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Giana de Vargas Mores

DYNAMICS OF FOOD PRODUCTION AND CONSUMPTION IN BRAZIL

Porto Alegre
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Tese de doutorado apresentada ao Programa de Pós-Graduação em Agronegócios da Universidade Federal do Rio Grande do Sul, como requisito parcial para obtenção do título de Doutora em Agronegócios.

Orientador: Prof. Dr. Homero Dewes

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To my family, my all...

Dimorvan, Ivete, and Fernanda Mores,

Sady and Arlinda Mores,

Ivo and Iria de Vargas (*in memorian*).

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Giana de Vargas Mores

“Almost certainly, however, the first essential component of social justice is adequate food for all mankind. Food is the moral right of all who are born into this world. […] Without food, man can live at most but a few weeks; without it, all other components of social justice are meaningless. Therefore I feel that the aforementioned guiding principle must be modified to read: If you desire peace, cultivate justice, but at the same time cultivate the fields to produce more bread; otherwise there will be no peace.”

(Norman Borlaug, The Nobel Peace Prize 1970)

ABSTRACT

Agribusiness operates in multiple forms, each one having a unique repercussion on the food systems and behaviors of local and global populations. Estimates suggest that Brazil will become the world's largest producer of food in the coming decades. It is imperative, therefore, to examine Brazil's agricultural commodities and analyze the different temporal and geographical changes related to food production and consumption. To contribute to the body of knowledge on the dynamics of food production and consumption in Brazil, this thesis includes a scientific investigation of interdisciplinary studies that are complementary to the proposed theme. The main purpose of this thesis is to analyze two aspects regarding food systems and their dynamics. The first aspect refers to food production in Brazil, specifically how the different expressions of agribusiness within agricultural and animal production have evolved, while the second aspect is related to changes in the Brazilian population's dietary patterns. Through these analyses, this thesis will determine the participation of the Midwest region in changing the distribution of Brazil's agricultural production. The movements of the geographical midpoints of major Brazilian agricultural commodities, which occurred between 1990 and 2015, seem to closely associated with changes in agricultural production and land use that occurred within this region during the same period. This thesis also presents the geographical changes related to Brazilian agribusiness and discusses how these changes are reflected in the population's food patterns as well as in the heterogeneity of food acquisition among the Brazilian states. Sustainability is necessary for improving food production and accessibility and for preserving natural resources, and new consumption models and sustainable food supply chains are required to address these issues. The phenomenological analysis performed in this thesis offers insights for agribusiness agents regarding the main products that can boost sustainable development in Brazilian agriculture.

Keywords: Food supply chains; Food systems; Agribusiness; Human consumption; Agricultural frontier.

RESUMO

O agronegócio expressa-se de múltiplas formas e tem repercussões nos sistemas alimentares e no comportamento das populações locais e globais. As estimativas sugerem que o Brasil se tornará o maior produtor mundial de alimentos nas próximas décadas. Assim, cumpre-se examinar as commodities agrícolas brasileiras e analisar as diferentes mudanças temporais e geográficas relacionadas à produção e ao consumo de alimentos no país. Com vistas a apresentar uma investigação científica que contribua para a construção do conhecimento da dinâmica da produção e do consumo de alimentos no Brasil, esta tese inclui pesquisas interdisciplinares que fornecem análises complementares para o tema proposto. O objetivo principal deste estudo é composto por dois aspectos que envolvem os sistemas agroalimentares e as suas dinâmicas. O primeiro refere-se à produção de alimentos no Brasil – especificamente como as diferentes expressões do agronegócio na produção agrícola e pecuária evoluíram – enquanto o segundo aspecto analisa como a população brasileira mudou seus padrões alimentares. Assim, a tese examina a participação da região do Centro-Oeste brasileiro na alteração da distribuição da produção agrícola brasileira. Os movimentos dos pontos médios geográficos dos principais produtos agrícolas brasileiros, ocorridos entre 1990 e 2015, parecem corresponder às mudanças geográficas ocorridas na produção agrícola e no uso da terra desta região durante o período analisado. Esta pesquisa também apresenta as mudanças geográficas relacionadas ao agronegócio brasileiro e discute como elas se refletem nos padrões alimentares de sua população, assim como na heterogeneidade da aquisição de alimentos entre os estados brasileiros. A relação entre o agronegócio e a sustentabilidade é necessária para melhorar a produção e a acessibilidade aos alimentos e preservar os recursos naturais. Nesse sentido, são necessários novos modelos de consumo e cadeias sustentáveis de suprimentos de alimentos para mitigar este problema. A análise fenomenológica realizada neste trabalho pode oferecer uma visão do agronegócio às partes interessadas, no que diz respeito ao panorama dos principais produtos que podem impulsionar o desenvolvimento sustentável da agricultura brasileira.

Palavras-chave: Cadeias de suprimentos de alimentos; Sistemas agroalimentares; Agronegócios; Alimentação humana; Fronteiras agrícolas.

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CHAPTER 1: General introduction

The 21st century is beset by several challenges, not least of all the production of enough food for humanity. As food production may be affected by a number of factors, including population growth, resource scarcity, climate change, it is crucial to minimize the environmental impact of the food system based on the larger global strategy for food security (PINSTRUP-ANDERSEN, 2007; SCHMIDHUBER; TUBIELLO, 2007; BEDDINGTON, 2010; GODFRAY *et al.*, 2010a; 2010b; CHEN *et al.*, 2011; TSCHARNTKE *et al*., 2012; CURTIS; HALFORD, 2014; MCDONAGH, 2015).

Consider this: there will be more than nine billion people on Earth by 2050; although the eradication of poverty and hunger are among the United Nations Millennium Development Goals, right now, one in nine people is hungry in the world; approximately one–third of all food produced in the world is lost or wasted in different stages of the food supply chains (GUSTAVSSON *et al*., 2011; MOURAD, 2016); and one billion people could be fed if food losses and waste would be reduced by just half (KUMMU *et al*., 2012; LEBERSORGER; SCHNEIDER, 2014). When one faces this issue, the discussion on food security intensifies and remains a global challenge – one that encompasses various areas of knowledge as well as the public and private sectors.

Brazil remains one of the world's largest food producers for both domestic and export consumption. The Brazilian Law No. 11,346, which passed on September 15, 2006, and gave rise to the National System of Food and Nutritional Security (Sisan), aimed to ensure the human right to adequate, healthy, permanent, and sustainable food. In the quest for sustainability, and taking into account cultural, environmental, economic, social, and regional differences, under this law, in the interest of fostering food practices that promote health, everyone has the right to regular and permanent access to quality food in a sufficient quantity, without access to other needs being compromised (BRASIL, 2006).

Since the 18th century and the work of Thomas Malthus, there has been a concern about the relationship between population growth and food production (MALTHUS, 1996). The connections among agriculture, food systems, and land use are pressing topics in agricultural geography. This work considers aspects such as globalization, urbanization, population ageing, increasing population wealth, changes in human dietary practices, and the interdependence of food production and consumption regions (RENTING; MARSDEN; BANKS, 2003; HEADLEY; FAN, 2008; NRC, 2010; DREWNOWSKI; KAWACHI, 2015;

ARGENT, 2016; GATRELL; REID; ROSS; 2011; SCHNEIDER *et al.*, 2011; HINRICHS; CHARLES, 2012; MCGIRR; BATTERBURY, 2016; MOSELEY; WATSON, 2016).

In this context, it points out that agribusiness is expressed in multiple forms and has repercussions on both the food systems and the behavior of local and global population. In other words, agribusiness development has an important impact on the international food supply and on the local conditions of production and consumption. Among the main concerns of agribusiness are the occupation of geographic space and territory, and the path that food travels geographically from production to consumption (WATTS; ILBERY; MAYE, 2005; MCMANUS *et al*., 2016; MOSELEY; WATSON, 2016).

Food products can be analyzed in different perspectives: local or global production, traditional verses alternative production. Every product produced can cause different transformations and significant impacts before it reaches the consumers' table (WATTS; ILBERY, MAYE 2005; MOSELEY; WATSON, 2016). Local and global production and consumption, therefore, are essential topics surrounding food and involve analyses of food supply chains. Certainly there are connections between the agents of food supply chains in time and space which can be observed in analyses surrounding the geographies of production and consumption (GRIGG, 1995; HARTWICK, 1998; GRIGG, 1999; PARKINSON, 2010; MOSELEY; WATSON, 2016).

The description of agricultural geography is redefined by Bowler and Ilbery (1987). Atkins (1988) stresses the need to advance the discussion of agricultural geography to include the geography of food and to take into account a broader view of the interactions in different food systems (WINTER, 2003). In this sense, this definition includes the historical processes that influence food systems, such as the development of global agribusiness in recent decades.

Thus, this definition advocates the redesign of agricultural and agri-industrial markets, which present traditional and alternative food systems. Due to the effects of conventional (large–scale) farming, movements promoting sustainable agriculture are currently active. In this sense, food systems can impact economic development, environmental quality, and social welfare (MARTINEZ *et al*., 2010; FRISON; CHERFAS; HODGKIN, 2011; LAMBIN; MEYFROIDT, 2011; HOORNWEG; BHADA-TATA; KENNEDY, 2013; MCDONAGH, 2014; BRUNORI *et al*., 2016; MOSELEY; WATSON, 2016). Reducing the environmental impact of agricultural production is fundamental in the quest for sustainability, mainly through the mitigation of greenhouse gas emissions (LAL, 2004; CHAKRABORTY; NEWTON, 2010; HANJRA; QURESHI, 2010; SCHIPMANN; QAIM, 2010; RUVIARO;

BARCELLOS; DEWES, 2014; MCMANUS *et al*., 2013; FERREIRA FILHO; MORAES; 2015; MCMANUS *et al*., 2016).

The main purpose of this study comprises two aspects involving food systems and their dynamics. The first aspect refers to food production in Brazil – specifically how the different expressions of agribusiness in agriculture and animal production have evolved – while the second aspect analyzes how the Brazilian population has changed its dietary patterns.

As mentioned above, food connects consumers daily to the agricultural, logistical, commercial, and financial sectors, and plays an important role in climate change debate. Moreover, the food supply and demand have repercussions on food security, which, in turn, has a direct bearing on sustainability. The expansion of agriculture provides a population with a constant and affordable food supply. These same factors, however, can generate environmental impacts and detrimental side effects surrounding water, land, and energy use.

In order to present scientific investigations that contribute to the construction of knowledge surrounding the dynamics of food production and consumption in Brazil, this thesis is composed of researches that provide complementary analyses in line with the proposed theme. Thus, each chapter presents specific materials and methods according to the proposed objectives.

In the first paper (Chapter 2), titled "Changes in Brazilian agriculture facing the country's Midwest region development", it aims to analyze the dynamics of agriculture and animal production in Brazil on a microregional scale, focusing on the Brazilian Midwest region. In the second paper (Chapter 3), "Changes in the geography of Brazilian diet diversity", in search of the main drivers behind the changes, the work presents the evolution of Brazilian food patterns (based on the 2002–2003 and 2008–2009 Brazilian Household Budget Surveys), and evaluates similarities in food acquisition among the Brazilian states.

In this context, by demonstrating how the issues of food production, distribution, commercialization, and consumption (and changes in related policies) have relevance and impact the agribusiness productive chains, the relationship between food intake and agribusiness can be verified. The field of discussions surrounding food encompasses complex and broad reflections, with epistemological and methodological heterogeneity, all of which affirm the quest for an interdisciplinary study (LEDFORD, 2015; VASCONCELOS; ASSIS, 2015; PEDRAZA; MENEZES, 2015).

This thesis is organized into four main chapters. The first chapter provides a general introduction to the research. The second chapter presents the changes in Brazil's agricultural

sector that have occurred in the Midwest region, while the third chapter discusses changes in dietary diversity across the geographic regions of Brazil. Finally, concluding remarks are provided in the fourth chapter.

CHAPTER 2: Changes in Brazilian agriculture facing the country's Midwest region development[1]

Giana de Vargas Mores, Edson Talamini, and Homero Dewes

Abstract: Estimates suggest that Brazil will be the world's largest producer of food in the coming decades. Thus, it is imperative to examine the major Brazilian agricultural commodities and analyze the different temporal and geographical changes related to this production. The aim of this paper is to analyze the dynamics of agriculture and animal production in Brazil on a microregional scale, focusing on the Midwest region, which is recognized as the main Brazilian agricultural frontier of the 21st century. We assessed the participation of this region in changing the distribution densities of Brazilian agricultural production. The movements of the geographical midpoints of some of the main Brazilian agricultural commodities, which occurred between 1990 and 2015, seem to correspond to the geographical changes that took place in the agricultural production and land use in this region during the same period.

Keywords: food systems, food supply chains, geography of food, farming, livestock, Brazilian biomes.

Introduction

Human food comprises the most important issue in contemporary discussions regarding rural areas. Agricultural production is directly related to quality of life, food supply, distribution and consumption, as well as social, economic, and spatial inequalities. Furthermore, an understanding of the geography of food procurement and the evolution of food systems guides the development of public policies.

Food connects consumers daily to the agricultural, logistical, commercial and financial sectors, and it plays an important role in current climate change debate. These connections can be observed through analyses of the geographies of both production and consumption (Parkinson 2010). Moreover, economic geography also helps to establish the characteristics of the globalized food trade (Parrott, Wilson and Murdoch 2002).

