Istvan Bánkuti, Ferenc; Marques Caldas, Marcellus; Schiavi Bánkuti, Sandra Mara;
Granco, Gabriel
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Dinâmicas espaciais: um novo corredor da produção leiteira no Paraná

Ferenc Istvan Bánkuti[1*]; Marcellus Marques Caldas[2];
Sandra Mara Schiavi Bánkuti[3]; Gabriel Granco[4]

Abstract

Brazil is the fourth largest milk producer in the world, and Paraná state is the third largest producer in the country. Milk production plays an important socioeconomic role in Paraná state, and since the 1990s, institutional and market changes have influenced Paraná's milk production. Given this context, this study searches to analyze the spatial dynamics of dairy activity in Paraná state. Specifically, it seeks to identify areas of greater expansion and contraction in dairy activities, and discuss possible structural and socioeconomic consequences in those regions. Data concerning productive and economic variables of the 399 municipalities in Paraná state were used to generate an indicator of dairy activity through Common Factor Analysis. Cluster analysis allowed the formation of groups, according to municipalities' importance in Paraná's dairy activity. We conclude that since the 1990s, there has been displacement of dairy activity from the northern regions and toward the south. Dairy activity has started to occupy areas otherwise considered "agriculturally empty" and socioeconomically vulnerable. Those areas, along with traditional production regions, comprise a new "milk corridor" in Paraná. This may generate a set of socioeconomic benefits in the region. Important structural changes may occur along the dairy chain, and both public and private policies should be set to assure dairy chain competitiveness in Paraná state.
Key words: Border production. Geographic distribution. Milk farming.

Resumo

O Brasil é o quarto maior produtor de leite no mundo e o Paraná, é o terceiro maior produtor brasileiro de leite. A produção de leite no Paraná desempenha importante função econômica e social. A partir da década de 90, alterações institucionais e de mercado, condicionaram mudanças significativas na produção de leite neste Estado. O objetivo foi analisar a dinâmica espacial da atividade leiteira paranaense. Buscou-se a identificação de regiões de maior concentração e retração da atividade e a indicação de consequências estruturais, econômicas e sociais nas novas regiões de produção. Foram coletadas variáveis produtivas e econômicas de 399 municípios paranaenses nos anos de 1990, 2000 e 2014. A partir destas, e das técnicas de Análise Fatorial Comum e clusters hierárquicos, os municípios foram classificados como de baixa, média e alta importância na atividade leiteira. Os grupos foram plotados no mapa do Paraná. A partir da década de 90, houve deslocamento da atividade leiteira de regiões ao norte do estado, em direção ao sul. A atividade leiteira passou a ocupar áreas consideradas como "vazios da agropecuária" e caracterizadas pela fragilidade socioeconômica e passaram a definir um novo "corredor da produção leiteira" no Paraná. Como resultado, benefícios sociais e econômicas poderão ser gerados. Mudanças estruturais importantes poderão ocorrer em toda cadeia produtiva do leite paranaense, com impactos diretos na competitividade deste setor.
Palavras-chave: Distribuição geográfica. Fronteiras de produção. Produção de leite.

[1] Prof. Associado, Departamento de Zootecnia, Universidade Estadual de Maringá, UEM, Maringá, PR, Brasil. E-mail: fibankuti@uem.br
[2] Prof. Departamento de Geografia, Kansas State University, Manhattan, Kansas, USA. E-mail: caldasma@ksu.edu
[3] Profª Adjunta, Departamento de Administração, UEM, Maringá, PR, Brasil. E-mail: sandraschiavi@gmail.com
[4] PhD. Student, Departamento de Geografia, Kansas State University, Manhattan, Kansas, USA. E-mail: ggranco@gmail.com
* Author for correspondence

Introduction

Agribusiness is among the most dynamic and important economic sectors in Brazil, as it produces food for both the domestic market and a number of countries. Among the sectors that comprise the Brazilian livestock business, milk production has been of great economic importance: the country is the world's fourth-largest milk producer, producing 33.4 billion liters of milk in 2014, or 6% of world production (USDA, 2015). In addition to its economic importance, milk production also serves an important social function in Brazil (OLIVEIRA; SILVA, 2012).

Milk production in Brazil, as well as other agribusiness sectors, has undergone restructuring as a result of institutional and market changes that have taken place since the 1990s (FARINA et al., 2005). In this context, we see that during the 1990s, the southern and southeastern regions of Brazil occupied an important place in national milk production, but important states from those regions, lost position to less-traditional areas, in the northern and the central-western regions of Brazil (IBGE, 2015). However, starting in 2000, there was a resumption of milk production in the southern areas of the country, indicating that there had been a restructuring of production in some states. Among these, Paraná resumed an important position in national production, going from the fifth-largest producer in 2000 to the third-largest in 2014, when it produced 4.53 billion liters of milk, 12.9% of national production (IBGE, 2015).

