

THE BOVINE COMMERCIALIZATION CIRCUITS AS ELEMENTS OF SANITARY INTERVENTION

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SUMMARY. The bovine commercialization circuits (CCB) are defined and assessed as a method to understand and epidemiologically intervene in the agricultural and livestock-producing space. Each CCB is defined as that geopolitical space containing agents that maintain mutual relationships of buying and selling animals during a determined period of time. Considering the municipality as the primary unit of analysis, the CCBs may be identified from a study of the dynamics of bovine animal transit, the intensity and predominance of animal entry and exit in each one of them. The case of Brazil's state of Mato Grosso do Sul is examined for the year 1989, yielding the existence of three circuits (Northwest, Northeast and South) and 19 linking municipalities. The results indicate transformations in the distribution of the state's bovine production systems and suggests the need to redefine the foot-and-mouth disease ecosystems in the region. It is concluded that animal transit should be considered as a direct indicator in the analysis of the risk of disease transmission, especially in the case of foot-and-mouth disease.

The action of the animal-health services presupposes, among other factors, a full understanding of the space over which they exercise influence; one may even affirm that the more precise the knowledge, the greater will be their capability to transform the situation.

The struggle against foot-and-mouth disease in South America is an example of this relationship. From the end of the 1970's on, the few encouraging results achieved in fighting the disease stimulated efforts to define the foot-and-mouth disease ecosystems based on the determining relationship between the organizational forms of production and the animal-health profile. Sup-

ported by information systems that led to the determination of indicators of the disease's behavior, animal demography and the production structure preponderant in certain regions (3, 13, 15), the definition of these ecosystems afforded health agents the possibility of intervening in the environment by means of differentiated actions according to the particularities and objectives envisaged in each case.

However, the information needed for defining the ecosystems is not always available in the animal-health services; this situation makes operationalization difficult, especially in the regions undergoing agricultural and livestock-raising development.

The transit of animals has been historically recognized as one of the main determinants in the spread of foot-and-mouth disease (2, 4, 7), as well as being a major factor in the anti-foot-and-mouth

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disease programs (5,6). In Brazil, the direct relationship between cattle transit and foot-and-mouth disease, where the periods of greatest cattle movements coincide with the periods of highest disease incidence, has been evidenced in different times and regions (8,10,11,12,14).

Among the information normally generated during the action of the veterinary services, this study is intended to enhance the data on bovine transit control; it proposes a methodology that provides a complementary reading of the agricultural and livestock-production space based on the bovine commercialization circuits (CCB) as another form of orienting animal-health actions, especially in the case of foot-and-mouth disease.

METHODOLOGY UTILIZED

The CCB concept emerges as a function of the interchange relationships established among the various agents composing the bovine production process, and which are dynamically interrelated and influenced by socioeconomic factors such as geographic proximity, presence of consumer markets and commercial value of the product in the different markets and times.

A CCB may be defined as: that geopolitical space constituted of elements that mutually maintain a certain degree of relationship (GR) in the buying and selling of bovines during a given period.

These elements constitute the basic units of each circuit; they are the agents of the process, grouped in levels that may vary according to the object and the objectives of the study (individual producers, municipalities, etc.).

The GR expresses the intensity of the interchange that exists among the agents; the greater the GR, the more closed and independent will be the circuit.

Each agent maintains a certain GR with each of the other members of the circuit, and with other agents not belonging to the circuit. Thus the final GR of a CCB is represented by the number of GRs among members over the total of relationships established by each one of them:

$$\text{GR of the CCB} = \frac{\Sigma \text{GR between elements of the CCB}}{\Sigma \text{Total GR of the elements of the CCB}}$$

For the purpose of conducting this study at the state level, the municipalities were regarded as the basic units in defining the CCBs. The entries and exits of animals into and from the municipalities are therefore analyzed in an independent manner by calculating the degree of relationship established on the basis of "inbound animals" (GRI) and the degree of relationship established on the basis of "outbound animals" (GRE). To this end the data are shown on the tables in order to obtain the total of animals entering into or exiting from each municipality, and the partial numbers classified by origin and destination, respectively.

$$\text{GRI}_i = \frac{X_i}{\Sigma X_i} \times 100$$

where:

GRI_i is the degree of relationship by entries from a determined municipality coming from municipality i ;

X_i is the number of cattle entering a determined municipality from municipality i .

$$\text{GRE}_j = \frac{Y_j}{\Sigma Y_j} \times 100$$

where:

GRE_j is the degree of relationship by exit from a determined municipality towards municipality j ;

Y_j number of animals outbounded from a determined municipality towards municipality j .