[1] The text was written in American English. This chapter follows the suggested journal's guidelines for future submission.

On the one hand, the increase in population income, agricultural productivity, and a more diverse and developed food trade cause changes to where food is procured and where it is consumed (Grigg 1995, 1999, Barrett 1996). These factors also highlight the increase of food presence with specific local and regional characteristics. On the other hand, food production and consumption as parts of the larger global economic system also have to be taken into consideration. Clearly then, this interdependence emphasizes the complexity and importance of defining the spatial dynamics of food systems (Parrott, Wilson and Murdoch 2002, Ross 2011, McDonagh 2014, Handford, Campbell and Elliott 2016).

Brazil may become the world's largest producer of food over the next decades (Oecd/Fao 2015). Indeed, parts of Brazilian territory are reserved for agriculture and animal production. In this sense, it is imperative to look at the major Brazilian agricultural commodities and to analyze the different temporal geographical changes related to their production. This growth will be pushed by the diffusion of innovation and knowledge, as we have seen in past trajectories (Gasques et al. 2012, Buainain et al. 2014, Vieira Filho 2016).

In this context, this paper aims to analyze the dynamics of agriculture and animal production in Brazil on a microregional scale, focusing specifically on its Midwest region, which is recognized as the main Brazilian agricultural frontier of the 21st century (Jepson 2006, Rada 2013, Hosono and Hongo 2016, Spera et al. 2016). The focus on this region enables us to both verify the potential areas for maintenance and expansion of food chains under analysis as well as the geographical transformations which have occurred.

Materials and methods

Brazil has five macroregions: the North region (N), the Northeast region (NE), the Southeast region (SE), the South region (S), and the Midwest region (MW). Each region has its own cultural, gastronomic, geographical, climatic, and historical peculiarities that directly interfere in its economic and sectorial issues.

This work analyzes the period from 1990 to 2015. The selected products for analysis are soybeans (tons), maize (tons), beef cattle (number of heads), milk (thousand liters), pork (number of heads), and poultry (number of heads). Data on soybeans and maize were collected from the Municipal Agricultural Production survey (PAM) (Ibge 2016a) for temporary crops. Data refer to the quantity produced and the planted area of soybeans and maize. The animal products were beef cattle, milk, pork, and poultry. Quantity produced data were extracted from the Municipal Livestock Research survey (PPM) (Ibge, 2016b). Both

surveys are available annually through the Brazilian Institute of Geography and Statistics (Ibge).

In 2014, Brazil had 5,570 counties. During the period analyzed in this work, 1,079 emancipations occurred (Ibge 2016c), which restricts the analysis on the municipality scale. To address this, we chose to work with the Brazilian geographic microregions (Figure 1) available for each product at Ibge, aiming to reduce the data variability.

The data analyses consist of descriptive statistics (i.e., absolute and relative frequencies, percentage variations, and quantiles) and spatial statistics (i.e., midpoint). The localization of soybean, maize, beef cattle, milk, pork, and poultry productions in Brazil was spatialized in Arcgis® software for the period from 1990 to 2015 (by year). The spatial midpoint (measure of central tendency and spatial dispersion) of the six cultures' quantity produced was calculated to identify Brazil's trends in agriculture and animal production (McManus et al. 2014, McManus et al. 2016).

To deepen the analysis of Brazilian agriculture dynamics, further analyses were performed for the Brazilian Midwest region, which is an important Brazilian agricultural frontier. The Brazilian Midwest region includes four federative states: Mato Grosso (MT, 22 microregions), Mato Grosso do Sul (MS, 11 microregions), Goiás (GO, 18 microregions), and Distrito Federal (DF, one microregion).

In analyzing the Brazilian Midwest region, as based on quantiles (frequency distribution into equal groups), soybean, maize, beef cattle, milk, pork, and poultry productions were georeferenced in separate cartograms for the years 1990, 1995, 2000, 2005, 2010, and 2015 (interval of five years). Thus, 36 Midwest region maps were generated for quantity produced. The same procedure was performed for the planted area for soybean and maize production, generating 12 additional maps for the Midwest region. The EstatGeo from Ibge assisted in this step.

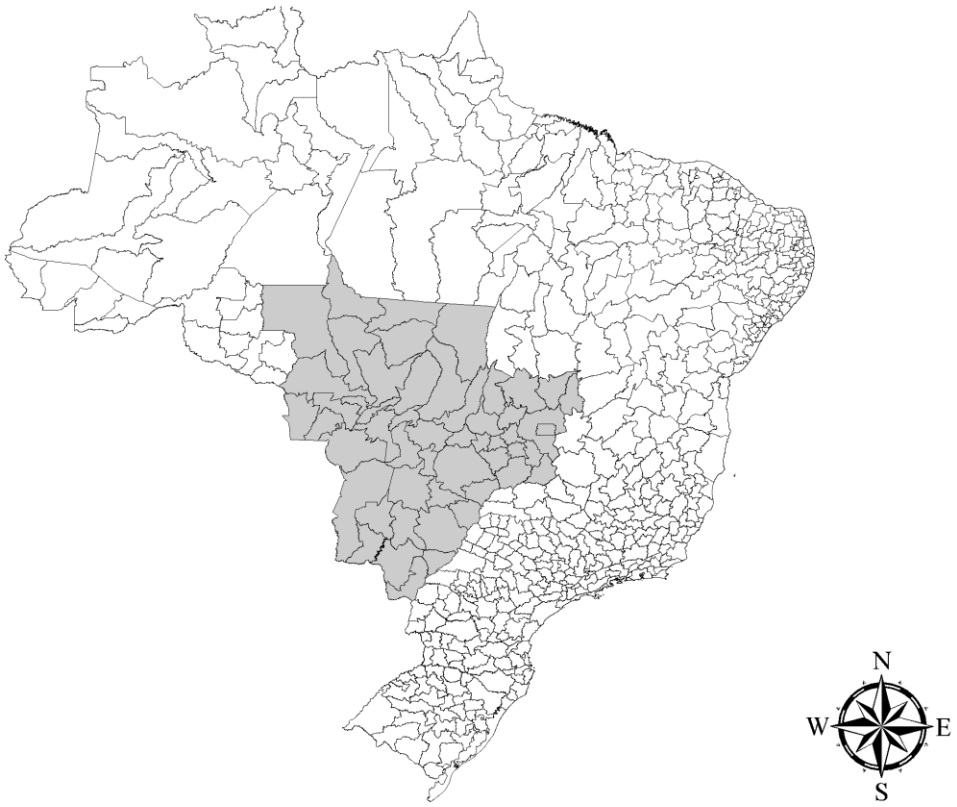


Figure 1. The Brazilian geographic microregions (558 in total) and the geographic microregions of the Midwest region are highlighted in gray (52 in total).
Source: Data derived from the Brazilian Institute of Geography and Statistics.

Results and discussion

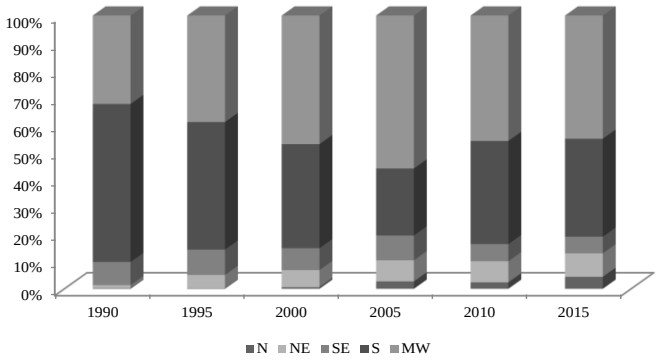
Of continental dimensions, Brazil is the largest country in South America, extending more than 4000 km from both north to south and east to west (Ibge 2017). Its extent confers upon the country a wide range of geomorphological and climatic diversity (mainly into the tropical zone), and with this, great productive potential.

Brazil is among the world's major producers of soybeans and maize. In the 2014/2015 harvest, Brazil produced 207,667,000 tons of cereal crops, with soybeans, maize, rice, wheat, and beans accounting for 97.30% of this production (Conab 2016). A large proportion of the rice and beans harvested in Brazil is consumed by the domestic population, while soybeans and maize are used in animal feed to bolster nutrition, thus serving as relevant components of Brazil's meat and milk industries.

In this context, the absolute data on the quantity produced and the respective variations in percentage (for soybeans, maize, beef cattle, milk, pork, and poultry confirm an expansion in agricultural and animal production in all Brazilian regions from 1990 to 2015 (Figures 2A, 2B, 3A, 3B, 4A and 4B). During this period, only the North and the Northeast regions performed negatively in regards to pork production (Figure 4A).

(A) Soybean (tons)

	Year												
Region	1990	Δ%	1995	Δ%	2000	Δ%	2005	Δ%	2010	Δ%	2015	Δ%	Δ% 1990-2015
N	44392	-	47271	6,49	184614	290,54	1384561	649,98	1625120	17,37	4274638	163,04	9529,30
% BR	0,22		0,18		0,56		2,71		2,36		4,39		
NE	225502	-	1255571	456,79	2063859	64,38	3959940	91,87	5307202	34,02	8386412	58,02	3619,00
% BR	1,13		4,89		6,29		7,74		7,72		8,60		
SE	1685994	-	2385166	41,47	2628939	10,22	4640903	76,53	4315398	-7,01	5930317	37,42	251,74
% BR	8,47		9,29		8,01		9,07		6,28		6,08		
S	11500593	-	11986519	4,23	12496969	4,26	12544106	0,38	25950387	106,87	34929965	34,60	203,72
% BR	57,80		46,67		38,08		24,51		37,74		35,84		
MW	6441323	-	10008110	55,37	15446445	54,34	28652564	85,50	31558236	10,14	43943604	39,25	582,21
% BR	32,37		38,97		47,06		55,98		45,90		45,09		
Total	19897804	-	25682637	29,07	32820826	27,79	51182074	55,94	68756343	34,34	97464936	41,75	389,83
% BR	100,00		100,00		100,00		100,00		100,00		100,00		



(B) Maize (tons)

	Year												
Region	1990	Δ%	1995	Δ%	2000	Δ%	2005	Δ%	2010	Δ%	2015	Δ%	Δ% 1990-2015
N	539637	-	948781	75,82	944563	-0,44	1082683	14,62	1299751	20,05	2314968	78,11	328,99
% BR	2,53		2,62		2,92		3,08		2,35		2,71		
NE	648582	-	2437783	275,86	2948801	20,96	2933266	-0,53	4140132	41,14	5865820	41,68	804,41
% BR	3,04		6,72		9,12		8,35		7,48		6,88		
SE	5258540	-	8069674	53,46	7436683	-7,84	10486951	41,02	10199656	-2,74	11564629	13,38	119,92
% BR	24,63		22,25		23,01		29,87		18,42		13,56		
S	11792614	-	18575039	57,51	14693510	-20,90	12752615	-13,21	22854811	79,22	24417444	6,84	107,06
% BR	55,24		51,22		45,46		36,32		41,28		28,63		
MW	3108401	-	6235674	100,61	6297443	0,99	7857797	24,78	16869921	114,69	41121795	143,76	1222,92
% BR	14,56		17,19		19,48		22,38		30,47		48,22		
Total	21347774	-	36266951	69,89	32321000	-10,88	35113312	8,64	55364271	57,67	85284656	54,04	299,50
% BR	100,00		100,00		100,00		100,00		100,00		100,00		

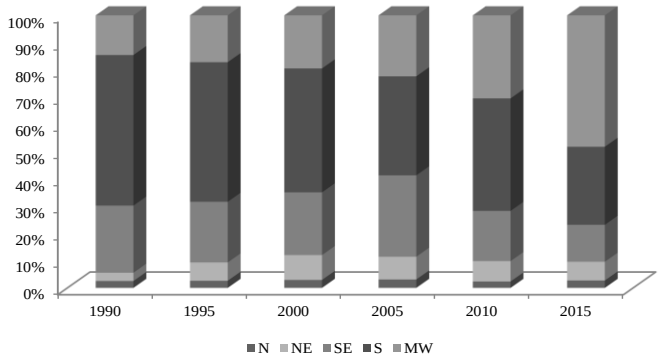


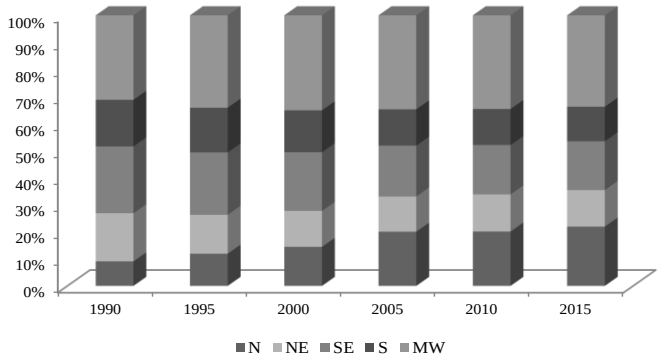
Figure 2. Quantity produced of soybeans (A) and maize (B) in Brazil and in its five regions in the years 1990, 1995, 2000, 2005, 2010, and 2015.

Source: Data derived from the Municipal Agricultural Production and the Municipal Livestock Research – Brazilian Institute of Geography and Statistics (Ibge 2016a, b).