Besides its economic importance, Paraná's milk production also has an important social function, positioning itself as the fourth most prevalent activity in family farming in the state, after corn, poultry and swine (IBGE, 2006). According to the Agricultural Census 2006, 101,102 from 302,907 family-based farms are in milk activity in Paraná, producing 68% of milk in the state (IBGE, 2006). Milk activity employs 114,500 milk producers, of which 99,600 participate in the market. Among

those producers who participate in the market, 55% produce on a small scale, with a volume up to 50 liters/day (IPARDES, 2009). More indirectly, milk production also develops a larger set of positive benefits for the municipalities and regions (NICHOLSON et al., 2011; ROYER, 2011).

Given the socioeconomic importance of milk farming in Paraná and the recent resumption of production (IBGE, 2015), it is important to analyze how milk activity has grown in this state, among its various municipalities and regions. Moreover, it is important to determine whether the observed production growth was accompanied by a concentration of milk production in municipalities and regions that had already been considered important, or if it has been occurring in newly established production areas, as observed in the national context (CARVALHO; HOTT 2007). Despite the importance of understanding the special distribution of dairy activity in Paraná, few studies have been accomplished in this direction (CAPUCHO; PARRÉ, 2012; SILVA et al., 2016).

The objective in this study is to analyze the spatial dynamics of dairy activity in Paraná state. Specifically, we seek to identify areas of greater expansion and contraction in dairy production activity, as well as indications of possible structural and socioeconomic consequences in newly established dairy regions in Paraná state.

Material and Methods

We used data from the Municipal Livestock Survey (PPM) from the Brazilian Institute of Geography and Statistics (IBGE) database, comprising three variables: milk production (liters of milk/municipality), milk production value (R$/liter of milk/municipality), and milked cows (number of milked cows/municipality) (IBGE, 2015). We considered data from the state's 399 municipalities in the years 1990, 2000, and 2014. Those three periods were considered due to their importance in Brazilian dairy chain context.

During the 90's, institutional and market changes in Brazil brought important shifts in most agri-food systems (SAES; SILVEIRA, 2014). In the following decades, other institutional changes were set, specifically concerning dairy chain, namely Normative Instructions n° 51 (BRASIL, 2002) and n° 62 (BRASIL, 2011). Thus, in this research, 1990 represents a previous period; we assume 2000 as a period reflecting the first wave of changes; and the most recent data at the moment of this research (2014) represents the final period. Using the three variables and through common factor analysis (CFA), we generated an indicator of milk activity for each municipality and period. Data were analyzed using the Statistical Program for Social Science, SPSS – version 18 (IBM, 2009).

Common Factor Analysis is a multivariate technique used to combine a large set of interrelated variables into a smaller number of factors. A factor objectively represents the different variables compounding it. Each factor é formed by variables presenting a large correlation among each other and little correlation with the variables forming of factors (FÁVERO et al., 2009; HAIR et al., 2009).

Factor analysis states the following assumptions:

1. Common factors (F_k) are independent and equally distributed, with mean 0 and variance 1 (k = 1, …, m);

2. Errors (ε_i) are independent and equally distributed, with mean 0 and variance $\psi_i \ (i = 1, …, p)$;

3. F_k e ε_i are independent.

Factors are estimated through the combination of linear variables, as in equation 1.:

$$F_1 = d_{11} + X_1 + d_{12} + X_2 + \cdots + d_{1m} + X_i$$
$$F_2 = d_{21} + X_1 + d_{22} + X_2 + \cdots + d_{2m} + X_i$$
$$\vdots$$
$$F_m = d_{m1} + X_1 + d_{m2} + X_2 + \cdots + d_{mi} + X_i \quad (1)$$

Where:

F_m = common factors,

d_{mi} = coefficient of factorial scores, and

X_i = original variables.

Factor analysis model is presented in equation 2.

$$X_1 = \mu_1 + a_{11}F_1 + a_{12}F_2 + \cdots + a_{1m}F_m + \varepsilon_1$$
$$X_2 = \mu_2 + a_{21}F_1 + a_{22}F_2 + \cdots + a_{2m}F_m + \varepsilon_2$$
$$\vdots$$
$$X_p = \mu_p + a_{p1}F_1 + a_{p2}F_2 + \cdots + a_{pm}F_m + \varepsilon_p \quad (2)$$

Where:

$\mu_p = mean\ vector$,

$a_{ij} = loading$,

$X_i = variable$,

$F_m = common\ factor$, and

$\varepsilon_i = error$.

