SPATIAL DYNAMICS OF GRAPES PRODUCTION IN BRAZIL BETWEEN 1975 AND 2005

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ABSTRACT

The present work evaluates the spatial dynamics of grape production in Brazil, between 1975 and 2005, by means of: 1) measures of assymetry and concentration; 2) distance measures involving some geographical aggregates; 3) the determination of the national center of gravity of grapes production in each one of the selected years, and the terrestrial distances between any two of them. It was found that grapes production is concentrated in a few micro-regions. In the selected years, only one micro-region was sufficient to reach 25% of grape production, and either one or two to reach 50%. In order to reach 75% of total production, between five and eight micro-regions were sufficient. Of the six micro-regions which were sufficient to reach 75% in 1975, three remained in 2005, while three left and were replaced by five new ones. The national center of gravity, which may not fall into a grape-producing micro-region, moved to the North, following an almost perfect terrestrial straight line.

RESUMEN

El artículo evalúa la dinámica espacial de la producción de uva en Brasil, entre 1975 y 2005, por medio de: 1) medidas de asimetría y concentración; 2) medidas de distancia entre ciertos agregados geográficos; 3) la determinación del centro de gravedad nacional de la producción de uva, y las distancias terrestres entre cada dos de ellos. Se encontró que la producción de uva está concentrada en unas pocas microrregiones. En los años seleccionados, sólo una microrregión fue suficiente para alcanzar 25% de la producción total, y una o dos para reunir 50%. Para alcanzar 75% de la producción total, fueron suficientes entre cinco y ocho microrregiones. De las seis microrregiones que fueron suficientes para reunir 75% en 1975, tres permanecian en 2005, mientras que tres salieron y fueron substituídas por cinco nuevas. El centro de gravedad nacional, que puede no estar situado en una microrregión productora de uvas, se desplazó hacia el norte, siguiendo casi perfectamente una recta terrestre.

INTRODUCTION

Viticulture is an activity that creates employment and is adequate to provide economic and social sustainability to small family-based farms. For these reasons, it has been used in several regions of Brazil. More than 50% of grapes are consumed in natura; the remaining are processed to produce juices and wines. In 2007, 1,334,960 tonnes of grapes were produced on 76,987 hectares (Mello, 2008a). The grape production chain has some features that differentiate the grape from other fruits. The grapes used for consumption in natura and for the internal market are divided into two major groups: fine (vitis vinifera) and rustic (American and hybrid) grapes; those for the foreign market are, predominantly, seedless grapes. The grape occupies a remarkable place in the economy of the country due to the high export tariff . In 2007, the export of 79.08 thousand tonnes of grapes yielded 169.7 million dollars to the country, occupying the first place among the Brazilian fruit exports (Mello, 2008b).

The grapes for processing have several purposes: juice, table wines, fine wines and sparkling wines.

The market for grape juice is very promising in Brazil. The main varieties used for grape juices are the traditional Isabel, Concord and Bordo. The following new cultivars were recently developed and released by Embrapa: BRS Rúbea, BRS Cora, BRS Violeta, BRS Carmem, and early-ripening clones Isabella and Concord Clone 30. Some of these grapes are also used for table wine. The most important grape juice and wine producing zone, with temperate climate, is located in the South Region, in the micro-region of Caxias do Sul. This micro-region is also the main producer of fine wines and has an adequate infrastructure for tourism.

A new vineyard region with tropical climate was established. It is located in the Northeast, in the micro-regions of Petrolina and Juazeiro, where both table grapes and grapes for fine wine are cultivated. This work evaluates the spatial dynamics of grape production in Brazil, between 1975 and 2005.