Notes: The Brazilian macroregions: the North region (N), the Northeast region (NE), the Southeast region (SE), the South region (S), and the Midwest region (MW). In tables, gray lines show the absolute values of the quantity produced of the respective product in each Brazilian region, as well as the percentage variation from one year to another (interval of five years). White lines show how much each product produced in each region represented the total production of that product in Brazil (percentage participation) by year (interval of five years). This information is also displayed in the stacked column graph.

(A) Beef cattle (number of heads)

	Year												
Region	1990	Δ%	1995	Δ%	2000	Δ%	2005	Δ%	2010	Δ%	2015	Δ%	Δ% 1990-2015
N	13316950	-	19183092	44,05	24517612	27,81	41489002	69,22	42100695	1,47	47154969	12,01	254,10
% BR	9,05		11,90		14,43		20,03		20,09		21,91		
NE	26190283	-	23173936	-11,52	22566644	-2,62	26969286	19,51	28762119	6,65	29092184	1,15	11,08
% BR	17,80		14,37		13,28		13,02		13,73		13,52		
SE	36323168	-	37168199	2,33	36851997	-0,85	38943898	5,68	38251950	-1,78	38812076	1,46	6,85
% BR	24,69		23,05		21,69		18,80		18,26		18,04		
S	25325979	-	26641412	5,19	26297970	-1,29	27770006	5,60	27866349	0,35	27434523	-1,55	8,33
% BR	17,22		16,52		15,48		13,41		13,30		12,75		
MW	45945934	-	55061299	19,84	59641301	8,32	71984504	20,70	72559996	0,80	72705736	0,20	58,24
% BR	31,23		34,15		35,11		34,75		34,63		33,79		
Total	147102314	-	161227938	9,60	169875524	5,36	207156696	21,95	209541109	1,15	215199488	2,70	46,29
% BR	100,00		100,00		100,00		100,00		100,00		100,00		



(B) Milk (thousand liters)

	Year												
Region	1990	Δ%	1995	Δ%	2000	Δ%	2005	Δ%	2010	Δ%	2015	Δ%	Δ% 1990-2015
N	555216	-	706696	27,28	1049768	48,55	1743253	66,06	1737406	-0,34	1832765	5,49	230,10
% BR	3,83		4,29		5,31		7,08		5,66		5,24		
NE	2045268	-	1886614	-7,76	2159230	14,45	2972130	37,65	3997890	34,51	4143038	3,63	102,57
% BR	14,12		11,45		10,92		12,07		13,02		11,84		
SE	6923301	-	7539464	8,90	8573731	13,72	9535484	11,22	10919686	14,52	11901959	9,00	71,91
% BR	47,80		45,76		43,37		38,73		35,55		34,01		
S	3262255	-	4102597	25,76	4904356	19,54	6591503	34,40	9610739	45,80	12320002	28,19	277,65
% BR	22,52		24,90		24,81		26,77		31,29		35,20		
MW	1698374	-	2238994	31,83	3080121	37,57	3778490	22,67	4449738	17,76	4802463	7,93	182,77
% BR	11,73		13,59		15,58		15,35		14,49		13,72		
Total	14484414	-	16474365	13,74	19767206	19,99	24620860	24,55	30715459	24,75	35000227	13,95	141,64
% BR	100,00		100,00		100,00		100,00		100,00		100,00		

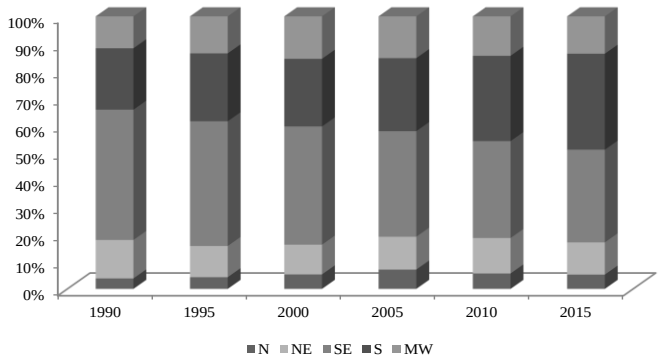


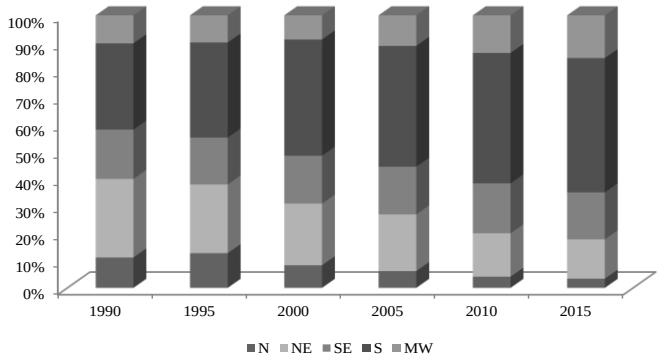
Figure 3. Quantity produced of beef cattle (A) and milk (B) in Brazil and in its five regions in the years 1990, 1995, 2000, 2005, 2010, and 2015.

Source: Data derived from the Municipal Agricultural Production and the Municipal Livestock Research – Brazilian Institute of Geography and Statistics (Ibge 2016a, b).

Notes: The Brazilian macroregions: the North region (N), the Northeast region (NE), the Southeast region (SE), the South region (S), and the Midwest region (MW). In tables, gray lines show the absolute values of the quantity produced of the respective product in each Brazilian region, as well as the percentage variation from one year to another (interval of five years). White lines show how much each product produced in each region represented the total production of that product in Brazil (percentage participation) by year (interval of five years). This information is also displayed in the stacked column graph.

(A) Pork (number of heads)

	Year												
Region	1990	Δ%	1995	Δ%	2000	Δ%	2005	Δ%	2010	Δ%	2015	Δ%	Δ% 1990-2015
N	3750066	-	4595163	22,54	2619791	-42,99	2100033	-19,84	1607481	-23,45	1363355	-15,19	-63,64
% BR	11,15		12,74		8,30		6,16		4,13		3,38		
NE	9691742	-	9083746	-6,27	7140280	-21,39	7090085	-0,70	6197109	-12,59	5815558	-6,16	-39,99
% BR	28,82		25,19		22,62		20,81		15,91		14,42		
SE	6085142	-	6210177	2,05	5548313	-10,66	5956328	7,35	7133257	19,76	6957511	-2,46	14,34
% BR	18,10		17,22		17,58		17,49		18,31		17,25		
S	10636968	-	12579582	18,26	13452029	6,94	15090727	12,18	18643470	23,54	19875316	6,61	86,85
% BR	31,64		34,88		42,62		44,30		47,86		49,28		
MW	3459268	-	3593435	3,88	2801698	-22,03	3826761	36,59	5375441	40,47	6320813	17,59	82,72
% BR	10,29		9,96		8,88		11,23		13,80		15,67		
Total	33623186	-	36062103	7,25	31562111	-12,48	34063934	7,93	38956758	14,36	40332553	3,53	19,95
% BR	100,00		100,00		100,00		100,00		100,00		100,00		



(B) Poultry (number of heads)

	Year												
Region	1990	Δ%	1995	Δ%	2000	Δ%	2005	Δ%	2010	Δ%	2015	Δ%	Δ% 1990-2015
N	26793111	-	35358178	31,97	29277894	-17,20	27475284	-6,16	27791056	1,15	49296645	77,38	83,99
% BR	4,91		4,85		3,47		2,75		2,24		3,70		
NE	102014803	-	112199505	9,98	112611466	0,37	124702116	10,74	139450997	11,83	158295760	13,51	55,17
% BR	18,68		15,38		13,36		12,48		11,26		11,88		
SE	171072807	-	210586436	23,10	254193982	20,71	291167123	14,55	355248221	22,01	368250500	3,66	115,26
% BR	31,32		28,87		30,16		29,14		28,67		27,64		
S	218269586	-	327869197	50,21	379831270	15,85	455136559	19,83	587643506	29,11	604937587	2,94	177,15
% BR	39,96		44,94		45,07		45,56		47,43		45,41		
MW	28085198	-	43517983	54,95	66825561	53,56	100560152	50,48	128778757	28,06	151297558	17,49	438,71
% BR	5,14		5,97		7,93		10,07		10,39		11,36		
Total	546235505	-	729531299	33,56	842740173	15,52	999041234	18,55	1238912537	24,01	1332078050	7,52	143,87
% BR	100,00		100,00		100,00		100,00		100,00		100,00		

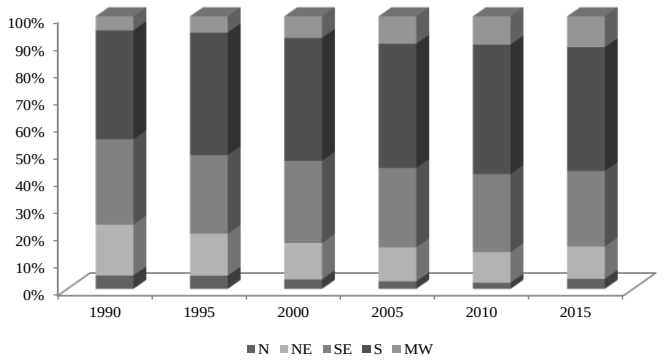


Figure 4. Quantity produced of pork (A) and poultry (B) in Brazil and in its five regions in the years 1990, 1995, 2000, 2005, 2010, and 2015.

Source: Data derived from the Municipal Agricultural Production and the Municipal Livestock Research – Brazilian Institute of Geography and Statistics (Ibge 2016a, b).

Notes: The Brazilian macroregions: the North region (N), the Northeast region (NE), the Southeast region (SE), the South region (S), and the Midwest region (MW). In tables, gray lines show the absolute values of the quantity produced of the respective product in each Brazilian region, as well as the percentage variation from one year to another (interval of five years). White lines show how much each product produced in each region represented the total production of that product in Brazil (percentage participation) by year (interval of five years). This information is also displayed in the stacked column graph.

In terms of temporary crops, soybeans are the main commodity in Brazilian agricultural production. From 1990 to 2015, soybean production varied by 389.83% (Figure 2A). The Midwest and the South regions combined for 80.93% of the overall production. The South region represented 57.80% of the country's soybean production in 1990, decreasing to 35.84% in 2015. In the same year, the Midwest region accounted for 45.09% of Brazil's soybean production. The years from 2000 to 2015 were important for the growth of soybeans in the North and the Northeast regions; however, these regions' total participation percentage was still less than double–digits. Soybean production comprises various social relations and production systems, whether on a large or small scale (Mier and Cacho 2016), which also occurs with other cultures.

With a percentage variation of 299.50% in the analyzed period (Figure 2B), maize production was concentrated at 48.22% in the Midwest region in 2015. This value was 14.56% in 1990. The South and the Southeast regions had decreased production, falling from 79.87% (in 1990) to 42.19% (in 2015). In 2015, the Midwest and the South regions accounted for 78.85% of Brazil's maize production. The fact that the two crops have had their percentage reduced in Southern production is not linked to lower productivity in the region, but to a reduction in their corresponding land use (McManus et al. 2016). The Southern territory had been occupied for agriculture earlier than the Midwest region.

Maize and soybeans, as grains, are of little use for direct human consumption. However, their derivatives enter into food chains via many forms. The main products derived from maize are flour, oil, starch, margarine, glucose syrup, and flakes. The main soybeans derivatives are oil and bran, which are products with high relative protein values.

Many countries, like China, have expanded their need for grain imports, which has led to changes in land use in agriculture–exporting countries, like Brazil (Moseley and Watson 2016). The agri-industry invests heavily in the development of new products derived from soybeans. The increased demand for cereal crops requires high yields, adapted varieties for climate, technological alternatives, and public and private investments (Shiferaw et al. 2011). Prior to the 1990s, changes in crop adaptation led to increased agricultural productivity overall. Changes have also occurred in terms of market efficiency (economic aspects, food prices). For example, Chinese trade liberalization increased world demand for soybeans in the 1990s.

Aside from its vegetal products, Brazil stands out globally in the production of animal protein (Figures 3A, 3B, 4A, and 4B). In contrast to the exportation of commodity crops, this production is destined more for domestic markets. Official practices in food quality control

for improving animal health have promoted gains in the food supply chains' performance. The worldwide rise in consumption of animal protein is putatively associated with the Brazilian agriculture's economic performance in the first decade of the 2000s.

With one of the largest herds in the world, the Brazilian beef industry is highlighted in this scenario, with 215,199,488 heads in 2015 (Figure 3A) creating productive chains for beef cattle and milk. The percentage variation of beef cattle production in the analyzed period was 46.29%. The North region's Brazilian beef cattle production had a percentage variation from 9.05% (in 1990) to 21.91% (in 2015). In the Midwest region, the values for 1990 and 2010 were 31.23% and 33.79%, respectively. The two regions accounted for 55.70% of the country's cattle production in 2015. In some regions, beef cattle production has also moved from the extensive to the intensive model due to farming modernization and productivity gains.

Milk production (Figure 3B) showed a percentage variation of 141.64% in the period from 1990 to 2015. The South and the Southeast regions comprised 69.21% of the country's milk production in 2015. The South region represented 47.80% in 1990 and 34.01% in 2015, while the Southeast region showed an increase from 22.52% in 1990 to 35.20% in 2015. Available land and the tropical climate enable cattle production in free pastures. Investments in technology, in research and development, and in human capital, as well as public policies aimed at tracking the herd and controlling diseases, are factors that have contributed to beef and dairy cattle production growth.

