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The agrarian space of the Brazilian semi-arid region: the dichotomies between the space of irrigated agriculture and the space of traditional agriculture

There is a relevant debate in the literature regarding the influence of the State in the production of space. The State was the main agent of the production of the agrarian space in the Brazilian semi-arid region, which is characterised by the territorialisation of two contrasting food systems: the irrigated productive model and the traditional family farming model. This study investigates the extent to which the spatial and sectoral selectivity of public policies has interfered in dichotomous agrarian space. The agrarian space is analysed on two spatial scales, the municipal and the local. On the municipal scale, we have selected the municipalities of Petrolina and Casa Nova. The local scale, by contrast, refers to spatial fragments of these municipalities, where food systems spatially manifest themselves (modern irrigated and traditional rainfed agriculture). The results show that until 1980, public policies favoured the development and consolidation of modern irrigated agriculture in selected spatial fragments. This was due to public investments in irrigation, transport, communication and energy infrastructure, facilitated access to land, technical assistance and agronomic engineering services. From 1990 onwards, policies have become inclusive, aimed at the Family Farmers social group. Policies have entailed local solutions for access to water, contextualised technical assistance, alternative markets, income stabilisation for family farmers and improvement in food production and consumption. However, despite the inclusion of family farming in the agrarian structure, imbalances of power remain among the food systems, highlighting the great contradiction brought about by these public policies.

Keywords: food system; public policies; fundo de pasto communities; irrigated agriculture

JEL classifications: Q15, Q20

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Introduction

It has been sixty years since the productivist paradigm emerged as a possible solution to food insecurity (De Schutter, 2014). The productivist model was supported by institutions worldwide due to the alarmist discourse of the demographic explosion, which was linked to the widespread hunger in developing countries. It entails the 'progress' engendered in the process conventionally called the 'Green Revolution', based on mechanisation and the intensive use of agro-industrial inputs, natural resources, genetically improved seeds, irrigation, and chemical fertilisers (Borlaug and Dowswell, 2003). The advance of the model was translated into, on the one hand, the implementation of a series of technological innovations to improve the productivity performance of agriculture and, on the other hand, the subsequent insertion of agriculture into the agro-industrial complex.

In Brazil, the productivist model was implemented during the second half of the 20th century, when the State began to intervene in the agriculture and husbandry sectors through policies aimed at reducing production costs, stabilising producers' income and the granting of credit. Between 1960 and 1970, the State increased its efforts to promote the modernisation of agriculture by incorporating the technological package imposed by the Green revolution, associated with tax incentives and easy access to means of production. Politically, the 1960s and 1970s were marked by the military dictatorship. During this period, civil society representatives linked to family farming had no space in the public arena to discuss and build together with public managers, policies for their social

category (Grisa, 2012). Policies in this period had a triple selective character: they (1) were targeted at medium and large farmers; (2) had an export-oriented character; and (3) encouraged the expansion of agribusiness (Guedes Pinto, 1978).

Throughout the second half of the twentieth century, socioeconomic inequalities and interregional disparities became more evident in Brazil (Prado Junior, 1981; Furtado, 1997). Geographically, uneven development intensified in the 1950s, due to the intensification of industrialisation that took place in the southeast and south regions, which triggered rapid urbanisation, whose corollary was the emptying of the rural areas (Baeninger, 2003).

The 1990s were marked by political and economic changes in the agrarian conjuncture, given the advance of economic neo-liberalisation. The new strategies included reducing the State's intervention, deregulation of economic activities, privatisations of State-owned companies, liberalisation of markets, etc. (Lopes *et al.*, 2011; Sallum Jr., 2003). During this period, the Southeast region was responsible for contributing more than 58% to the Gross Domestic Product and the South region for more than 17%, both regions accumulating more than ¾ of the wealth produced in the country (IBGE, 2010).

Despite the abstention from the State, the possibilities rendered in a re-democratisation pushed representatives from civil society and small rural producers to demand specific policies for the category (Grisa, 2012). In the light of increasing social movement's pressure, the State rebuilt institutions that had been dismantled and started implementing a new generation of agrarian policies targeted at family farmers and female rural workers (Schneider, 2003). This set

of policies prioritised local development and aimed at stabilising the family farming food system. Most new policies were institutionalised during the government of former president Luiz Inácio Lula da Silva (2003–2011). However, the asymmetries between macro-regions have not been reduced, since the Midwest, North and Northeast regions together, which comprise more than 82% of the country's territory, and where more than 43% of the population live, contributed only with 27.4% to Brazilian GDP (IBGE, 2010). Thus, the inequalities that persist – on different scales, between rural and urban areas, between macro-regions and micro-regions – have been the result of the unequal advance of these productive activities.

The influence of the State in the production of the agrarian space

The State plays a fundamental role in the development and distribution of space and in this regard, it is essential to remember the contributions of Henri Lefebvre (1974). In addition to the State, multiple actors influence the spatial dynamics, even though they have converging and diverging interests and different degrees of influence over decision making. According to Santos (1996), space formation involves civil society, geographic objects (natural and artificial), institutions and the State as the regulator of the development and distribution of the capitalist system. Agrarian space is defined as a subspace used for agricultural activities that has peculiarities in terms of a territorial and socio-economic organisation. These characteristics have their origin not only in the productive activities but also in previous and external influences (Galvão, 1987).

The production of space approach is relevant to understanding the implicit interests and influences of actors – especially the State – in territorial dynamics, providing inputs to help identify and solve conflicts, and is also relevant to analysing spatial imbalances in terms of socio-economic development, environmental degradation and the consequences of the productive (re)organisation of territory. Also, possible mismatches between social demands and development policy can be identified. In this sense, the time variable is also crucial, as it yields a broad picture as to how the State's interventions, the performance of civil society and public and private entities have acted over time to generate the current landscape.

Agrarian space was continuously influenced by development trends that transformed productive standards. The influence of the productivist paradigm in the Brazilian agrarian space began in the mid-1960s as a potential and easy solution for tackling food insecurity by increasing food production. The Green Revolution, based on mechanisation, intensive use of agro-industrial inputs, natural resources and chemical fertilisers, was the strategy for boosting agricultural productivity and solving the mismatch between supply and demand for food (Borlaug and Dowsell, 2003). Since then, the Brazilian semi-arid region has been subjected to spatially selective economic growth. The most visible manifestation of this phenomenon is the presence of two main food systems in the semi-arid agrarian space that contrast

with each other, namely, the irrigated productive model and the traditional family farming model.

Buainain and Garcia (2015) question the irrigation policy by highlighting that, due to the limited water availability in the semi-arid region, irrigation increases pressure on the water resources that supply the region. Sobel and Ortega (2010) meanwhile analysed the impacts of the irrigation policy on social inclusion degree and concluded that historically, public investments in irrigation have privileged the consolidation of agro-companies and capitalised farmers. The authors concluded that the policy privatised the irrigation benefits. The links between the top-down character of the irrigation policies and the little or no participation of the population in the policy formulation were the topics analysed by Pontes *et al.* (2013). For their part, Brito *et al.* (2010) analysed the environmental impacts of the irrigation policies in the semi-arid region, discussing the impacts on the soil compaction, salinisation, nutrient imbalance, loss of organic matter and the reduction of microbiological activity. The authors indicated that the interaction of these factors results in the loss of agricultural productivity in the medium and long terms.