Considering the standardization of X (mean 0 and standard deviation 1), Factorial Analysis model can be generically presented as in equation 3:

$$X_i = a_{i1}F_1 + a_{i2}F_2 + \cdots + a_{im}F_m + \varepsilon_i \quad (i = 1, \cdots, p) \ (3)$$

For CFA, we used Varimax-type rotation with standardized Kaiser-Meyer-Olkin (KMO) and Bartlett sphericity tests (LEBART, 2000; BARROSO; ARTES, 2003) to extract the principal components. Variables with low factor loadings, less than 0.05, were discarded. To determine the number of factors to be retained in the analysis, we used the minimum criteria of an accumulated variance of 60% and an eigenvalue greater than 1.0 in each factor (FÁVERO et al., 2009; HAIR et al., 2009). Eigenvalues represent how much each factor explains total variance. Considering that the variables are standardized, with mean 0 and

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variance 1, the selection of factors with eigenvalues higher than 1 indicates that the factor explains the variance of at least one variable in the model, Thus, only factors presenting eigenvalues higher than one are significant (P<0.05) (FÁVERO et al., 2009).

As a next step, the factors derived from the CFA were used as input to define homogeneous groups of municipalities in 1990, 2000 and 2014. To do so, we used the agglomerative cluster analysis method (RIVAS et al., 2015).

The decision on the number of groups was made from the dendogram analysis, considering the quadradic Euclidian distance (FÁVERO et al., 2009; HAIR et al., 2009). We considered the higher intern consistency among municipalities in each group and the larger centroid distance among groups.

Using the mean factor scores, cluster were classified as low, medium or high importance in terms of its dairy activity. Finally, we used vector data for the regions and municipalities of Paraná (MINISTÉRIO DOS TRANSPORTES, 2010), which allowed us to plot the municipalities on Paraná's map, according to importance in dairy activity for the three periods.

Results and Discussion

Using CFA, we generated factors F1, F2, and F3, for each of the analyzed periods. The high percentage of variance explained by F1 (F1_1990 [90.63%], F1_2000 [92.12%], and F1_2014 [90.98%]) (Table 1) and the high factor-loading values that defined them (F1_1990 [2.71], F1_2000 [2.76], and F1_2014 [2.73]) (Table 2), indicate the large capacity for these data to represent dairy activity in Paraná's municipalities. This result suggests that the factor F2 and F3 can be excluded from the analysis (FÁVERO et al., 2009; HAIR et al., 2009). In addition, the KMO and Bartlett's tests were suitable for the method used (Table 3) (FÁVERO et al., 2009; HAIR et al., 2009; BRITO et al., 2015).

Table 1. Factors' explained variance.

Factors	Loading factors	Variance (%)	Total variance (%)
F1_1990	2.71	90.63	90.63
F2_1990	0.24	8.07	98.71
F3_1990	0.03	1.28	100.00
F1_2000	2.764	92.126	92.12
F2_2000	0.218	7.280	99.40
F3_2000	0.018	0.594	100.00
F1_2014	2.730	90.988	90.98
F2_2014	0.267	8.906	99.89
F3_2014	0.003	0.106	100.00

Table 2. Variables loadings in factors definition.

Variables	Factor Loadings		
	F1_1990	F1_2000	F1_2014
Milk production (liters/municipality)	0.971	0.986	0.981
Milk production value (R$/liter/municipality)	0.899	0.969	0.977
Milked Cows (heads/municipality)	0.849	0.923	0.901

Table 3. KMO and Bartlett Test.

Year	Tests	
	KMO	Bartlett´s
1990	0,63	0,00
2000	0,65	0,00
2014	0,67	0,00

The score values of F1_1990, F1_2000, and F1_2014 were used to define groups, using the clustering technique (BARNES; TOMA, 2012).

For each period, nine groups of municipalities were generated (Table 4).

Table 4. Groups of municipalities and the importance in dairy activity.

Groups	1990			2000			2014			Importance
	(N)	(%)	F1(Mean)	(N)	(%)	F1(Mean)	(N)	(%)	F1(mean)	
1	222	55,6	-0,49	248	62,2	-0,41	252	63,2	-0,48	Low
2	143	35,8	0,21	95	23,8	0,14	100	25,1	0,25	Low
3	18	4,5	1,22	35	8,8	0,77	23	5,8	1,19	Low
4	10	2,5	2,04	9	2,3	1,28	13	3,3	1,79	Medium
5	2	0,5	3,22	2	0,5	1,66	2	0,5	2,61	Medium
6	1	0,3	4,53	4	1,0	2,47	4	1,0	3,22	Medium
7	1	0,3	6,46	4	1,0	4,94	3	0,8	4,33	High
8	1	0,3	8,25	1	0,3	5,98	1	0,3	5,47	High
9	1	0,3	9,97	1	0,3	11,97	1	0,3	10,0	High
Total	399	100,0	-	399	100,0	-	399	100,0	-	-

Municipalities in the nine clusters were grouped into three classes, according to their importance in Parana's dairy activity: low (clusters 1, 2, and 3), medium (clusters 3, 4, and 5) and high (clusters 7, 8, and 9) (Table 4). For simplification, the combination of those nine clusters in three groups allowed a more fluid and less exhausting discussion, while preserving important information to reach the paper's purposes.

