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Chapter

Sustainable Production of Certified Beef Cattle Farming in the Pantanal

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Abstract

The Pantanal is a Brazilian biome with a peculiar beef cattle production system. In November 2018, the Government of Mato Grosso do Sul, Brazil, approved legislation that made the tax incentive for organic and sustainable meat production official. Despite the initial difficulty in organizing the production chain and, in parallel, going through 2 years of pandemic, in 2022 the production system was consolidated. In order to evaluate the progress of the sustainable and organic meat production system in the Pantanal, data from nine slaughterhouses accredited by the Pantanal Sustainable Livestock Program were subjected to unstructured modeling using the K-means method. Two groups were identified (C1 and C2). The first (C1) had a smaller number of animals per batch, and most batches had females. Group C2 had a larger number of animals, mainly males. C1 and C2 received, respectively, 53 and 47% of the total tax exemption (BRL 8,495,587.53). The development of a sustainable livestock system with quality and certification for bovine at slaughter proved to be an important option for the development of livestock farming in the Pantanal.

Keywords: beef cattle, production systems, livestock development, unstructured modeling, wetland

1. Introduction

The term sustainable agriculture is used to describe everything from organic farming to conventional agriculture that maximizes economic returns with minimum environmental impact. However, the concept of sustainability is based on a holistic philosophy with a series of principles and values, which also involves specific practices [1]. Currently, a large portion of the world's population is concerned about the use of chemical compounds, growth promoters, and chemical additives in animal production. In addition, it is important to consider aspects related to animal welfare and environmental conservation, among others, which are negatively associated with more intensive livestock production systems, leading some consumers to increasingly choose to consume organic products [2].

Data from the Brazilian organic food market since the 1980s were analyzed [3]. These authors found that a social ideology and initiatives opposed to conventional

agriculture were the basis of the organic production systems. However, as the patterns of supply and demand changed, particularly in the last 25 years, the expansion of the organic products market has gone beyond ideological motivation. The Brazilian agribusiness sector has been adapting to this reality. The main reasons for this expansion are changes in the awareness of Brazilian consumers. A substantial number, especially in large cities, are concerned about nutritional quality and aspects of the production systems of the food they eat.

According to Ref. [4], in the Brazilian case, the dissemination of sustainable practices in the beef chain is desirable to provide coordination for the organization of production, processing, and distribution, which generates opportunities for the development of sustainable livestock farming. In 2004, WWF-Brazil and the Brazilian Association of Organic Producers (ABPO) launched the Sustainable Livestock in the Pantanal project. The certified organic livestock farming in this region was grounded in three pillars, namely environmental conservation, animal welfare, and decent working conditions. These are the premises of all organic and sustainable meat protocols [5].

The competitiveness of the organic production chain is currently achieved through product differentiation strategies. In the beef chain in Rio Grande do Sul, a Brazilian Southern state, there was a need to establish partnerships between the agents in the chain to obtain a differentiated product [6]. This is in line with the process underway in Mato Grosso do Sul, a state in the Center-West region of Brazil, where ABPO, WWF-Brazil, different private companies, and the state government are establishing strategic partnerships to develop the production chain.

In 2018, the government of the state of Mato Grosso do Sul approved legislation that formalizes the tax incentive to produce organic and sustainable meat. It created the Subprogram to Support the Production of Sustainable Meat in the Pantanal, within the scope of the Mato Grosso do Sul Livestock Advancement Program (PROAPE), through a joint resolution of the State Secretariat for Finance and the State Secretariat for the Environment, Economic Development, Production, and Family Agriculture [7]. This resolution defines that “PROAPE Sustainable and Organic Meat of the Pantanal aims to foster competitiveness and encourage low-environmental-impact cattle farming in the Pantanal, stimulating production based on the traditional model, with a low level of intervention in the region’s natural resources, and using technological scopes for characteristic and differentiated product lines with greater added value, duly certified by independent third-party companies, accredited by Inmetro¹”. Basically, the awards for certification are:

1. For the organic system (following the organic production legislation determined by Federal Law No. 10831), an exemption of 67% of the Tax on Circulation of Goods and Provision of Services (ICMS); and
2. For the sustainable system (adoption of the ABPO protocol) exemption of 50% of the Tax on the Circulation of Goods and Services (ICMS²).

