

# Productive Concentration in the Agricultural Frontier of Matopiba: Performance of Its Three Main Crops — Soybean, Maize and Cotton\*

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Abstract: This article sought to analyze, through data from the Municipal Agricultural Production (PAM<sup>1</sup>), the production and productivity evolution of the main crops (soybean, maize and cotton) in the Matopiba region — confluence of the states of Maranhão, Tocantins, Piauí and Bahia — the new Brazilian agricultural frontier. From 1998 to 2017, the Herfindahl-Hirschman and Gini indexes, combined with the geographic-distributive analysis, allowed to conclude that: a) the most relevant volumes of production have been concentrated in the central-eastern portion of Matopiba, between the west of Bahia and the south of Maranhão and Piauí; b) there is a trend of spatial dispersion of production in the three crops; c) overall productivity has been below the national average in soybean and, in maize and cotton, has performances compatible with the main producing centers of the country; d) it is identified close productivity between the microregions (MCRs) in soybean and cotton and, although still relatively uneven between the MCRs, there is indicative of convergence of the indicator in maize; e) there are cities that appear in the productions and productivity of soybean, corn and cotton, which can serve as a benchmark for agribusiness in the region.

Key words: distribution of production; agricultural production and productivity; agribusiness; regional economic activity

JEL codes: D30, O13, Q13, R11

### 1. Introduction

In broad countries such as Brazil, observing the development of various locations is a worthy topic when considering the perspective of a more decentralized model of income generation. It is also true that better distributing production is no easy endeavour; however, withdrawing attention from it implies wasting Brazilian differentials like regional and environmental diversities (Bacelar de Araújo, 2006, p. 373). To overcome said

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<sup>&</sup>lt;sup>1</sup> Data collected by IBGE (Brazilian Institute of Geography and Statistics).

challenge it seems convenient to scrutinize regions that stand out in their specialties, so as to replicate — whenever possible — their successful experiences.



Figure 1 The Matopiba Region

That said, this article analyzes the growth and concentration of production and productivity for soybean, maize and cotton crops in Matopiba, also called "Brazil's new agricultural frontier" (Dutra E. Silva et al., 2014, p. 152). Its name is an acronym for the abbreviations of the states Maranhão (MA), Tocantins (TO), Piauí (PI) and Bahia (BA) and refers to an area over 700,000 km<sup>2</sup> and reaching 31 MCRs and 337 cities<sup>2</sup>.

The region's participation in the agricultural GDP for the four federative units which form it can prove its relevance as a center of primary activities since Matopiba is responsible, on average, for half of the amount of the sectorial gross value added (GVA) of all the states together from 2010 to 2016<sup>3</sup>.

Given how significant agriculture is to the national figures, along with other factors — like income and job generation, progress expansion and environmental impact — this work emphasizes the performance of Matopiba's three main crops<sup>4</sup> currently. This study's structure derives from observations, especially of Technical Note (T.N.) no. 9 by Embrapa — Brazilian Company of Agricultural Research (Garagorry et al., 2015), which emphasizes Matopiba's consolidated grains production. Through its methods, the current research offers an additional contribution by updating information about the performance of the selected crops, which improves the results at a municipal level as well.

Ensuing these preliminary points, the analysis hereby presented organizes itself in five sections: along with this introduction, the next section presents the theoretical framework; the third block then describes the methods used; the fourth section follows with the analysis of results and, onwards, conclusions are decreed.

<sup>&</sup>lt;sup>2</sup> Delimitation out of Presidential Decree no. 8,447 of May 6, 2015 and MAPA's (Ministry of Agriculture, Livestock and Provisions) Ordinance no. 244 of November 12, 2015, related to the Agricultural Development Plan of Matopiba (PDA-Matopiba).

<sup>&</sup>lt;sup>3</sup> Verification through data by IBGE – Brazilian Institute of Geography and Statistics, available until 2016.

<sup>&</sup>lt;sup>4</sup> Soybean, maize and cotton, in that order, according to data by PAM/IBGE from 2017.

### 2. Theoretical Framework

Eradicating hunger is an increasingly pressing worry, being a global problem that already affects over 800 million people (FAO, 2018). In this context Brazil assumes a main role in food production: the availability of land and the advancement of research and management techniques have expanded the agricultural activities to new frontiers, such as the scrubland region (Perobelli et al., 2007, pp. 66-67). It is true that the agricultural growth within this area complies with legal limitations, so it must conciliate the goals of rural exploitation to those of resources preservation — especially being a legal reservation (Fasiaben et al., 2011, p. 1053). The existence of areas with great biological value in the country imposes preoccupations beyond economic matters, spanning environmental externalities. Hence, the search for solutions oriented towards food production without necessarily opening new cultivation areas — thereby through an increase of productivity — is permanent (Borghi et al., 2014, p. 265).

Lücker (1992, p. 35) comments precisely about the environmental impact resulting from the agricultural frontiers' expansion in the scrublands and the damage deriving from that. At the same time, Mueller (1992, pp. 80-84) points to the fact that Brazilian's horizontal agricultural expansion, up until the mid-seventies in the twentieth century, happened without much consideration to the environment, because "woodland could be destroyed, as well as letting the ground become depleted and eroded, because there was much more land to occupy ahead". In regard to the advancement of agribusiness in the scrublands, the author also indicates that the biggest advent of correction and fertilization of areas occurred, alongside mechanization, in the face of challenges interposed by poorer and more fragile soils. Incidentally, as soon as such expansion was incentivized, the least environmental impact was expected, but doubts about that premise arose at a later time.

In the original process of the primary sector's expansion into the scrublands, the Second National Development Plan (1975-1979) emphasized such advancement in the states of Mato Grosso, Goiás and Minas Gerais, while the other areas this biome included would assume a generic character. In this context, Matopiba's agricultural modernization happens at a relatively late time compared to the boost felt in the scrubland's previous exploitation areas (Dutra E. Silva et al., 2018, p. 150).

Matopiba emerges as an area of special interest in face of the agricultural activities' potential impacts, as well as due to its recent occupation by large scale agriculture with respective unwanted externalities, which are capable of better correction and prevention. So much so, that the region is the basis for analysis conducted by IBGE and UFRJ (Federal University of Rio de Janeiro) for collecting data assigned to elaborate the world methodological framework SEEA — Experimental Ecosystem Accounting (IBGE, 2019). This action integrates UN's initiative in what is called System of Environmental-Economic Accounting (UN, 2014). Studies in Brazil particularly address aspects such as erosion and the consequences to agricultural territories' hydric availability.

Through such ponderings, the relevance of investigating factors related to Matopiba's crops production and productivity becomes apparent. This subject matter encourages research towards creating awareness of agricultural expansions occurred by low efficiency methods which, from the environmental-accounting's point of view, can be harmful to ecosystems and populations in the mid and long terms.

## 3. Methods

The basis used for this study were PAM and IBGE. The observations consisted of data on physical

production (in tons), harvested area (in hectares<sup>5</sup>) and production worth (in Brazilian real<sup>6</sup>), regarding the period from 1998 to 2017 (PAM's last available year until June 2019). The integration of information was inspired by T.N. no. 9 by Embrapa (Garagorry et al., 2015), which analyzed the dynamics of grain harvests<sup>7</sup> in Matopiba from 1991 to 2011.

During the analysis, an analogous measure to that of T.N. no. 9 was to calculate — according to the verification spectrum — the means of the results in annual intervals, in order to mitigate fluctuations inherent to agricultural production, like the harvest drop between 2015 and 2016 due to climatic problems in Matopiba (CONAB, 2017).

Other approaches were also considered for this paper; measures such as those undertaken by Costa and Santana (2014, pp. 113-117) related to the concentration in the soybean market. To obtain the results for soybean, milk and cotton in Matopiba, the following indicators were observed (subsequently presented): productivity variation, concentration ratio and the Herfindahl-Hirschman and Gini indexes.

# **3.1 Productivity Variation**

The productivity variation<sup>8</sup> was calculated upon comparison of equal cycles (every three years, for instance), thus diminishing harvest oscillations as mentioned before. Its computation followed these steps:

$$x = \frac{\sum_{t1}^{t1+n} x}{\sum_{t0}^{t0+n} x}$$
(1)

where:

*x*: productivity variation;

X: annual production (tons);

n: time span;

$$y = \frac{\sum_{t1}^{t1+n} Y}{\sum_{t0}^{t0+n} Y}$$
(2)

where:

y: harvested area variation;

Y: annual area (harvested hectares);

n: time span;

$$p = \frac{\sum_{t1}^{t1+n} X}{\sum_{t0}^{t0+n} Y}$$
(3)

where:

p: region's productivity.

#### **3.2** Concentration Ratio

Akin to the approach verified in N.T. no. 9 by Embrapa (2015), quantiles of volume produced per crop (concentration ratios) were calculated — according to the research's context — observing the following equation:

$$\mathbf{R}\boldsymbol{C}_{\boldsymbol{x}} = \sum_{i=1}^{n} \boldsymbol{p}_{i\boldsymbol{x}},\tag{4}$$

<sup>&</sup>lt;sup>5</sup> Please note that 1 hectare (ha) = 2.47 acre (ac).

<sup>&</sup>lt;sup>6</sup> Brazilian real is Brazil's national currency. Amounts in this currency shown in this paper use the sign R\$.

<sup>&</sup>lt;sup>7</sup> In T.N. no. 9 the following crops were observed together: maize, rice, sorghum, castor bean, peanut, soybean, cotton, bean and fava bean.

<sup>&</sup>lt;sup>8</sup> Production per area (in our study, it corresponds to the ratio of tons produced per harvested hectare - t/ha).

where:

RCx: concentration ratio for crop (x);

pix: percentual participation of production per region (i) in crop (x);

i: region considered (MCR or city);

n: number of regions considered.