There is also quite some research about alternative models for the semi-arid agrarian development. Silva (2006) analysed the main paradigms for development historically introduced in the semi-arid and identified existing local forms of sustainable development that considers contextualized rural practices, specifically adapted to edaphoclimatic semi-arid conditions. More recently, Santos (2016) has analysed how social demands became public policies since the 1990s. The author emphasises the important role played by NGO's in assisting the population and enabling access to water and food between 1980 and 1990, when the State abstained from regulating socio-economic imbalances. In addition, some studies have assessed the contribution of progressive policies to family farming. Wittman and Blesh (2017) assessed the impacts of the food procurement for land reform beneficiaries, indicating that the programmes are key to ensuring farmers' food sovereignty. However, despite the number of pertinent studies, the specific features of food systems in the Brazilian semi-arid region, and the challenges family farmers from that region face in linking their production to the wider food systems of which they also form part have not been extensively analysed.

This study aims to fill this research gap by investigating the dichotomies of the Brazilian semi-arid agrarian space, taking into account the State's interference on the activities of both food systems (input provision, producing, processing, trading, and consuming). This research differs from other studies, since the analysis concerns the impact of a group of policies on the activities of the irrigated and rainfed food systems that are part of the agrarian space in the semiarid region.

The agrarian space was analysed on two spatial scales, the municipal and the local. On the municipal scale, we selected the municipalities of Petrolina and Casa Nova. The local scale, by contrast, refers to spatial fragments of these municipalities, where the food systems spatially manifest themselves (modern irrigated and traditional rainfed agriculture). The main research question was through which mechanisms did the State influence the activities (input provision, producing, processing, trading, and consuming) of modern irrigated and traditional food systems over time?

Conceptual Framework

The modern State and the production of space

Lefebvre argues that the “Production of Space” approach must offer inputs for a critical understanding of the peculiarities of space and the history behind the organisation of geographical objects in order to enable a dialectical analysis of the social complexities through which space is produced in the end of the 20th Century capitalism (Lefebvre, 1991). The production of space refers to the spatio-temporal rationalisation of social relations, whose results are coextensive (Lefebvre, 1991).

Still according to Lefebvre, the space of modern capitalism is permeated by contradictions which the State must tackle, especially the contradictions involving exchange value and use value, production and consumption spaces, rural and urban, centre and periphery (Lefebvre, 1978; 1991). In order, to repair such contradictions that are engendered by the capitalist accumulation process, according to Lefebvre, the State must adopt several strategies, which include the production, control and surveillance of the social space. Among the strategies it is worth highlighting the control over flow (energy, raw material, labour, etc.), capital mechanisms (investments, credits, techniques, etc.), in addition to introducing instruments and control institutions and regulation to promote regional equity and reduce socio-economic inequalities (Lefebvre, 1978).

Finally, Lefebvre (1977) argues that during the second half of twentieth century, the State assumed the role of facilitator of the reproduction of capitalism. The ‘State mode of production’ emerges when there is a shift in the modern State’s criteria in intervening the space, from the strategy to correct contradictions to act as a mediator, regulator and facilitator of the reproduction of the capitalist order (Lefebvre, 1977). The modern State continuously shapes and reshapes the spaces of capital accumulation and commodity exchange, exposing them to fragmentation, hierarchisation

and homogenisation. In parallel, as the State’s strategies of intervention are oriented toward the restructuring of specific spaces, scales and territories, they are deeply spatially selective.

Food system approach

The food system approach (FSA) contributes to understanding the complexities of food chain (production, processing, distribution and consumption) and key actors by interconnecting inputs, flows, and outputs (FAO, 2018). The FSA provides powerful analysis on the relationship between food chain, actors and public policies, making outcomes of activities apprehensible, in terms of socio-economic, production practices, access to means of production and environmental terms. The framework is a relevant interdisciplinary analysis instrument for research and policy-making processes aimed at sustainable solutions for access to means of production, production models and supply of sufficient and healthy food. The FSA also highlights rooted causes of problems such as poverty, malnutrition and socio-economic and geographical inequalities (FAO, 2018).

Food systems entail processes related to food production and use, such as producing (growing and harvesting), processing, packing, transporting, marketing, consuming and disposing of food waste. Their activities demand inputs and engender products and/or services, income and access to food, as well as environmental impacts (UNEP, 2016; HLPE, 2014). A food system is also defined as interconnected networks of stakeholders (NGOs, public and private organisations, citizens, financial institutions, and companies) coexisting in a geographic space (region, state, multinational region) that contribute directly or indirectly to generation of flows of goods and services oriented towards meeting the food needs of groups of consumers located in the same geographic space or elsewhere (Rastoin and Gherzi, 2010). Such a food system is strongly influenced by social-economic, political, technological, cultural, and natural means (Global Panel, 2016; HLPE, 2017).

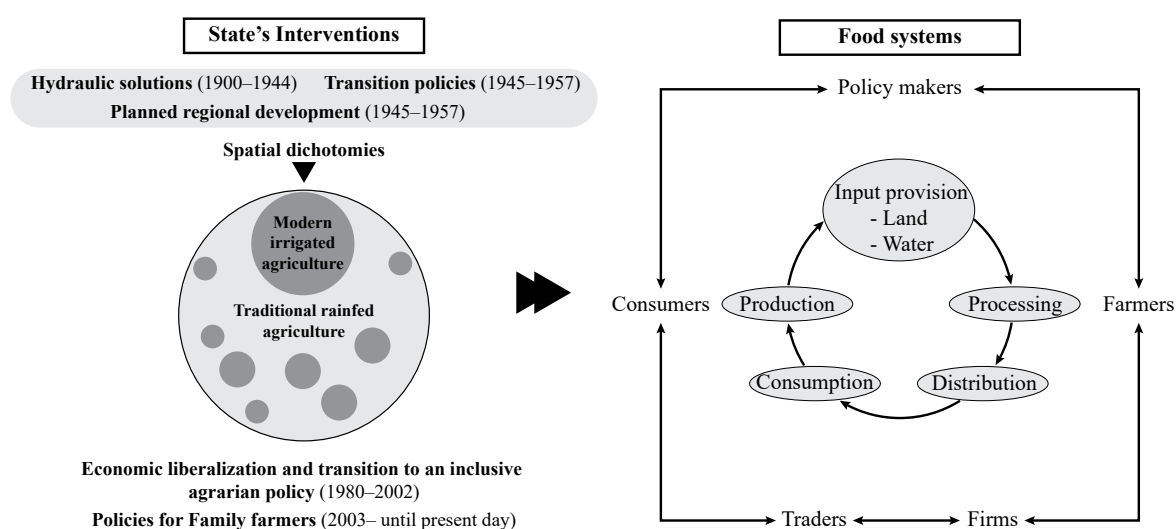


Figure 1: Conceptual Framework.

Source: own composition

Conceptual scheme

The conceptual framework contains two parts: the State's intervention, and the food system's activities. The first part concerns public policies implemented in the semi-arid region. The period between 1900 and 1980 was decisive towards creating spaces for modern irrigated agriculture, outlining the dichotomies of the agrarian space. The second part corresponds to the policies' influence over the activities of the food systems (input provision, producing, processing, trading, and consuming).

State's intervention and the production of the agrarian space dichotomies

The Portuguese occupation of the Brazilian territory in the colonial period (16th Century) was characterised by the appropriation of sparse sites, especially in the coastal areas due to the fertile lands. Thus, remote regions, such as the semi-arid, were neglected for years (Andrade, 2004; Prado Jr, 1981). The first interventions of the federal government were launched in the 20th century to mitigate effects of droughts. The policies involved the construction of hydraulic infrastructure, such as public and private dams, irrigation canals, reservoirs, well drilling and drainage (Alves, 1982; Silva, 2006).