MATERIAL AND METHODS

The following years were selected: 1975, 1985, 1995 and 2005. This work used data from the Brazilian Geographical and Statistical Service (IBGE), at the micro-regional level. Initially, for each year, a ranking of microregions, according to the amount of grape produced, was performed. The amount produced was accumulated to determine the quarters for each year. Working in descending order, the minimum number of micro-regions that were sufficient to achieve 25% of total production formed the upper quarter (Q4). The third quarter (Q3) was formed by the micro-regions which, added to those in Q4, reached 50%. The second quarter (Q2) was formed by additional micro-regions, that together with those in Q3 and Q4 reached 75%. The remaining micro-regions formed the first quarter (Q1). Based on this classification, the following measures of assymetry, concentration and distance were calculated: index of stochastic dominance (Garagorry et al, 2003), Theil concentration index (Theil, 1967), Gini concentration index (Kendall and Stuart, 1977), Cantor distance (defined as 1 minus Jaccard's coefficient; Anderberg, 1973) and distance of transvariation (Souza, 1977). In order to evaluate, in aggregate terms, the mobility of grape production in Brazil, the national center of gravity of grape production, in each one of the selected years, was determined. The determination of the centers of gravity, as well as the terrestrial distance between any two of them, used geodesic calculations, so as to take into account the sphericity

of the earth. It must be noted that, being an overall weighted mean, a centre of gravity can be located in a micro-region that does not produce grapes.

RESULTS AND DISCUSSION

As shown in Table 1, grape production has increased in Brazil during the period under study. From 1975 to 2005, total grape production rose by 112%. In the main producing region (South), the production showed a growth of 73.60%. In 1975, the Northeast region produced only 2,097 t of grape, which reached 262,776 t in 2005. In this region, characterized by tropical agriculture, the viticulture is in full development. This region can become the second largest grape production pole in Brazil.

Tab. 1 Production of grape (t)

Year	Brasil	North	Northeast	Southeast	South	Cent,-West
1975	580,586	0	2,097	142,362	436,102	25
1985	712,182	0	8,766	104,015	599,401	0
1995	836,545	0	118,321	146,258	571,805	161
2005	1,232,564	300	262,776	205,553	757,092	4,843

The dynamics of regional viticulture was evaluated using the percentage of total grape production in each region. Table 2 shows the annual index of stochastic dominance (DOM) and Theil's concentration index, as well as distance of transvariation (DIST) with respect to the initial distribution (1975). There was a change in the relative participation of the regions. During the period of 1975 to 2005, the relative participation of the South region decreased from 75.11% to 61.59%, while the contribution of the Northeast region increased from 0.36% to 21.23%.

The index of dominance (DOM), which uses an ordinal scale of the regions (from North to Center-West), ranged from 0.293 to 0.398. Values of DOM smaller than 0.5 show the existence of a right asymmetry (due to the predominance of the South region). The smaller value of DOM in 1985 reflect the exceptional harvest of the South region in that year. For 1995 and 2005, increasing values of DOM point to a significant shift to the left, which was due to a significant increase in the contribution of the Northeast region.

The values of Theil's concentration index (standardized to a maximum value of 1) show that there was a reduction in the concentration of grape production; it changed from 0.639 in 1975 to 0.409 in 2005. As mentioned above, grape production in 1985 was atypical because there was one of the most expressive harvests of grapes for processing in Rio Grande do Sul.

The distance of transvariation (DIST) measures the magnitude of changes between the distribution in the initial year (1975) and those in the other years. The distances are increasing over the period, which indicates a gradual movement away from the initial distribution.

Tab. 2 Regional dynamics

Year	North	Northeast	Southeast	South	Cent.-West	DOM	THEIL	DIST
1975	0.00	0.36	24.52	75.11	0.00	0.313	0.639	0.000
1985	0.00	1.23	14.61	84.16	0.00	0.293	0.702	0.099
1995	0.00	14.14	17.48	68.35	0.02	0.364	0.476	0.138
2005	0.02	21.32	16.68	61.59	0.39	0.398	0.409	0.214

Table 3 shows that the total number of micro-regions (TOTMIC), with record of grape production, decreased in 1985 and in 1995, in regard to 1975 (190), but increased in 2005 (204). Over the period studied, the production of only one micro-region was enough to represent at least 25% of the total amount (Q4). In order to reach 50% of total production (Q3+Q4), only one micro-region was sufficient in 1985, and two in 1975, 1995 and 2005.