We noted that during the period analyzed, the number of municipalities in the low-importance groups fell from 383 to 375, a 2.09% reduction. In addition, there was a 46.15% increase in the number of municipalities in the medium-importance groups and a 66.7% increase in the number of municipalities in the high-importance groups (Table 4).

The average level of milk production among the municipalities in the low, medium and high-importance groups differed (p < 0.05) for the three periods of analysis. During these periods, the municipalities in low-importance groups had lower average dairy production (2.201 million liters/ municipality), followed by municipalities in medium-importance groups (14.602 million liters / municipality) and municipalities in high-importance groups (42.417 million liters / municipality) (Table 5).

The average number of cows milked during the study period also differed among the groups (p < 0.05) (Table 5). The highest average number of cows milked was identified in municipalities in the high-importance groups (23,125 heads / municipality), followed by that of the medium and

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low-importance groups (10,935 and 2,296 heads / municipality, respectively) (Table 5).

The average level of milk productivity, which is the milk production divided by the number of milked cows, differed ($p < 0.05$) among the groups in 2000 and 2014. In 1990, productivity between municipalities in groups of high importance (1,940 liters/head) and those of low importance (950 liters/head), and between municipalities in low importance and medium importance were statistically different at 5% significance level ($p < 0.05$). For those in the groups of medium importance (1,500 liters/head) and high importance (1,940 liters/head), we observed difference at 10% significance level ($p < 0.10$) (Table 5). Data on average level of productivity indicate different degrees of specialization among municipalities. In addition, since 2000, the high-importance groups have been showing marked differences in terms of their productivity, compared to the other groups of municipalities.

Table 5. Milk production, number of milked cows and productivity by importance in dairy activity.

	Importance	N	A	B	C
1990	Low	383	2201[c]	2296[c]	0,95[b]
	Medium	13	14602[b]	10935[b]	1,50[a*]
	High	3	42417[a]	23125[a]	1,94[a]
	Total	399	2907	2735	0,98
2000	Low	378	3217[c]	2374[c]	1,31[c]
	Medium	15	15436[b]	10278[b]	1,66[b]
	High	6	58624[a]	17258[a]	3,43[a]
	Total	399	4509	2895	1,35
2014	Low	375	7728[c]	3443[c]	2,08[c]
	Medium	19	50256[b]	16566[b]	3,37[b]
	High	5	135924[a]	23590[a]	5,60[a]
	Total	399	11360	4321	2,19

A= Milk production (Thousand liters of milk /groups of municipalities)
B= Number of milked cows (Heads/groups of municipalities)
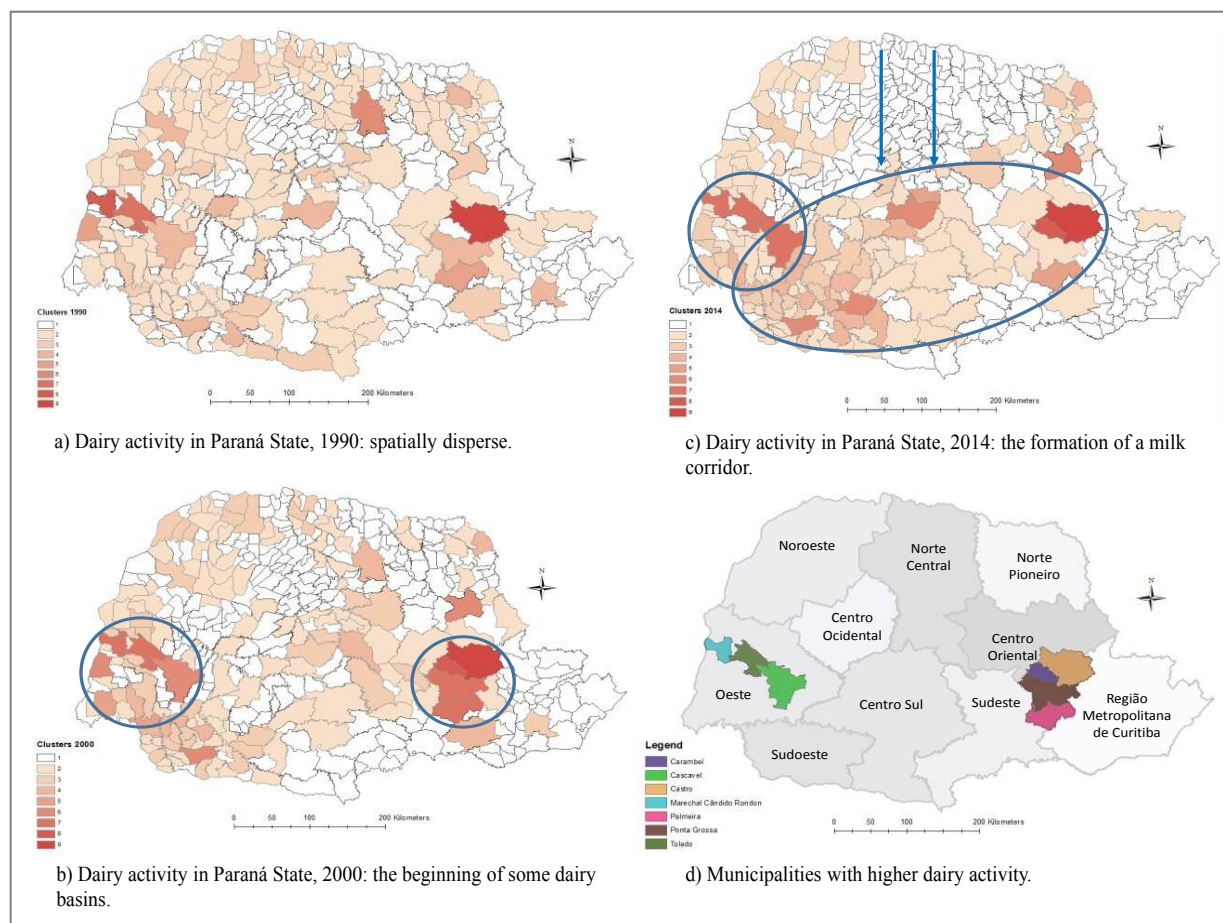C= Productivity (Thousand liters of milk / number of milked cows/ groups of municipalities
Means in columns followed by different letters are statistically different ($p < 0.05$) using Student's t-Test
Means in columns followed by * are statistically different ($p < 0.10$) using Student's t-Test.