Between 1945 and 1957, the federal Government launched policies to promote socioeconomic development by exploring the economic potential of the São Francisco River and granting credit lines to foster the local economy (Duarte, 2002). Transition policies went beyond the pattern of the previous period since in addition to mitigating the effects of drought, the policies aimed at a deeper structural change in economy and society.

In 1958, studies were carried out by the Working Group for the Development of the Northeast (GTDN) aiming at identifying the causes of regional poverty and underdevelopment and raise possible solutions (Furtado, 1997). The reports concluded that poor management of the resources, unequal access to means of production such as inputs, land, water and capital were the main issues (Furtado, 1997). The study also revealed the aptitude for irrigation of spatial fragments, especially the São Francisco river humid Valleys. Based on the results and also influenced by the productivist paradigm, the federal government started to invest in industrial and agricultural projects.

Thereafter, the State devoted itself for creating a space for the development of a modern agriculture, based on irrigation. For that purpose, three main actions guided public investments (Ortega and Sobel, 2010):

1. Investments in the construction of federal highways to link irrigated areas to urban centres in the country, construction of electrical grids to supply electricity, networking and communication infrastructure, Petrolina airport and the Sobradinho dam (Sobradinho hydroelectric power plant). These investments were prior to the implementation of the perim-

eters and were fundamental to connect the region to markets.

2. Investments in irrigation comprised the construction of canals, water pumps and irrigation reservoirs. The São Francisco Valley Development Company (CODEVASF) and the Brazilian Agricultural Research Corporation (EMBRAPA) cooperated in planning and execution of the works and preparation of agricultural studies, respectively.
3. Incentives for private investment, such as financial and fiscal incentives such as the Financial Assistance Programme for Agroindustry and Industry of Inputs, Machines, Tractors (Proterra/Pafai, 1971), and further financing programmes for the capitalisation of agro-industrial companies, such as the Northeast Agroindustry Development Programme (PDAN, 1974), the Agroindustrial Development Programme and the National Agroindustry Assistance Programme.

In the 1960s, irrigated agriculture pilot projects started to be implemented in the humid valleys of the São Francisco river situated in the municipalities of Petrolina and Juazeiro.

Between 1980 and 1990 the trend towards neoliberal policies promoted a dismemberment of the public sector, through the privatisation of public institutions. From 1990 onwards the State expanded the process of agrarian reform across the country and launched programmes to include traditional family farming in the regional development project. The National Programme for Strengthening Family Farming (PRONAF), created in 1996, was one of the first programmes that granted credit to family farmers.

The State's movement towards policies to Family farmers from the 2000 onwards is especially characterised by the expansion and consolidation of more inclusive measures, based on the conception of territorial development, unlike the sectorial previous model of development, which focused on the modernisation of agriculture and irrigation. The State launched programmes to promote access to water through cisterns to traditional rainfed farmers (One Million Cisterns for Drinking Water – P1MC, 2003), created institutional markets and food security programmes (Food Procurement Programme – PAA; 2003 and National School Feeding Programme – PNAE, 2003) and implemented programmes to offer rural technical assistance to family farmers (Technical Assistance and Rural Extension programme – ATER, 2010).

Materials and Methods

Case study

Our case study entails sites situated in the municipalities of Petrolina and Casa Nova, which are part of the Brazilian semi-arid region. High temperatures and droughts are characteristic of the region, which features annual average rainfall and temperature of 800 mm and 25.4 °C, respectively (Malvezzi, 2007). The regional aridity relates to spatiotem-

poral rainfall concentration, since 71% of the precipitation occurs between January and April. In addition, the rate of evaporation of 3,000 mm/year is three times higher than the precipitation (Malvezzi, 2007). The region is crossed by the São Francisco River, which is the main source of water for irrigation in the region. The semi-arid space is covered by seasonally dry tropical biome, so-called Caatinga, which presents a great diversity of species resistant to long periods of drought, such as xerophilous and deciduous vegetation (Por *et al.*, 2005).

The semi-arid region's levels of poverty have historically stood out as the highest in the country. Out of the nearly 13.4 million Brazilians (6.5% of the country's population) currently living in a situation of extreme poverty (monthly household income per capita below R\$133,70 – maximum of US\$1,90 per day), about 7.3 million are residents of the semi-arid region (PNAD, 2016). In Figure 2, the location of the municipalities of Petrolina and Casa Nova can be seen.

The municipality of Casa Nova covers an area of 9.697 km² and is home to 64,940 inhabitants, 42% of whom reside in rural areas (IBGE, 2010). The extension of the territory of Petrolina is 4.561 km² and presents a population of 293,962 inhabitants, 25% of whom are from rural areas (IBGE, 2010). The criteria we used to select both municipalities were as follows: (1) availability of secondary data from agricultural census survey at the municipal level; (2) the differences and convergences between Petrolina and

Casa Nova in terms of agrarian space; and (3) the prevailing food systems (irrigated agriculture and rainfed agriculture) that are relevant for the regional economy. In Petrolina we visited irrigated agricultural areas, the so-called irrigated perimeter, and in Casa Nova we visited traditional rainfed farming communities.

Data collection

Both primary and secondary data were used in this study. Primary qualitative data were collected during the fieldwork we conducted in the municipalities of Petrolina and Casa Nova in two occasions: the first in July 2018 and the second from October 2018 to January 2019. Secondary data were sourced from agricultural census of 2017, published by the Brazilian Institute of Geography and Statistics (IBGE). Primary data were gathered through participatory observation, focus groups and semi-structured interviews. We also took notes and made audio recordings. In Petrolina we visited irrigated areas and interviewed the representative of a fruit-growing agro-company, three family farmers who grow fruits and annual crops (e.g. onions, beans, cassava, maize) in the irrigated areas and three family farmers that occupy the peripheries of the irrigated areas (*agrovilas*). In Casa Nova we visited the rainfed areas, where we conducted six focus groups with traditional family farmers from the *fundo de pasto* communities of Melancia, Riacho Grande and