In 2005, only eight out of 204 grape-producing micro-regions (that is, less than 4% of the total number) were sufficient to reach 75% of national production.

The statistics of stochastic dominance and concentration (Gini and Theil), calculated from the number of micro-regions in the quarters, reflect the high concentration in the quantity of grape produced.

Tab. 3 Number of micro-regions per quarter of production, total number of micro-regions with record of grape production, and indexes of asymmetry (DOM) and concentration (GINI, THEIL)

Year	Q1	Q2	Q3	Q4	TOTMIC	DOM	GINI	THEIL
1975	184	4	1	1	190	0.984	0.968	0.879
1985	139	4	0	1	144	0.984	0.972	0.879
1995	157	6	1	1	165	0.978	0.956	0.834
2005	196	6	1	1	204	0.982	0.964	0.860

Table 4 shows that, with regard to group 75 (defined as Q2 + Q3 + Q4), here were only three persistent micro-regions (colum "a") from 1975 to 2005; however, the percentage of contribution had important differences between the initial and final years (Table 5). The three persistent micro-regions accounted for 63.01% of total grape production in 1975, while, in 2005, they accounted for only 43.80%. The spatial displacement of group 75, between 1975 and 2005, is shown in Fig. 1.

Tab. 4 Dynamics of production at micro-regional level, group 75 (Q2+Q3+Q4): number of micro-regions persistent (a), which were present in 1975 but not in the final year (b), and which were not present in 1975 but entered in the final year (c), persistence coefficient and distances (Cantor and transvariation)

Initial	Final	Number of micro-regions					Distance	
year	Year	b	a	c	Involved	Persistence	Cantor	Transvar.
1975	1985	3	3	2	8	0.375	0.625	0.220
1975	1995	2	4	4	10	0.400	0.600	0.261
1975	2005	3	3	5	11	0.273	0.727	0.422

Tab. 5 Dynamics of production at micro-regional level, group 75: percentage of contribution of parts a, b and c

Initial	Final	Percentage of contribution			
year	year	b	a (initial year)	a (final year)	c
1975	1985	14.27	63.01	70.42	6.39
1975	1995	10.30	66.98	55.84	19.74
1975	2005	14.27	63.01	43.80	31.91