These factors have also fostered the expansion of pork breeding in Brazil for domestic consumption and export (Figure 4A). From 1990 to 2015, pork production registered the lowest increase (19.95%) among the analyzed cultures. The South region comprised 49.28% (in 2015) of Brazil's overall pork production, up from 31.64% in 1990. Research involving nutrition (a decrease in the percentage of meat fat, cholesterol, and calories), adequate management, and integrated production should also be highlighted as this industry's development factors (Mapa 2016b).

Poultry meat production (Figure 4B), particularly chicken, varied by 143.87% in the period analyzed. The South and the Southeast regions accounted for 71.28% of poultry output in 1990, rising to 73.05% in 2015. This may be associated with the land structure and the availability of labor within the region. In the period under review, the Midwest recorded a 438.71% boost in Brazilian poultry production, from 5.14% (in 1990) to 11.36% (in 2015).

The Brazilian industry's competitiveness for these products has been achieved through productivity growth, quality improvement, industry modernization, and nutrition and animal

health. This success is also due to producing chickens free of hormones and other banned veterinary products and to reduced production costs because of better coordination among the links in the poultry production chains (Mapa 2016b).

Changes in the geography of agriculture and animal production in Brazil

Agricultural–pastoral production occupies a part of the Brazilian territory. In this work, we looked at the major Brazilian agricultural commodities to analyze temporal geographical changes in their production. The analysis focused on Brazil's Midwest region, which encompasses the second-largest area of Brazil (about 1/5 of the nation's territory), extending over three large and different biomes: Amazon, Pantanal and Cerrado.

Brazil's geographical center coincides with its Midwest region. In the period referenced, peculiar and intense human geography dynamics happened in this region. We assessed this region's participation in changing the geographical distribution of specific Brazilian agricultural production densities.

The surveyed productive chains' spatial movement can be observed in Brazil from a midpoint analysis of the respective quantities of the major agricultural commodities produced from 1990 to 2015. These productions were gravitating toward the Midwest region (Figure 5). In the major part of the analyzed period, the respective midpoints of the Brazilian soybean and maize productions were in the Midwest and moved toward the Northern regions. Beef cattle production showed similar movement. This migration is also presented in Bowman et al. (2013), Walker et al. (2015), and McManus et al. (2016), particularly due to the availability of lower–priced land.

In contrast, the pork, poultry, and milk productions moved toward the Brazilian South. Pork, poultry, and milk production does not necessarily require extensive farming. However, soybean, maize, and beef cattle production usually requires more planted area, which is tied to the availability of agricultural land and to territorial occupations (Figure 5).

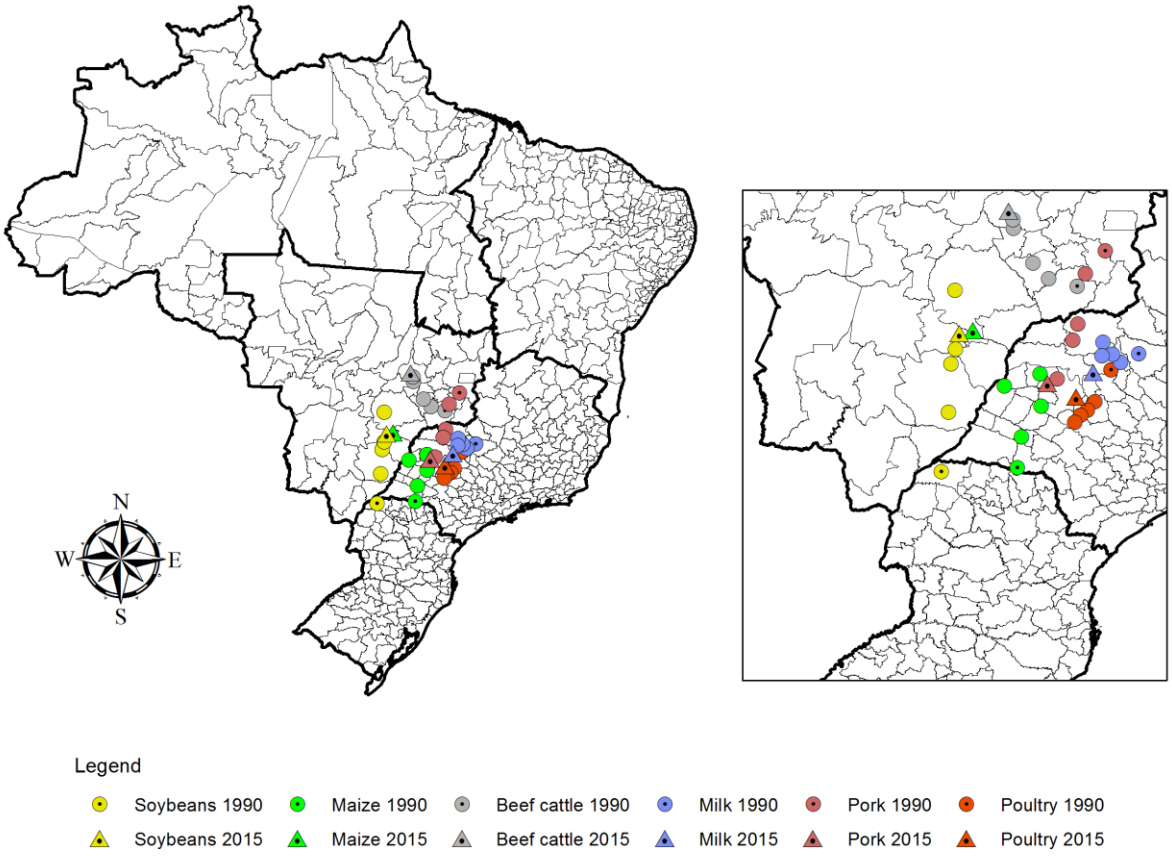


Figure 5. Annual midpoint of the production of soybeans, maize, beef cattle, milk, pork, and poultry in Brazil from 1990 to 2015.

Source: Data derived from the Municipal Agricultural Production and the Municipal Livestock Research – Brazilian Institute of Geography and Statistics (Ibge 2016a, b).

Maize's mean production point is the one that varies the most when considering the Brazilian production's geographical midpoint (Figure 5). Maize production is at the center of the local culture changes, suggesting the existence of a spatial association between the crop and the animal chains' production. The midpoint migration of soybean and beef cattle productions followed linearly. Milk, pork, and poultry productions showed more stability in localization.

The determinants of the production transitions are conditioned to biophysical, institutional, and technological aspects. Regarding the biophysical determinants, specific cultures are more adapted to certain soil and climatic conditions. In this sense, the Pantanal biome territory is typically used for cattle production. As the Midwest region shows relatively stable weather throughout the year, it is possible to obtain two or three annual crop harvests. In other words, the Brazilian Midwest region is where most agricultural transitions have occurred in Brazil since the 1950s.

In this research, we suggest that the changes of agricultural production and land use in the Brazilian Midwest region have markedly affected the geographical distribution of the agricultural production throughout Brazil. The movements of the geographical midpoints of the major Brazilian agricultural commodities that occurred in the years 1990–2015 (Figure 5) seem to be related to the geographical changes that occurred in the agricultural production and land use in the Brazilian Midwest region during the same period (Figures 6 and 7).

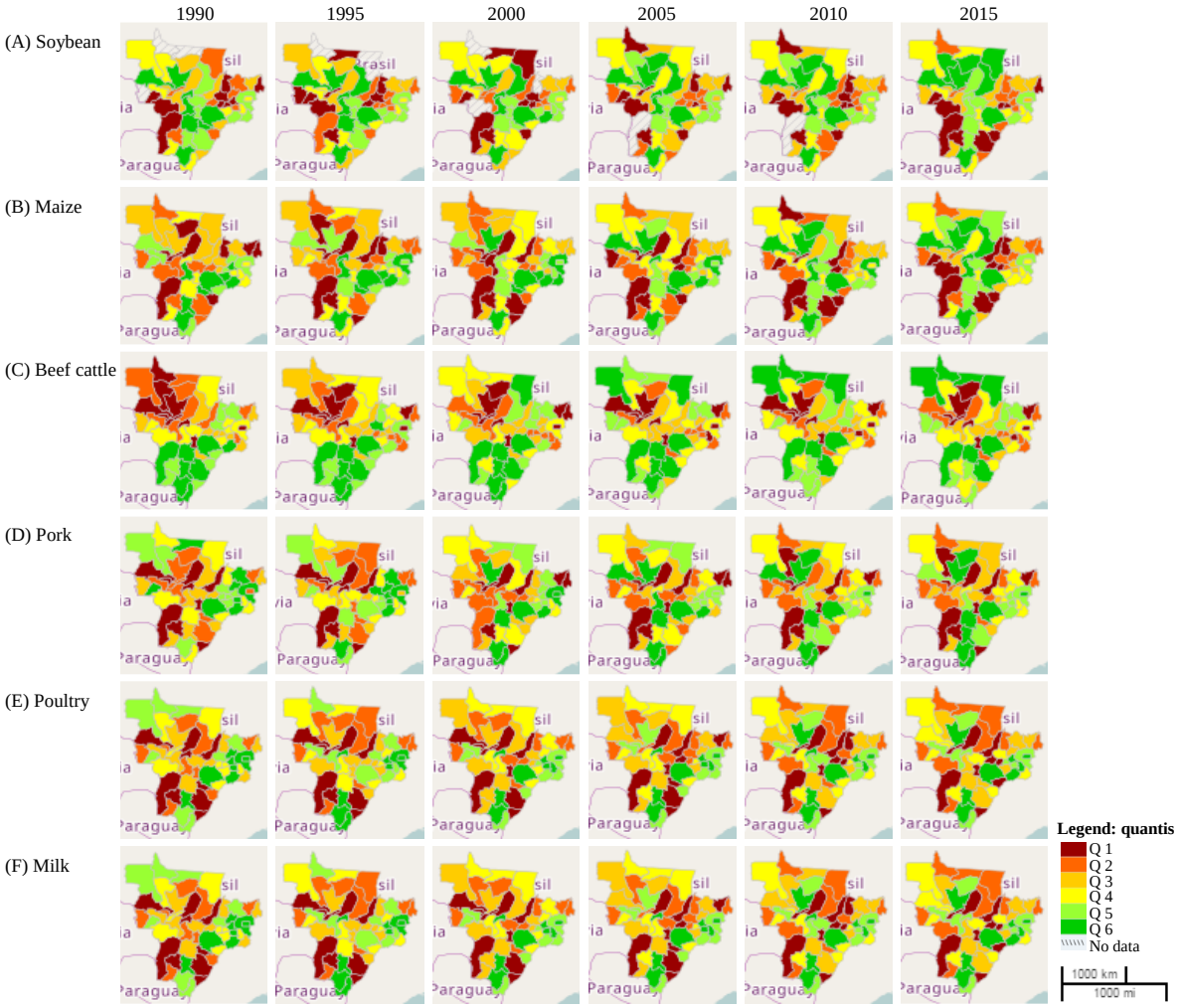


Figure 6. Six quantiles of quantity produced for soybeans (A), maize (B), beef cattle (C), milk (D), pork (E), and poultry (F) in the Brazilian Midwest region for the years 1990, 1995, 2000, 2005, 2010, and 2015.

Source: Data derived from the Municipal Agricultural Production and the Municipal Livestock Research – Brazilian Institute of Geography and Statistics (Ibge 2016a, b).

Notes: Each Midwest region map is distributed in six quantiles (frequency distribution of quantity produced into equal groups) for each of the six products analyzed in each year (interval of five years from 1990 to 2015). The quantiles are presented from the lowest to the highest quantity produced, that is, from Quantile 1 (Q1 or strong red in color palette) to Quantile 6 (Q6 or strong green in color palette).

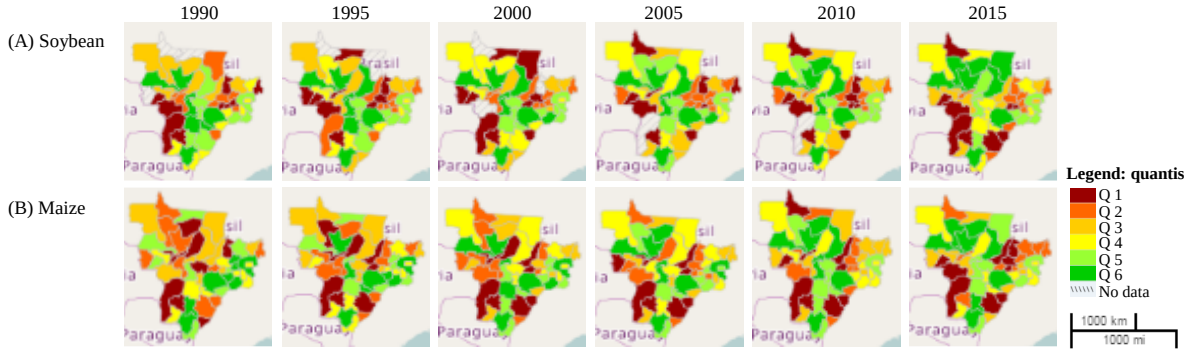


Figure 7. Six quantiles of planted area for soybeans (A) and maize (B) in the Brazilian Midwest region for the years 1990, 1995, 2000, 2005, 2010, and 2015.