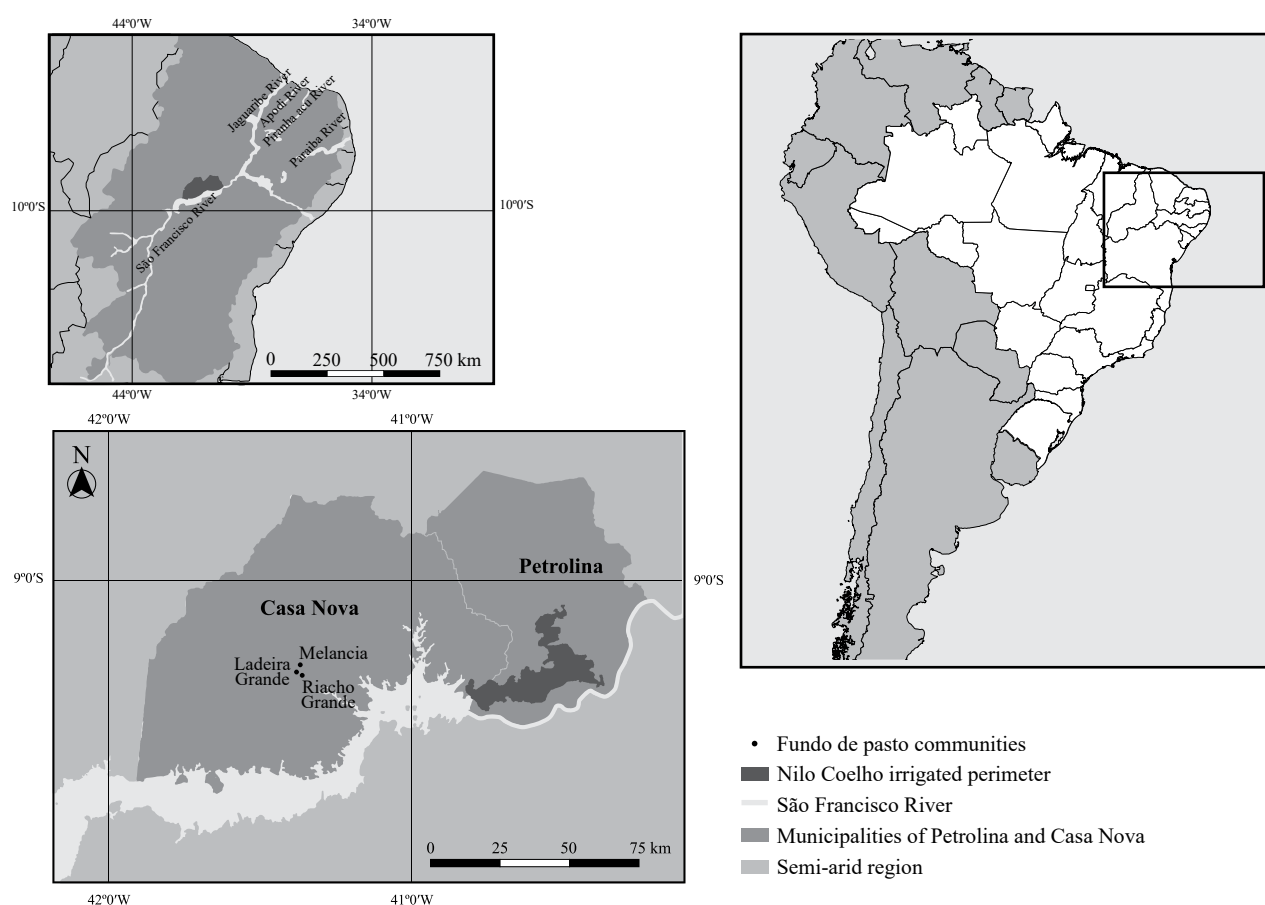


Figure 2: Location of the case study on two spatial scales: municipal (Petrolina and Casa Nova) and local (rainfed area, *fundo de pasto* communities and irrigated perimeter of Nilo Coelho).

Source: own composition

Lagoa Grande. We also conducted eleven semi-structured interviews with academics and representatives from NGOs, social movements, and private and public institutions⁴. Secondary data were obtained through digital platforms of the public institutions mentioned above. We collected data on the following topics: area occupied by the food systems (irrigated agriculture and rainfed agriculture), number of farmers and companies in the irrigated and rainfed areas, main crops grown, animal rearing and trade.

Data analysis

Primary data were used to support local-scale analysis of the agrarian space, which comprises the irrigated areas (irrigated perimeter) and rainfed areas (traditional *fundo de pasto* communities). Secondary data were collected to support analysis at the municipal scale considering differences and convergences of agrarian spaces of Petrolina and Casa Nova. We analysed the forms of the State's intervention in the different activities of the food systems, which include input provision, producing, processing, trading, and consuming.

According to the federal law (Act No. 11.326, July 24, 2006), family farmers are the rural family entrepreneurs who practice activities in rural areas and, simultaneously, meet the following requirements: (1) do not hold, in any way, proprietary property of a size greater than four fiscal modules⁵; (2) use, predominantly, the labour force of their own family in the economic activities of their property or enterprise; (3) the family income must come, predominantly, from economic activities linked to the property or enterprise; (4) manage their property or enterprise with their family. The remaining productive models that do not fit this definition are considered “non-family farming”, according to the Brazilian Institute of Geography and Statistics (IBGE). Since the data from the agricultural census uses this criterion to define the types of farmers in Brazil, we also use the same nomenclature.

Hypothesis

The construction of the agrarian space is influenced by the interaction of different actors and elements (civil society, geographic objects, institutions and the State). However, in this study, we approach the State's contribution as central to the agrarian space (re)production. The study hypothesis consists in the assumption that the historical spatial and sectoral selectivity of public policies was decisive for building a dichotomous agrarian space, characterised by traditional

agriculture and modern irrigated agriculture. Policies were translated into differentiated opportunities for rural development in the Brazilian semi-arid agrarian space.

Results

The dichotomies of the agrarian space

Petrolina and Casa Nova present spaces of both modern irrigated agriculture and traditional rainfed agriculture, but different proportionalities in terms of the food systems' spatial distribution. As can be seen in Figure 3, the area covered by the rainfed food system is more significant in comparison to the irrigated fields in both municipalities. However, looking at the detail, we perceive that in Casa Nova the rainfed area is around double that of Petrolina's. On the other hand, the irrigated area of Petrolina is about four times larger than Casa Nova's, measuring approximately 397 km² and 90 km², respectively. Based on this data, we chose to analyse irrigated areas of Petrolina and traditional rainfed areas of Casa Nova.

The space of irrigated agriculture is composed of public irrigation projects, so-called ‘irrigated perimeters’. These projects resulted from the period of planned regional development (1958–1980). The creation of the perimeters involved two primary actions of the State: (1) the transformation of public lands into private lands and (2) investment in the construction of canals, water pumps, irrigation reservoirs, as well as infrastructure for transportation, energy, communication, etc. We visited the irrigated perimeter of Nilo Coelho, which is located in the municipality of Petrolina and covers an area of 18.667 hectares, being equivalent to 46% of the Petrolina's irrigated area.

The irrigated perimeters are occupied by agricultural companies (national and multinational) and capitalised family farmers. Fruits of temperate and tropical climate are grown in the lands of agribusiness. In contrast, fruits and annual crops are grown in the lands of family farmers. The labour employed by agribusiness comes from urban areas (people who make the countryside-city commute every day)

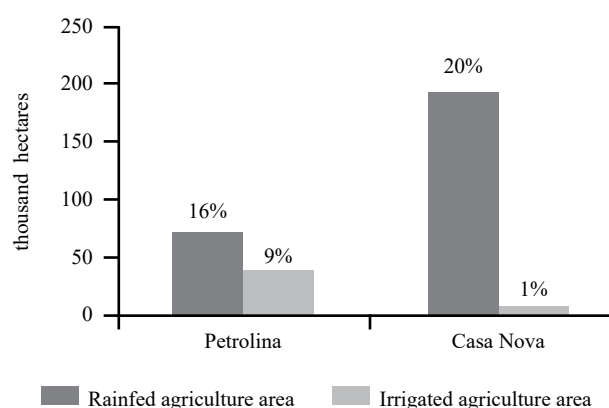


Figure 3: The proportion of food systems' spatial occupation in Petrolina and Casa Nova (2017).

Source: IBGE, 2017 and EMBRAPA (fieldwork data collection)

⁴ The institutions that participated in this study break down as follows: Brazilian Agricultural Research Corporation (EMBRAPA), Food and Nutrition Security National Council (CONSEA), Regional Institute for Appropriate Small Farming and Animal Husbandry (IRPAA), Advisory Service for Rural People's Organizations (SASOP), Pró-Semiárido, Pastoral Land Commission (CPT), Agrarian Development Coordination (CDA) and Secretariat for the Promotion of Racial Equality (Sepromi), São Francisco Valley Development Company (CODEVASF) and Irrigation District of Nilo Coelho.

