

# Slaughter condemnation in bovine due to parasitic lesions and their economic impact in Federal Inspection System establishments in Brazil and in State inspection System in Rio Grande do Sul State

Condenação ao abate em bovinos devido a lesões parasitárias e seu impacto econômico em estabelecimentos do Sistema Federal de Inspeção no Brasil e no Sistema Estadual de Inspeção no Rio Grande do Sul

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## Abstract

Slaughter condemnations are important sources of information on cattle health. The incidence of bovine parasitic diseases is still very high in Brazil. These diseases, in addition to causing harm to the animals health, are neglected zoonotic diseases in several parts of world. The study analysed not only the Carcass losses, but also the economic damage resulting from slaughter condemnations due to parasitic causes. Cattle slaughter data from the Brazilian Ministry of Agriculture, Livestock and Supply (MAPA), over the period of 2012 to 2015 and data from the Secretary of Livestock and Irrigation of the state of Rio Grande do Sul (SEAPI-RS) were analyzed between 2014 and 2018. The number of organs and carcasses condemned was multiplied by the respective values (in Brazilian Real) obtained from slaughterhouses and subsequently converted into dollars. Brazilian analysis in SIF (Federal Inspection System) establishments showed that more than 1.2 million organs (3,884,505 kg) and 20,000 carcasses (4,547,718 kg) were condemned only due to parasitic causes during post-mortem inspection. In Rio Grande do Sul, in state inspection establishments, more than 1.7 million organs (8,210,559 kg) and 5,000 carcasses (1,243,200 kg) were condemned. These data are alarming and support the need for public policies to control these parasitic diseases.

**Keywords:** Parasitic diseases, economic losses, cattle slaughter, inspection service.

## Resumo

Condenações durante o abate são importantes fontes de informação sobre a sanidade dos rebanhos. Ainda são altas as incidências de doenças parasitárias, as quais trazem consequências à saúde dos animais, são zoonoses e têm sua importância negligenciada em diversos países. O estudo objetivou quantificar não apenas as perdas encontradas, mas o prejuízo econômico resultante das condenações ao abate por causas parasitárias. Para isso foram analisados dados de abate de bovinos do Ministério da Agricultura Pecuária e Abastecimento, no período de 2012 a 2015, e dados da Secretaria da Agricultura Pecuária e Irrigação, do estado do Rio Grande do Sul, no período de 2014 a 2018. A quantidade de órgãos e carcaças condenados foi multiplicada pelos respectivos valores (em Reais), obtidos da indústria frigorífica e, posteriormente, convertidos para dólar. A análise brasileira de estabelecimentos com SIF (Serviço de Inspeção Federal) mostrou que mais de 1,2 milhão de órgãos (3.884.505 kg) e 20 mil carcaças (4.547.718 kg) foram condenados devido a causas parasitárias durante a inspeção. No estado do Rio Grande do Sul, nos estabelecimentos de inspeção estadual, foram condenados mais de 1,7 milhão de órgãos (8.210.559 kg) e 5 mil carcaças (1.243.200 kg). Os dados são alarmantes e ressaltam a necessidade de políticas públicas para controlar estas parasitoses.

**Palavras-chave:** Doenças parasitárias, perdas econômicas, abate bovino, serviço de inspeção.

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## Introduction

Brazil, with its 226 million cattle population, has 22.6% of the total cattle worldwide. Brazilian beef production is the second largest in the world, with the United States ranking first for meat production (FAO, 2016). Products resulting from the process of slaughtering bovine are called carcasses and by-products; organs are economically important, because they add value to production and are potential sources of nutrients, especially with the increasing world population size and the increasing demand for high quality protein (Kale et al., 2008).

In addition to causing decreased performance of animals *in vivo*, parasitic diseases such as cysticercosis, fasciolosis and hydatidosis cause carcass and organ damage due to the stages of parasite's biological cycle. These injuries, when identified at slaughter, result in elimination of the carcass or part of the carcass or organ as it cannot go to human consumption, generating an economic loss.