Cattle ranchers from the Pantanal region created ABPO. They aimed at standardizing their production to meet the requirements of the Certified Organic Livestock.

¹ Inmetro is the acronym of the Brazilian National Institute of Metrology, Standardization and Industrial Quality.

² ICMS is a state tax under Brazilian state administration.

This was fulfilled by embracing the statements of quality, social and ecological responsibility, and sustainable development in their activities. They established a protocol managed by the Brazilian Confederation of Agriculture and Livestock (CNA³), which must be adopted and applied by producers in their livestock production systems. The protocol was developed primarily for heifers raised in the Pantanal; the age range for slaughter is 2.8–3 years, the latter being the maximum age allowed [5]. The use of herbal medicines and homeopathy are the preferred breeding practices. The use of urea as fertilizer or as an element mixed in any type of supplement is prohibited. In the Pantanal, fattening is limited due to logistics issues. In addition to the strong dependence on the cyclical factors of the price of cows and steers and the abundant supply of pasture, which does not occur every year due to the more severe floods, restricting the grazing areas. The animals are taken by groups to finishing farms, where they remain for around 4 months in semi-confinement or confinement. After this period, they are slaughtered in a specific meatpacking plant prepared for deboning in accordance with the specificities of the sale. Afterwards, the meat receives its own packaging and identification of sustainable or organic origin from the Pantanal, and then the partner private company is responsible for selling and distributing it.

Considering this brief context, the aim of this chapter is to evaluate the progress of the sustainable and organic meat production system in the Pantanal, using data from farmers under the Pantanal Sustainable Livestock Program, for the period 2019–2022. We propose here an unstructured modeling approach using the K-means method to cluster these observations.

1.1 Livestock in the Pantanal

All links in the beef cattle production chain face a considerable challenge in achieving a balance between economic viability, environmental responsibility, and social acceptability to ensure the sustainability of meat production [8]. Data regarding the balance of these factors should generate information, which is fundamental and is part of the concerns of more conscious consumers [9]. This is more noticeable in biomes with peculiar characteristics, such as the Pantanal (**Figure 1**). Pantanal is located in the central-western region of Brazil. It is an immense sedimentary plain, with an area of 138,183 km², 65% of it in the state of Mato Grosso do Sul state and 35% in the state of Mato Grosso. It is bordered to the north by the southern formations of the Amazon rainforest (near the municipality of Cáceres); to the east, by the cerrados of the Brazilian central plateau; to the west, by the wetlands of the Bolivian-Paraguayan borders; and to the south, through the Chaco forests, on the border with Paraguay.

Pantanal of Mato Grosso, such as the sub-regions of Nhecolândia, Paiaguás, and Miranda, among others, do not have any rock formations on their surface. The slope of the region is very small, which contributes to the prolonged retention of water on the soil surface during river and rain floods. The number of rivers that run through the region is considerable, with the Paraguay River being the most important one. It flows from North to South and runs through the entire region, extending 2730 km from its sources to its confluence with the Paraná River at the border between

³ CNA represents small, medium, and large Brazilian rural producers and is responsible for bringing together associations and political and rural leaders throughout the country.