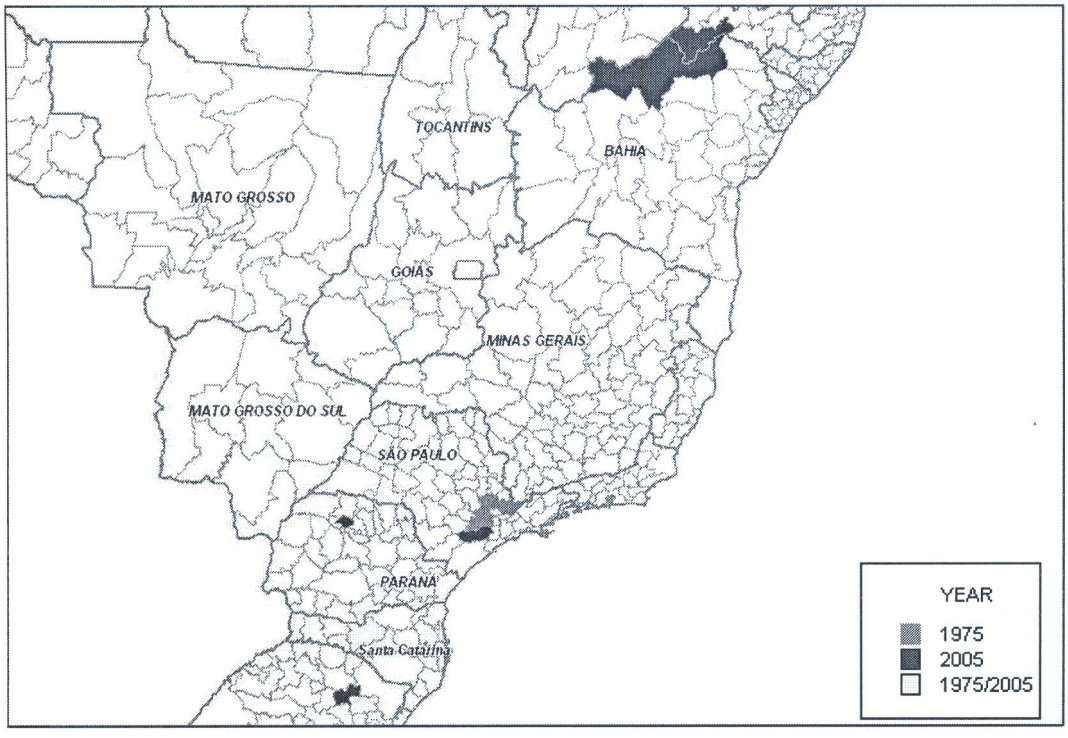

Fig 1. Displacement, between 1975 and 2005, of the micro-regions sufficient to achieve 75% of the total amount of grape produced.

As it can be seen, six micro-regions were sufficient to reach 75% of total production in 1975, and eight in 2005. Of these two groups, only three were persistent (Caxias do Sul, Joaçaba and Jundiaí). In 2005, the importance of the northeastern cluster is well established, with a contribution of 21% to national grapes production (Petrolina-PE and Juazeiro-BA) (Table 6).

Tab. 6 Micro-regions which formed group 75 in 1975 and 2005: quarter, state, production, percentage of total production and accumulated percentage

Year	Quarter	State	Micro-region	Production (t)	%	Accum. %
1975	4	RS	Caxias do Sul	286,805	49.40	49.40
1975	3	SC	Joaçaba	41,230	7.10	56.50
1975	2	SP	Jundiaí	37,785	6.51	63.01
1975	2	SP	Bragança Paulista	30,604	5.27	68.28
1975	2	SP	Sorocaba	29,209	5.03	73.31
1975	2	SP	Campinas	23,045	3.97	77.28
2005	4	RS	Caxias do Sul	479,025	38.86	38.86
2005	3	PE	Petrolina	147,472	11.96	50.83
2005	2	BA	Juazeiro	106,590	8.65	59.48
2005	2	SP	Piedade	61,431	4.98	64.46
2005	2	PR	Maringá	47,454	3.85	68.31
2005	2	SP	Jundiaí	34,963	2.84	71.15
2005	2	RS	Guaporé	30,370	2.46	73.61
2005	2	SC	Joaçaba	25,862	2.10	75.71

Table 7 shows the location of the national center of gravity of grape production, for the selected years. It follows that de center of gravity moved to the South from 1975 to 1985; the exceptionally good harvest, in 1985, in the Rio Grande do Sul State, explains that movement. Later, in 1995 and 2005, it moved to the North from the position in 1975. If $d(a, b)$ denotes the distance, in kilometers, between the center of gravity in year a and that in year b, it can be further noticed the following result, with the understanding that the center for year 1975 falls "between" those for 1985 and 1995: on the one hand, $d(1985, 2005) = 554$ (Table 8); on the other hand, $d(1985, 1975) + d(1975, 1995) + d(1995, 2005) = 60 + 304 + 191 = 555$. Therefore, all the centers of gravity fall on an almost perfect geodesic ("straight") line. Furthermore, if the center of gravity for 1985 is disregarded (as outlier), then the following results are obtained: $d(1975, 2005) = 495$, while $d(1975, 1995) + d(1995, 2005) = 304 + 191 = 495$; since the two numbers are equal, the centers of gravity corresponding to 1975, 1995 and 2005 are precisely on a geodesic line. Fig. 2 shows the location of the national centers of gravity for grape production.