Nosographic data obtained from slaughterhouses are an important source of information, and economic losses due to condemnations of affected organs and carcasses can be estimated through them (Nif & Alonge, 1987). There are three inspection systems to animal by-products in Brazil, federal, state and municipal and they are not interconnected, each one has a different database. The main reasons for condemnations in cattle slaughterhouses are due to lesions associated with cysticercosis (Marques et al., 2008; Dutra et al., 2012), hydatidosis (Cabrera et al., 2002, Tessele et al., 2013) and fasciolosis (Dutra et al., 2010); all of these are parasitic and zoonotic diseases, which are often neglected in the prevention aspect (Molento & Pritsch, 2018). Economic research of animal health aims to quantify the financial effects of diseases so that methods can be developed to optimize decisions when animal populations are affected and determine the costs and benefits of disease control (Dijkhuizen & Morris, 1997).

In the face of a large number of studies demonstrating the occurrence of condemnation due to parasitic diseases and knowing that the data are generally restricted to the sanitary and industrial inspection of animal products, the objective of this analysis was to characterize the economic loss due to parasitic lesions of bovines in SIF (Federal Inspection System) slaughterhouses in Brazil and also for the state of Rio Grande do Sul - RS analysing DIPOA (Animal Products Inspection Division) establishments because it has historical problems with livestock parasites and there is no consistent data to support public policies.

## Methodology

### Data origin

Data on numbers of animals slaughtered and their condemnations were obtained from the slaughtering information system for cattle linked to the Federal Inspection Service (SIF), from the Ministry of Agriculture, Livestock, and Supply (MAPA) available in the website from the period of 2012 to 2015. Amapá, Alagoas, Ceará, Federal District, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Norte and Roraima states were not included in the survey since only animals slaughtered under Federal inspection were considered, and in these States, there were no SIF establishment assets during the period studied.

Information regarding slaughtering in the state inspection service was collected from the slaughtering data of Rio Grande do Sul Secretary of Livestock and Irrigation (SEAPI-RS), available through direct consultation with DIPOA (data extracted from the secretariat's internal system), from when data started to be registered, 2014 to 2018. This study has been approved by the Institutional Research Committee "Comissão de Pesquisa Veterinária" (Compesq- FAVET -UFRGS) of the Faculty of Veterinary of the Federal University of the state of Rio Grande do Sul (protocol 35862).

### Data organization

All the obtained data were tabulated in spreadsheets. From these, only data of interest, that is, condemnations caused by identifiable parasites in carcasses and organs that appear in the system as fasciolosis, hydatidosis, esophagostomosis and/or cysticercosis and the respective organs where these lesions were located, were filtered. To support data visualization, a spatial analysis was performed using QGIS 2.18.27 'Las Palmas' program (QGIS Trademark, 2018).

## Trade data

Values used for organ and carcass prices were provided by the meat industry, through a survey of sale prices from four slaughterhouses with an average being made. The affected parts considered in the study were those that were used commercially. The parts that presented some parasitic injury and that were not totally discarded were not counted, because they were not registered. For carcasses, the value was changed for each year studied, according to commercial variations in price.

The loss was calculated by the sales price of the injury-free part minus the sales value of the affected organ after discard to grease or conditional treatment by cold, respecting the different values involved in the different destinations (greasing or cold treatment) according to Tables 1 and 2.

**Table 1.** Value per unit, in Brazilian Real (R\$), of the affected parts used for calculating the losses in bovine meat by-products.

Affected part	Commercial value (A)	Grease value (B)	Value used for calculation (A-B)	Cold treatment value (C)	Value used for calculation (A-C)
Heart	4.67	0.31	<b>4.36</b>	2.80	<b>1.87</b>
Liver	6.63	0.31	<b>6.32</b>	3.98	<b>2.65</b>
Lungs	0.80	0.31	<b>0.49</b>	0.48	<b>0.32</b>
Kidneys	3.80	0.31	<b>3.49</b>	2.28	<b>1.52</b>
Tongue	7.60	0.31	<b>7.29</b>	4.56	<b>3.04</b>
Intestine	4.83	0.31	<b>4.52</b>	2.90	<b>1.93</b>
Stomach and Pre-stomach	9.17	0.31	<b>8.86</b>	5.50	<b>3.67</b>
Diaphragm	10.75	0.31	<b>10.44</b>	6.45	<b>4.30</b>
Esophagus	2.00	0.31	<b>1.69</b>	1.20	<b>0.8</b>
Head (muscle)	5.30	0.31	<b>4.99</b>	3.18	<b>2.12</b>