#### 3.3 Herfindahl-hirschman Index (HHI)

The HHI allows to infer, theoretically, what would be the equivalent number of firms operating in a sector given its concentration profile, in a value resulting from its inverse (1/HHI). The index is also adopted in market analysis in the United States (Costa, Santana, 2014, p. 116), which reinforces its importance. Following, the HHI formula and its interpretation as per the American Department of Justice's methodology (United States of America, 2010, p. 19)<sup>9</sup>:

$$HHI_X = \sum_{i=1}^n p_{ix}^2, \tag{5}$$

where:

HHIx: HHI for crop (x);

p<sup>2</sup>: percentual participation of production per region (i) in crop (x);

i: region considered (MCR);

n: number of regions considered.

HHI parameterization:

HHI < 0.15: deconcentrated market;

 $0.15 \le HHI \le 0.25$ : moderately concentrated market;

HHI  $\geq$  0.25: highly concentrated market.

# 3.4 Gini Index

Even though it emerged to measure income inequality, this indicator can also be utilized as a tool in the analysis of concentration coefficients (Coelho J. R., 2016, p. 856). In this paper the index pointed to the productivity concentration in terms of the distribution between tons produced and harvested areas. Let us examine its formula:

$$G_{j} = 1 - \sum_{i=1}^{n} (X_{n+1} - X_{n})(Y_{n+1} + Y_{n})$$
(7)

where:

 $G_l$ : productivity Gini for the Matopiba's regions (MCRs) in crop (j);

X: accumulated proportions of production per region (i);

Y: accumulated proportions of harvested area per region (i);

i: region considered (MCR);

n: number of regions considered.

<sup>&</sup>lt;sup>9</sup> Values divided by 10,000.

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Figure 2 Matopiba's Main Crops

# 4. Presentation of Results

Figure 2 contains the performance of the three main grains seeded in Matopiba, which were responsible for 42.2% of the local agricultural production value in 2017<sup>10</sup>; exponentially, the total growth for soybean, maize and cotton from 1999 and 2017 was of about 11.3% annually. In effect, these crops already assume a relevant portion of the national production<sup>11</sup> in the present day.

Veen	(I) Harvested	area (1,000 ha)	(II) Prod. amo	ount (1,000 t)	(I/II) Producti	vity (t/ha)
Year	CW + S	Matopiba	CW + S	Matopiba	CW + S	Matopiba
2000	11.384	838	44.865	1.872	3,94	2,23
2001	11.495	926	47.669	2.059	4,15	2,22
2002	12.385	1.061	52.371	2.261	4,23	2,13
2003	13.698	1.225	61.672	2.492	4,50	2,04
2004	15.779	1.399	65.653	3.191	4,16	2,28
2005	17.544	1.587	67.633	4.025	3,86	2,54
2006	18.493	1.725	66.621	4.461	3,60	2,59
2007	18.260	1.787	71.562	4.571	3,92	2,56
2008	17.817	1.825	77.073	4.857	4,33	2,66
2009	17.751	1.873	78.936	5.219	4,45	2,79
2010	18.450	2.023	83.580	5.770	4,53	2,85
2011	19.159	2.171	91.321	6.335	4,77	2,92
2012	19.957	2.363	94.000	7.026	4,71	2,97
2013	21.130	2.574	99.766	7.201	4,72	2,80
2014	22.691	2.887	104.067	7.609	4,59	2,64
2015	24.416	3.272	120.261	8.740	4,93	2,67
2016	25.594	3.552	126.882	8.794	4,96	2,48
2017	26.299	3.756	139.709	9.844	5,31	2,62
Accumulated variation	131%	348%	211%	426%	35%	17%

Table 1 Soybean: Triennial Means of the Harvested Area, Produced Amount and Productivityased on annual data from 1998 to 2017

Source: PAM/IBGE

<sup>&</sup>lt;sup>10</sup> Of R\$ 39 billion for the sum of all 71 crops catalogued by PAM/IBGE.

<sup>&</sup>lt;sup>11</sup> In 2017, the soybean, maize and cotton harvested in Matopiba represented, respectively, 10.3%, 5.2% and 24.1% of the total national production (PAM/IBGE).

In light of this we then gathered information about their production and productivity history and confronted them with the results noted in the country's main producing areas, combined (Central-West and South regions: "CW + S"). Considering the criterion of triennial means' verification, these were the correlated performances:

¥7	(I) Harvested	area (1,000 ha)	(II) Prod. :	amount (1,000 t)	(I/II) Produ	(I/II) Productivity (t/ha)	
Year	CW + S	Matopiba	CW + S	Matopiba	CW + S	Matopiba	
2000	15.905	440	46.137	979	2,90	2,22	
2001	16.795	478	52.875	1.171	3,15	2,45	
2002	16.866	502	54.815	1.203	3,25	2,39	
2003	17.416	527	63.295	1.225	3,63	2,32	
2004	17.130	552	61.517	1.374	3,59	2,49	
2005	16.740	570	59.892	1.537	3,58	2,70	
2006	16.436	565	56.180	1.444	3,42	2,56	
2007	17.007	562	61.772	1.415	3,63	2,52	
2008	18.402	580	73.772	1.581	4,01	2,73	
2009	18.798	608	76.471	2.036	4,07	3,35	
2010	18.161	621	77.167	2.324	4,25	3,74	
2011	17.431	633	75.063	2.592	4,31	4,09	
2012	17.552	698	83.143	2.938	4,74	4,21	
2013	18.582	778	92.524	3.274	4,98	4,21	
2014	19.277	921	101.420	4.092	5,26	4,44	
2015	19.404	971	106.769	4.550	5,50	4,69	
2016	19.027	970	99.745	4.387	5,24	4,52	
2017	19.705	985	106.378	4.317	5,40	4,38	
Accumulated variation	24%	124%	131%	341%	86%	97%	

 Table 2
 Maize: Triennial Means of the Harvested Area, Produced Amount and Productivity

 Based on annual data from 1998 to 2017

Source: PAM/IBGE

Table 3	Cotton: Triennial Means of the Harvested Area, Produced Amount and Productivity
Based on annual data f	rom 1998 to 2017

Veen	(I) Harvested	area (1,000 ha)	(II) Prod. amo	ount (1,000 t)	(I/II) Producti	ivity (t/ha)
rear	CW + S	Matopiba	CW + S	Matopiba	CW + S	Matopiba
2000	837	26	1.687	64	2,02	2,49
2001	840	35	2.179	112	2,59	3,17
2002	866	50	2.400	158	2,77	3,13
2003	829	62	2.447	209	2,95	3,39
2004	912	104	2.803	373	3,07	3,57
2005	1.085	158	3.302	582	3,04	3,68
2006	1.142	211	3.518	767	3,08	3,63
2007	1.122	252	3.601	932	3,21	3,70
2008	1.040	287	3.686	1.081	3,54	3,77
2009	1.008	305	3.681	1.121	3,65	3,68
2010	905	295	3.285	1.084	3,63	3,67
2011	1.017	322	3.643	1.212	3,58	3,76
2012	1.206	370	4.332	1.369	3,59	3,70
2013	1.244	376	4.487	1.355	3,61	3,60
2014	1.152	359	4.208	1.239	3,65	3,45
2015	1.035	334	3.887	1.212	3,75	3,63
2016	1.053	339	3.903	1.196	3,71	3,53
2017	986	294	3.771	1.076	3,83	3,66
Accumulated variation	18%	1052%	124%	1589%	90%	47%

Source: PAM/IBGE

Firstly, the data for the soybean (Table 1) exhibits a persistently lower productivity in Matopiba than that of the main producing centers. So, even though its absolute production has more than quadrupled in the last decades, it is evident that its productivity grew less than the country's average (17% opposed to 35%). To some extent, the data behavior for the maize (Table 2) is distinct from that of the soybean. Accordingly, its harvest has also grown more than expected for the central-western and southern regions. However, its productivity curve — albeit still lower than the national benchmark — has a slightly higher evolution when compared to the Brazilian central-meridian crops.

Finally, there are the figures for the cotton (Table 3). Above all, they are important to indicate Matopiba's conversion into a main center of its cultivation, with almost ¼ of national production according to the 2017 PAM. These results also show that Matopiba has aligned its productivity with the national mean since the second half of the 2010s, registering a production growth rate almost 50% higher than the increase of harvested areas.

Upon revelation of such results, the current study considers that the analysis of the agricultural production in Matopiba, due to its extent, cannot be completed if such area is treated as a whole and uniform territory. To the contrary, there is an accentuated difference in atmospheric conditions and biomes throughout its land, in addition to diverse soils — basic element to the agricultural production (Lumbreras et al., 2015, p. 9). That said, we checked the distribution of the main producing MCRs up to a level immediately equal to or over 75% of the total production in each triennium from 2000 to 2017. Tables 4 and 6 depict the areas that stood out corresponding to this approach:

**...** 

			Trien	niums		
MCR	00 - 02	03 - 05	06 - 08	09 -11	12 - 14	15- 17
Santa Maria da Vitória (BA)	8.0% / 2.0	7.9%/2.5	8.0% / 2.6	7.9% / 3.0	5.6% / 2.0	7.8%/2.6
Barreiras (BA)	56.5% / 2.0	44.2% / 2.4	40.1% / 2.6	39.5% / 3.0	34.4% / 2.6	35.8% / 2.8
Alto Médio Gurgueia (PI)					4.1% / 1.9	
Alto Parnaíba Piauiense (PI)		6.8%/2.6	8.6% / 2.6	9.7% / 2.7	10.6% / 2.4	10.0%/2.3
Chapadas das Mangabeiras (MA)		5.6%/2.5				
Gerais de Balsas (MA)	15.6% / 2.3	13.8% / 2.6	13.9% / 2.7	13.0% / 2.9	13.0% / 2.8	10.0% / 2.2
Jalapão (TO)			4.7% / 2.5	4.8% / 2.8	5.5%/3.0	4.4% / 2.8
Porto Nacional (TO)					4.4% / 2.9	4.3% / 2.5
Gurupi (TO)						4.8% / 2.6
Source: PAM/IBGE Table	5 Maize: Partic	pipation in Pro	duction/Produ	ctivity (t/ha)		
Source: PAM/IBGE Table	e 5 Maize: Partic	ipation in Pro	duction/Produ Trien	ctivity (t/ha) niums		
Source: PAM/IBGE Table MCR	e 5 Maize: Partic	ipation in Pro-	duction/Produ Trien 06 - 08	ctivity (t/ha) niums 09 -11	12 - 14	15- 17
Source: PAM/IBGE Table MCR Santa Maria da Vitória (BA)	00 - 02	203 - 05	duction/Produ Trien 06 - 08	ctivity (t/ha) niums 09 -11	<b>12 - 14</b>	15-17
Source: PAM/IBGE Table MCR Santa Maria da Vitória (BA) Cotegine (BA)	00 - 02	<b>03 - 05</b>	duction/Produ Trien 06 - 08 14.2% / 3.5	ctivity (t/ha) niums 09 -11 14.6% / 5.3	<b>12 - 14</b> 10.3% / 5.7	<b>15-1</b> 7 9.8% / 6.0
Source: PAM/IBGE Table MCR Santa Maria da Vitória (BA) Cotegipe (BA) Barreiras (BA)	00 - 02 15.5% / 3.9 47.6% / 5.1	<b>03 - 05</b> 18.9% / 4.6 2.4% / 2.0 <b>45.5%</b> / 5.7	duction/Produ Trien 06 - 08 14.2% / 3.5 45.1% / 5.6	ctivity (t/ha) niums 09 -11 14.6% / 5.3 42.3% / 8.4	<b>12 - 14</b> 10.3% / 5.7 <b>35.3% / 8.3</b>	15-17 9.8%/6.0 24.3%/7.1
Source: PAM/IBGE Table MCR Santa Maria da Vitória (BA) Cotegipe (BA) Barreiras (BA) Alto Médio Gurgueia (PI)	e 5 Maize: Partic 00 - 02 15.5% / 3.9 47.6% / 5.1	<b>03 - 05</b> 18.9% / 4.6 2.4% / 2.0 <b>45.5%</b> / <b>5</b> .7	duction/Produ Trien 06 - 08 14.2% / 3.5 45.1% / 5.6	ctivity (t/ha) niums 09 -11 14.6% / 5.3 42.3% / 8.4	<b>12 - 14</b> 10.3% / 5.7 <b>35.3% / 8.3</b>	<b>15-17</b> 9.8% / 6.0 <b>24.3%</b> / 7.1 5.9% / 5.0
Source: PAM/IBGE Table MCR Santa Maria da Vitória (BA) Cotegipe (BA) Barreiras (BA) Alto Médio Gurgueia (PI) Alto Parnaíba Piauiense (PI)	<b>00 - 02</b> <b>15.5% / 3.9</b> <b>47.6% / 5.1</b> <b>2.1% / 3.8</b>	<b>03 - 05</b> 18.9% / 4.6 2.4% / 2.0 <b>45.5%</b> / <b>5.</b> 7	duction/Produ Trien 06 - 08 14.2% / 3.5 45.1% / 5.6 4.1% / 5.4	ctivity (t/ha) niums 09 -11 14.6% / 5.3 42.3% / 8.4 8.9% / 7.2	<b>12 - 14</b> 10.3% / 5.7 <b>35.3% / 8.3</b> 12.3% / 6.2	<b>15-1</b> 7 9.8% / 6.0 <b>24.3%</b> / <b>7.1</b> 5.9% / 5.0 14.5% / 4.9
Source: PAM/IBGE Table MCR Santa Maria da Vitória (BA) Cotegipe (BA) Barreiras (BA) Alto Médio Gurgueia (PI) Alto Parnaíba Piauiense (PI) Chapadas das Mangabeiras (MA)	<b>00 - 02</b> <b>15.5% / 3.9</b> <b>47.6% / 5.1</b> <b>2.1% / 3.8</b>	03 - 05 18.9% / 4.6 2.4% / 2.0 45.5% / 5.7	duction/Produ Trien 06 - 08 14.2% / 3.5 45.1% / 5.6 4.1% / 5.4	ctivity (t/ha) niums 09 -11 14.6% / 5.3 42.3% / 8.4 8.9% / 7.2 3.7% / 4.8	<b>12 - 14</b> 10.3% / 5.7 <b>35.3% / 8.3</b> 12.3% / 6.2	<b>15-1</b> 7 9.8% / 6.0 <b>24.3%</b> / <b>7.1</b> 5.9% / 5.0 14.5% / 4.9 5.0% / 4.5
Source: PAM/IBGE Table MCR Santa Maria da Vitória (BA) Cotegipe (BA) Barreiras (BA) Alto Médio Gurgueia (PI) Alto Parnaíba Piauiense (PI) Chapadas das Mangabeiras (MA) Gerais de Balsas (MA)	<b>00 - 02</b> <b>15.5% / 3.9</b> <b>47.6% / 5.1</b> <b>2.1% / 3.8</b> <b>4.7% / 4.4</b>	<b>03 - 05</b> 18.9% / 4.6 2.4% / 2.0 <b>45.5%</b> / <b>5.7</b> 3.0% / 4.6	duction/Produ Trien 06 - 08 14.2% / 3.5 45.1% / 5.6 4.1% / 5.4 3.3% / 6.1	ctivity (t/ha) niums 09 -11 14.6% / 5.3 42.3% / 8.4 8.9% / 7.2 3.7% / 4.8 3.8% / 6.6	<b>12 - 14</b> 10.3% / 5.7 <b>35.3% / 8.3</b> 12.3% / 6.2 13.7% / 4.60	<b>15-17</b> 9.8% / 6.0 <b>24.3% / 7.1</b> 5.9% / 5.0 14.5% / 4.9 5.0% / 4.5 13.2% / 4.1
Source: PAM/IBGE Table MCR Santa Maria da Vitória (BA) Cotegipe (BA) Barreiras (BA) Alto Médio Gurgueia (PI) Alto Parnaíba Piauiense (PI) Chapadas das Mangabeiras (MA) Gerais de Balsas (MA) Presidente Dutra (MA)	<b>00 - 02</b> <b>15.5% / 3.9</b> <b>47.6% / 5.1</b> <b>2.1% / 3.8</b> <b>4.7% / 4.4</b> <b>1.9% / 0.9</b>	<b>03 - 05</b> 18.9% / 4.6 2.4% / 2.0 <b>45.5%</b> / <b>5.7</b> 3.0% / 4.6	duction/Produ Trien 06 - 08 14.2% / 3.5 45.1% / 5.6 4.1% / 5.4 3.3% / 6.1 2.2% / 1.2	ctivity (t/ha) niums 09 -11 14.6% / 5.3 42.3% / 8.4 8.9% / 7.2 3.7% / 4.8 3.8% / 6.6	<b>12 - 14</b> 10.3% / 5.7 <b>35.3% / 8.3</b> 12.3% / 6.2 13.7% / 4.60	<b>15-17</b> 9.8% / 6.0 <b>24.3% / 7.1</b> 5.9% / 5.0 14.5% / 4.9 5.0% / 4.5 13.2% / 4.1
Source: PAM/IBGE <b>MCR</b> Santa Maria da Vitória (BA) Cotegipe (BA) Barreiras (BA) Alto Médio Gurgueia (PI) Alto Parnaíba Piauiense (PI) Chapadas das Mangabeiras (MA) Gerais de Balsas (MA) Presidente Dutra (MA) Alto Mearim e Grajaú (MA)	<b>00 - 02</b> <b>15.5% / 3.9</b> <b>47.6% / 5.1</b> <b>2.1% / 3.8</b> <b>4.7% / 4.4</b> <b>1.9% / 0.9</b> <b>2.4% / 0.9</b>	<b>03 - 05</b> 18.9% / 4.6 2.4% / 2.0 <b>45.5%</b> / <b>5.7</b> 3.0% / 4.6 2.8% / 1.2	duction/Produ Trien 06 - 08 14.2% / 3.5 45.1% / 5.6 4.1% / 5.4 3.3% / 6.1 2.2% / 1.2 3.1% / 1.3	ctivity (t/ha) niums 09 -11 14.6% / 5.3 42.3% / 8.4 8.9% / 7.2 3.7% / 4.8 3.8% / 6.6	<b>12 - 14</b> 10.3% / 5.7 <b>35.3% / 8.3</b> 12.3% / 6.2 13.7% / 4.60	<b>15-17</b> 9.8% / 6.0 <b>24.3% / 7.1</b> 5.9% / 5.0 14.5% / 4.9 5.0% / 4.5 13.2% / 4.1
Source: PAM/IBGE <b>MCR</b> Santa Maria da Vitória (BA) Cotegipe (BA) Barreiras (BA) Alto Médio Gurgueia (PI) Alto Parnaíba Piauiense (PI) Chapadas das Mangabeiras (MA) Gerais de Balsas (MA) Presidente Dutra (MA) Alto Mearim e Grajaú (MA) Dianópolis (TO)	<b>00 - 02</b> <b>15.5% / 3.9</b> <b>47.6% / 5.1</b> <b>2.1% / 3.8</b> <b>4.7% / 4.4</b> <b>1.9% / 0.9</b> <b>2.4% / 0.9</b> <b>2.4% / 3.0</b>	<b>03 - 05</b> <b>18.9% / 4.6</b> <b>2.4% / 2.0</b> <b>45.5% / 5.7</b> <b>3.0% / 4.6</b> <b>2.8% / 1.2</b> <b>2.7% / 2.9</b>	duction/Produ Trien 06 - 08 14.2% / 3.5 45.1% / 5.6 4.1% / 5.4 3.3% / 6.1 2.2% / 1.2 3.1% / 1.3 2.8% / 2.6	ctivity (t/ha) niums 09 -11 14.6% / 5.3 42.3% / 8.4 8.9% / 7.2 3.7% / 4.8 3.8% / 6.6	<b>12 - 14</b> 10.3% / 5.7 <b>35.3% / 8.3</b> 12.3% / 6.2 13.7% / 4.60	<b>15-17</b> 9.8% / 6.0 <b>24.3% / 7.1</b> 5.9% / 5.0 14.5% / 4.9 5.0% / 4.5 13.2% / 4.1

