D. in Sociology. Researcher at the Centre de Coopération Internationale en Recherche Agronomique pour le Développement. Visiting Professor at the CPDA, Federal Rural University of Rio de Janeiro. frederic.goulet@cirad.fr

Helder Ribeiro Freitas

Professor at the Federal University of São Francisco Valley - UNIVASF. Permanent Professor of the Postgraduate Program in Rural Extension of UNIVASF and the Postgraduate Program in Agroecology and Territorial Development - Associação Ampla UNIVASF/UFRPE/UNEB. Agronomy Graduate. Master's and Ph.D. in Soil and Plant Nutrition. Coordinates the NUSAN/CVT/NEA and the Research Group Sertão Agroecológico/UNIVASF. helder.freitas@univasf.edu.br

Helena Rodrigues Lopes

Ph.D. candidate at the Social Sciences Graduate Program in Development, Agriculture, and Society; Federal Rural University of Rio de Janeiro (CPDA/UFRRJ). helenaeco.agro@gmail.com

Jean-Luc Battini

Researcher in agronomy, specialized on perenial crops and agroforestry tropical systems at CIRAD; actual Regional representative of CIRAD, INRAe and Agreenium for Brazil and southern cone countries; founding member of the ReFBN network; brasil-conesul@cirad.fr

Joacir Rufino de Aquino

Economist and Master in Rural and Regional Economics from UFCG. Adjunct Professor IV at the State University of Rio Grande do Norte (Assú Campus). Regional Representative (2017–2021) and Vice-President (2021–2023) in the Northeast of the Brazilian Society of Economics, Administration, and Rural Sociology (SOBER). Member of the International Celso Furtado Development Policies Center. joaciraquino@yahoo.com.br

Juliane Rafaele Alves Barros

Agronomic Engineer and Technologist in Irrigated Fruit Culture from the Instituto Federal do Sertão Pernambucano. Master in Agronomy from the Federal University of Paraíba. Ph.D. student in Plant Genetic Resources at the State University of Feira de Santana/Embrapa Semiárido. juliane-ab@hotmail.com

Louise Cavalcante

Ph.D. candidate in Public Administration and Policy at the University of Wageningen. Master's in Sustainable Development from the University of Brasília. Bachelor's in Ecology from the Federal University of Rio Grande do Norte. Email: csc.louise@gmail.com

Lucas Ricardo Souza Almeida

Undergraduate student in Agronomic Engineering - UNIVASF. lucas.ricardo@discente.univasf.br

Lúcia Marisy Souza Ribeiro de Oliveira

Professor at UNIVASF. Permanent Professor of the Postgraduate Programs in Rural Extension of UNIVASF and Postgraduate in Agroecology and Territorial Development - Associação Ampla UNIVASF/UFRPE/UNEB. Pedagogy Graduate. Ph.D. in Sustainable Development of the Humid Tropics. lucia.oliveira@univasf.edu.br

Luciano Marçal da Silveira

Agronomist. Master's degree student at the International University of Andalusia. Technical Advisor and Member of the Coordination Nucleus of AS-PTA Family Agriculture and Agroecology and the Biodiversity Working Group of the National Agroecology Articulation (ANA). Coordinator of the AS-PTA Local Development Program in the Territory of Polo da Borborema, PB (1993–2010)

and member of the Executive Coordination of Articulação do Semiárido Brasileiro (ASA) from 2005 to 2009. luciano@aspta.org.br

Luis Cláudio Mattos

Ph.D. in Social Sciences in Development, Agriculture, and Society, with special focus in Agrarian and Territorial Development of the Semi-arid Region, from the Federal Rural University of Rio de Janeiro (CPDA/DDAS/ICHS/UFRRJ). Adjunct Professor in Rural Extension, Agroecology, and Sustainable Development at the Federal Rural University of Pernambuco (UFRPE). Collaborating Professor of the Professional Doctorate of the Postgraduate Program in Agroecology and Territorial Development (PPGADT/UNIVASF/UNEB/UFRPE). luis.mattos@ufrpe.br

Márcio Caniello

Professor of Anthropology at the Federal University of Campina Grande (UFCG) and permanent lecturer in the Postgraduate Program in Social Sciences (PPGCS). Master's in Social Anthropology from the Postgraduate Program in Social Anthropology of the National Museum of the Federal University of Rio de Janeiro (PPGAS/MN/UFRJ, 1993). Ph.D. in Sociology from the Federal University of Pernambuco (PPGS/UFPE, 2001). Co-creator and co-coordinator of the Universidade Camponesa Project (UniCampo, 2003-2010). caniello@ufcg.edu.br