**Table 2.** Value, in Brazilian Real (R\$), used for calculating the losses in bovine carcasses (kg).

Year	Average carcass price (A)	Grease value (B)	Value for calculation (A-B)	Cold treatment value (C)	Value for calculation (A-C)
2012	8.20	0.31	<b>7.89</b>	4.92	<b>3.28</b>
2013	8.50	0.31	<b>8.19</b>	5.10	<b>3.40</b>
2014	10.30	0.31	<b>9.99</b>	6.18	<b>4.12</b>
2015	12.00	0.31	<b>11.69</b>	7.20	<b>4.80</b>
2016	12.80	0.31	<b>12.49</b>	7.68	<b>5.12</b>
2017	13.20	0.31	<b>12.89</b>	7.92	<b>5.28</b>
2018	13.20	0.31	<b>12.89</b>	7.92	<b>5.28</b>

Price reduction of affected parts was multiplied by the total weight (kilograms-kg) of each organ or carcass sent to grease or to conditional treatment by cold (Table 3), and then converted to the dollar value of the corresponding year, thus generating the value. Calculations of dollar values were done by the annual average using the data from the site "investing" (Investing.com, 2019) which provides information for the daily currency for every year. An injury simulation was also elaborated considering all the spheres of inspection (federal, state and municipal). Considering that 77% of the cattle in Brazil are slaughtered under a Federal Inspection System (SIF), the remaining (state and municipal slaughtering) comprise 23% of slaughtering houses. Thus, we considered the possibility that the number of injuries followed the same pattern regardless the type of slaughtering house, to estimate losses for the whole country (Table 4). For the state of Rio Grande do Sul, the simulation was similar and we took into account that 49% of slaughtering occurs at establishments under the State Inspection System, 39% under the Federal Inspection system, and 12% under the Municipal Inspection Systems. For the simulated values presented in Table 5, the values of 39% and 12% for the other inspection spheres were added.

**Table 3.** Number of affected parts of bovine by parasitic causes evaluated at slaughter houses by the Federal Inspection establishments (SIF) and in the state of Rio Grande do Sul by the State Inspection Establishments - DIPOA (Animal Products Inspection Division).

Affected part	Inspection sphere*	Quantity (unit)	Quantity(kg)
Head (muscle)	Federal (SIF)	62,792	163,259
	State/DIPOA	17,582	45,713
Carcass	Federal (SIF)	20,034	4,547,718
	State/DIPOA	5,180	1,243,200
Heart	Federal (SIF)	77,428	100,656
	State/DIPOA	64,532	85,182
Diaphragm	Federal (SIF)	1,989	2,386
	State/DIPOA	473	567
Esophagus	Federal (SIF)	7,469	4,481
	State/DIPOA	826	495
Liver	Federal (SIF)	767,686	3,608,124
	State/DIPOA	1,183,763	5,587,361
Intestine	Federal (SIF)	3,146	28,304
	State/DIPOA	212,908	1,914,042
Tongue	Federal (SIF)	51,766	67,295
	State/DIPOA	2,721	3,618
Lungs	Federal (SIF)	203,973	444,661
	State/DIPOA	259,188	565,029
Kidneys	Federal (SIF)	45,461	36,368
	State/DIPOA	10,559	8,552

\*Evaluated period SIF: 2012 to 2015. Evaluated period DIPOA: 2014 to 2018.

**Table 4.** Amount lost due to bovine slaughter condemnations due to parasitic diseases in establishments under Federal Inspection in Brazil, from 2012 to 2015, in million dollars.

Condemnation	Year				Annual average	Loss simulation* (adding 23%)*
	2012	2013	2014	2015		
Cisticercosis	3.4	2.5	2.4	2.1	2.6	3.3
Hidatidosis	0.6	0.5	0.4	0.5	0.5	0.6
Fasciolosis	1.1	0.9	1.0	1.1	1.0	1.3
<b>Total</b>	5.1	4.0	3.9	3.7	4.1	5.2

\*Considering that the number of injuries followed the same pattern regardless the type of slaughtering house we can simulate adding 23% (state and municipal slaughtering).