When all the relationships established by a municipality have been quantified they are arranged in decreasing order for an assessment of their relative importance. Those under 1% should be eliminated because it is highly probable that

they are the result of only occasional interchange, provided that the sum of the remainder represent at least 90% of the inbound and outbound transit.

The delimitation of the CCBs begins with the selection of the most representative municipalities. A primary criterion of selection is the relative weight that each municipality has in relation to the total transit in the state:

$$TTM_i = \frac{DM_i + DE_i + FE_i}{\Sigma(DM_i + DE_i + FE_i)} \times 100$$

where:

TTM_i is the percentage of total transit in municipality i ;

DM_i total transit in the municipality (intramunicipal)

DE_i total transit by entries and exits for municipality i within the state;

FE_i total transit of the municipalities outside the state (interstate).

Secondly, among the municipalities having the highest TTM values, those showing lower degrees of GRE and GRI relationships between each other are selected as references. On this basis, the high GR units are first grouped with the reference municipalities, and this is complemented with criteria like geographic proximity and other information on the local reality.

The objective of this initial grouping around the reference municipalities is to form the primary nuclei that will originate the CCBs. The intensity of the relationship initially utilized as the grouping factor depends on the GRE and GRI between the municipalities close to each other.

The municipalities that interact indistinctly with different primary nuclei or that have a strong GR with others geographically distant are called *linking municipalities*. The degree of relationship between and with the linking municipalities is referred to as the degree of linking relationship (GRL).

The following criteria were used to define the commercialization circuits:

(a) geographical location: each municipality should border with at least one of the members of the primary nucleus, or with another municipality limiting on the primary nucleus, and so on, successively;

(b) degree of relationship: the value of the GRE and GRI should be higher than the value stipulated for the grouping factor;

(c) the GRL may be utilized to define the participation of a municipality in a given CCB provided that it is not higher than the GRE or GRI .

The GR for the municipalities within a given circuit is called the degree of internal relationship (GRD), while the degree of relationship that they have with municipalities located outside the state is called "degree of out-of-state relationship" (GRF). Therefore, the total degree of relationships (GRT) established by a municipality is:

$$\begin{aligned} GRT_{inbound} &= GRD_{inbound} + GRL_{inbound} + GRF_{inbound} \\ GRT_{outbound} &= GRD_{outbound} + GRL_{outbound} + GRF_{outbound} \end{aligned}$$

The GRE and GRI of a commercialization circuit is the mean of the GRE and GRI of the municipalities that compose it:

$$GRI_{CCB} = \frac{\Sigma z_i}{\Sigma Z_j} \quad \text{and} \quad GRE_{CCB} = \frac{\Sigma w_i}{\Sigma W_j}$$

where:

z_i = number of cattle entering the municipality i from other municipalities in the circuit, from linking municipalities, and from out of state;

Z_j = total of cattle entering municipality j ;

w_i = number of cattle exiting from municipality i bound to other municipalities in the circuit, to linking municipalities, and to out of the state areas;

W_j = total of cattle exiting from municipality j .

The final GR of a CCB is given as:

$$GR_{CCB} = \frac{\sum z_i + \sum w_i}{\sum Z_j + \sum W_j}$$

THE CASE OF THE STATE OF MATO GROSSO DO SUL, BRAZIL

The proposed methodology was used to analyze the state of Mato Grosso do Sul, Brazil, for the year of 1989. Its bovine herd of 17,732,406 head was Brazil's second largest that year (9). Accounting for 29.8% of the state's gross internal product (1,5), it grew from 1980 to 1990 at an annual rate of 4.9%. The livestock industry is an important factor in socioeconomic development in the state, with a predominance of extensive open-range beef production with zebu breeds, a smaller number of semi-intensive establishments, and a very small percentage of intensive or feedlot properties.