The high rate of productivity growth among municipalities in high-importance groups (189% between 1990 and 2014) suggests that greater investments in milk production techniques were applied, such as handling practices, nutrition and genetics. Among all the regions, dairy production systems in the central western region presented higher productivity indexes, mainly due to investments in production, nutrition and genetics (CARVALHO; HOTT, 2007; IPARDES, 2009; SILVA et al., 2016).

The geographical distribution of dairy activity allow us to identify the dynamics and location of municipalities and regions where there was greater contraction and expansion over the period analyzed (Figure 1).

Figure 1. Spatial distribution and municipalities with higher dairy activity in Paraná.

a) Dairy activity in Paraná State, 1990: spatially disperse.

c) Dairy activity in Paraná State, 2014: the formation of a milk corridor.

b) Dairy activity in Paraná State, 2000: the beginning of some dairy basins.

d) Municipalities with higher dairy activity.

In 1990, dairy activity was geographically more dispersed among the municipalities. Low-importance groups were more intensely concentrated in the Central North ("Norte Central"), Central South ("Centro Sul") and Southeastern ("Sudeste") regions and the Metropolitan Region of Curitiba ("Região Metropolitana de Curitiba") (Figure 1a). The high-importance municipalities in terms of dairy activity, Toledo (Group 7), Marechal Cândido Rondon (Group 8) and Castro (Group 9), were located in the central eastern and western regions of the state, and other regions were identified as having the state's highest concentration of dairy activity (Figures 1d).

In 2000, compared to the previous period, there was a loss of importance in terms of dairy activity in those municipalities located in the northern region of the state, and an intensification of activity in the southern regions, especially in the extreme west and central eastern areas, in the vicinity of Castro (Group 9), Carambeí (Group 8), Ponta Grossa, Palmeira, Toledo and Marechal Cândido Rondon (Group 7) (Figures 1b and 1d). At this point, there had been a displacement of dairy activity from northern to southern regions of Paraná, indicating the beginning of concentration in the western ("Oeste") and central Eastern ("Centro-Oriental") regions (Figure 1b). In fact, those are important regions in terms of dairy production in the state (CAPUCHO; PARRÉ, 2012; IPARDES, 2009; SILVA et al., 2016).

The decrease of dairy activity in the northern portion of Paraná may be due to institutional and market changes from the 90's in Brazil, as well as to soil and relief characteristics. Requirements

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for higher quality and larger production scales demanded financial investments in dairy production systems (BÁNKUTI et al., 2008; SAES; SILVEIRA, 2014). Such situation, combined with good soil fertility, relief adequacy for mechanization and the massive presence of agroindustries (IPARDES, 2004) allowed lower opportunity costs for farmers to produce grains, such as soybean, and sugarcane (PETRINI et al., 2016). In Paraná, sugar cane and soybean planted areas increased 327% and 120%, respectively. In 2014, the northern region comprised 94% of sugar cane and 37% of soybean production in the state (IBGE, 2015).