**Table 5.** Value lost due to bovine slaughter condemnations due to parasitic diseases in establishments under State Inspection in Rio Grande do Sul, from 2014 to 2018, in million dollars.

Condemnation	Year					Annual average	Loss simulation* (adding 51%)*
	2014	2015	2016	2017	2018		
Cisticercosis	1.1	0.6	1.1	0.9	1.7	1.1	2.2
Hidatidosis	0.6	0.3	0.3	0.3	0.2	0.3	0.8
Fasciolosis	1.5	1.0	1.1	1.6	1.9	1.4	2.9
Esofagostomosis	0.2	0.4	0.4	0.6	0.6	0.4	0.9
<b>Total</b>	3.5	2.5	2.9	3.5	4.5	3.2	6.8

\*Considering that the number of injuries followed the same pattern regardless the type of slaughtering house we could simulate adding 39% under Federal Inspection System and 12% under Municipal Inspection System (51%).

## Results

### Data from Federal Inspection Service (SIF) in Brazil

During the studied period, 97 million bovines were slaughtered nationwide in slaughterhouses under Federal inspection. Among their carcasses, more than 1.2 million parts were condemned only due to parasitic causes during post-mortem inspection (Table 3). There was an average annual loss in SIF establishments of 2.6 million US\$ for cysticercosis, 529 thousand US\$ for hydatidosis, and more than 1 million US\$ due to fasciolosis (Table 4). Although cold treatment of cysticercosis-infected carcasses is the most effective and commonly used method, it costs 23.27 US\$ per animal, which also represents a significant economic loss in the production chain (Rossi et al., 2014). If we consider all parasitoses that result in condemnations, we have a total loss of 4.1 million US\$ per year (Table 4). The result of the simulation, when considering all inspection spheres, shows a total loss of 5.2 million US\$ (Table 4).

### Data from State inspection system in Rio Grande do Sul

Considering only Rio Grande do Sul state, in its state inspection establishments (DIPOA), where most animals are slaughtered, there were high values of average annual loss, such as 1.1 million US\$ for cysticercosis, 391 thousand US\$ for hydatidosis, 458 thousand US\$ for esophagostomosis and the 1.4 million US\$ loss for fasciolosis (Table 5). The simulation shows 6.9 million US\$ lost total, considering that all cattle slaughtered in the other spheres would have the same condemnation occurrence pattern (Table 5).

## Discussion

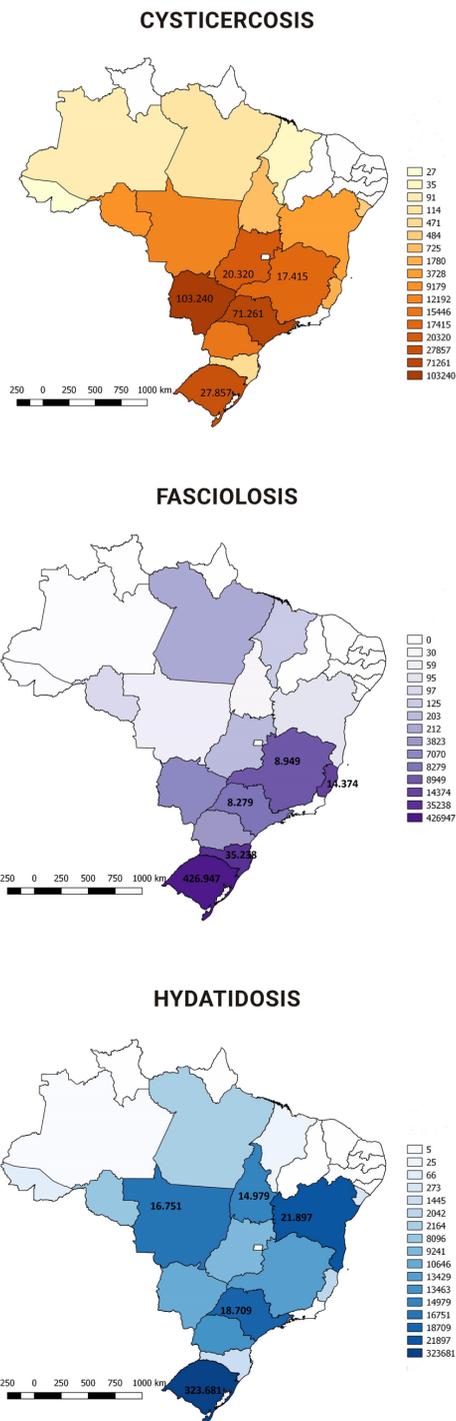
Lesion numbers should be analyzed together with the number of slaughtered animals in order to not overestimate or underestimate disease rates. Spatial analysis, through occurrence maps, facilitates data analysis and interpretation. Table 6 shows the number of slaughtered animals per state in the period evaluated in SIF establishments. It is important to emphasize that states of Amapá, Alagoas, Ceará, Federal District, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Norte and Roraima were not included in the survey since only animals slaughtered under Federal inspection were considered, and in these States, there were no SIF establishment assets during the period studied. These places are likely to have the diseases studied; however, it would be necessary to evaluate the state and municipal inspection services, since they constitute the total slaughtering in these regions. It's also important to know that parasitosis occurrences measured through slaughterhouses do not exclusively reflect local health situation as, sometimes, cattle from one locality are slaughtered in the nearby state, and not in their state of origin.