Tab. 7 Coordinates (degrees and decimals) of the national center of gravity of grape production with state and micro-region where it is located, for the selected years

Year	Latitude	Longitude	State	Micro-region
1975	-27.098	-50.271	SC	Rio do Sul
1985	-27.538	-50.630	SC	Campos de Lages
1995	-24.541	-49.171	SP	Capão Bonito
2005	-22.964	-48.418	SP	Botucatu

Tab. 8. Distance (km) between any two national centers of gravity of grape production for the selected years

Initial Year	Final year		
	1985	1995	2005
1975	60	304	495
1985	.	363	554
1995	.	.	191

CONCLUSION

- The shift of the center of gravity towards the North is a consequence of the new Brazilian vineyard pole established in a tropical region. For the development of viticulture in this Brazilian pole, several public policies have been implemented, which encourage wine production as an activity that creates jobs and income.
- The micro-region of Caxias do Sul, a traditional grape and wine producer, remains as an important pole of viticulture, though its relative production has decreased over the years.

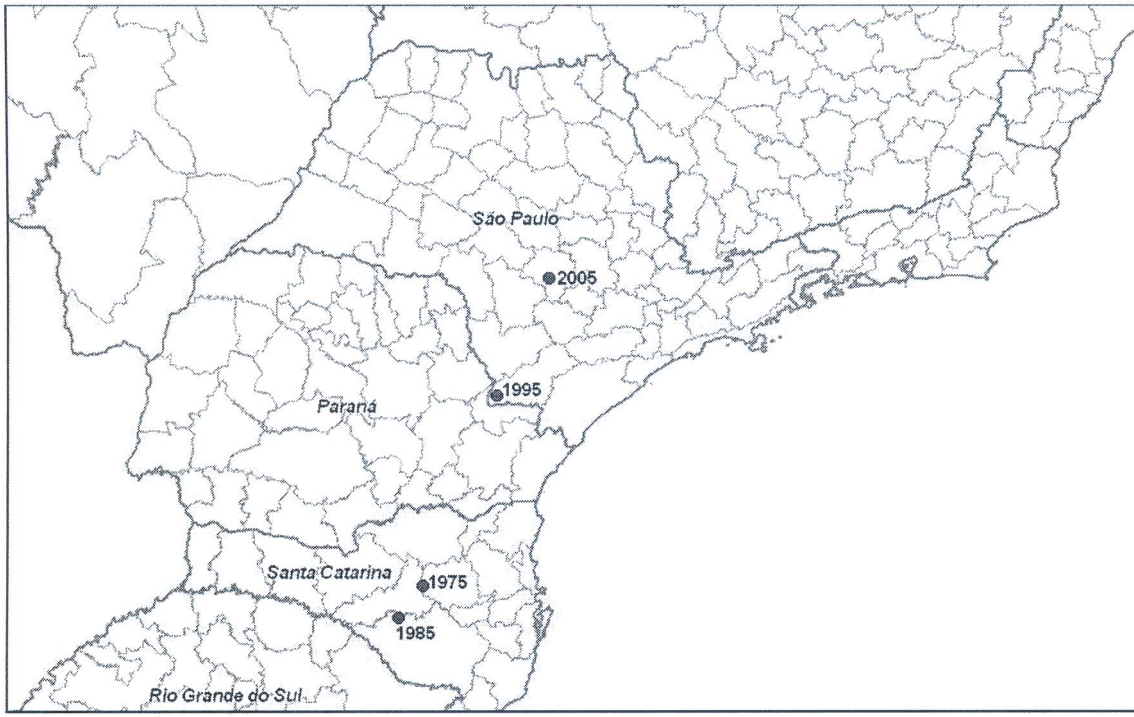

Fig. 2 National center of gravity of the production of grape in 1975, 1985, 1995 and 2005.

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