Source: Data derived from the Municipal Agricultural Production and the Municipal Livestock Research – Brazilian Institute of Geography and Statistics (Ibge 2016a, b).

Notes: Each Midwest region map is distributed in six quantiles (frequency distribution of planted area into equal groups) for each of the six products analyzed in each year (interval of five years from 1990 to 2015). The quantiles are presented from the lowest to the highest planted area, that is, from Quantile 1 (Q1 or strong red in color palette) to Quantile 6 (Q6 or strong green in color palette).

The productive expansion during the 1990–2015 period in the Brazilian Midwest region was particularly linked to changes in land use. This can be observed in some similarities of quantiles of the quantity produced (Figure 6) and the planted area (Figure 7) for soybean and maize productions, respectively. During the analyzed period, there was a marked phenomenon of changes in Brazilian land use due to agricultural expansion into previously unoccupied territories according to a pattern of successive cultures, starting with cattle and then continuing with alternating crops. Thus, the major axes of the Brazilian agricultural production were redesigned (North–South, East–West).

The respective production systems adopted for each culture can explain these transitions. Soybeans, maize, and beef cattle are large commodities based usually on independent production units. Therefore, the individual decision of the locally based stakeholders (rural entrepreneurs, often landowners) mostly determines the land use for these cultures. Farmers usually assess market prices for crops and beef to decide the next culture cycle.

However, pork, poultry, and milk production are based mostly on integrated systems, with industrial units located at strategic points that induce farmers to establish their animal production units closer to agri-industries for convenient logistics. Because most of these industrial units belong to companies rooted in Brazilian Southern states, by institutional force, the migration axis of the integrated animal production midpoints faces the South.

To interpret the strong drive to the North for soybean, maize, and beef cattle productions, our attention shifts to the agriculture development in Brazil's North and

Northeast regions, particularly in the regions called Matopiba (enclosed by the states of Maranhão, Tocantins, Piauí, and Bahia) and Sealba (enclosed by the states of Sergipe, Alagoas, and Bahia). These new agricultural frontiers seem to have played an important role in the changes of the Brazilian agricultural production axis during the time analyzed in this research, and in coming decades.

Innovation is also important since it increases the production output per unit of input. Although the Brazilian agricultural frontier has been expanding into the Cerrado biome, thereby encroaching upon the Midwest region, Matopiba, and Amazonian transition zones, this intensive use of knowledge and technology has led to an increase in livestock activity over the last few decades. While the intensification and commodification of Brazilian agriculture has been growing since 2005, deforestation practices have sharply reduced and are now dissociated from agricultural production growth (Lapola et al. 2014).

Soybeans and maize are the major nutritional inputs for animal production. Therefore, once these cultures are established in one region, animal production becomes economically attractive. The integration of agriculture and animal production also plays a relevant role in the changes we described in this work. Public policies enacted based on environmental concerns may restrict the migratory phenomenon in some places; for example, preventing deforestation in certain territories (e.g., the Amazon Legal Territory, with the allocation of conservation units and indigenous lands).

Projections for 2014/2015 to 2024/2025 indicate that soybean production will increase 29.40%, while planted areas will rise 14.80% (Mapa 2015a). This may indicate that the production increase will be more vertical, meaning a higher productivity per hectare. Maize production will present higher productivity per hectare than soybeans, producing 6.39 tons per hectare (2024/2025) compared to soybeans' 5.21 tons (2014/2015) (Mapa 2015a). In terms of the maize planted area, the increase may be small since soybean areas are later used for maize production.

Some factors that will improve the growth of Brazilian agricultural products, as well as those that have already caused changes in the nation's agricultural dynamics, include: the extension of arable land while lowering production costs, biome conditions, technological developments, modern machinery and implementation methods, fertilizers, pesticides, precision agriculture, biotechnology, genomics, genetically modified organisms, technical assistance, plant breeding, sensing, animal health and welfare, agri-industrial management, regulatory environment, data and information availability, research and development, sustainable practices, adequate infrastructure and logistics, and credit programs.

Final considerations

This paper used spatial analysis to better visualize the distribution of agriculture and animal production in Brazil from 1990 to 2015. The Brazilian Midwest region is where most agricultural transitions have occurred in Brazil since the 1950s. Based on this analysis, we assessed the Brazilian Midwest region's participation in changing the distribution densities of Brazilian agricultural production.

The movements of the geographical midpoints of the major Brazilian agricultural commodities, which occurred in the years 1990–2015, seem to be related to the geographical changes which occurred in the agricultural production and land use in the Midwest region in the same period. However, analysis of a greater territorial area, extending beyond the Midwest region, is necessary in order to broaden the analysis of the spatial displacement of agricultural production into the various Brazilian regions.

Another suggestion for research would be to establish a model for projection of the displacement of agricultural products (both latitudinal and longitudinal) based on a time series. The spatial dynamics of Brazilian agriculture could be improved by analyzing more cultures, such as sugarcane[2] and coffee[3]. These cultures are considered to be the bases of change in the Brazilian territory and could be used as vectors for each product analyzed (such as control over the movements of the production).

Phenomenological analysis, such as the one performed in this research, provides subsidies to policymakers regarding the panorama of the main agribusiness products to boost the sustainable development of Brazilian agriculture. There is a need to enhance regional food systems to comply with a fair and sustainable food supply while facing increased demand[4]. However, in considering Brazil as one of the largest producers and exporters of food in the world, a greater level of innovation is expected for the country's agribusiness to remain competitive. Such an innovation should be based on environmental sustainability in such a way that it contributes to the challenges of food security and climate change.

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CHAPTER 3: Changes in the geography of Brazilian diet diversity[5]

Giana de Vargas Mores, Edson Talamini, and Homero Dewes

Abstract

Purpose – The purpose of this paper is to present the evolution of Brazilian food patterns, based on the 2002–2003 and 2008–2009 Brazilian Household Budget Surveys (POFs), and to evaluate similarities in food acquisition among the Brazilian states, in search for the main drivers of the changes.

Design/methodology/approach – Using the data gathered from the 17 food groups within the POFs and multidimensional scaling, the Brazilian states were divided into groups and analysed according to their similarities in terms of annual per capita household food acquisition.

Findings – The study's results point to five groups with similarities in terms of food acquisition among the Brazilian states. Additionally, the issues that reflect Brazil's diversity were discussed, highlighting possible factors that caused the movement of some states between groups during the analysis period. The heterogeneity observed in food acquisition in Brazil emphasises Brazilian agribusiness development and underscores the influence of the food supply chains on the regional food patterns.

Originality/value – This research presents geographic changes in the Brazilian agribusiness, and how these changes are reflected in the population food patterns and in the heterogeneity in food acquisition among the Brazilian states. Concerning this work, supply chains of agri-industrial products focussed on the domestic market can be analysed in depth, offering guidelines for future research in logistics and agri-industrial economy.

Keywords Regional development, Food consumption, Agribusiness, Food security, Eating behaviours

Paper type Research paper

[5] The manuscript entitled "Changes in the geography of Brazilian diet diversity" was accepted in its current form for publication in the British Food Journal, on November 28, 2016 (Annex A). The text was written in British English and follows the author guidelines of the journal.

Introduction

Food consumption is a complex subject, defined by factors such as gastronomy, availability of food resources, food habits, food types, family income, social group and influence exercised by media (Abreu *et al.*, 2001; Dishchekenian *et al.*, 2011; Ribeiro de Castro, 2015). These issues intersect with other potentially conflicting forces, including food production, distribution along supply chains and population growth. All of these interrelated elements impact the consumption patterns of a society.

Concerns about human eating habits are not recent, but the food patterns have recently aroused more interest in research (Duran, 2000; Schulze *et al.*, 2001; Dixon *et al.*, 2007; Hinrichs and Charles, 2012; Sy *et al.*, 2013; Abbade and Dewes, 2015). Examples of issues of interest are as follows: how the food supply patterns evolve in the world, what causes food habit changes, nutritional aspects related to health issues (obesity and chronic diseases) and sociodemographic features that affect dietary intakes. Nowadays, there is a worldwide standardisation trend in food patterns, mostly due to the fact that the food system is intensively related to industrial processes, more than to the natural systems of production (Murdoch and Miele, 1999). This sets the current dynamics of the global food supply.

Currently, the worldwide food distribution presents two distinct scenarios. In developed countries, there is a wide and varied food supply and a portion of the population presents problems of nutritional imbalance (Menotti *et al.*, 1999; Lytle *et al.*, 2000; St-Onge *et al.*, 2003; Newby *et al.*, 2004; Caballero, 2007; Panagiotakos *et al.*, 2007; Spanhol-Finocchio and Dewes, 2016). On the other hand, developing nations face food shortages, and frequently their population does not have sufficient means to acquire the appropriate food resources, which can worsen poverty, hunger and malnutrition (Wang *et al.*, 2002; Caballero, 2005; Mendez *et al.*, 2005; Pinstrup-Andersen, 2007; Varela-Silva *et al.*, 2012; Gómez and Ricketts, 2013; Miller and Welch, 2013; Shonchoy, 2016). Brazil, the country considered in this paper, in many aspects reflects both, the first and the second scenarios.

Brazil is a country of diversity: the feeding habits of its inhabitants are hardly homogeneous, due to economic, social, geographical, cultural, and ethnic factors. The country was a food importer up to the first half of the twentieth century and is nowadays one of the biggest exporters worldwide (OCDE/FAO, 2015). The Brazilian territorial occupation was quite recent, and more profound demographic changes occurred in the countryside than in the coastal areas.

The distinction of Brazil from other regions of the world is that the country has experienced a wave of migratory movements, which occurred mostly in the recent decades.

Earlier, the population in Brazil was concentrated along its coast line, but since the middle of the last century, strong migratory movement into the inland territory started. The distribution of the population throughout the country in these new regions, very thinly populated previously, caused a new economy development based on agriculture and agri-industry expansion, bringing to these areas not only new economic activities, but also migrants from other cultural backgrounds. This has led to changes in the patterns of food consumption in these regions. Originally, small communities kept their old habits, rooted in the local production of traditional foods. The agricultural development – associated with global trade and exchange of cultural values with other regions, as well as migration – has fostered changes in the regional feeding habits.

In recent years, profound socioeconomic changes caused alterations in health patterns and food acquisition in Brazil. These changes have reduced poverty and social inequality, while intrinsically reducing malnutrition and hunger; however, all social classes show weight gain, which raises emerging questions and observations on the connections between diet and nutritional problems (Brasil, 2012a). Increased consumption of ultraprocessed foods helped to deteriorate the nutritional profile of Brazilians across all socioeconomic lines (Hawkes, 2008; Louzada *et al*., 2015).

In general, Brazilian food intake is based on both consumption of energy–dense foods, high in fats, salt and sugars, and increasing proportion of healthy and functional foods (Martins *et al.*, 2013; Avegliano *et al.*, 2015; Keatinge *et al.*, 2011; Louzada *et al.*, 2015; Moreira *et al.*, 2015). Brazil's condition is controversial; on one side, there are high rates of overweight and obesity, and on the other side, poverty and malnutrition rates that are also high (Brasil, 2012b).

This scenario offers the opportunity to compare the phenomenon of homogenisation of food habits worldwide (Pingali, 2007). In our study, we aim to understand what is currently happening in Brazil. In a way, the process in Brazil would apparently emulate an earlier process which occurred in other regions of the world and resulted in new and homogeneous food patterns.

Knowledge of the food patterns of the population along with the economic, demographic and anthropometric profiles is necessary for implementation of strategies aimed at improving social welfare (Heitor *et al.*, 2013). In this context, our study's goal was to present the evolution of Brazilian food patterns, based on the 2002–2003 and 2008–2009 Brazilian Household Budget Surveys (POFs), and to evaluate similarities in food acquisition among the Brazilian states, in search for the main drivers of the changes.

Methodology

The data for this research were obtained from two of the Brazilian Household Budget Surveys (POFs), related to the periods of 2002–2003 (Period 1) and 2008–2009 (Period 2), published by the Brazilian Institute of Geography and Statistics (IBGE, 2004, 2010a). The values taken into account refer to the average data of POFs, considering the statistical sampling criteria of IBGE. Therefore, the analysis of food acquisition similarity among the Brazilian states was done considering the population of each state, based on the number of surveyed households.

Among its applications, a POF presents a survey of consumption structures, expenditures and family income, giving basis for the profile description of the Brazilian population with regard to the living conditions according to family budgets.

For the purpose of comparing the evolution of the food patterns of the population in the Brazilian states, we grouped the states considering the similarities in their respective annual per capita household food acquisition, for the 17 food groups, in kilograms, as listed in the POFs. Food is defined as the "total acquisition of food made by the consumption unit, both intended and used at home and that performed and consumed away from home" (IBGE, 2010a, p. 27).

The food groups are: cereals and legumes; vegetables; fruit; coconut, chestnut and walnut; flour, starch and pasta; bakery goods; meats; animal viscera; fish; chicken and eggs; milk and derivatives; sugar, sweets and confectionery; salt and condiments; oils and fats; beverages and infusions; ready-to-eat food and processed products; other products. In the POF, the quantities purchased in liquid form were converted to kilograms. The annual values were transformed into monthly values through analysis.