Table 6	<b>Cotton:</b> Partie	Cotton: Participation in Production/Productivity (t/ha)							
	-		Trien	niums					
	00 - 02	03 - 05	06 - 08	09 -11	12 - 14	15-17			
					17.8% / 3.3	13.6% / 3.1			
	79.3%/3.1 84.2%/3.7 81.9%/3.8 76.6%/3.7 70.0%/3.4 74.6%/3.8								
	Table 6	Table 6         Cotton: Parti-           00 - 02	Table 6         Cotton: Participation in Pro           00 - 02         03 - 05           79.3% / 3.1         84.2% / 3.7	Table 6         Cotton: Participation in Production/Produ           Trien           00 - 02         03 - 05         06 - 08           79.3% / 3.1         84.2% / 3.7         81.9% / 3.8	Table 6 Cotton: Participation in Production/Productivity (t/ha)           Trienniums           00 - 02         03 - 05         06 - 08         09 - 11           79.3% / 3.1         84.2% / 3.7         81.9% / 3.8         76.6% / 3.7	Table 6 Cotton: Participation in Production/Productivity (t/ha)         Trienniums         00 - 02       03 - 05       06 - 08       09 - 11       12 - 14         00 - 02       03 - 05       06 - 08       09 - 11       12 - 14         00 - 02       03 - 05       06 - 08       09 - 11       12 - 14         00 - 02       03 - 05       06 - 08       09 - 11       17.8% / 3.3         79.3% / 3.1       84.2% / 3.7       81.9% / 3.8       76.6% / 3.7       70.0% / 3.4			

Productive Concentration in the Agricultural Frontier of Matopiba: Performance of Its Three Main Crops — Soybean, Maize and Cotton

Source: PAM/IBGE

The detailing of the main producing regions denotes the concentration in harvested volume. In almost two decades, only thirteen MCRs distinguished themselves in the analyzed crops; such amount recedes to only nine areas if restricted to the 2015-2017 triennium.

Another way we selected to demonstrate the condensation of the main crops in certain regions of Matopiba was to elaborate maps; to that purpose, Figure 3 contains the relative participation in the total production of soybean, maize and cotton from 2012 to 2017. The longest time span — of six years — tried to attenuate activity fluctuations; in Matopiba, this possibility meets the real occurrence of draughts and production breakage between 2015 and 2016, for example.



Figure 3 Matopiba: Main Producing MCRs

The production geo-distribution especially highlights areas situated in Matopiba's central-eastern portion — mostly the MCRs of Barreiras and Santa Maria da Vitória on the utmost western side of Bahia (on the west bank of the San Francisco River) — and the territories Gerais de Balsas (MA) and Alto Parnaíba Piauiense, in Maranhão and Piauí's southernmost portions (siding the Parnaíba River). The *quantum* of crops in these regions assume extremely elevated amounts in cotton (88.6% of the total produced) followed by maize (67.3%) and

soybean (56.8%), considering the MCRs with production over 10% of Matopiba's total per crop.

The aspect of such concentration led to the need of a more precise quantification. To that end, we calculated the equivalent number of MCRs that would accommodate a minimum of three quartiles of production (C75) using triennial means of production and harvested area; the HHI for production and Gini Index for productivity (t/ha) were also calculated, drawing out the following results:

		C75		Herfindah	l-Hirschman i	ndex - HHI	(	Gini index	
Year		(production)	)		(production)		(p)	roductivity	<i>i</i> )
	Soybean	Maize	Cotton	Soybean	Maize	Cotton	Soybean	Maize	Cotton
2000	2	6	2	0,40	0,26	0,45	0,03	0,48	0,10
2001	3	6	2	0,38	0,27	0,63	0,04	0,42	0,04
2002	3	7	2	0,36	0,26	0,65	0,04	0,43	0,02
2003	3	7	2	0,31	0,26	0,63	0,05	0,42	0,03
2004	4	7	2	0,27	0,25	0,70	0,03	0,43	0,02
2005	5	6	2	0,24	0,25	0,72	0,02	0,42	0,01
2006	5	7	2	0,21	0,23	0,73	0,01	0,40	0,01
2007	5	8	2	0,21	0,22	0,73	0,02	0,40	0,01
2008	5	7	2	0,20	0,23	0,68	0,02	0,40	0,02
2009	5	6	2	0,20	0,25	0,65	0,02	0,40	0,02
2010	5	6	2	0,20	0,24	0,62	0,01	0,40	0,01
2011	5	6	2	0,20	0,22	0,61	0,02	0,40	0,01
2012	5	5	2	0,20	0,20	0,60	0,04	0,40	0,01
2013	6	5	2	0,18	0,19	0,58	0,05	0,37	0,02
2014	7	5	2	0,16	0,18	0,53	0,06	0,33	0,02
2015	7	5	2	0,15	0,17	0,54	0,05	0,29	0,03
2016	7	6	2	0,16	0,15	0,55	0,05	0,27	0,03
2017	7	7	2	0,17	0,12	0,58	0,05	0,22	0,03

Fable 7	Production	Concentration	and	Productivity	Analysis
on and ha	rugeted oran	annual data from	1008	to 2017	

Source: PAM/IBGE

Based on triennial means of producti

The prominence of some MCRs, chiefly according to the C75 indicator, cross-references the former observation derived from the geographical distribution of production. Nevertheless, the soybean and maize crops pointed towards expansion, with HHI values that virtually reduced to half in the examined time span. Cotton, on the other hand, remained its hyper concentrated aspect in Bahia's MCRs Barreiras and Santa Maria da Vitória; this can be confirmed by its HHI close to 0.58, implying the occurrence of the crop's duopoly.

In turn, when focusing the reading of results on the Gini, nearly equal profiles in productivity per MCR emerge for the soybean and cotton crops, showing essentially constant results and low divergence for almost all the analyzed time span<sup>12</sup>. That is, the index's outcomes indicate produced volumes almost proportional to the extent of the harvested areas in the MCRs with these crops. In regard to maize, there is a greater differentiation in the microregional productivities. The outcome is actually compatible with two aspects: the first is that the crop reaches all of Matopiba; the second being that, given the great differences in volumes between MCRs, the coexistence of large scale crops — as occurs in Barreiras (BA) — and properties with subsistence harvesting profiles indicates that they are, numerically and factually, majority in Matopiba (Alves et al., 2010, p. 2). Nevertheless, in the maize's case, the differences in productivity within the region have been gradually converging, with a lasting reduction of the Gini. Finally, combining the data for C75, HHI and Gini enhances the reading of performances for the tracked crops, as Table 8 shows:

 $<sup>^{12}</sup>$  A slightly higher Gini for the cotton is observed in the triennium ended in 2000 (0.10); however, given the small production volume at the time (see Table 3), it can be considered less relevant in defining the crops' later trend in Matopiba.

#### Productive Concentration in the Agricultural Frontier of Matopiba: Performance of Its Three Main Crops — Soybean, Maize and Cotton