The concentration of dairy production in the Western, Southwestern and Central Eastern regions may have been fueled by a set of factors. In those regions, dairy production systems employ more technology in production, produce in larger scale and are more connected to cooperatives (CAPUCHO; PARRÉ, 2012; IPARDES, 2009; SILVA et al., 2016). Such aspects allow a safer and more stable position in the medium and long run, more cohesive relations between agents, and higher exit costs (BÁNKUTI et al., 2008). Besides that, it can improve farmers' financial dependency to dairy activity (IPARDES, 2009).

In 2014, the displacement of dairy activity from the north to the south of the state intensified, mainly to the western, southwestern, central southern, and southeastern regions. At that time, in terms of their dairy activity, these regions became characterized by groups of medium and high importance (Figure 1c). Among the municipalities in high importance groups were Castro (Group 9); Carambeí (Group 8); Cascavel, Toledo and Marechal Cândido Rondon (Group 7) (Figure 1d). These results indicate there have been constant investments in production and technology in those municipalities along the years. In fact, those municipalities are among the most productive in Brazil (CARVALHO; HOTT, 2007). It is also important to note that Central Eastern region ("Centro-Oriental") has been losing relative importance in terms of milk activity, associated to

the gain of importance of other regions, namely Western ("Oeste") and Southwestern ("Sudoeste") regions of Paraná (IBGE, 2015).

The displacement of milk activity to the southern areas of Paraná has geographically defined a new production area, a "milk corridor," that goes across the southern region, from west to east (Figure 1c). The milk corridor comprises a belt with set of municipalities relevant for dairy activity in Paraná state, in the southern portion of Paraná. It extends from the western part of the state, passing through municipalities in the Southwest, Central South and Southeast Paraná, to the Central East, and connecting important municipalities in dairy production (e.g. Toledo, Cascavel and Marechal Candido Rodon, in the West, and Castro and Carambeí in the East of the corridor).

Except for the far eastern and western portions of the "milk corridor", which had already been important in terms of milk activity in earlier times, the other areas were hitherto regarded as "agriculturally empty" and traditionally characterized by their socioeconomic vulnerability. These areas have also been characterized by a predominantly low population density, low human development indexes (HDI), concentration of agrarian settlements and indigenous reserves (IPARDES, 2004; SILVA et al., 2016).

Thus, the displacement of production from the northern areas has impacted not only on the intensification of dairy activity in more traditional areas, such as Western and Southwestern Paraná (CAPUCHO; PARRÉ, 2012; SILVA et al., 2016) in previous periods. In more recent periods, it has brought a new configuration of dairy activity in Paraná, which the intensification of dairy activity in other regions, namely the southern central part of the state.

The increased dairy activity in these newer areas of the state are important to regional development, especially when one considers the restrict use of those areas for other agricultural activities and the

intensive use of family labor in milk farming. A set of positive socioeconomic benefits among the various municipalities and regions can be generated with the emergence of the new "milk corridor." Among the benefits, dairy activity may create more direct and indirect employment, higher revenues and incentives for farmers to keep in rural activities (GOMES; FERREIRA FILHO, 2007; RIPOLL-BOSCH et al., 2012).

Indirect positive benefits may also be generated, such as the relocation of dairy processing industry to new areas of production, given the high time and site specificity of milk (ROYER et al., 2011).

Logistically, the formation of a new "milk corridor" may favor the flow of milk towards domestic and external markets, namely the metropolitan region of Curitiba, the capital of the state, and the port of Paranaguá. More specifically, that corridor may facilitate the connection between important regions (Western and Southwestern) and those markets. It is important to consider that the improvement of dairy exports have been highlighted as important for dairy sector performance, being focused in actions such as the formation of South Dairy Alliance in 2014 (ALIANÇA LÁCTEA SUL BRASILEIRA, 2017). Paraná's dairy exports value increased 275% between 2012 and 2016 (from US$ 6 billion to US$ 22.7 billion FOB), responding for 15% of Brazilian dairy exports in 2014, against 6.5% in 2012 (MDIC, 2016). However, the efficiency of production flow will depend on logistics and transport structures in those regions. Public and private agents should consider the need for appropriate logistic and transport structure for collecting and distributing raw material and products (MINISTÉRIO DOS TRANSPORTES, 2010). Failures in such aspects may lead to problems in performance and competitiveness of Paraná's dairy chain.

The displacement of milk activity could also result in major structural changes in Paraná's dairy chain. New patterns of milk production systems in terms of scale and technology, for example, and the costs and barriers for geographic relocation of downstream agents will affect chain structures and bring challenges to the sector, such as the availability of skilled labor, technical assistance, dairy cooperatives and associations, as well as differences in local consumer market and in production systems.