In order to complement our descriptive analysis, other two POF variables were considered: familial average total monthly income in Brazilian Real (BRL); and food, monetary and non–monetary familial average consumption monthly expenditure in BRL.

The sample considered 27 Brazilian federative units, which make up the five macroregions of the country: the North region (states of Rondônia – RO, Acre – AC, Amazonas – AM, Roraima – RR, Pará – PA, Amapá – AP and Tocantins – TO), the Northeast region (states of Maranhão – MA, Piauí – PI, Ceará – CE, Rio Grande do Norte – RN, Paraíba – PB, Pernambuco – PE, Alagoas – AL, Sergipe – SE and Bahia – BA), the Southeast region (states of Minas Gerais – MG, Espírito Santo – ES, Rio de Janeiro – RJ and São Paulo – SP), the South region (states of Paraná – PR, Santa Catarina – SC and Rio Grande do Sul – RS), and the Midwest region (states of Mato Grosso do Sul – MS, Mato Grosso – MT, Goiás – GO and Distrito Federal – DF). The DF was treated as a federative state in our research.

To present the evolution of Brazilian food patterns, descriptive statistical analysis was performed. In order to verify the similarity in food acquisition between the Brazilian states, we opted for multidimensional scaling (Robinson and Bennett, 1995). In proximity matrices (using similarities of the annual per capita household food acquisition), Pearson correlations were considered significant at the 1 per cent level (prioritising the highest values among the federative units). The data were processed by software Statistical Package for Social Sciences (SPSS, 22 version).

Results and discussion

By means of the data from the two periods of POFs – concerning the 17 food groups and the multidimensional scaling – Brazilian states were divided, respectively, into five groups, according to their similarities in terms of annual per capita household food acquisition (Table 1):

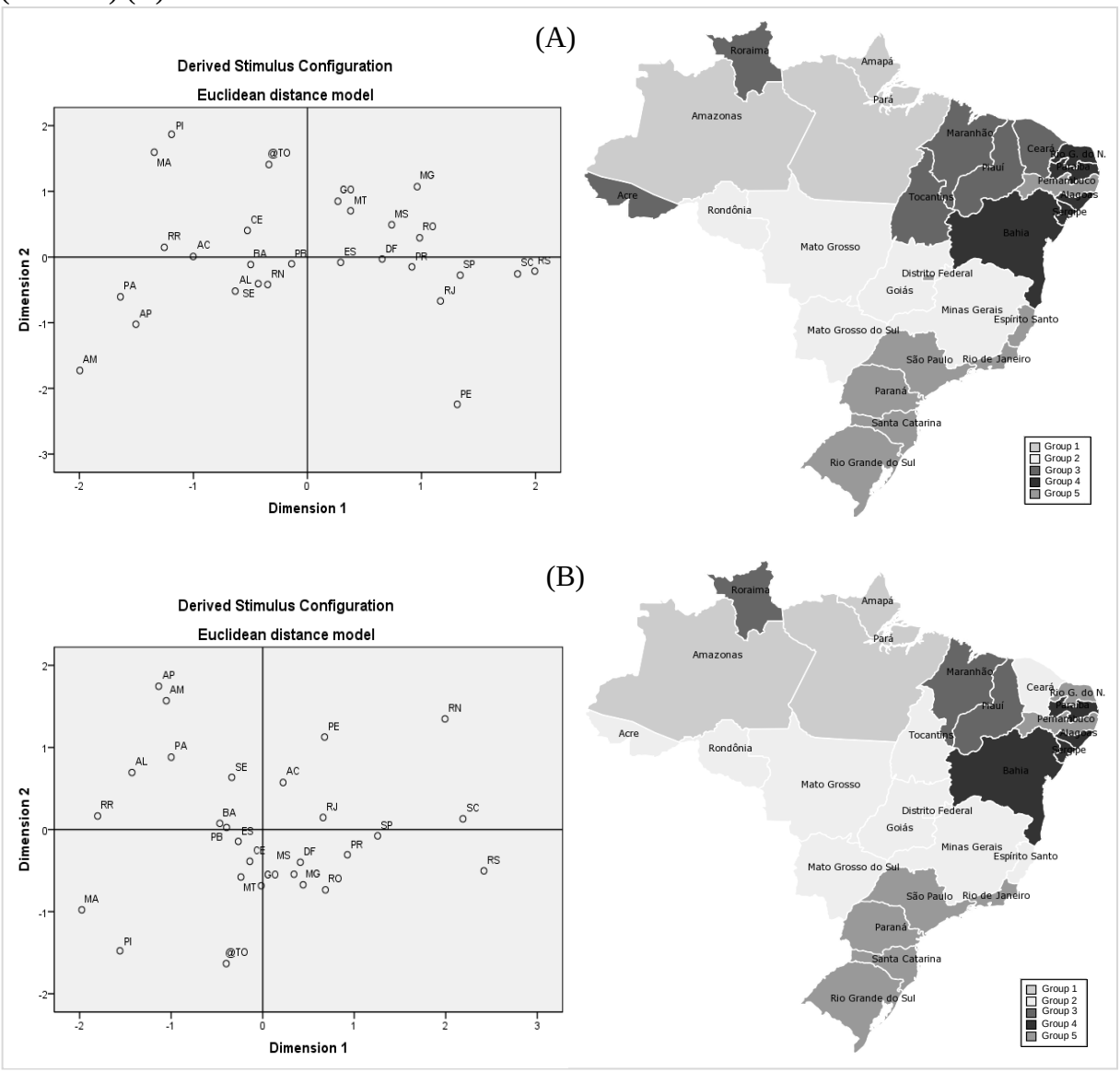
Table 1. Brazilian states grouped according to the respective food acquisition based on the multidimensional scaling, in the periods of 2002–2003 (Period 1) and 2008–2009 (Period 2)

2002-2003 (Period 1)			2008-2009 (Period 2)		
Group	**Number of states**	**Brazilian states**	**Group**	**Number of states**	**Brazilian states**
1	3	Amazonas (AM), Pará (PA), Amapá (AP)	**1**	3	Amazonas (AM), Pará (PA), Amapá (AP)
2	5	Rondônia (RO), Mato Grosso (MT), Mato Grosso do Sul (MS), Goiás (GO), Minas Gerais (MG)	**2**	10	Rondônia (RO), Mato Grosso (MT), Mato Grosso do Sul (MS), Goiás (GO), Minas Gerais (MG), Acre (AC), Tocantins (TO), Ceará (CE), Distrito Federal (DF), Espírito Santo (ES)
3	6	Acre (AC), Roraima (RR), Tocantins (TO), Maranhão (MA), Piauí (PI), Ceará (CE)	**3**	3	Roraima (RR), Maranhão (MA), Piauí (PI)
4	5	Rio Grande do Norte (RN), Paraíba (PB), Alagoas (AL), Sergipe (SE), Bahia (BA)	**4**	4	Paraíba (PB), Alagoas (AL), Sergipe (SE), Bahia (BA)
5	8	Pernambuco (PE), Distrito Federal (DF), Espírito Santo (ES), Rio de Janeiro (RJ), São Paulo (SP), Paraná (PR), Santa Catarina (SC), Rio Grande do Sul (RS)	**5**	7	Pernambuco (PE), Rio de Janeiro (RJ), São Paulo (SP), Paraná (PR), Santa Catarina (SC), Rio Grande do Sul (RS), Rio Grande do Norte (RN)

Source: Data derived from the Brazilian Household Budget Surveys – Brazilian Institute of Geography and Statistics (IBGE, 2004, 2010a)

Table 1 summarises the basis of our research, for evaluating the similarities in food acquisition among the Brazilian states. In this sense, Figure 1 (A and B) graphically shows what happened with the distribution of the five groups during the analysed periods. In this work, we speculate about the main drivers of these changes.

Figure 1. Similarities in terms of food acquisition of the five groups of Brazilian states, based on multidimensional scaling, in the periods of 2002–2003 (Period 1) (A) and 2008–2009 (Period 2) (B)



Source: Data derived from the Brazilian Household Budget Surveys – Brazilian Institute of Geography and Statistics (IBGE, 2004, 2010a)

Notes: The maps were shaded according to the proximity between the states, concerning the respective Pearson correlations, as shown in the respective graphics

The composition of the five groups reflects the diversity of the Brazilian states in terms of food acquisition and raises questions regarding the possible factors that caused the changes in the position of some states during the two periods analysed.

Following the recent and current demographic and economic dynamics of Brazil, the expansion of agricultural practices towards the Midwest, North and Northeast areas produced market changes in the feeding habits, or feeding patterns, in these regions. This strengthening

of an agricultural economy is followed by changes in the sociocultural expressions of the local population, consequently causing a new socioeconomic development process.

One of the main drivers of changes of the feeding habits could be the changes in the region's agricultural basis. Thus, not only the availability of new food or crops in the area, but also the changes in income of the population in these regions allowed them to change their feeding habits. We interpreted that among the main causes of these changes, it is possible to highlight these regions' economic remodelling.

Table 1 and Figure 1 show that Group 1 presented the same composition in the two periods of survey. In Group 2, – in addition to RO, MT, MS, GO and MG from Period 1, – new states were incorporated in Period 2, namely, AC, TO and CE from the earlier Group 3, and DF and ES from Group 5. Group 3 maintained the states of RR, MA and PI. The states of PB, BA, AL and SE remained in Group 4. The state of RN was added to Group 5 in Period 2, whose composition remained stable.

The moving of five states into Group 2 in Period 2 presents an interesting question for further analyses. Group 2 includes a number of states from the so-called new agricultural frontiers, namely, the Midwest of Brazil and the region called Matopiba (states of MA, TO, PI and BA). The steady advance of agribusiness in these areas both drives and interferes with the agricultural and agri-industrial supply chains, which impacts food availability which, in turn, can be associated with oscillations in human food resources (Hall and Caviglia-Harris, 2013; Horvat *et al.*, 2015).

In this context, the question arises regarding the relationship between migratory dynamics and oscillations in human production and consumption of food. For example, the percentage of the Northeastern-originated population which returned to their home state, after living in other regions, has increased from the 2000s, especially those people who had migrated to the Brazilian South-Central states looking for better temporary job opportunities.

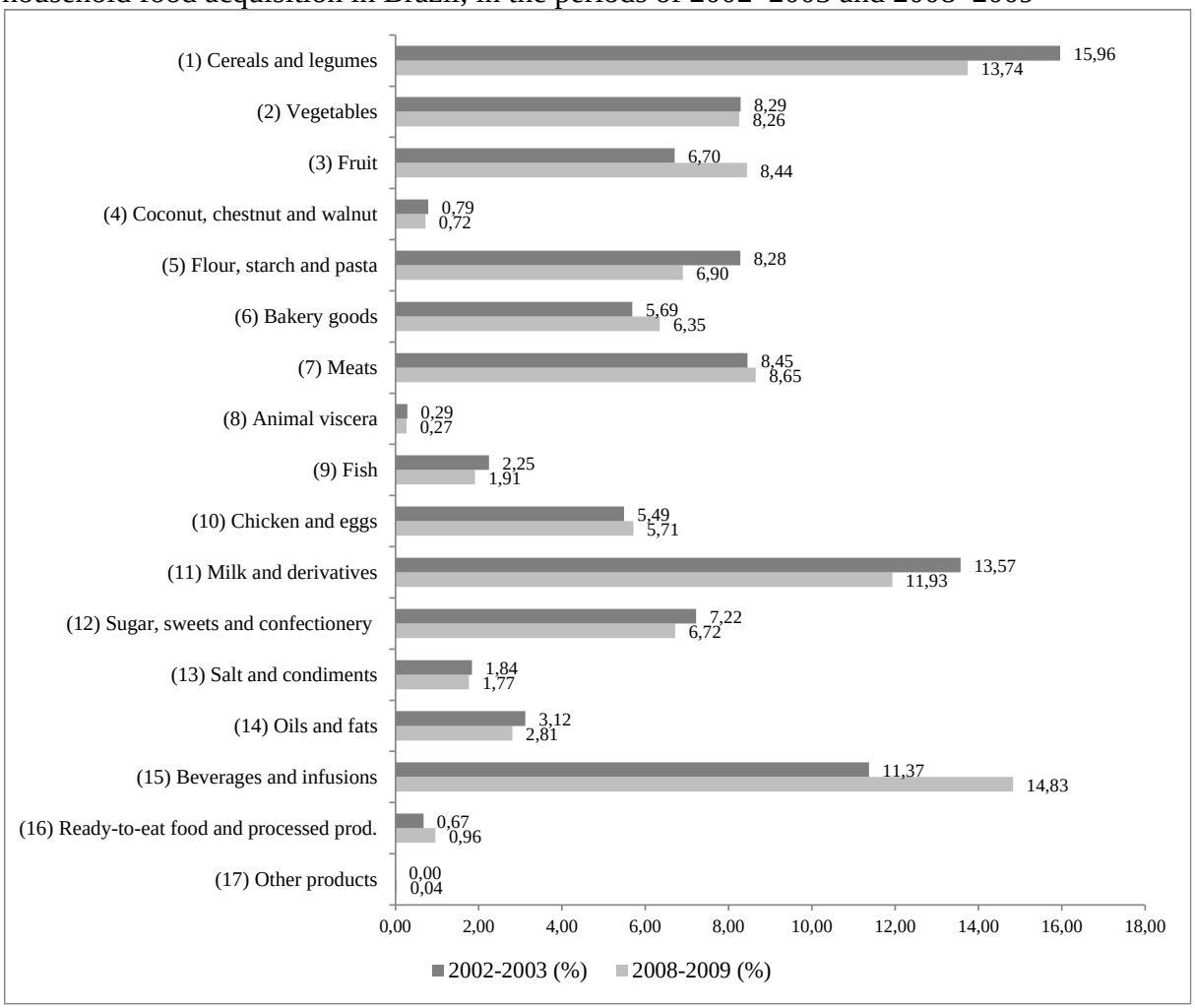
Regarding the 2009 National Research for Sample of Domiciles (PNAD) (IBGE, 2010b), PE and RN presented 23.61 and 21.14 per cent, respectively, of relative participation of the population which returned to their home states, in relation to total immigrants. Thus, a factor that may be associated with both Northeast states that have food similarities with South and Southeast states lies in the fact that the Northeastern population acquired Southern food and cultural habits in the period in which they resided in those states.