<table-container>          Physical         image: i</table-container>	Based on annual means of production (t) and	l harvested area (ha) - data fi	rom 2012 to 2017 (per	iod 2) v. 2006	to 2011 (period 1)					
Production growth (1)         Area growth (11)         (11)         Production growth (10)         Area growth (11)         (11) </th <th>Region</th> <th>1</th> <th>Soybean</th> <th></th> <th>I</th> <th>Maize</th> <th></th> <th>(</th> <th>otton</th> <th></th>	Region	1	Soybean		I	Maize		(	otton	
		Production growth (I)	Area growth (II)	(I/II)	Production growth (I)	Area growth (II)	(I/II)	Production growth (I)	Area growth (II)	(I/II)
South         41%         25%         1,6         11%         -1.0         -9.2%         -8.9%         1,0           Matopha Jotal         36%         56%         1.8         12%         39%         4.6         NR         NR         -           Aragmina (TO)         8%         56%         1.8         12%         39%         4.6         NR         NR         -           Margenina (TO)         19%         123%         1.1         213%         76%         2.7         NR         NR         -           Gumpi (TO)         30%         14%         1.0         44%         -6%         7.9         41%         1.6         0.4           Orapita (TO)         30%         34%         1.1         42%         4%         9.6         1.4         7%         64%         0.9           Data foolis (TO)         5%         6%         1.1         10%         36%         3.0         34%         1.8           Lapcis Marahemes (MA)         NR         NR         -         7%         1.6%         1.8         NR         -           Lapcis Marahemes (MA)         NR         NR         -         -23%         1.4%         1.6         NR	Central-West	45%	39%	1,2	145%	92%	1,6	18%	13%	1,4
Matopha total         38%         55%         0.6         102%         37%         1.8         1%         7%         0.1           Bics do Papagaio (TO)         98%         55%         1.8         182%         39%         4.6         NR         NR         -           Araguina (TO)         139%         123%         77%         6%         12.3         NR         NR         -           Ko Formso (TO)         139%         123%         79%         2.7         NR         NR         -           Gunup (TO)         330%         344%         1.0         44%         -6%         -7.9         470%         464%         1.0           Jalapáo (TO)         5%%         0.4         1.3         193%         167%         1.2         58%         64%         0.9           Jalapáo (TO)         5%%         7%         1.1         10%         3%         3.0         34%         1.8         1.8           Lençois Maranhenses (MA)         NR         NR         -         2%         -24%         1.6         NR         NR         -           Inspecture Miring (MA)         5%         17%         0.7         8%         -5%         -2.4         NR <td>South</td> <td>41%</td> <td>25%</td> <td>1,6</td> <td>11%</td> <td>-11%</td> <td>-1,0</td> <td>-92%</td> <td>-89%</td> <td>1,0</td>	South	41%	25%	1,6	11%	-11%	-1,0	-92%	-89%	1,0
Bice of papagia (TO)       99%       55%       1.8       182%       39%       4.6       NR       NR       -         Angunia (TO)       80%       113%       0.7       78%       6%       12.3       NR       NR       -         Rio Fornoso (TO)       139%       123%       1.1       213%       79%       2.7       NR       NR       -         Rio Fornoso (TO)       196%       187%       1.0       44%       -6%       7.9       470%       385%       0.4         Output (TO)       330%       344%       1.0       44%       -6%       -7.9       470%       183%       0.4         Jatajako (TO)       59%       47%       13       193%       167%       12       58%       64%       0.9         Dianópois (TO)       88%       79%       1.1       10%       3%       3.0       34%       1.8       1.8         Lençois Maranhenses (MA)       NR       NR       -       -23%       -14%       1.6       NR       NR       -         Inper atrix (MA)       534%       71%       0.7       8%       -1.0       NR       NR       -         Preisidarie Durira (MA)       138% <td>Matopiba - total</td> <td>36%</td> <td>56%</td> <td>0,6</td> <td>102%</td> <td>57%</td> <td>1,8</td> <td>1%</td> <td>7%</td> <td>0,1</td>	Matopiba - total	36%	56%	0,6	102%	57%	1,8	1%	7%	0,1
Araguina (TO)       80%       111%       0.7       78%       6%       12,3       NR       NR       NR	Bico do Papagaio (TO)	98%	56%	1,8	182%	39%	4,6	NR	NR	-
Miracena do Tocantins (TO)       139%       123%       1.1       213%       79%       2.7       NR       NR       -         Rio Formoso (TO)       330%       148%       1.0       42%       4%       9.6       148%       38%       0.4         Garupi (TO)       330%       64%       1.0       44%       -6%       -7.9       470%       464%       1.0         Parto Nacional (TO)       5%       69%       1.1       42%       316%       1.4       73%       18%       0.4         Jalpão (TO)       5%       69%       1.1       10%       316%       1.4       73%       18%       0.4         Lençis Marahness (MA)       NR       NR       -       7%       1.6       NR       NR       -         Inprestriz (MA)       9349%       6322%       1.5       52%       -22%       -2.4       NR       NR       -         Inprestriz (MA)       9349%       6322%       1.7       7%       -2.6%       0.2       NR       NR       -         Presidente Durin (MA)       NR       NR       -       -       43%       0.9       NR       NR       -         Codo (MA)       238%	Araguaína (TO)	80%	111%	0,7	78%	6%	12,3	NR	NR	
Rie Formoso (TO)       196%       187%       1.1       42%       4%       9.6       14%6       385%       0.4         Gumpi (TO)       330%       344%       1.0       44%       -6%       -7.9       470%       464%       1.0         Porto Nacional (TO)       59%       47%       1.3       193%       16%       1.4       73%       183%       0.4         Jalapão (TO)       59%       47%       1.3       193%       16%       1.2       58%       64%       0.9         Dinacionis (TO)       88%       79%       1.1       10%       3%       3.0       34%       1.8       NR       -       7%6       1.6%       0.5       NR       NR       -       1.0       14%6       1.6       NR       NR       -       1.0       1.4       1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0       1.0	Miracema do Tocantins (TO)	139%	123%	1,1	213%	79%	2,7	NR	NR	-
Gurupi (TO)         330%         344%         1.0         44%         -6%         -7.9         470%         464%         1.0           Porto Nacional (TO)         75%         69%         1.1         427%         316%         1.4         73%         183%         0,4           Jalapão (TO)         59%         47%         1.3         193%         167%         1.2         58%         64%         0,9           Dianópolis (TO)         88%         79%         1.1         10%         3,6         3,4%         18%         1,8           Lençõis Maranhenses (MA)         NR         NR         -         -23%         -16%         -0.5         NR         NR         -           Inperatiz (MA)         9349%         6322%         1.5         52%         -22%         -2.4         NR         NR         -           Alto Maraines (MA)         NR         NR         -         -23%         0.9         NR         NR         -           Parsidente Dutra (MA)         53%         71%         0.7         7%         -12%         -6,4         NR         NR         -           Chapadinha (MA)         63%         0.7         77%         -12%         -6,4 <td>Rio Formoso (TO)</td> <td>196%</td> <td>187%</td> <td>1,1</td> <td>42%</td> <td>4%</td> <td>9,6</td> <td>148%</td> <td>385%</td> <td>0,4</td>	Rio Formoso (TO)	196%	187%	1,1	42%	4%	9,6	148%	385%	0,4
Porto Nacional (TO)         75%         69%         1,1         427%         31.6%         1.4         73%         183%         0.4           Jalapão (TO)         59%         47%         1,3         193%         167%         1.2         58%         64%         0.9           Dinajopiis (TO)         88%         79%         1,1         10%         3%         3.0         34%         18%         1.8           Lençõis Maranhenses (MA)         NR         NR         -         7%         -16%         -0.5         NR         NR         -           Imperatriz (MA)         9349%         6322%         1.5         52%         -22%         -2.4         NR         NR         -           Indo derim (MA)         NR         NR         -         -20%         -22%         0.9         NR         NR         -           Presidente Dutra (MA)         53%         71%         0.7         7%         -20%         0.2         NR         NR         -           Chapadinha (MA)         62%         60%         1.0         -33%         -37%         0.9         NR         NR         -           Codo (MA)         NR         NR         -         - <td>Gurupi (TO)</td> <td>330%</td> <td>344%</td> <td>1,0</td> <td>44%</td> <td>-6%</td> <td>-7,9</td> <td>470%</td> <td>464%</td> <td>1,0</td>	Gurupi (TO)	330%	344%	1,0	44%	-6%	-7,9	470%	464%	1,0
Jalapão (TO)       59%       47%       1,3       193%       167%       1,2       58%       64%       0,9         Dianópolis (TO)       88%       79%       1,1       10%       39%       3,0       34%       18%       1,8         Lençois Maranhenses (MA)       NR       NR       NR       -       -23%       -16%       -0,5       NR       NR       NR       -         Imperatriz (MA)       NR       NR       -       -23%       -14%       1,6       NR       NR       -         Médio Mearin (A)       NR       NR       NR       -       -20%       -22%       -2,4       NR       NR       -         Alto Mearin (AA)       NR       NR       NR       -       -20%       -23%       0,9       NR       NR       -         Presidente Durta (MA)       2388%       1419%       1,7       -5%       -20%       0,2       NR       NR       -	Porto Nacional (TO)	75%	69%	1,1	427%	316%	1,4	73%	183%	0,4
Dianópolis (TO)         88%         79%         1.1         10%         39%         3.0         34%         18%         1,8           Lençois Maranhenses (MA)         NR         NR         NR         -         7%         -16%         -0,5         NR         NR         -           Inpectrut Mirim (MA)         NR         NR         -         -23%         -14%         1,6         NR         NR         -           Inpectrut Mirim (MA)         NR         NR         NR         -         22%         -2.4         NR         NR         -           Alto Mearine Grajai (MA)         53%         71%         0,7         8%         -8%         -1,0         NR         NR         -           Alto Mearine Grajai (MA)         238%         1419%         1,7         -5%         -20%         0,2         NR         NR         -           Presidente Dutra (MA)         238%         60%         1,0         -33%         -37%         0,9         NR         NR         -           Codo (MA)         Alt%         NR         -         -         -47%         -43%         1,1         NR         NR         -           Codo (MA)         243%	Jalapão (TO)	59%	47%	1,3	193%	167%	1,2	58%	64%	0,9