Transit data for 1989 were used. It was possible to determine, for each movement, the municipality from which the animals exited, the municipality which they entered, and the purpose of the transit (breeding, grazing, fattening, reproduction and slaughter).

Three commercialization circuits were identified, called the Northeast (NE), Northwest (NO) and South (SUR) circuits, as well as 19 linking municipalities (tables 1, 2, and figure 1). The degree of independence among the CCBs varied from 83.9% to 89.6%; the most independent circuit was the NE, followed by NO and then SUR.

The SUR circuit showed the lowest GRI, which indicates higher external dependence, and the NO circuit was the principal supplier. The SUR and NE circuits are both characterized by the exiting of animals bound for slaughter, while the animals exiting in the NO circuit are bound for the internal market.

Interstate transit is shown in table 3, which indicates that the NE and SUR circuits are those which route most of the animals out of the state. The GRF represents approximately half of the

outbound transit of circuit NE, with São Paulo as the main destination state. For circuit SUR, also showing a high GRF, the main destination is the state of Paraná. The low GRF of the NO circuit, when compared to the other two circuits, shows the internal supply tendency of the state of Mato Grosso do Sul.

With regard to the linking municipalities, the main bovine exporters are in the region bordering São Paulo and Paraná, states that accounted for more than 90% of the interstate transit from Mato Grosso do Sul in 1989.

The dynamics of the CCBs and linking municipalities can be appreciated in figure 2, where the thickness of the arrows reflects the intensity of the transit.

In the municipalities bordering the states of São Paulo and Paraná, where the value of land is higher, it was mostly used for fattening and finishing-out purposes. But the municipalities farther inland, mainly those located in the "pantanal" region, were predominantly dedicated to the breeding, calving and prefattening stages. This example is typical of livestock development in Latin America (13,15).

In the first instance the existence of these CCBs indicates a transformation in the distribution of the state's cattle production forms. Historically, cattleraising in this region was an activity secondary to the main objectives of gold and diamond mining, but has since become the dominant economic activity. The stimulus was the growing consumer market in the south and south-eastern regions.

The CCBs have revealed a change in the behavior of the distribution of the livestock-production organization in the state. Presently, the great majority of the municipalities is characterized by the complete livestock-production cycle, without predominance of any single one of the production stages. This overall change is a consequence of the fact that agribusiness has moved into the interior while new consumer markets have emerged and/or expanded.

Consequently, this transformation in the distribution of the ways of organizing the bovine production implies a transformation in the ecosys-

Table 1. Bovine commercialization circuits, Mato Grosso do Sul, 1989. Overall results

CCB	Nr of municipalities	Inbound		Outbound		Degree of final relationship (GR)	Total bov. transit	
		GRI	HEAD	GRE	HEAD		Inbound	Outbound
Northeast	08	85.9	438645	91.6	886200	89.6	510503	967951
South	12	77.3	480406	88.7	763784	83.9	621700	860663
Northeast	25	88.0	1155252	85.3	1493174	86.9	1298777	1749680
Linking Municipalities	19	37.3	321165	59.1	719199	50.1	861934	1216193
TOTAL	64	-	2395468	-	3862357	-	3292914	4794487

GRI = Degree of relationship by inbound; GRE = Degree of relationship by outbound.