**Table 6.** Cattle slaughtered in Brazilian states between 2012 and 2015 under Federal Inspection System (SIF).

Brazilian State	Number of cattle slaughtered (2012-2015)
Mato Grosso	19,161,088
Mato Grosso do Sul	14,482,660
São Paulo	11,497,265
Goiás	11,338,688
Minas Gerais	8,955,119
Rondônia	8,237,842
Pará	7,211,599
Tocantins	4,190,147
Paraná	3,951,466
Rio Grande do Sul	2,860,143
Bahia	1,876,104
Maranhão	1,628,181
Acre	1,029,364
Santa Catarina	401,791
Amazonas	193,705
Sergipe	171,414
Espírito Santo	18,196
Total	97,204,772

### Cysticercosis

SIF data shows that, in absolute numbers, the state that had the most animals affected with cysticercosis-compatible lesions was Mato Grosso do Sul, with 103 thousand cases, and was second in number of animals slaughtered. In São Paulo state, there were 71 thousand cases, occupying the second place in number of lesions, and this was the third state in the number of slaughtered animals. Special attention should be given to Rio Grande do Sul's numbers, because even though it was in tenth place for slaughtered animals in SIF establishments, it has had the third largest number of cysticercosis lesions, with 27 thousand cases. In figure 1 this distribution can be observed.



**Figure 1.** Brazilian Maps showing the number of cysticercosis, fasciolosis and hydatidosis lesions in cattle, by state, between 2012 and 2015, highlighting highest occurrence states.

Cysticercosis studies in cattle in RS shows a prevalence between 2.5%, in the recent studies (Teixeira et al., 2015), and 4.6%, in older studies (Corrêa et al., 1997). There is a predominance of extensive breeding, often in small field areas, contributing to greater contact between humans and animals, as well as human excrement through pasture and water courses through an inadequate disposal of sewage in rural areas. In Brazil's Southeastern and Midwest regions there is an increase in cattle confinement systems (Nieto et al., 2012; Felipe et al., 2014). This system limits livestock contact with human waste, and generally corresponds to large areas of business with greater attention to basic sanitation. This is a possible explanation for a relatively higher number of cysticercosis lesions in RS state.

In Rio Grande do Sul state the region that sends most animals with cysticercosis lesions, in absolute numbers, is the southwest region. However, this is the region with the highest number of cattle being sent to slaughter. When analyzing the percentage of animals with cysticercosis lesions destined to slaughter in the state, we have a different result, as can be seen in Figure 2. Regions in the north and northeast were sent the most animals with cysticercosis (in relation to the number of animals sent to slaughter). According to a previous study conducted by Aragão et al. (2010), there are large number of cases in regions with indigenous communities, which was compatible with what found in this research.