Future research should examine the socioeconomic impacts in municipalities experiencing greater expansion or contraction of milk activity. In addition, researches considering data on farms and milk production system could bring important information about dairy activity. Future researches should also consider more detailed analyses of institutional and market factors that have favored the displacement of milk activity in Paraná, which was not the focus in this paper. Finally, it is important to assess the impact of displacement on technical and structural characteristics of dairy production systems, especially considering dairy genetics, handling and feeding practices in regions with distinct soil, topography and climate.

Conclusion

The displacement of milk activity to the southern areas of Paraná has geographically defined a new production area, a "milk corridor," that goes across the southern region, from east to west. Such displacement is a recent phenomenon in the state, not observed in other studies. The awareness of the "milk corridor" emergence is important in different aspects. First, it can bring important social and economic benefits for municipalities in the southern central portion of the state, since dairy activity may improve region's development, especially for those in less favorable situation. Nevertheless, dairy activity performance and success may depend on private and public efforts, especially considering economic, social, labor, productive, technological and structural disparities in that "agricultural emptiness". In this sense, public and private agents

should define policies and initiatives to support agents along the chain to face structural changes. We indicate, for example, the creation or enhancement of public policies for financial support and tax incentives, especially for farmers and associative forms, to promote milk production and processing in new regions. Additionally, appropriate technical and managerial assistance, in consonance with the characteristics of milk production systems, should be provided to farmers in those regions. Moreover, private policies are important in this new scenario. We recommend the definition of strategies for valuing processes and products aligned with social and environmental characteristics of the "milk corridor", that impose less social and environmental impacts, such as agro ecological production and production in land reform settlements. Such policies may be implemented by cooperatives and associations, and supported by public entities.

Acknowledgements

References

ALIANÇA LÁCTEA SUL BRASILEIRA. Aliança láctea Sul Brasileira. Curitiba: [s.n.], 2017. Disponível em: <http://www.aliancalactea.org.br/>. Acesso em: 13 jan. 2017.

BÁNKUTI, F. I.; SOUZA FILHO, H. M.; BÁNKUTI, S. M. S. Mensuração e análise de custos de transação arcados por produtores de leite nos mercados formal e informal da região de São Carlos, SP. *Organizações Rurais & Agroindustriais*, Lavras, v. 10, n. 3, p. 343-358, 2008.

BARNES, A. P.; TOMA, L. A typology of dairy farmer perceptions towards climate change. *Climatic Change*, v. 112, n. 2, p. 507-522, 2012.

BARROSO, L. P.; ARTES, R. *Análise multivariada.* Lavras: Universidade Federal de Lavras, 2003. 151 p.

BRASIL. Instrução Normativa Nº 51 Brasil. Ministério da Agricultura Pecuária e Abastecimento – MAPA. Brasilia: [s.n.], 2002. Disponível em: <http://www.qualidadedoleite.com.br/hd/arquivos/IN51de2002_leitecrunormas.pdf>. Acesso em: 10 fev. 2016.

_____. Instrução Normativa Nº 62 Brasil. Ministério da Agricultura Pecuária e Abastecimento – MAPA. Brasilia: [s.n.], 2011. Disponível em: <http://www.universidadedoleite.com.br/imagens/uploads/files/instrução_normativa_62.pdf>. Acesso em: 10 fev. 2016.

BRITO, M. M. de.; BÁNKUTI, F. I.; BÁNKUTI, S. M. S.; FERREIRA, M. C.; DAMASCENO, J. C.; ZAMBOM, M. A. Horizontal arrangements: strategy for reducing the asymmetry information for dairy farmers in Paraná, Brazil. *Ciência Rural,* Santa Maria, v. 45, n. 11, p. 2069-2075, nov. 2015.

CAPUCHO, T. O.; PARRÉ, J. L. Produção leiteira no Paraná : um estudo considerando os efeitos espaciais. *Informe GEPEC*, Toledo, v. 6, n. 1, p. 112-127, 2012.

CARVALHO, G. R.; HOTT, M. C. Análise da concentração e geografia da produção de leite no Brasil. *Política Agrícola,* Brasília, v. 16, n. 2, p. 82-97, 2007.

FARINA, E. M. M. Q.; GUTMAN, G. E.; LAVARELLO, P. J.; NUNES, R. REARDON, T. Private and public milk standards in Argentina and Brazil. *Food Policy*, v. 30, n. 3, p. 302-315, 2005.

FÁVERO, L. P.; BELFIORE, P. P.; SILVA, F. L. da; CHAN, B. L. *Análise de dados*: modelagem multivariada para tomada de decisões. 3. ed. Rio de Janeiro: Elsevier, 2009. 646 p.