Table 2. Degree of relationship of the bovine commercialization circuits and linking municipalities, Mato Grosso do Sul, 1989

CCB	Inbound						Outbound									
	GRD	HEAD	GRL	HEAD	GRF	HEAD	GRI	HEAD	GRD	HEAD	GRF	HEAD	GRI	HEAD		
NO	68.3	348609	17.6	90038	-	0	85.9	438645	35.3	341862	7.3	70719	48.9	473620	91.6	886200
SUR	50.8	315823	26.5	164584	-	0	77.3	480406	36.1	310675	12.5	107279	40.2	345833	88.7	763784
NE	77.0	999824	12.0	155432	-	0	88.0	1155252	56.8	783013	15.5	270828	12.0	210440	85.3	1493174
L.M.	-	0	37.3	32165	-	0	37.3	321165	-	0	25.3	307683	33.8	411516	59.1	719199

NE = Northeast Circuit SUR = South Circuit NO = Northwest Circuit
 L.M. = Linking Municipalities GRD = Degree of internal relationship GR = Degree of linking relationship
 GRF = Degree of out-of-state relationship GRI = Degree of relationship, by inbound animals GRE = Degree of relationship, by outbound (existing) animals.

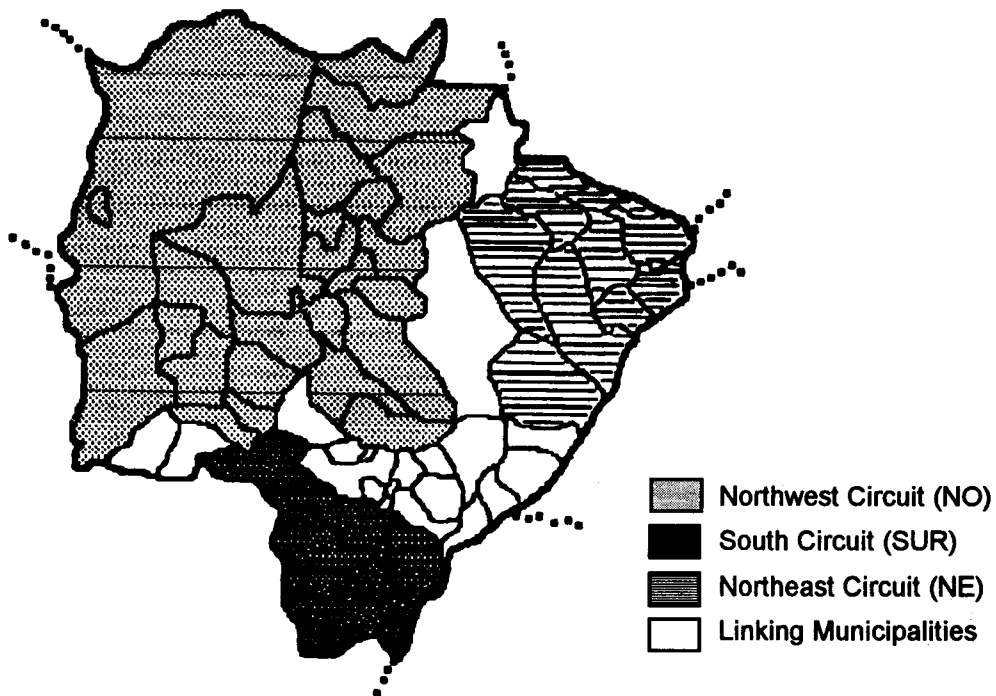


Figure 1. Bovine commercialization circuits and linking municipalities. Mato Grosso do Sul, 1989