The geographic factor can help elucidate similarities with respect to food among Brazilian states. One example is the expansion of the production of certain agricultural commodities in the regions and how those products might interfere in the regional patterns of

food supply and consumption. That is, the emergence of new food supply chains would explain at least some of the regional food consumption changes. In this scenario, geographically closer regions tend to have similar food patterns. However, other factors are surely involved and should be considered.

Moreover, the research of Fabri *et al*. (2015) points out symbolic aspects pertinent to the production and consumption of regional foods that promotes healthy diets. The study of the diversity in food acquisition in Brazil is a complex subject, which goes beyond our present research. Figure 2 shows the relative frequency of the 17 food groups in the annual per capita household food acquisition of Brazilians, in the periods of 2002–2003 and 2008–2009.

Figure 2. Relative frequency (in percentage) of 17 food groups in the annual per capita household food acquisition in Brazil, in the periods of 2002–2003 and 2008–2009



Source: Data derived from the Brazilian Household Budget Surveys – Brazilian Institute of Geography and Statistics (IBGE, 2004, 2010a)

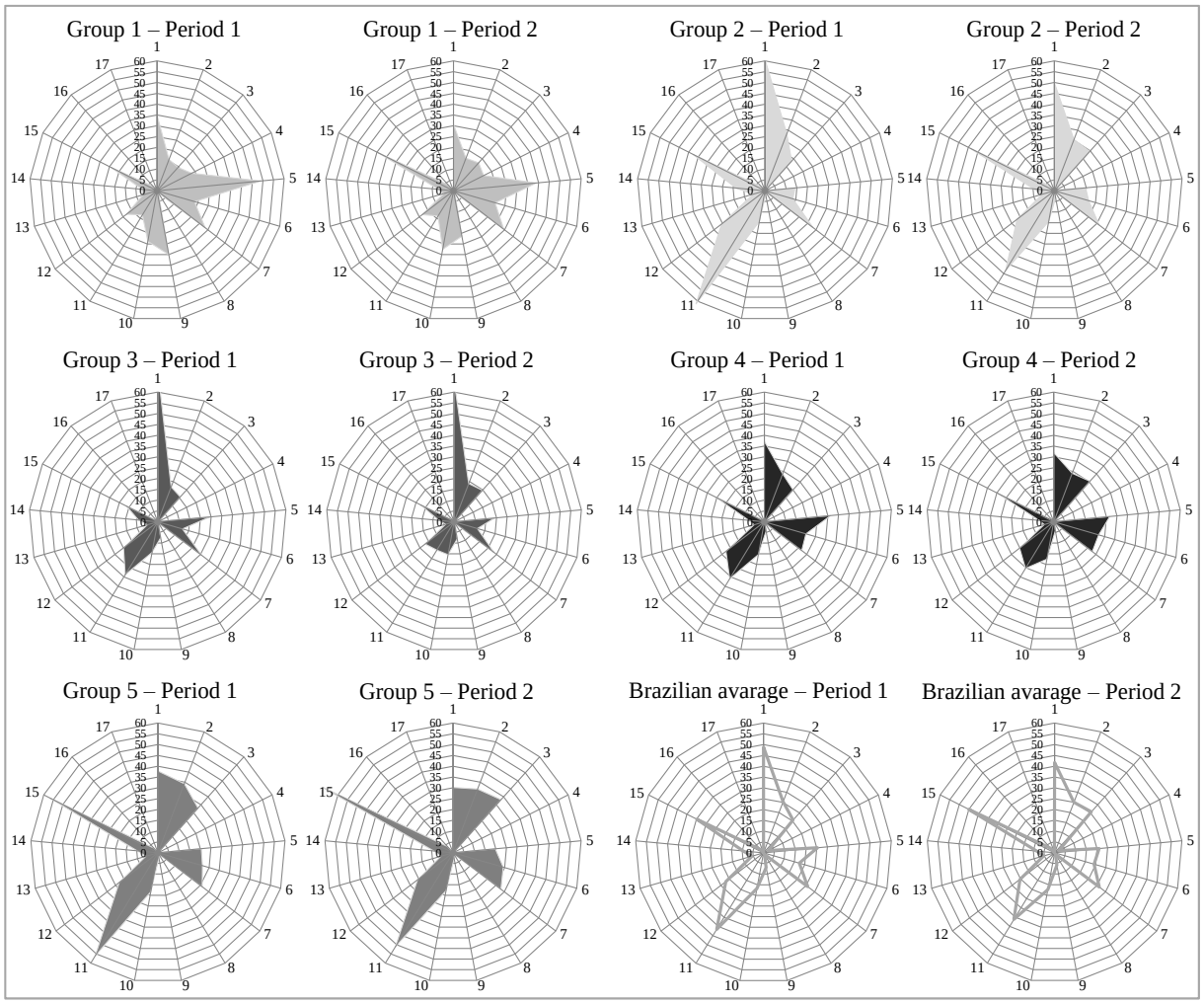
Considering Figure 2, the largest food acquisition (per capita household) during the period considered was “beverages and infusions”, rising from 11.37 to 14.83 per cent of total food

measured in the surveys, followed by “cereals and legumes” (from 15.96 to 13.74 per cent), and “milk and derivatives” (from 13.57 to 11.93 per cent). Relevant changes in percentages can be checked between the three groups with the highest participation in food acquisition. The smallest acquisitions occur in the groups “other products”, “animal viscera” and “coconut, chestnut and walnut”.

The stable availability of new products for human consumption in a region might induce changes in the consumer preferences and expectations. This can help explain the observed variations in the regional Brazilian food patterns during the two periods, stressing the importance of agribusiness production chains and their impact in this scenario.

Data presented in Figure 3 complements Figures 1 and 2, presenting in detail the annual per capita household food acquisition (regarding the average of states belonging to each group, respectively), and the oscillations observed in the periods. In Figure 2, the comprehensive Brazilian food acquisition average is also presented. We pointed out that Group 2 features food acquisition that is very close to the Brazilian average.

Figure 3. Detailed annual per capita household food acquisition of the respective five groups of Brazilian states and the Brazilian average with respect to the 17 food groups, in 2002–2003 (Period 1) and 2008–2009 (Period 2)



Source: Data derived from the Brazilian Household Budget Surveys – Brazilian Institute of Geography and Statistics (IBGE, 2004, 2010a)

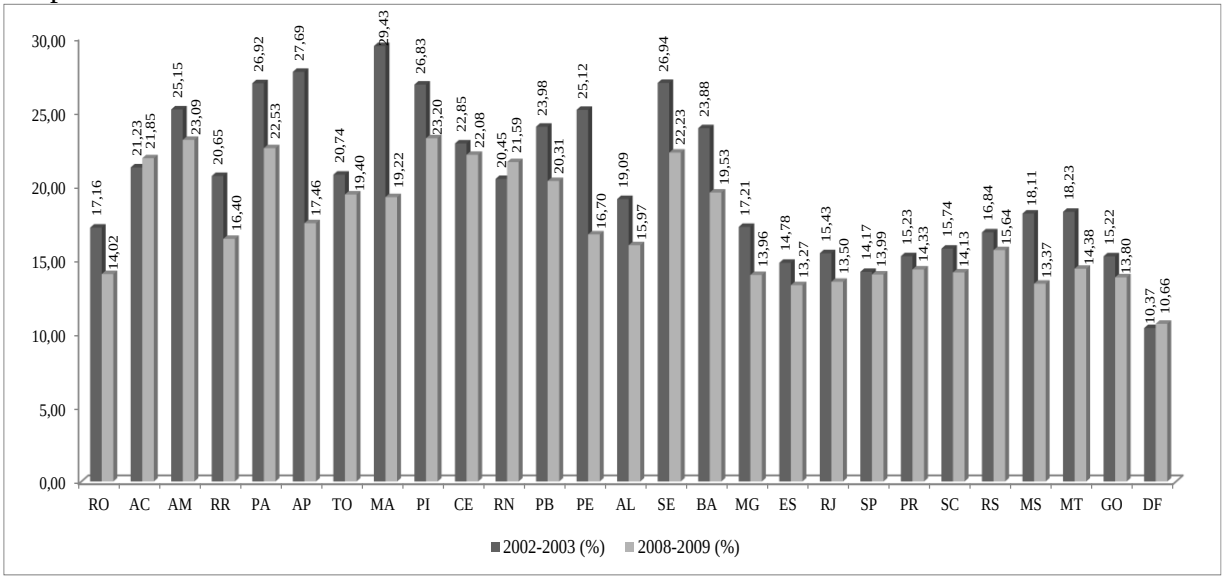
Notes: The food groups are as follows: (1) cereals and legumes; (2) vegetables; (3) fruit; (4) coconut, chestnut and walnut; (5) flour, starch and pasta; (6) bakery goods; (7) meats; (8) animal viscera; (9) fish; (10) chicken and eggs; (11) milk and derivatives; (12) sugar, sweets and confectionery; (13) salt and condiments; (14) oils and fats; (15) beverages and infusions; (16) ready-to-eat food and processed products; (17) other products. Food acquisition of the Brazilian states of Group 2 is quite similar to the Brazilian average

Results presented in Appendix A show that the annual per capita household food acquisition was reduced in Brazil during the analysed periods, from 330.26 to 315.21 kilograms, that is, -4.56 per cent. This scenario was observed in four Brazilian regions, especially in the Southeast region, with a decrease of 9.34 per cent. Only the North region showed a relative small increase (0.76 per cent).

In the comparison that is showed in Appendix A, the states of RN and AC recorded the highest growth percentage in terms of food acquisition: 44.96 per cent and 20.67 per cent, respectively, due especially to the “beverages and infusions” category.

Data from Period 2 might be reflecting the effects of the global economic crisis which occurred in 2008, which also led to general consumption restrictions in Brazil, as in the case of food products. We found that the annual food acquisition decreased by approximately one kilogram in most Brazilian states in the Period 2. In this context, the food expenditures of Brazilians were associated with food acquisition. In this scenario, we verified the behaviour (relative participation) of food expenditures in the familial average income during the analysis period (Figure 4).

Figure 4. Participation (relative frequency, in percentage) of food familial average consumption expenditures in familial average total income, in each of the Brazilian states, in the periods of 2002–2003 and 2008–2009



Source: Data derived from the Brazilian Household Budget Surveys – Brazilian Institute of Geography and Statistics (IBGE, 2004, 2010a)

Figure 4 shows that the percentage of food expenditures in terms of familial income decreased in most states from Period 1 to Period 2. It illustrates that, for example, in Midwestern states (MS, MT and GO) there was a decrease in percentage of food expenditures based on familial income.

Facts like this can be related to the expansion of agricultural and agri-industrial activities in these regions, where an increase in productivity and in the production of certain specialised products occurred. Agricultural productivity is recognised as the determinant of food supply and prices, and food demand is influenced by population growth and by real per capita income (Alston *et al.*, 2009).

A significant factor that defines the population's diet consists of food prices, since changes in prices affect food demand. This highlights the elasticity concept and its analysis

for the most varied food products (Hawkes, 2008; Andreyeva *et al.*, 2010). A way to stimulate healthy food purchases is to consider a reduction in prices of such foods. Even so the search for a nutritionally balanced diet has increased in recent decades and has been on the agenda of public policies. However, Brazilian food choices are not yet at desirable levels, across all age groups and socioeconomic strata (Ribeiro de Castro, 2015).

The research of Verly Júnior *et al.* (2013) shows that 80 per cent of the Brazilian population consume less than the recommended categories of milk and derivatives, fruit and fruit juices, cereals, tubers and roots; while 60 per cent of people fail to eat the required amount of vegetables. Among other troubling results of this research, we inferred that an inadequate diet can result in development of chronic diseases (such as cardiovascular disease, hypertension and diabetes) (Popkin, 2006).

The research of Finocchio and Dewes (2015) discusses rising obesity rates and the importance of agribusiness in promoting balanced diets for the population. However, before food can reach the consumer, issues of production, distribution, commercialisation and food consumption and changes in policies related to food and nutrition have relevance and impact the agribusiness production chains (Finocchio *et al.*, 2015).