GOMES, A. L.; FERREIRA FILHO, J. B. de S. Economias de escala na produção de leite: uma análise dos estados de Rondônia, Tocantins e Rio de Janeiro. *Revista de Economia e Sociologia Rural,* Brasília, v. 45, n. 3, p. 591-619, 2007.

HAIR, J. F. J.; ANDERSON, E.; TATHAM, R.L. *Multivariate data analysis.* 7th ed. Saddle River: Prentice Hall, 2009. 768 p.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA – IBGE. Censo Agropecuário 2006. Brasilia: IBGE, 2006. Disponível em: <http://www.ibge.gov.br>. Acesso em: 2 dez. 2014.

_____. Pesquisa da Pecuária Municipal. Brasília: IBGE, 2015. Disponível em: <http://www.ibge.gov.br>. Acesso em: 8 out. 2015.

INTERNATIONAL BUSINESS MACHINE – IBM. Statistical Program for Social Sciences – SPSS. Nova York: [s.n.], 2009. (Software).

INSTITUTO PARANAENSE DE DESENVOLVIMENTO ECONÔMICO E SOCIAL – IPARDES. Caracterização socioeconômica da atividade leiteira no Paraná. Curitiba: [s.n.], 2009. Disponível em: <http://www.ipardes.gov.br/biblioteca/docs/relatorio_atividade_leiteira_parana.pdf>. Acesso em: 12 jun. 2016.

_____. Leituras regionais: mesoregiões geográficas paranaenses. Curitiba: [s.n.], 2004. Disponível em: <http://www.ipardes.gov.br/index.php?pg_conteudo=1&sistemas=1&cod_sistema=1&ano_estudo=2004>. Acesso em: 07 jun. 2016.

LEBART, L. *Data analysis*. Berlin: Springer, 2000. 11 p.

MINISTÉRIO DA INDÚSTRIA, COMÉRCIO EXTERIOR E SERVIÇOS – MDIC. Sistema AliceWeb. Brasília: [s.n.], 2016. Disponível em: <http://aliceweb.mdic.gov.br/>. Acesso em: 13 jan. 2017.

MINISTÉRIO DOS TRANSPORTES – MT. Banco de Informações e Mapas de Transporte. Brasília: [s.n.], 2010. Disponível em: <http://www2.transportes.gov.br/bit/01-inicial/index.html>. Acesso em: 10 dez. 2015.

NICHOLSON, C. F.; GÓMEZ, M. I.; GAO, O. H. The costs of increased localization for a multiple-product food supply chain: dairy in the United States. *Food Policy*, v. 36, n. 2, p. 300-310, 2011.

OLIVEIRA, L. F. T.; SILVA, S. P. Mudanças institucionais e produção familiar na cadeia produtiva do leite no Oeste Catarinense. *Revista de Economia e Sociologia Rural*, Brasília, v. 50, n. 4, p. 705-720, 2012.

PETRINI, M. A.; ROCHA, J. V.; BROWN, J. C.; BISPO, R. C. Using an analytic hierarchy process approach to prioritize public policies addressing family farming in Brazil. *Land Use Policy,* v. 51, n. 1, p. 85-94, jan. 2016.

RIPOLL-BOSCH, R.; DÍEZ-UNQUERA, B.; RUIZ, R.; VILLALBA, D.; MOLINA, E.; JOY, M.; OLAIZOLA, A.; BERNUÉS, A. An integrated sustainability assessment of mediterranean sheep farms with different degrees of intensification. *Agricultural Systems,* v. 105, n. 1, p. 46-56, 2012.

RIVAS, J.; PEREA, J.; ANGÓN, E.; BARBA, C.; MORANTES, M.; DIOS-PALOMARES, R.; GARCÍA, A. Diversity in the dry land mixed system and viability of dairy sheep farming. *Italian Journal of Animal Science*, v. 14, n. 2, p. 179-186, 2015.

ROYER, A. Transaction costs in milk marketing: a comparison between Canada and Great Britain. *Agricultural Economics*, v. 42, n. 2, p. 171-182, 29 mar. 2011.

SAES, S. M. M.; SILVEIRA, R. L. F. Agropecuárias brasileiras: tendências recentes. *Estudos Sociedade e Agricultura*, Rio de Janeiro, v. 22, n. 2, p. 386-407, 2014.

SILVA, L. H. A. da; CAMARA, M. R. G. da; TELLES, T. S. Evolução e distribuição espacial da produção de leite no estado do Paraná, Brasil. *Acta Scientiarum. Human and Social Sciences,* Maringá, v. 38, n. 1, p. 37-47, 2016.

UNITED STATES DEPARTMENT OF AGRICULTURE – USDA. Market and Trade, custom query. Whasington: [s.n.], 2015. Available at: <http://apps.fas.usda.gov/psdonline/psdQuery.aspx>. Accessed at: 26 jun. 2015.