Lençõis Maranhenses (MA)         NR         NR         NR         NR         -         7%         -16%         -0,5         NR         NR         -           Itapecturu Mirini (MA)         NR         NR         NR         -23%         -14%         1.6         NR         NR         -           Inderatiru (MA)         9349%         6322%         1.5         52%         -22%         -2.4         NR         NR         NR         -           Médio Mearini (MA)         NR         NR         -         -20%         -23%         0.9         NR         NR         -           Alto Mearin e Grajaú (MA)         53%         71%         0.7         8%         -8%         -1.0         NR         NR         -           Baixo Parnaiba Maranhense (MA)         41%         63%         0.7         77%         -12%         -6.4         NR         NR         -           Chapadinha (MA)         62%         60%         1.0         -33%         -37%         0.9         NR         NR         -           Codio (MA)         NR         NR         -         -47%         -31%         1.1         NR         NR         -           Codio NA1 <td< td=""><td>Dianópolis (TO)</td><td>88%</td><td>79%</td><td>1,1</td><td>10%</td><td>3%</td><td>3,0</td><td>34%</td><td>18%</td><td>1,8</td></td<>	Dianópolis (TO)	88%	79%	1,1	10%	3%	3,0	34%	18%	1,8
Inpectrum Mirim (MA)         NR         NR         -         -23%         -14%         1.6         NR         NR         -           Imperative (MA)         9349%         6322%         1.5         52%         -22%         -2.4         NR         NR         -           Medio Mearim e Grajait (MA)         NR         NR         -         -20%         -22%         0.9         NR         NR         -           Alto Mearim e Grajait (MA)         53%         71%         0.7         8%         -8%         -1.0         NR         NR         -           Presidente Dutra (MA)         238%         141%         0.7         7%         -20%         0.2         NR         NR         -           Chapadinha (MA)         62%         60%         0.0         -33%         -37%         0.9         NR         NR         -           Code (MA)         NR         NR         NR         -         -47%         -43%         1.1         NR         NR         -           Code (MA)         243%         306%         0.8         -45%         -31%         1.5         NR         NR         -           Cavias (MA)         219%         0.0         1.0 </td <td>Lençóis Maranhenses (MA)</td> <td>NR</td> <td>NR</td> <td>-</td> <td>7%</td> <td>-16%</td> <td>-0,5</td> <td>NR</td> <td>NR</td> <td>-</td>	Lençóis Maranhenses (MA)	NR	NR	-	7%	-16%	-0,5	NR	NR	-
Imperatiz (MA)         9349%         6322%         1.5         55%         -2.2%         -2.4         NR         NR         -           Médio Mearim (MA)         NR         NR         -         -20%         -23%         0.9         NR         NR         -           Alto Mearim (MA)         53%         71%         0.7         8%         -8%         -1.0         NR         NR         -           Presidente Duta (MA)         2388%         1419%         1.7         -5%         -20%         0.2         NR         NR         -           Baixo Paranaba Maranhense (MA)         62%         60%         1.0         -33%         -37%         0.9         NR         NR         -           Codo (MA)         NR         NR         -         -47%         -43%         1.1         NR         NR         -           Codo (MA)         18%         306%         0.8         -45%         -31%         1.5         NR         NR         -           Caxias (MA)         22%         16%         1.0         125%         37%         3.4         NR         NR         -           Porto Franco (MA)         193%         214%         0.9         165% <td>Itapecuru Mirim (MA)</td> <td>NR</td> <td>NR</td> <td>-</td> <td>-23%</td> <td>-14%</td> <td>1,6</td> <td>NR</td> <td>NR</td> <td>-</td>	Itapecuru Mirim (MA)	NR	NR	-	-23%	-14%	1,6	NR	NR	-
Médio Mearim (MA)         NR         NR         -         -20%         -23%         0.9         NR         NR         -           Alto Mearim (Grajaú (MA)         53%         71%         0.7         8%         -8%         -1.0         NR         NR         -           Presidente Durta (MA)         2388%         1419%         1.7         -5%         -20%         0.2         NR         NR         -           Baixo Parnaiba Maranhense (MA)         41%         63%         0.7         77%         -12%         -6.4         NR         NR         -           Chapadinha (MA)         62%         60%         1.0         -33%         -37%         0.9         NR         NR         -           Codo (MA)         NR         NR         -         -47%         -43%         1.1         NR         NR         -           Codo (MA)         243%         306%         0.8         -45%         -31%         1.4         NR         NR         -           Chapadas do Alto Itapecuru (MA)         222%         216%         1.0         125%         37%         3.4         NR         NR         -           Chapadas do Alto Itapecuru (MA)         20%         30%	Imperatriz (MA)	9349%	6322%	1,5	52%	-22%	-2,4	NR	NR	
Alto Mearinn c Grajaiu (MA)       53%       71%       0,7       8%      8%       -1,0       NR       NR          Presidente Dutra (MA)       2388%       1419%       1,7      5%      20%       0,2       NR       NR          Baixo Parnaba Maranhense (MA)       41%       63%       0,7       77%      12%      64       NR       NR          Chapadinha (MA)       62%       60%       1,0      33%      37%       0,9       NR       NR          Code (MA)       NR       NR        -47%      43%       1,1       NR       NR          Code (MA)       243%       306%       0,8      45%      31%       1.5       NR       NR          Caxias (MA)       69%       708%       1,0      51%      57%       1,4       NR       NR          Chapadas do Alto Itapecuru (MA)       122%       216%       1.0       1.25%       37%       3.4       NR       NR          Gerais de Balasa (MA)       20%       0,6       647%       1013%       0.6       1.08%       74%       0.9       NR       <	Médio Mearim (MA)	NR	NR		-20%	-23%	0,9	NR	NR	
Presidente Dutra (MA)       2388%       1419%       1,7       -5%       -20%       0,2       NR       NR       -         Baixo Parnaiba Maranhense (MA)       41%       63%       0,7       77%       -12%       -6,4       NR       NR       -         Chapadinia (MA)       62%       60%       1,0       -33%       -37%       0,9       NR       NR       -         Codo (MA)       NR       NR       -       -47%       -43%       1,1       NR       NR       -         Coelho Neto (MA)       243%       306%       0,8       -45%       -31%       1,5       NR       NR       -         Caxias (MA)       699%       708%       1,0       -51%       -37%       1,4       NR       NR       -         Chapadas do Alto Itapecuru (MA)       222%       216%       1,0       125%       37%       3,4       NR       NR       -         Porto Franco (MA)       193%       214%       0,9       165%       90%       1,8       NR       NR       -         Chapadas da Mangabeiras (MA)       31%       49%       0,6       647%       1013%       0,6       108%       74%       1,5	Alto Mearim e Grajaú (MA)	53%	71%	0,7	8%	-8%	-1,0	NR	NR	
Baixo Paranaba Maranhense (MA)         41%         63%         0,7         77%         -12%         -6,4         NR         NR         -           Chapadinha (MA)         62%         60%         1,0         -33%         -37%         0,9         NR         NR         -           Codo (MA)         NR         NR         -         -47%         -43%         1,1         NR         NR         -           Coelho Neto (MA)         243%         306%         0.8         -45%         -31%         1,5         NR         NR         -           Caxias (MA)         243%         306%         0.8         -45%         -31%         1,5         NR         NR         -           Chapadas do Alto Itapecuru (MA)         222%         216%         1,0         125%         37%         3,4         NR         NR         -           Chapadas do Alto Itapecuru (MA)         22%         214%         0,9         165%         90%         1,8         NR         NR         -           Chapadas da Mangabeiras (MA)         31%         49%         0,6         647%         1013%         0,6         108%         74%         1,5           Chapadas das Mangabeiras (MA)         20% <td>Presidente Dutra (MA)</td> <td>2388%</td> <td>1419%</td> <td>1,7</td> <td>-5%</td> <td>-20%</td> <td>0,2</td> <td>NR</td> <td>NR</td> <td></td>	Presidente Dutra (MA)	2388%	1419%	1,7	-5%	-20%	0,2	NR	NR	
Chapadinha (MA)         62%         60%         1,0         -33%         -37%         0,9         NR         NR         -           Codé (MA)         NR         NR         -         -47%         -43%         1,1         NR         NR         -           Codé (MA)         243%         306%         0,8         -45%         -31%         1,5         NR         NR         -           Caxias (MA)         699%         708%         1,0         -51%         -57%         1,4         NR         NR         -           Chapadas do Alto Itapecuru (MA)         22%         216%         1,0         125%         37%         3,4         NR         NR         -           Chapadas do Alto Itapecuru (MA)         193%         214%         0.9         165%         90%         1,8         NR         NR         -           Chapadas da Magabeiras (MA)         19%         0,6         647%         1013%         0,6         108%         74%         1,5           Chapadas da Magabeiras (MA)         20%         30%         0,7         225%         247%         0,9         NR         RR         -           Alto Parnaiba Piauiense (PI)         73%         97%         <	Baixo Parnaiba Maranhense (MA)	41%	63%	0,7	77%	-12%	-6,4	NR	NR	
Code (MA)         NR         -         -47%         -43%         1.1         NR         NR         -           Code (MA)         243%         306%         0.8         -45%         -31%         1.5         NR         NR         -           Code (MA)         699%         306%         0.8         -45%         -31%         1.5         NR         NR         -           Caxias (MA)         699%         1.0         -51%         -37%         1.4         NR         NR         -           Chapadas do Alto Itapecuru (MA)         222%         216%         1.0         125%         37%         3.4         NR         NR         -           Porto Franco (MA)         193%         0.4%         0.9         165%         90%         1.8         NR         NR         -           Gerais de Balas (MA)         31%         49%         0.6         64%         1013%         0.6         108%         74%         1.5           Chapadas das Mangabeiras (MA)         20%         30%         0.7         225%         247%         0.9         NR         NR         -           Alto Panaiba Piauiense (PI)         73%         97%         0.6         18%	Chapadinha (MA)	62%	60%	1,0	-33%	-37%	0,9	NR	NR	- C