⁵ Fiscal module is the unit applied to define the land size (in hectares). The minimum lot size must be sufficient to meet the families' necessity in terms of food production for their livelihood and for economic purposes. The size of a fiscal module varies according to the municipality where the property is located. In Petrolina a fiscal module covers an area of 55 hectares, while in Casa Nova a fiscal module covers an area of 65 hectares.

and from the rainfed areas. The land occupation of the irrigated perimeter of Nilo Coelho is shown in Table 1.

At the perimeter of Nilo Coelho, we visited an agribusiness plot of 390 hectares (340 hectares for growing mangoes and 50 hectares for grapes) that during the harvest hire approximately 900 workers. We also visited three lots of family farmers, whose area varies from 8 to 14 hectares, one focused exclusively on mangoes and two of which growing mangoes, acerola and annual crops. Permanent employees range from 4 and 6 and in the harvest period, the number of extra persons working on the farm might reach 15 temporary workers. In addition, we visited three small lots of family farmers that occupy the peripheries of the perimeter, so-called *agrovilas*, each lot-sizing approximately 2 hectares, which are used for growing mangoes and organic annual crops. The irrigated perimeter is managed by the Irrigation District, which is a non-profit legal entity responsible for maintaining the hydraulic infrastructure, controlling water use and collecting fees.

The traditional rainfed food system occupies public lands and farmers are dependent on rainwater for self-consumption and food production. We visited three traditional communities in the municipality of Casa Nova that occupies an area of 15,100 hectares, which corresponds to approxi-

mately 8% of the rainfed area of the municipality. The rainfed area is occupied by family farmers from traditional communities (*quilombolas*, *povos de terreiro*, *fundo de pasto*, artisanal fishermen, etc.) and family farmers settled on agrarian reform settlements. They produce crops such as fruits, vegetables, greenery and practice extensive livestock production with such animals as cattle, chicken, pig, but mainly goats. The traditional rainfed farmers we visited in Casa Nova are so-called *fundo de pasto* communities, whose main feature is the communal land (used for animal rearing) combined with individual areas (used for family crop production). Table 2 shows the key characteristics of each community.

Table 3 shows the main crops grown in both municipalities, according to the type of producer (family farmers and non-family farmers). Petrolina produces more fruits, while Casa Nova stands out more for the cultivation of vegetables and grains, such as onions, beans and corn. When comparisons involve the type of producers, it is noticeable that non-family farmers produce considerably more grapes and mangoes while family farmers are engaged in producing fruits, vegetables and grains in a more balanced way.

The goat production, as shown in Figure 4, is more prominent among family farmers of Casa Nova. Goats are the main source of income of the *fundo de pasto* communities

Table 1: Land occupation of the irrigated perimeter of Nilo Coelho.

	Family farmers	Agribusiness
Number of lots	1,983	244
Area in hectares	12,027	6,024

Source: Fieldwork data collection

Table 2: Main features of the *fundo de pasto* communities participating in this study.

Community	Total number of families	Size of land occupied (hectares)
Melancia	42	600
Riacho Grande	211	12,000
Ladeira Grande	60	2,500

Source: Fieldwork data collection

Table 3: Quantity produced by family and non-family agriculture according to the municipality (tons).

	Petrolina					Casa Nova				
	Family farming	%	Non-family farming	%	Total	Family farming	%	Non-family farming	%	Total
Pumpkin	724	59	496	41	1,220	181	58	132	42	313
Onion	0	0	0	0	0	3,743	34	7,329	66	11,072
Beans	232	78	67	22	299	292	79	79	21	371
Cassava	7,404	92	607	8	8,011	534	76	168	24	702
Corn	443	76	143	24	586	329	30	774	70	1,103
Watermelon	1,306	57	992	43	2,298	1,651	51	1,558	49	3,209
Acerola	8,894	57	6,746	43	15,640	380	86	63	14	443
Banana	15,049	62	9,042	38	24,091	254	13	1,630	87	1,884
Cashew	436	13	2,796	87	3,232	20	100	0	0	20
Guava	10,009	52	9,183	48	19,192	2,889	28	7,309	72	10,198
Mango	15,646	15	88,236	85	103,882	3,566	8	40,311	92	43,877
Grape	10,190	7	132,968	93	143,158	2,145	13	14,188	87	16,333
Total					321,609					89,525

Source: IBGE, 2017

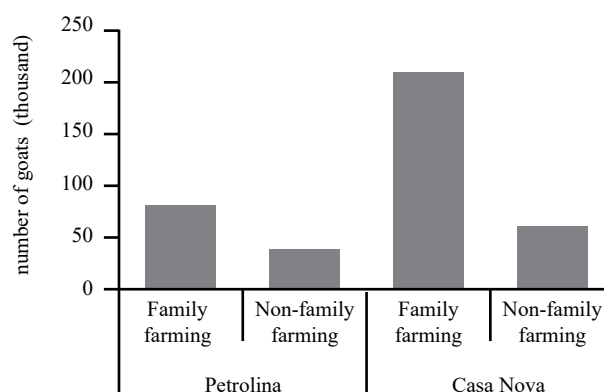


Figure 4: The goats rearing (number of goats) by region and area.

Source: IBGE, 2017

and are raised extensively, feeding on native vegetation and consuming water from dams. Also, in Petrolina, family farmers produce more goats than non-family farmers.

In face of the above results, we interpreted that in Petrolina, where the irrigated areas are larger than the Casa Nova's, non-family farming stands out for fruit production, whilst in Casa Nova, where the rainfed area is considerably superior, the amount of vegetables, grains and goats is greater. In both municipalities, family farming produces more vegetables, grains and goats than non-family farmers.

The State's influence over the activities of the food systems

Input provision: land access

In the case of Nilo Coelho perimeter, there are disagreements concerning the land's occupation before its transformation into irrigated perimeters. While the irrigation district employee affirmed that the lands used for the activities were vacant, the representatives from Pró-Semiárido and the Pastoral Land Commission (CPT) stated that the lands were occupied by landless squatters and family farmers that had no land title. As a consequence of the irrigation policy, squatters and family farmers were expropriated and communal public land were transformed into private properties.

The access to the lands of the irrigated perimeters is made through land purchases. In the first years of the occupation, land payment could be made within 10 years, with low interest rates and tax incentives. The historical occupation of the perimeter may be divided into two main periods, according to the member from the irrigation district. At first, in the 1970s, the land was occupied by traditional farmers and small family farmers from nearby areas who had experience with small-scale irrigation practices. In the second phase, mid-1980s, the federal government moved away from the administration of the perimeters, under the influence of the neoliberalism and also because of the deep economic crisis that hit public accounts. The crisis affected the farmers in the perimeters, who sold their land and moved to the rainfed area nearby the perimeters (*agrovilas*). Subsequently, the traditional farmers were replaced with small agricultural entrepreneurs and national and international companies (agribusiness). According to the irrigation district employee, it was when the fruit growth and trade expanded to national and international scales. Currently, only 10% of the first farmers continue occupying the land of the Nilo Coelho perimeter, which means that family members are no longer the natural successor.

The three farmers who live in the *agrovila* explained how they failed to subvert the logic of capitalist accumulation and sold their land. Below we highlight an excerpt from the testimony of one of the farmers.