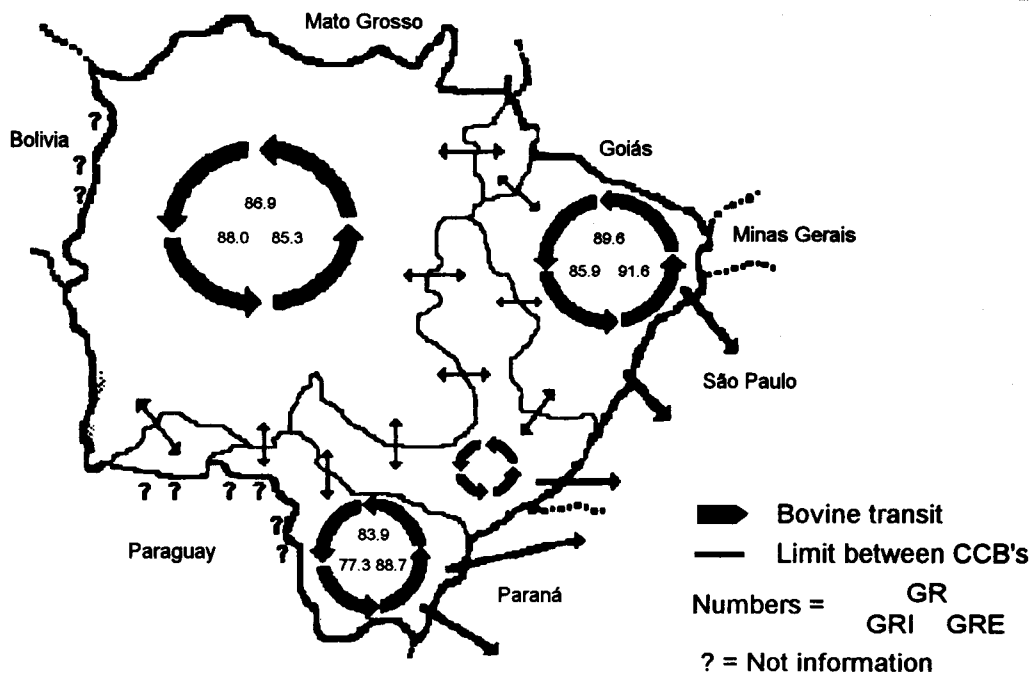


Figure 2. Dynamics of Bovine Transit according to the CCBs. Mato Grosso do Sul, 1989

Table 3. Main states receiving cattle produced in Mato Grosso do Sul, 1989

State	NE		SUR		NO		Linking municipalities		Total	
	Head	%	Head	%	Head	%	Head	%	Head	%
São Paulo	441111	91.0	101947	28.7	173615	68.9	262511	61.3	979184	64.7
Paraná	12037	2.5	209622	59.1	53568	21.3	143278	33.5	418505	27.6
Santa Catarina	—	—	31589	8.9	6316	2.5	7866	1.8	45771	3.0
Goiás	12677	2.6	—	—	—	—	896	0.2	13573	0.9
Minas Gerais	7595	1.6	—	—	2054	0.8	272	0.1	9921	0.7
Mato Grosso	5648	1.2	—	—	—	—	3255	0.8	8903	0.6
TOTAL	479068	98.9	343158	96.7	249630	99.1	418078	97.7	1475857	97.5

NE = Northeast Circuit; SUR = South Circuit; NO = Northwest Circuit

tems defined for foot-and-mouth disease in the state, once these are based in the existence and behavior of the primer.

Studies of the State of Mato Grosso do Sul led to the identification of an endemic ecosystem in the northwestern region (southern Pantanal and bordering municipalities) and of an epiendemic ecosystem in the rest of the state (6). Presently, the latter ecosystem is divided into a high-risk region represented by the municipalities near the endemic ecosystem, and a low-risk region comprising the municipalities near the states of Paraná and São Paulo. This definition is based on a bovine production gradient that extends from the endemic ecosystem as a provider of cattle for fattening to the rest of the state, and later forwarding to slaughter in the northwestern region of São Paulo and northeastern region of Paraná.

As the CCBs have demonstrated, this relationship has been changed. The circuits reflect the existence of distinct livestock-production spaces wherein the characterization of cattle production and of the disease's behavior should be reanalyzed and redefined. The definitions in use up to the

present are seen nowadays as "reductionist" for both understanding and intervention in the problem.

FINAL REMARKS

The methodology proposed for the study of bovine transit, based on an analysis of the source/destination relationship of the products involved in the process, was shown to be efficient for a temporal definition of the distinct spaces wherein the commercialization of bovines is conducted.

The consolidation of the CCBs for a given region contributes to the knowledge required in the process of disease eradication; it enables students of the subject to link areas limited not by political limits but rather by commercial relationships among the agents participating in the process. Due to the dynamic character of the livestock-production process, these circuits should be continually studied and reassessed as a way of discovering and evidencing the changes and enabling health action to be effectively directed.

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