Coelho Neto (MA)         243%         306%         0.8         -45%         -31%         1.5         NR         NR         -           Caxias (MA)         699%         708%         1,0         -51%         -37%         1.4         NR         NR         -           Chapadas do Alto Itapecuru (MA)         222%         216%         1,0         125%         37%         3.4         NR         NR         -           Opto Franco (MA)         193%         214%         0.9         165%         90%         1.8         NR         NR         -           Gerais de Balas (MA)         31%         49%         0.6         647%         1013%         0.6         108%         74%         1,5           Chapadas das Mangabeiras (MA)         20%         39%         0.7         22%         247%         0.9         NR         NR         -           Alto Panaiba Piauiense (PI)         73%         97%         0.8         280%         368%         0.8         47%         32%         1,5           Bertolinia (PI)         66%         117%         0.6         345%         237%         1,5         -38%         32%         1,3           Alto Médio Gurgueia (PI)         66%	Codó (MA)	NR	NR	-	-47%	-43%	1,1	NR	NR	-
Caxias (MA)         699%         708%         1,0         -51%         -37%         1,4         NR         NR         -           Chapadas do Alto Itapecuru (MA)         222%         216%         1,0         125%         37%         3,4         NR         NR         -           Deto Franco (MA)         193%         214%         0,9         165%         90%         1.8         NR         NR         -           Gerais de Balsas (MA)         31%         49%         0,6         647%         1013%         0,6         108%         74%         1,5           Chapadas das Mangabeiras (MA)         20%         30%         0,7         225%         247%         0.9         NR         NR         -           Alto Parnaiba Piauiense (PI)         73%         97%         0,8         280%         368%         0,8         47%         32%         1,5           Alto Medio Gurgucia (PI)         41%         71%         0,6         188%         52%         3,6         55%         42%         1,3           Alto Medio Gurgucia (PI)         66%         117%         0,6         345%         237%         1,5         -38%         -32%         1,2           Chapadas do Extremo Sul	Coelho Neto (MA)	243%	306%	0,8	-45%	-31%	1,5	NR	NR	
Chapadas do Alto Itapecuru (MA)         222%         216%         1.0         125%         37%         3.4         NR         NR         -           Porto Franco (MA)         193%         214%         0.9         165%         90%         1.8         NR         NR         -           Gerais de Balsas (MA)         31%         49%         0.6         647%         1013%         0.6         108%         74%         1.5           Chapadas das Mangabeiras (MA)         20%         30%         0.7         225%         247%         0.9         NR         NR         -           Alto Panaiba Piauiense (PI)         73%         97%         0.6         18%         26%         3.6         55%         42%         1.5           Bertolinia (PI)         41%         71%         0.6         18%         52%         3.6         55%         42%         1.3           Alto Médio Gurgueia (PI)         66%         117%         0.6         345%         237%         1.5         -38%         -32%         1.2           Chapadas do Extremo Sul Piauiense (PI)         671%         852%         0.8         -14%         27%         -0.5         NR         NR         -           Chapadas	Caxias (MA)	699%	708%	1,0	-51%	-37%	1,4	NR	NR	
Porto Franco (MA)         193%         214%         0.9         165%         90%         1.8         NR         NR         -           Gerais de Balsas (MA)         31%         49%         0.6         647%         1013%         0.6         108%         74%         1,5           Chapada das Mangabeiras (MA)         20%         30%         0.7         225%         247%         0.9         NR         NR         -           Alto Panaiba Piautense (PI)         73%         97%         0.8         280%         36%         0.8         47%         32%         1,5           Bertolinia (PI)         41%         71%         0.6         345%         52%         3.6         55%         42%         1,3           Alto Médio Gurgueia (PI)         66%         117%         0.6         345%         237%         1,5         -38%         -32%         1,3           Alto Médio Gurgueia (PI)         671%         852%         0.8         -14%         27%         -0,5         NR         NR         -           Barciars (BA)         38%         42%         0.9         38%         25%         1,5         -8%         -3%         3%         1.8         NR         NR	Chapadas do Alto Itapecuru (MA)	222%	216%	1,0	125%	37%	3,4	NR	NR	-
Gerais de Balsas (MA)         31%         49%         0.6         647%         1013%         0.6         108%         74%         1,5           Chapadas das Mangabeiras (MA)         20%         30%         0,7         225%         247%         0.9         NR         NR         -           Alto Pamaiba Piauiense (PI)         73%         97%         0.8         280%         368%         0.8         47%         32%         1,5           Bettolinia (PI)         41%         71%         0.6         188%         52%         3,6         55%         42%         1,3           Alto Medio Gurgueia (PI)         66%         117%         0.6         345%         237%         1,5         -38%         -32%         1,2           Chapadas do Extremo Sul Piauiense (PI)         671%         852%         0.8         -14%         27%         -0,5         NR         NR         -           Barrairas (BA)         38%         42%         0.9         38%         25%         1,5         -8%         -32%         1,2           Chapadas do Extremo Sul Piauiense (PI)         671%         852%         0.8         -14%         27%         -1,5         -8%         -3%         -32%         1,2	Porto Franco (MA)	193%	214%	0,9	165%	90%	1,8	NR	NR	
Chapadas das Mangabeiras (MA)         20%         30%         0.7         225%         247%         0.9         NR         NR         -           Alto Panalba Piauiense (PI)         73%         97% <b>0.8</b> 280%         368% <b>0.8</b> 47%         32%         1,5           Bertolinia (PI)         41%         71%         0.6         188%         52%         3,6         55%         42%         1,3           Alto Médio Gurgueia (PI)         66%         117%         0,6         345%         237%         1,5         -38%         -32%         1,2           Chapadas do Extremo Sul Piauiense (PI)         671%         852%         0,8         -14%         27%         -0,5         NR         NR         -           Barraras (BA)         38%         42%         0,9         38%         25%         1,5         -8%         -32%         1,2           Cotegipe (BA)         390%         479%         0,8         71%         39%         1,8         NR         NR         -	Gerais de Balsas (MA)	31%	49%	0,6	647%	1013%	0,6	108%	74%	1,5
Alto Panaiba Piauiense (PI)         73%         97%         0.8         280%         368%         0.8         47%         32%         1,5           Bertolinia (PI)         41%         71%         0.6         188%         52%         3.6         55%         42%         1.3           Alto Medio Gurgueia (PI)         66%         117%         0.6         345%         237%         1.5         -38%         -32%         1.2           Chapadas do Extremo Sul Piauiense (PI)         671%         852%         0.8         -14%         27%         -0.5         NR         NR         -           Bareriars (BA)         38%         42%         0.9         38%         25%         1.5         -8%         -39% <b>3.1</b> Cotegipe (BA)         30%         47%         0.8         71%         39%         1.8         NR         NR         -	Chapadas das Mangabeiras (MA)	20%	30%	0,7	225%	247%	0,9	NR	NR	
Bertolinia (PI)         41%         71%         0.6         188%         52%         3.6         55%         42%         1.3           Alto Médio Gurgueia (PI)         66%         117%         0.6         345%         237%         1.5         -38%         -32%         1.2           Chapadas do Extremo Sul Piauiense (PI)         671%         852%         0.8         -14%         27%         -0.5         NR         NR           Barteiras (BA)         38%         42%         0.9         38%         25%         1.5         -8%         -3,31           Cotegipe (BA)         390%         479%         0.8         71%         39%         1.8         NR         NR	Alto Parnaiba Piauiense (PI)	73%	97%	0,8	280%	368%	0,8	47%	32%	1,5
Alto Médio Gurgueia (PI)         66%         117%         0,6         345%         237%         1,5         -38%         -32%         1,2           Chapadas do Extremo Sul Piauiense (PI)         671%         852%         0,8         -14%         27%         -0,5         NR         NR         -           Barriars (BA)         38%         42% <b>0,9</b> 38%         25% <b>1,5</b> -8%         -3% <b>3</b> Cotegipe (BA)         390%         479%         0,8         71%         39% <b>1,8</b> NR         NR         -	Bertolínia (PI)	41%	71%	0,6	188%	52%	3,6	55%	42%	1.3
Chapadas do Extremo Sul Piauiense (PI)         671%         852%         0.8         -14%         27%         -0.5         NR         NR         -           Barciras (BA)         38%         42% <b>0.9</b> 38%         25% <b>1.5</b> -8%         -3% <b>3.1</b> Cotegipe (BA)         390%         47%         0.8         71%         39%         1.8         NR         NR         -	Alto Médio Gurgueia (PI)	66%	117%	0,6	345%	237%	1,5	-38%	-32%	1.2
Barreiras (BA)         38%         42%         0,9         38%         25%         1,5         -8%         -3%         3,1           Cotegipe (BA)         390%         479%         0,8         71%         39%         1,8         NR         NR	Chapadas do Extremo Sul Piauiense (PI)	671%	852%	0,8	-14%	27%	-0,5	NR	NR	-
Cotegipe (BA) 390% 479% 0.8 71% 39% 1.8 NR NR -	Barreiras (BA)	38%	42%	0,9	38%	25%	1,5	-8%	-3%	3,1
	Cotegipe (BA)	390%	479%	0,8	71%	39%	1.8	NR	NR	-
Santa Maria da Vitória (BA) 34% 58% 0.6 41% 8% 5.2 23% 44% 0.5	Santa Maria da Vitória (BA)	34%	58%	0,6	41%	8%	5.2	23%	44%	0.5
Bom Jesus da Lapa (BA) 10% 2% 4,0 229% 33% 6,9 -67% -45% 1,5	Bom Jesus da Lapa (BA)	10%	2%	4,0	229%	33%	6,9	-67%	-45%	1,5