"I know a lot of people who left the business, went back to work as employee. They lost everything. At least I live here in *Agrovila* and I have my land. It's small, but I can live. Better than in the city. I was unable to complete the pay-

ment for the land because the profits went down. I had to sell it. I sold it to a businessman from São Paulo. The problem of selling to these people is that they do not diversify [the production]. They prefer monoculture ... then people in the region lack food."

The traditional communities of farmers occupy rainfed land for over two hundred years and many do not have the land title, according to the Regional Institute for Appropriate Small Farming and Animal Husbandry (IRPAA).

In 2013 the State of Bahia launched a plan (Law 12.910), which provides for a contract regarding the right of land usufruct for up to 90 years, with the possibility of renewal for an equal period. Participants from the *fundo de pasto* communities reported that they have rights to this land and, for this reason, they claim that they deserve land titles, not simply an authorisation to occupy the land for a certain period. They also stated that accepting the contract meant confirming the premise that the land does not belong to them, as dictated by the State government.

As reported in focus groups the communities' land struggles began in the 1970s when the federal government built the Sobradinho hydroelectric dam, flooding an area of 4,214 km² and displacing approximately 12,000 families, including some of the study participants. The dam construction set a precedent for land grabbing in the region. Land grabbing is an old practice in Brazil, typically beginning with irregular occupation of land, supported by fraud and falsification of property titles. In 1979, there was an intense and violent conflict between the communities and a company that illegally occupied their lands for cattle production. Families were displaced, farmers were threatened with death, and a community leader was murdered. Nowadays, communities fear losing their lands to wind power companies, agribusinesses, and mining companies, which have been advancing in the region with the collusion of the government of Bahia⁶.

Input provision: water access

The irrigated perimeter of Nilo Coelho was created by the federal government between 1984 and 1996. The public investments entailed the construction of irrigation infrastructure (canals, water pumps, irrigation reservoirs) and electrical station to pump water from the São Francisco River. The Irrigation District manages the system and charges farmers and companies for water use. Families settled in the *agrovilas* collect water irregularly from the canals to grow crops such as organic fruits and vegetables. Given their illegal status, they do not pay the fee for water consumption. This situation is, constantly, the cause of conflict between insiders and outsiders. The Irrigation District takes strict measures, interrupting clandestine access to water.

Despite being close to the São Francisco river (see Figure 1), irrigation sourced from the river is not possible to the *fundo de pasto* communities. Rainwater is the main

⁶ The government of Bahia implemented a series of measures to attract investments, including offering concessions of State land for industrial and agricultural use and energy production; offering reductions and exemptions from State taxes, and offering low-interest financing (FIEB, 2019; SEI, 2019).

source of water for drinking and producing. The water is collected through the gutter installed on the roof of the houses and drained to the cisterns, where it is stored. Cisterns are given to the families through the federal programme One Million Cisterns for Drinking Water (P1MC). The P1MC became public policy in 2003 and participants confirmed they had at least one cistern.

Among the benefits of the cisterns, focus group participants highlighted its role in freeing women from daily long walks for water collection, since they were in charge of ensuring household water security. The testimony below we got from a female farmer from the *fundo de pasto* community.

“Now that we have the cisterns, the pain in my back reduced because I used to carry water since I was seven years old. We used to walk about 15 km a day or more. Now that we have cisterns at home, we can store water. In the past, the water truck brought water, but since we had no cistern, the water was thrown to the ground. Sometimes having a place to store is so much more important than having access to water itself.”

In the same focus group, we also discussed the role of the cisterns in food production. We selected the following testimony to illustrate the perception of a rainfed farmer on the subject.

“They [cisterns] were important because now we have water for small irrigation. At home, we began to produce more fruits and vegetables, for example. We also consume more of the food grown on our farm.”

The cisterns’ efficiency depends on the availability of rainfall throughout the year. As reported by the participants in focus groups, due to recurrent droughts the water in the cistern runs out in certain periods of the year, forcing families to rely on government assistance for water supplies. To improve people’s autonomy regarding water access, one academic interviewed recommended implementation of structuring measures to mitigate the effects of the drought, including the construction of small water aqueduct systems to connect the communities to the São Francisco River.

As mentioned above, another way to access water is through the water truck provided by the federal government, which is an emergency supply. The municipal government is responsible for planning water distribution and the army is in charge of hiring water suppliers and controlling the water supplied per house. However, according to participants in the focus groups, there is a mismatch between the plan and the execution of the project. In general, the water provision is inefficient because the amount does not meet the real needs of the communities. Below we selected a statement taken from the focus group dialogues.

“A clear example of disconnected measures is that last year the municipality of Casa Nova was provided with 10 water trucks, when actually its rural population demands water consumption of at least 90 trucks.”

Producing and processing

The State has been involved in helping production and processing activities in irrigated areas by providing technological and scientific knowledge through the Brazilian Agricultural Research Corporation (EMBRAPA). EMBRAPA’s office in semi-arid was created in 1975 to develop scientific studies in the field of agronomy to support the agriculture in irrigated areas. Below we highlight the testimony of an employee from EMBRAPA semi-arid on the importance of the institution for the development of the initial phase of fruit growing in irrigated areas.

“Embrapa was crucial in transforming the perimeter of Nilo Coelho into a station dedicated exclusively to the cultivation of fruits. This occurred around the end of the 1980s. EMBRAPA tested different fruit species, such as mangoes and grapes, so that the region would become attractive to private capital. We knew already that mangoes and grapes were well accepted in the global market.”

Embrapa’s representative informed us that the genetic modification of the seeds allowed the cultivation of fruits of temperate climate in edaphoclimatic conditions of the semi-arid region, which has high temperatures, high insolation and low humidity throughout the year. Besides, it helped to improve productivity and resistance to pests, to meet market demands (e.g. seedless grapes, mangoes with little fibre, fruits with uniform colours and appropriate balance between sugars and acids) and to extend the post-harvest conservation capability.

As a result of the adaptations, currently, grapes are produced twice a year and the length of the mangoes’ growth cycle has been reduced to 10 months. With no influence of genetic engineering services, this period would be nine months for grapes and 12 months for mangoes. In addition, producers manage the harvest in order to make it coincide with the off-season periods of other producers located in Brazil and abroad, benefiting from their competitive advantage. EMBRAPA also offers assistance to producers to get their products certificated, meeting the requirements imposed by the world market. Table 4 illustrates the mangoes and grapes growth cycle.

The State also offers technical assistance for farmers in rainfed areas, but the assistance was institutionalised in 2010, through the creation of the Technical Assistance and Rural Extension programme (ATER). The main goal of ATER is to transfer technical knowledge to family-farm food systems via environmental education, introduction of endogenous production techniques, and transition to agroecology (Brasil, 2018). In Bahia, policymakers opted for outsourcing this service to NGOs and other private entities, which are contracted through public calls.

Table 4: Mangoes and grapes growth cycle.

Crops	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mangoes												
Grapes												

Source: Fieldwork data collection

According to farmers, environmental education includes discussions of sustainable solutions to cope with the semi-arid climate. Regarding food security, the NGOs help farmers and associations make applications in response to public calls to participate in the PNAE (National School Feeding Programme) and PAA (Food Procurement Programme). This assistance has been fundamental, because farmers affirmed that they were not used to dealing with bureaucracies and formal contracts. Concerning agricultural practices, the projects involve assistance with soil management, creation of a seed bank, and preservation of the region's characteristic biome (Caatinga). The NGOs also encourage the transition to agroecology through the use of organic matter (manure) as a natural fertiliser (thus avoiding use of chemical fertilisers). Participants reported that the technical assistance enabled them to understand the benefits of agroecological practices that they applied intuitively, providing insights into how they work to maintain a resilient environment.