The same situation was also observed in mountainous regions of the state. This data corroborates with a study by Nieto et al. (2012), which showed that smaller properties and those closer to urban centers had a higher risk of cysticercosis infection, and animals in dairy farms (main activity in the region) remain longer on the property compared to those on beef cattle properties.

### Fasciolosis

In the present study, SIF losses were around 1 million US\$ over the course of each year from 2012 to 2015. In Rio Grande do Sul analyses (DIPOA DATA), losses were expressive, especially in the years 2017 and 2018 (1.6 and 1.9 million dollars), which can be explained by the rainfall index of previous years. It rained 3.114 mm in 2015 and 2.141 mm in 2016, and both values were higher than the average for the state, which was usually close to 1.500 mm (INMET, 2018). A high rainfall index contributes to maintenance of wetlands even during the summer, contributing directly to the survival of the intermediate host, a snail of genus *Lymnaea*.

Literature data on carcass weight reductions due to this disease added to losses from discarding livers were considered different from this study, in which only losses due to organ condemnations were recorded. It was also found by the authors that the losses were constant over the years, demonstrating that there has not been adequate control of this parasite, and that in the following years, it is probable that the same number of animals will remain at risk. Data for the whole country shows an extremely higher occurrence of fasciolosis in the southern states, especially RS, which holds 84% of the Brazilian fasciolosis lesions (Figure 1).

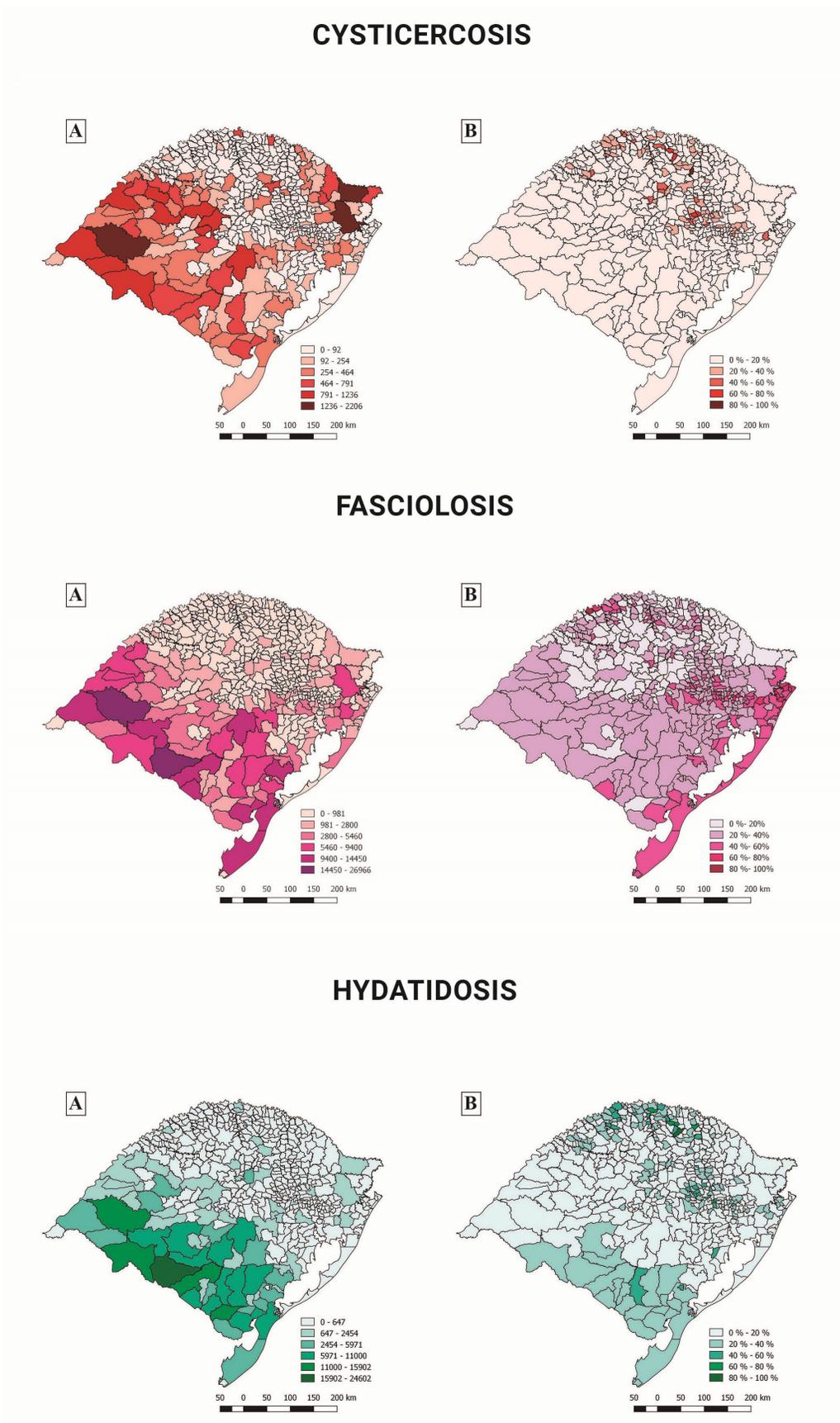
Beck (1993) investigated the presence of *Fasciola* spp. eggs in cattle feces and also observed highest occurrence rate in the southern states followed by São Paulo, Minas Gerais and Rio de Janeiro, similar to what was found in this research. This zoonosis is frequent in Rio Grande do Sul, as it finds ideal conditions for its proliferation. Besides the temperature, the physiographic condition with flooded areas, the presence of invertebrate hosts and management techniques such as breeding and fattening animals in rice growing areas contributed to the development of this disease in the southern region of Brazil specially in south and southeast of Rio Grande do Sul state (Cunha et al., 2007; Dutra et al., 2010).