Still based on Figure 4, in Period 2, the highest percentage of food expenditure in relation to income was observed in the North and Northeast states: PI (23.20 per cent), AM (23.09 per cent), PA (22.53 per cent), SE (22.23 per cent) and CE (22.08 per cent). On the other hand, the Midwest and Southeast states had the lowest percentage of food expenditure: DF (10.66 per cent), ES (13.27 per cent), MS (13.37 per cent), RJ (13.50 per cent) and GO (13.80 per cent). Another point to be highlighted in this discussion is the increased income in developing countries.

At the same time, observing the familial average income of Brazilian states, in absolute terms, one verifies that the highest incomes are found in the Midwest, Southeast and South regions (e.g. DF (BRL4,602.48) and SP (BRL3,630.95) in Period 2). The inverse is observed in states from the Northeast and North regions (e.g. AL (BRL1,429.22) and MA (BRL1,529.68) in Period 2).

The research of Moreira *et al.* (2015) points out that the eating quality is better when we consider the increase of the parents' level of education and the family income. Bortolini *et al.* (2015) describe that the quality of the Brazilian children diet is not adequate, because social vulnerability is considerably associated with unfavourable food situation.

This context reaffirms the unequal distribution of income and social inequality in Brazil, where the highest percentage of food expenditures falls on the population with the

lowest incomes. In this context, the study of Ivanic and Martin (2008) discusses rising food prices and the implications for the lower classes, especially in low-income countries.

Thereby, food consumption and agribusiness are intertwined. The expansion of Brazilian agribusiness has stood out since the 1960s through vertical integration of industries, expansion of agricultural frontiers, productive diversification and rising exports (Hall and Caviglia-Harris, 2013; Horvat *et al.*, 2015). The 1970s depict the dynamics of agri-industrialisation, a time when the agri-industrial complexes were formed in Brazil, which resulted in increasing labour division and intensification of the movement of people from rural to urban areas. There are also issues concerning Brazil's rural context, such as the socioeconomic dynamics fostered in the country, which are reflected in its agricultural development.

There are relevant transformations in traditional Brazilian rural scenarios, such as: the modernisation of the agriculture sector, promoted by the government some decades ago, which encompassed rural credit, research and development (biotechnology, genetic improvement and superior agronomic practices); technical assistance and rural extension. In addition to this, family farming has had an important role in hunger eradication, food security and nutrition of the population. In this regard, two Brazilian government programmes are highlighted: Food Acquisition Programme (PAA) (SAF/MDA, 2016) and National School Feeding Programme (PNAE) (FNDE, 2016).

When attention turns to the rural-urban migration (specifically, the reduction of manpower in the countryside), this migration pattern leads to higher rural wages and, consequently, to higher food prices (Buainain *et al*., 2013). Within a modernisation scenario, science and technology innovation also foster food initiatives (Delmer, 2005; Alston *et al.*, 2009; Osaki and Batalha, 2014).

On the one hand, the changes in the Brazilian food patterns have been caused by the farming activity migration, originally derived from the South and the Southeast regions. For this purpose, typical crops have been genetically improved to be produced in other regions. On the other hand, products derived from these new places were introduced in the South and the Southeast regions diets due to their industrialisation, originally typical in the Midwest, North and Northeast regions. For example, local fish species from the Amazon region such as *tucunaré* became popular in other regions. Consumption of fresh water fish is now part of the eating habits of all Brazilian regions. Another example is a local Northern fruit called *açaí*, which is nowadays consumed in all the Brazilian states.

We know that food choices are influenced especially by geographical location and sociocultural environment (Sy *et al*., 2013). Food homogenisation is not one–sided. It is also an enrichment cultural process. While many countries incorporate imported eating habits such as fast–food, local elements may be added, giving food local nuances. That is, local food supply chains based on new technologies add diversity to new products. Within a modernisation scenario, science and technology innovation also drive food initiatives (Delmer, 2005; Alston *et al*., 2009; Osaki and Batalha, 2014).

Final considerations

According to the 2015 OECD/FAO report, Brazil would be the world's largest producer of food in the next decade. On the other hand, Brazil is the most populous country in South America and presents a scenario of income inequality, occupying the 101st position in terms of gross domestic product per capita out of a total of 230 countries (CIA, 2015).

In our study, we stress the pertinence of the case of Brazilian regional development in understanding the historical causes of the changes in the populations feeding habits. By interpreting how and why these changes occur, our research would help to understand how the homogenisation of feeding habits leads to generalised public health consequences.

We identified that since it related to familial income, the percentage of food expenditures decreased in most states from Period 1 to Period 2. How do the increasing prices of agricultural commodities from 2008 influence this? This issue is suggested for future analyses, by updating this survey with data from the future POF. The research conducted in this paper can also be seen as a contribution to neoclassical microeconomics, directing a discussion on income elasticity (inferior, superior and normal goods) and price elasticity of demand (substitute and complementary goods).

Additionally, we suggest that one of the main drivers of the highlighted changes is the regional agribusiness, focusing on the importance of short and long food supply chains (Marsden *et al.,* 2000; Schipmann and Qaim, 2010). As Murdoch and Miele (1999) and Cadilhon *et al*. (2006) pointed out, these two tendencies can coexist in the food production system.

Such evaluation can result in better decision making by public and private initiatives with respect to investment in agri-food supply chains in the Brazilian regions. The supply chains of agri-industrial products focussed on the domestic market can be analysed in depth, offering guidelines for future research in the areas of logistics and agri-industrial economy.

An individualised analysis of each POF food group would offer much to the field, but it goes beyond the purpose of our research, whereas this survey presents a thorough composition at a macroeconomic level. In addition to the two analysed POFs, a comparison with more recent data is required; however, information from the new POF is not yet available. Therefore, this paper adds results in general terms that can serve as basis for detailed future research on the topic, given the vast field of Brazilian issues that influence food acquisition.

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Appendix A. Annual per capita household food acquisition (in kilograms), in Brazilian regions and states, and the comparative percentages during the analysed periods

Annual per capita household food acquisition			
	2002-2003 POF	**2008-2009 POF**	**%**
Brazil	**330,26**	**315,21**	**-4,56**
North region	**320,20**	**322,64**	**0,76**
Rondônia	362,35	341,77	-5,68
Acre	262,60	316,87	20,67
Amazonas	297,87	300,57	0,91
Roraima	201,23	196,00	-2,60
Pará	343,67	340,68	-0,87
Amapá	275,72	275,48	-0,09
Tocantins	281,39	322,79	14,71
Northeast region	**289,43**	**287,79**	**-0,57**
Maranhão	276,41	239,69	-13,28
Piauí	314,55	301,41	-4,18
Ceará	277,55	305,36	10,02
Rio Grande do Norte	252,08	365,40	44,96
Paraíba	270,70	289,25	6,85
Pernambuco	344,42	303,46	-11,89
Alagoas	243,84	188,31	-22,77
Sergipe	291,25	290,64	-0,21
Bahia	285,68	290,43	1,66
Southeast region	**344,28**	**312,12**	**-9,34**
Minas Gerais	369,12	313,23	-15,14
Espírito Santo	295,34	265,47	-10,12
Rio de Janeiro	331,06	299,55	-9,52
São Paulo	341,57	320,35	-6,21
South region	**388,86**	**384,38**	**-1,15**
Paraná	339,79	344,24	1,31
Santa Catarina	392,80	384,62	-2,08
Rio Grande do Sul	432,98	423,49	-2,19
Midwest region	**295,35**	**293,10**	**-0,76**
Mato Grosso do Sul	315,21	304,46	-3,41
Mato Grosso	294,14	274,59	-6,65
Goiás	295,86	292,40	-1,17
Distrito Federal	275,85	306,09	10,96

Source: Data derived from the Brazilian Household Budget Surveys – Brazilian Institute of Geography and Statistics (IBGE, 2004, 2010a)

CHAPTER 4: Final considerations

The production of more and better food will be the most important challenge in food security in the decades to come. The topic of food security requires interdisciplinary analysis, as it involves issues related to biophysics, economics, environment, institutional politics, society, behavior, culture, geography, and technology. In this sense, the discussion may also focus on the effects of climate change on the geographies of both production and consumption.

In order to present scientific investigations that contribute to knowledge concerning the dynamics of food production and consumption in Brazil, this thesis includes interdisciplinary studies providing complementary analyses in line with the proposed theme. The contemporary dynamics of food supply chains and issues concerning agribusiness as a whole need to be discussed with regards to their different, but complementary, parts. In this regard, this thesis presents two aspects with specific objectives: food production (Chapter 2 – "Changes in Brazilian agriculture in relation to the development of the country's Midwest region"), and food consumption (Chapter 3 – "Changes in the geography of Brazilian diet diversity").

Brazil may become the world's largest producer of food over the next decades. In addition to the natural environment, regional diversities in Brazil shape both the geographic space and its productive development. Therefore, in Chapter 2, it was imperative to examine Brazilian agricultural commodities and to analyze the different temporal and geographical changes related to their production. The movements of the geographical midpoints of the considered agricultural commodities that occurred between 1990 and 2015 seem to correspond to the geographical changes that took place in agricultural production and land use in the Brazilian Midwest region in this period, whereas most agricultural transitions have been occurring in Brazil since the 1950s.

Moreover, Brazil is a country of great diversity, and due to economic, social, geographical, cultural, and ethnic factors, the eating habits of its inhabitants are far from homogeneous. The country was a food importer until the first half of the twentieth century, but nowadays it is one of the biggest food exporters worldwide. The Brazilian territorial occupation was relatively recent, and more profound demographic changes occurred in the countryside than in the coastal areas. In this respect, Chapter 3 aims to present the evolution of Brazilian food patterns and to evaluate food acquisition among the Brazilian states, in

search of the main drivers of change. The heterogeneity observed in food acquisition in Brazil emphasizes Brazilian agribusiness development and underscores the influence of food supply chains on the regional food patterns among the Brazilian states.

The increasing food supply, concentrated largely in cereals and oilseeds, was accompanied by a differentiation of products by agri-industries. Such concentration on a traditional, standardized, and global type of agriculture has been a problem in many food systems, since it can trigger the loss of regional/local food diversity. One strategy to counter this is to supply the local population through short food supply chains. Inherent in this strategy is the idea that there will be less distance between farmers and consumers than in the more traditional food supply networks.

Due to the often-detrimental effects of traditional farming, movements promoting sustainable agriculture are currently active in Brazil and elsewhere. Reducing the environmental impact of agricultural production and consumption patterns is fundamental in the quest for sustainability, mainly through the mitigation of greenhouse gas emissions. This point emphasizes the complexity and importance of defining the spatial dynamics of food systems.

Environmental concerns influence agriculture and animal production in Brazil, giving rise to, for example, the optimization of cultivated land from crop–livestock integration and no-till farming systems. These methods, resulting in increased productivity per hectare owing to technological innovations, were especially prompted by research led by the Brazilian Agricultural Research Corporation (Embrapa), including the productive expansion in the Brazilian Cerrado region.

A better relationship between agribusiness and sustainability is necessary in order to improve food production and accessibility and to preserve natural resources. New consumption models and sustainable food supply chains to increase production and optimize the use of natural resources are required to mitigate this scenario.

As the products of agricultural supply chains, and thus the presence of food with local characteristics, extend across Brazil, the foodstuffs being produced and transported using shorter food supply chains will increase the overall food security and diversity. In this way, dietary intake can depend on long and short food supply chains. In an agricultural production unit, however, it is possible to produce and supply foodstuffs either through long supply chains, such as in the case of meat and cereals, or by means of shorter supply networks.

Considering the systemic view of food production and consumption, many research opportunities can emerge. Production can influence patterns of food consumption arising, for

example, from geographic changes in production systems, as emphasized in Chapter 3. However, the importance of understanding other factors involved in this dynamic should also be emphasized. Thus, a research opportunity lies in a broadening of the analysis to include the consumer perspective, and in seeking to identify sustainability issues and economic, social, cultural, behavioral, psychological, and technological changes. These analyses could help in decision making, both in terms of public policies and in business issues related to agribusiness.

Another useful exercise could be to verify the relation between consumer habits and consumer income, as evidenced in the calculation of the income elasticity of the seventeen food groups presented in Chapter 3. In addition, the differences in food consumption between rural and urban populations could be analyzed. Anthropological and sociological analyses have the potential to create interesting and complementary results in relation to this theme.

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ANNEX A – E-mail confirming acceptance for publication of the paper "Changes in the geography of Brazilian diet diversity" in British Food Journal

Gmail

Giana Mores <gimores@gmail.com>

British Food Journal - Decision on Manuscript ID BFJ-05-2016-0208.R1

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28-Nov-2016

Dear Prof. Mores:

It is a pleasure to accept your manuscript entitled "Changes in the geography of Brazilian diet diversity" in its current form for publication in British Food Journal.

By publishing in this journal, your work will benefit from Emerald EarlyCite. This is a pre-publication service which allows your paper to be published online earlier, and so read by users and, potentially, cited earlier. Emerald operates a 'right first time' policy, which means that the final version of the article which has been accepted by the Editor will be the published version. We cannot allow further changes to the article once it has been accepted.

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Thank you for your contribution. On behalf of the Editors of British Food Journal, we look forward to your continued contributions to the Journal.

Yours sincerely,
Prof. Christopher Griffith
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