One of the problems identified by the communities was that by outsourcing the technical assistance service, the number of family farmers receiving support had fallen. Participants stated that when the Bahia State government provided the service in the past, it covered more families. They said that the institutions that replaced the State in this function have a limited budget, which translates into less coverage. Participants pointed out that since some families were not informed and properly guided regarding the procedures and bureaucratic steps involved in applying for contracts, they had difficulties accessing public policies.

Trading and consuming (food security)

The producers from the irrigated perimeter have easy access to the market, as they are close to the urban centre of Petrolina. In other words, producers have access to trans-

port infrastructure, such as airport and federal roads (see Figure 1). The State's investments in transport, communication and energy infrastructures turned the irrigated territory more fluid to exchange goods and movement of people. Differently, farmers in rainfed areas – especially the communities we visited – are distant from urban markets and devoid of adequate transportation infrastructure. Figure 5 shows the infrastructure implemented in the region.

In Figures 6 and 7, we see the main commercialisation niches for food produced in the municipalities of Petrolina and Casa Nova. The data from the agricultural census did not cover the differentiation between family farming and non-family farming for this indicator.

The most important common aspect shared by the municipalities is the sales to middlemen/ intermediaries. Many middlemen are farmers or micro-entrepreneurs from nearby localities that purchase a variety of products from producers at a lower price and resell to large supermarket chains and export. The intermediaries are strong because, according to farmers from both areas, for many years they were one of the only forms of trade. Farmers and intermediaries created strong bonds over time and built relationships based on of trust and friendship. Therefore, despite the advent of food procurement and other trade mechanisms, intermediaries are still very important for the production flow.

In Casa Nova, sales of food through cooperatives and associations involve products such as corn, cassava, beans and onions. Data on the destination of the goats were not available through census data, but according to participants most part of the animals are sold through cooperatives. According to farmers, sales through cooperatives and associations usually occur within the standards of the mediated market, through the Food Procurement Programme (PAA) and National School Feeding Programme (PNAE). In both municipalities, products are pooled together for collective sales, enabling economies of scale.

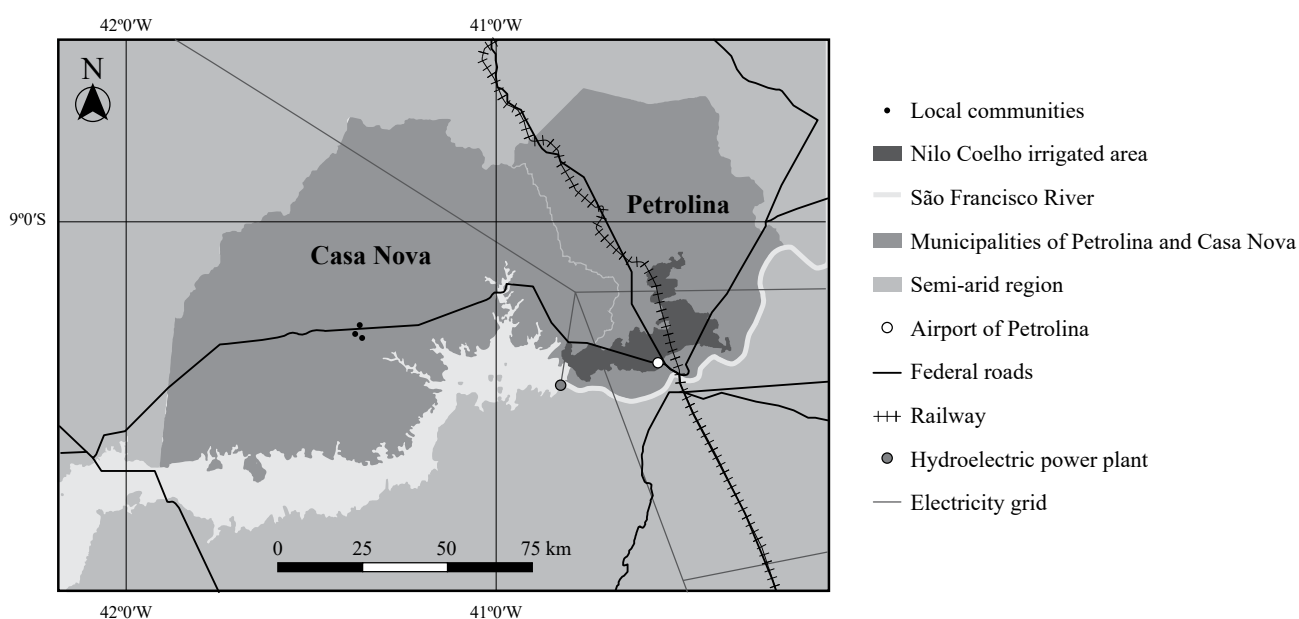


Figure 5: Geographical distribution of physical infrastructure in the agrarian space.

Source: own composition

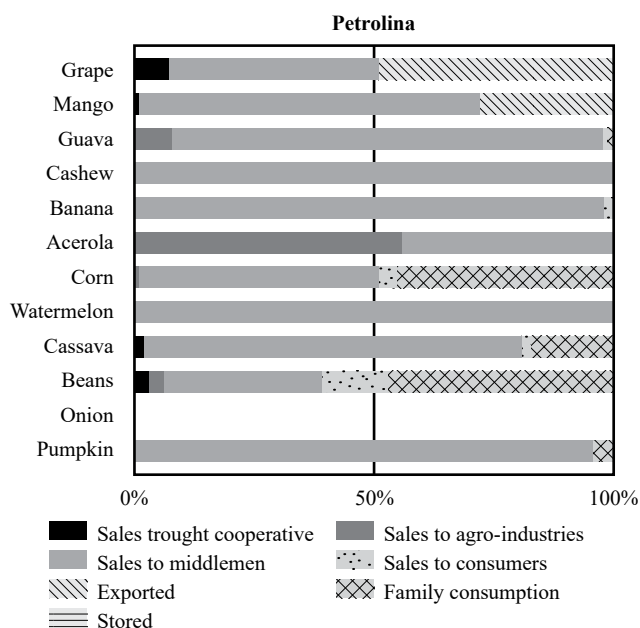


Figure 6: Destination of the products, Petrolina

Source: IBGE (2017)

Exports are also expressive in both municipalities, especially mangoes and grapes, which are fruits mainly produced in irrigated areas. Petrolina exports 70 thousand tons of grapes and 29 thousand tons of mangoes, respectively, which corresponds to approximately three times more than Casa Nova exportation. In terms of absolute values, Petrolina exports more, but in figures 3 and 4 we see that Casa Nova exports most of mangoes and grapes produced in its territory. Also, annual crops (pumpkin, beans, cassava and maize) are sold directly to consumers, which means that these products are mostly sold at local fairs, in addition to being highly consumed by families, especially those from the municipality of Casa Nova.

As for access to food in satisfactory quality and quantity, as food security advocates (FAO, 1999), rainfed areas stand out for subsistence agriculture, with a low level of food insecurity. Figures 5 and 6 show that a large amount of the food produced is consumed. However, farmers admitted that vulnerability to food insecurity is more imminent in periods of drought, pointing out that the semi-arid climate aggravates food insecurity, but the problem is rooted in low household income and high levels of poverty. The drought that occurred between 2005 and 2009 was remembered as a difficult time for food production and in this period families in the communities received cassava, milk, rice and beans from PAA. They also highlighted the importance of food procurement programmes (PAA and PNAE) as an important means for achieving income stability, translating into household financial planning concerning family feeding.