When analyzing the map of slaughtered animals in Rio Grande do Sul state inspection establishments that presented lesions of fasciolosis, it can be observed that in absolute numbers the southwest region presents the highest value (Figure 2), showing the same patten observed when evaluating cysticercosis.

The epidemiological survey of this disease in each region is essential for planning an appropriate control. The impact of diseases such as fasciolosis deserves more attention, and the compilation of information on the evolution of occurrences can be used to predict future events, allowing preventive interventions (Molento & Pritsch, 2018).

### Hydatidosis

Southern Brazil is considered a hyperendemic zone, both for domestic ruminants and for humans. In Rio Grande do Sul, hydatidosis is a serious public health problem, especially in municipalities bordering Uruguay or Argentina, due to the sheep herding in the region. Clandestine slaughter and the access of dogs to hydatid cyst infected viscera is the main reason for the large number of cases of this parasitosis (Tessele et al., 2013). The



**Figure 2.** Slaughtered cattle between 2015 and 2018 in establishments under state inspection that presented cysticercosis, fasciolosis and hydatidosis compatible lesions. "A" is the total number of animals that presented lesions. "B" is the percentage of animals that presented lesions in relation to the total sent to slaughter.

intercropping of cattle with sheep and the use of the dogs in rural work, a common practice in Rio Grande do Sul, contributes to the maintenance in both species, bovine and ovine. Public policies in other countries, such as New Zealand (Lawson, 2010) and Uruguay (Cóppola, 2013), significantly reduced cases of this parasitosis showing that this also must be done in Rio Grande do Sul state for an improvement in animal and public health.

In SIF analysis, Rio Grande do Sul state, despite being in 10th place in the number of bovine slaughtered in establishment under Federal Inspection, it represents the state with the highest number of animals affected by hydatidosis, with 323 thousand cases, followed by other states with lower numbers, such as Bahia with 22 thousand cases and São Paulo with 18 thousand cases (Figure 1). When we analysed data only for Rio Grande do Sul state, in DIPOA establishments, it is possible to verify that the highest number of affected animals was in the southern border region (Figure 2), as already analysed by Paz (2004).

## Conclusions

The analysis clearly demonstrated that the economic impact of parasites is extremely high, even though they are controllable through management techniques and sanitary procedures. There is still a lack of data from municipal inspection slaughterhouses, which would make this impact even greater. The information contained in this study emphasizes the importance of food inspection work and shows that investments in this area could bring a return in reducing condemnations, especially in Rio Grande do Sul state.

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