#### Table 8 Variation of Production and Harvested Area — Selected Regions

Source: PAM/IBGE

\*\*R - inexistent production or not relevant. \*\*Highlighted MCRs combined represent 70% or more of the total production from 2012 to 2017.

Building data per MCR reveals some facts, evidenced by the broader time span from 2006 to 2017. The first one is that not only the soybean production has a more leveled productivity but Matopiba as whole — and quite a few of its MCRs — have been recently displaying production growth lower than the expansion of harvested areas. The general variation of product growth versus the variation of hectares is of only 0.6 when comparing the period from 2012 to 2017 with 2006 to 2011 (lower than the computation for the central-western and southern regions of Brazil). Differently, cotton — present in relatively few MCRs but dominating the utmost western region of Bahia — displays near equivalent rates for crops expansion and results, in addition to a relative performance variability and stagnate growth in the last decade (see Table 3). Maize's results present an improvement in Matopiba combined — the production's increase was much higher than the area in the comparison of sexennial cycles, with comparative index of 1.8 — but a paradoxical volatility of results between regions; besides the fact that Santa Maria da Vitória and Barreiras (BA) concentrate 40% of the crop from 2012 onwards, consequently with some distortions in the reading of general productivity.

It became feasible — due to the nuances in the results per MCR — to assume equally important findings in terms of cities through a separate consultation of PAM/IBGE. Therefore, the research also undertook the evaluation of information at a municipal level, initially detaining itself in the classification of Matopiba's 337 cities in groups, as follows:

- cities with no production per crop (soybean, maize and cotton) from 2006 to 2017;
- cities pertaining to "agricultural frontiers", i.e., cities without perennial or continuous production of the three main crops from 2006 to 2017;
- main producing centers, with consecutive production of the tracked crops and representing at least 70% of the total production for the period;
- remaining producing cities, not included in the main centers but also pertaining to the group of cities

with continuous production from 2006 to 2017.

Thus, having structured these groups, we have the following:

#### Table 9 Soybean: City Groupings by Production and Productivity Variation

Based on annual production from 2006 to 2017

	Cities without production (2006 to 2017)	Cities with partial production (2006 to 2017)	Main producers (continuous production from 2006 to 2017)	Remaining producers (continuous production from 2006 to 2017)
Number of cities	139	106	20	72
% of production (2012 to 2017)	0%	4,81%	70,37%	24,82%
	% of production variation			
	<		5	37
% of harvested	area variation (2012 to 2017 v.	2006 to 2011)		
	% of production variation			
	<		15	35
% of harvested	area variation (2012 to 2017 v.	2006 to 2011)		

Source: PAM/IBGE

#### Table 10 Maize: City Groupings by Production and Productivity Variation

Based on annual production from 2006 to 2017

	Cities without production (2006 to 2017)	Cities with partial production (2006 to 2017)	Main producers (continuous production from 2006 to 2017)	Remaining producers (continuous production from 2006 to 2017)
Number of cities	287	40	7	3
% of production (2012 a 2017)	0%	5,76%	87,28%	6,96%
	% of production variation			
	<		3	-
% of harveste	d area variation (2012 to 2017 v.	2006 to 2011)		
	% of production variation			
	<		4	3
% of harveste	d area variation (2012 to 2017 v.	2006 to 2011)		

Source: PAM/IBGE

Table 11 Cotton: City Groupings by Production and Productivity Variation

Based on annual production from 2006 to 2017

	Cities without production (2006 to 2017)	Cities with partial production (2006 to 2017)	Main producers (continuous production from 2006 to 2017)	Remaining producers (continuous production from 2006 to 2017)
Number of cities	0	27	16	294
% of production (2012 a 2017)	-	1,61%	70,37%	28,02%
	% of production variation			
	<		9	134
% of harvested	area variation (2012 to 2017 v. 2	2006 to 2011)		
	% of production variation			
	<		7	160
% of harvested	area variation (2012 to 2017 v. 2	2006 to 2011)		

Source: PAM/IBGE

The municipal figures reveal noteworthy aspects; regarding soybean (Table 9), even though it is Matopiba's most important crop, 41.2% of the cities do not cultivate it. Another 106 cities (31.4% of the total) did not have the grain's crop for all the time span, which represents less than 5% of the production from 2012 to 2017. The

crop's dynamics concentrates itself in 92 cities, with prominence of the twenty greatest producers whose crop growth was above the harvested area when comparing the time spans. Next, the data for maize's harvest (Table 10) reaffirm, beforehand, that such crop occurs in all of 337 Matopiba's cities; however, 70.37% of the production — a result coincidentally equal to the soybean's — happened in solely 16 locations, of which only seven had a production evolution higher than the harvested area. Lastly, cotton's figures (table 11) corroborate the initial findings of the present study regarding being a mainly concentrated crop. Merely seven locations encompass almost 90% of the production from 2012 to 2017. The majority is of cities without production (287 in total); the remainder of the crop is comprised of those cities with occasional production (forty) and the ones with constant production but outside the group of main producers (only three).

Measuring results from a municipal perspective permitted, still, to detect cities simultaneously prominent in absolute production and that showed an expansion of the produced grains' tonnage higher than the harvested area (productivity variation >1). The final activity for this study was to isolate these results to allow for a better mapping of baseline practices which might be capable of replication in the over three hundred remaining Matopiba's cities. Figure 4 highlights the territories of the aforementioned cities (seventeen in total):



Figure 4 Matopiba: Main Producing Cities

# 5. Conclusions

As noted at the beginning of this study, the agricultural business significantly influences Brazilian economy. After observing Matopiba, this characteristic assumes an even larger relevance. So much so that the median agricultural participation in the region's GVA reached 21.8% between 2002 and 2016; while Brazil registered, altogether, a contribution of 5.5% to the segment, according to information by IBGE.

This study's findings allowed to infer that the distribution of productivity, along with productive

concentration in some MCRs, denotes significant differences — or similarities, in some cases — in the use of Matopiba's area dedicated to its main crops (soybean, maize and cotton). It is noteworthy that the increase in these crops have been largely "financed" by the progression into new land areas; therefore, few cities fit the criterium of production variation greater than the increase of areas utilized for cultivation. This matter imposes solid challenges in bettering results for the main source of income of such a large portion of Brazil and which might compromise the reckless support for expansions with low economic return and substantial environmental consequences, considering the indistinct occupation of the scrublands.

Lastly, all these factors combined reaffirm the importance of observing this agricultural frontier's evolution through a more refined development process — unlike predecessor expansions which were particularly aggressive in many ways, as documented by the national economic and agricultural literature.

#### References

- Alves E. et al. (Dec. 2015). "Renda e pobreza rural na região do MATOPIBA", Embrapa Strategic Territorial Intelligence Group (GITE), Technical Note no. 10. Campinas.
- Bacelar de Araújo T. (2006). "Desenvolvimento regional: A descentralização valorizaria a diversidade", in: Fleury S. (org.), Democracia, Descentralização e Desenvolvimento, Rio de Janeiro: Editora FGV.
- Borghi E. et al. (2014). "Desafios das novas fronteiras agrícolas de produção de milho e sorgo no Brasil: Desafios da região do MATOPIBA", in: EficiÊNcia Nas Cadeias Produtivas e o Abastecimento Global, Sete Lagoas: Associação Brasileira de Milho e Sorgo, ch. 25, pp. 263-278, accessed in May 30, 2019, available online at: https://www.embrapa.br/busca-de-publicacoes/-/publicacao/992201/desafios-das-novas-fronteiras-agricolas-de-producao-de-mil ho-e-sorgo-no-brasil-desafios-da-regiao-do-matopiba..
- CONAB (National Supply Company) (2019). "Perspectivas Para a Agropecuária Safra 2017-2018", *Produtos de Verão*, Vol. 5, accessed on June 14, 2019, available online at: https://www.conab.gov.br/perspectivas-para-a-agropecuaria.
- Coelho J. R. (Jul./Sep., 2016). "Concentração regional do valor bruto da produção do pinhão no Paraná", *Ciência Florestal*, Vol. 26, No. 3, pp. 853-861. Santa Maria.
- Costa N. and De Santana A. (2014). "Estudo da concentração de mercado ao longo da cadeia produtiva da soja no Brasil", *Revista de Estudos Sociais*, Vol. 16, No. 32, pp. 111-135.
- Dutra E. Silva S., Boaventura K., Porfirio J. R. E. and Silva Neto C. (2018). "A última fronteira agrícola do Brasil: o Matopiba e os desafios de proteção ambiental no cerrado", *Estudios Rurales*, Vol. 8, Número especial (Octubre), CEAR-UNQ, Buenos Aires, pp. 145-178.
- Department of Justice and the Federal Trade Comission, United States of America (2010). "Horizontal merger guidelines", accessed in June 14, 2019, available online at: https://www.ftc.gov/sites/default/files/attachments/merger-review/100819hmg.pdf.
- FAO (Food and Agriculture Organization of the United Nations) (2019). "Conferência em Roma pede compromisso global com o fim da fome no mundo", accessed on June 3, 2019, available online at: https://nacoesunidas.org/conferencia-em-roma-pede-compromisso-global-com-o-fim-da-fome-mundo/.
- Fasiaben M., Romeiro A., Peres F. and Maia A. (2011). "Impacto econômico da reserva legal sobre diferentes tipos de unidade de produção agropecuária", *Revista de Economia e Sociologia Rural*, Vol. 49, No. 4, pp. 1051-1096, accessed on June 14, 2019, available online at: http://www.scielo.br/pdf/resr/v49n4/a10v49n4.pdf.
- Garagorry F. et al. (Oct. 2015). "MATOPIBA: Evolução recente da produção de grãos", Embrapa Strategic Territorial Intelligence Group (GITE), Technical Note no. 9. Campinas.
- IBGE (Brazilian Institute of Geography and Statistics) (2019). "IBGE faz estudos no Matopiba para levantamento de dados para marco metodológico das Contas Econômicas Ambientais de Ecossistemas", accessed on June 3, 2019, available online at: https://www.ibge.gov.br/novo-portal-destaques.html?destaque=24035.
- Lücker R. (1992). "Modernization process in the Brazilian Mid-West region: the regional development in geographical perspective", *Cadernos de Geografia*, No. 11, Coimbra, pp. 27-36.
- Lumbreras J. et al. (2015). "Aptidão agrícola das terras do Matopiba", *Embrapa Solos*. Rio de Janeiro, Sep. 2015, accessed on June 6, 2019, available online at: https://www.embrapa.br/solos/publicacoes.

- Mueller C. (1992). "Dinâmica, condicionantes e impactos socioambientais da evolução da fronteira agrícola no Brasil", *Revista de Administração Pública*, Vol. 26, No. 3, pp. 64-87.
- United Nations (UN) (2014). "SEEA System of Environmental Economic Accounting 2012: Experimental ecosystem accounting", accessed on June 14, 2019. available online at: https://seea.un.org/sites/seea.un.org/files/websitedocs/eea final en.pdf.
- Perobelli F., Almeida E., Alvim I. and Ferreira P. (Jan./Apr. 2007). "Produtividade do setor agrícola brasileiro (1991-2003): uma análise espacial", *Nova Economia*, Vol. 17, No. 1, Belo Horizonte.