In the irrigated areas, there is also no evidence of food insecurity, given that farmers in these lands are financially able to purchase food. However, if food supply is considered on a regional scale, productive specialisation is a negative indicator, as it means that family farming is using land to produce food to satisfy market demands and not to satisfy the population's demands for food that meet their dietary needs.

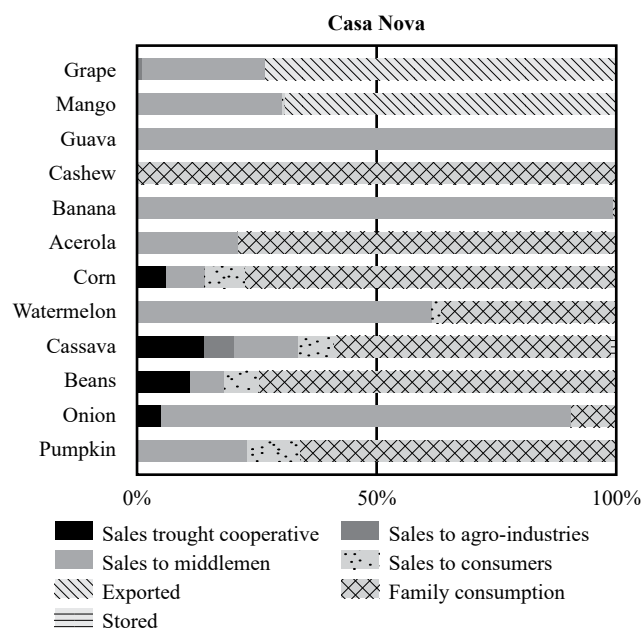


Figure 7: Destination of the products, Casa Nova

Source: IBGE (2017)

Discussion and Conclusion

Public policies transformed the agrarian space of the semi-arid region for generating productive restructuring of activities and spatial dichotomies. The territorialisation of the capitalised food systems was based on a set of policies launched between 1900 and 1990 that involved the construction of hydraulic infrastructure for irrigation, arrangements for communication and energy supply, easy access to land and technical information. The consequences of these commercially oriented policies include the dichotomies of agrarian space, the emergence of capitalised food systems in the humid valleys of the Rio São Francisco, the imposition of productive specialisation and connections with the global market scale.

Policies for traditional family farmers lasted almost a century after being implemented in the 1990s. Despite the delay, they improved the activities of the farmers from rainfed food system, as we have analysed. The cisterns provided household access to good quality water. Previously, people collected unsuitable water from dams located far from the communities. Technical assistance helps in the development of a contextualised agriculture, considering edaphoclimatic conditions of the semi-arid region. The projects also preserve the caatinga biome and guarantee food security conditions for family farming. Finally, food procurement programmes enabled an alternative market for family farmers. The issue not yet resolved concerns the regulation of communal land, since the communities fight for the title of the land and reject the contract that authorises the use of the land for a limited time. Among the most significant impacts it is worth highlighting the empowerment of family farmers, access to the institutional market, income stabilisation, and improvements in food production and consumption (food security), as well as the promotion of contextualised practices to deal with semi-arid edaphoclimatic conditions. Table 5 demonstrates

the connections between public policies, process factors and policies' impacts.

The most relevant differences between the set of policies of the two periods are (1) the focus on the modernisation of agriculture versus a more integrative emphasis; (2) commercially oriented goals versus an alternative market for family farmers; (3) the imposition of an artificial landscape to deal with the edaphoclimatic peculiarities of the semi-arid region versus endogenous development. The policies implemented between 1900 and 1990 had a biased sectoral character, channelling public investment to food systems modernisation and prioritising the activities of agribusiness and capitalised family farming. In contrast, the policies that have been launched since 1990 are inclusive and aim to develop productive activities for family farmers. These policies have achieved greater coverage since they were targeted at the social group of family farmers, being a counterpoint to previous policies that aimed at developing specific productive activities in selected space fragments.

In this sense, the second characteristic of the policies is the contrasts between the commercially oriented policies and the programmes targeted at family farmers. The first policies comprised investments to make the space more conducive to trade, and through the role of the capitalised food system sought adaptations of productive practices and food in order to serve the national and international market. In contrast, the second group of policies were targeted at family farmers' activities, aiming at the stabilisation and resilience of their food system through the creation of alternative markets.

Finally, the first group of policies transformed the landscape to promote capital accumulation through investments in irrigation. Currently, tropical and temperate climate crops share space with original drought-resistant species,

such as cacti, the original species of the caatinga biome. In contrast, the new policies strategically respect and preserve the edaphoclimatic conditions of the semi-arid climate (e.g. cisterns provide household water consumption, without the need to transform the landscape).

The great contradiction is that the first group of policies strengthened modern irrigated agriculture in a way that they became self-sufficient and their activities were consolidated. During this period small-scale producers were marginalised and did not benefit from policies. In contrast, recent policies have strengthened family farmers by stabilising their food system activities and safeguarding farmers' livelihoods. However, despite these improvements, the disparities in power between the actors from irrigated and rainfed areas remain very large.

Federal policies targeted at family farmers clearly did not equalise the differences between food systems in the region. Family farmers face disadvantages, since they lack the capital and transport infrastructure – being far from the markets they need to access – and furthermore, they have limited access to water, and legally no access to land. All of these elements together translate into powerlessness.

Achieving a more equal environment means strengthening the voice and participation of small-scale producers in policymaking, while reducing the power of agribusiness. Policies must support producer organisations, increase the participation of family farmers in the policy making process, devise a competition policy that protects these small producers, and impose high export taxes. Also, to improve the living conditions of *fundo de pasto* communities, the public agenda must include expanding access to rural infrastructure and services, such as roads, public slaughterhouses, physical markets, telecommunications, and electricity.

Table 5: Links between public policies, process factors and policies' impacts.

Policies			Policies		
Agribusiness/irrigation farmers			Rain feeding farmer		
1900–1990	Factors of the process	Impacts of the public policies	1990 – present days	Factors of the process	Impacts of the public policies
Hydraulic solution (1900–1944) Transition policies (1945–1957) Planned regional development (1958–1980) Economic liberalization and transition to an inclusive agrarian policy (1980–1990)	Input provision Access to land: easy access through instalment purchase and tax incentives	Emergence of capitalised food systems in the humid valleys of Rio São Francisco	Economic liberalisation and transition to an inclusive agrarian policy (1990–2002) Policies for Family farmers (2003 – until present day)	Input provision Access to land: the land usufruct contract was rejected by the communities	Alternative market
	Access to water: hydraulic infrastructure – dams, irrigation canals, reservoir, well drilling and drainage	Commercially oriented agriculture		Access to water: cisterns	Increased food production and consumption
	Producing and processing Access to technical information that enabled the adaptation of temperate fruit seeds to the edaphoclimatic conditions of the semi-arid region	Connection with the global market scale		Producing and processing Technical assistance: environmental education, introduction of endogenous production techniques, transition to agroecology and knowledge to participate in public programmes	Stable income
	Access to energy through the grid network	Productive specialisation		Trading and consuming Food procurement programmes and mediated market	Feasible access to water
	Trading and consuming Access to transport infrastructure: highways and airport Access to communication infrastructure	Dichotomy of agrarian space Artificial landscapes			Dealing with semi-arid edaphoclimatic conditions

Source: own composition

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