Maria de Fatima Vidal

Agronomic Engineer. Master in Rural Economics from the Federal University of Ceará (UFC). Researcher at the Technical Office for Northeast Economic Studies (ETENE-BNB). fatimavidal@bnb.gov.br

Maria Odete Alves

Agronomic Engineer. Ph.D. in Sustainable Development from the University of Brasília (UNB). Researcher at the Technical Office for Northeast Economic Studies (ETENE-BNB). moalves@bnb.gov.br

Mário Lúcio Ávila

Professor at the University of Brasilia in the Postgraduate Courses in Environment and Rural Development (MADER) and Public Management (PPGP). Ph.D. in Sustainable Development. Master in Rural Administration. Coordinates the Centre for Family Farming Management and Innovation (CEGAFI-CEGAFI-CEGAFI). unbavila@gmail.com

Miguel Julio Machado Guimarães

Agronomic Engineer from the Federal University of the Recôncavo da Bahia. Master's and Ph.D. in Agricultural Engineering from the Federal Rural University of Pernambuco. Post-Doctorate in Agricultural Engineering from the Federal University of Vale do São Francisco. Professor at the Federal Institute of Education, Science, and Technology of Maranhão (São Raimundo das Mangabeiras *Campus*). Member of the Teaching Staff of the Graduate Program in Agricultural Engineering at the Federal University of São Francisco Valley. miguel.guimaraes@ifma.edu.br

Mireya Eugenia Valencia Perafán

Ph.D. in Social Sciences from the University of Brasilia (UnB). Master's in Rural Development from the Pontifical Javeriana University of Colombia. Professor at the Faculty of Agronomy and Veterinary Medicine at UnB. Chairs the Brazilian Network for Research and Management in Territorial Development (RETE) and is a member of the Public Policies and Rural Development Network in Latin America. mireya@unb.br

Patrícia dos Santos Mesquita

Ph.D. in Sustainable Development from the University of Brasília (UnB). Master's in Geography from the University of Victoria (Canada). Bachelor's Degree in Biology (UFRN). Currently a post-doctoral researcher at INCT-Odisseia and Rede Clima at the Center for Sustainable Development (CDS/UnB) and executive editor of the *magazine Sustentabilidade em Debate* (UnB). patriciasmesquita@gmail.com

Paulo Frederico Petersen

Agronomist, Ph.D. in Environmental Studies from the Universidad Pablo de Olavide (Spain). Executive Coordinator of AS-PTA Family Agriculture and Agroecology. Editor of the *Journal Agriculturas: Experiences in Agroecology*. Member of the Board of Directors of the Brazilian Association of Agroecology (ABA) and the Executive Core of the National Articulation of Agroecology (ANA). Member of the Coordinating Board of the National Commission on Agroecology and Organic Production (CNAPO) between 2012 and 2018. paulo@aspta.org.br

Peter May

Ph.D. in Natural Resource Economics from Cornell University. Professor of the Postgraduate Program in Social Sciences in Development, Agriculture, and Society at the Federal Rural University of Rio de Janeiro (CPDA/ DDAS/ICHS/ UFRRJ). Permanent Professor of the Postgraduate Program in Public Policy, Strategies, and Development (PPED-IE/UFRJ). peterhmay@gmail.com

Rita de Cássia Rodrigues Gonçalves-Gervásio

Professor at UNIVASF. Permanent Professor of the Graduate Program in Agronomy at UNIVASF. Collaborator of the Postgraduate Program in Agroecology and Territorial Development - Associação Ampla UNIVASF/UFRPE/UNEB. Agronomy Graduate. Master in Agronomy. Ph.D. in Entomology. rita.gervasio@univasf.edu.br

Vanderlise Giongo

Agronomic Engineer from the Federal University of Pelotas. Master and Ph.D. in Soil Science from the Federal University of Rio Grande do Sul. Researcher at the Brazilian Agricultural Research Corporation, working at the Center for Agricultural Research of the Semi-Arid Tropics in the area of Soil Management and Conservation. Among the Teaching Staff of the Graduate Program in Environmental Science and Technology at the University of Pernambuco. vanderlise.giongo@embrapa.br