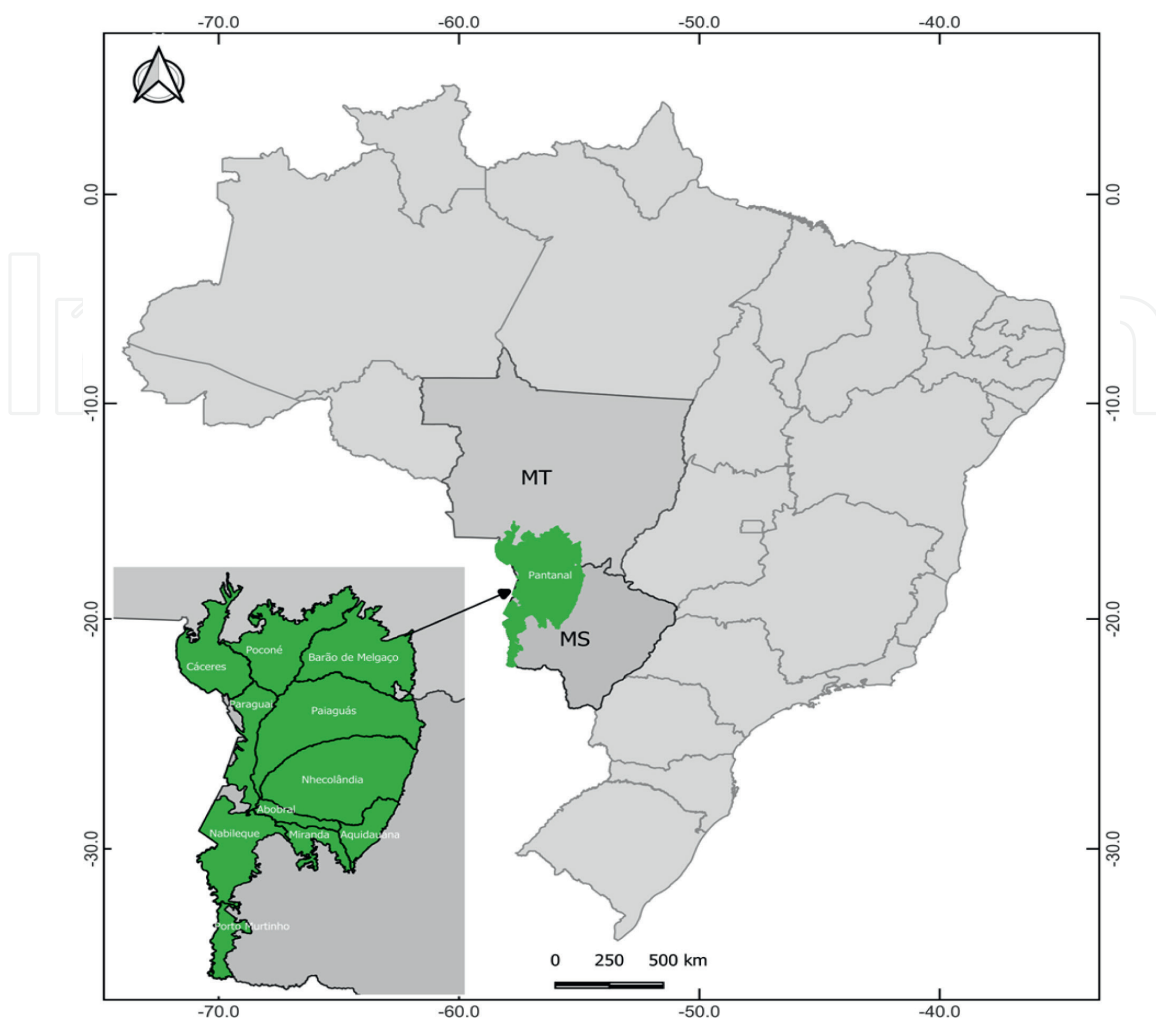


Figure 1. Location of the Pantanal and sub-regions in Brazil. MT is the acronym for the state of Mato Grosso and MS for the state of Mato Grosso do Sul. Source: Developed by the authors.

Argentina and Paraguay, forming the Upper Paraguay River Basin. The Negro, Miranda, Aquidauana, Bento Gomes, Taquari, Nabileque, Cuiabá, APA, etc., rivers flow directly into the Paraguay River. In addition to these, the Pantanal is home to a number of other rivers, including the Piquiri, Itiquira, and São Lourenço.

The vegetation covering the Pantanal is varied. The name ‘Pantanal Complex’ is used to define it. The region includes cerrado, clear grassland, dirty grassland, marshes with hydrophilic vegetation, subdeciduous tropical rainforests, and others. There are several plant communities with a clear dominance of one species, with the plant community being named after the dominant species (e.g., canjiqueiral, caronal, paratudal, etc.).

The origin of cattle farming in the Pantanal dates to the seventeenth century, with two major periods identified by the type of cattle [10]. Before the beginning of the twentieth century, Iberian cattle, locally called Tucura or Bovino Pantaneiro, predominated. The second period begins with the replacement of Tucura cattle by Zebu cattle [11]. The average ranch size decreased over time. By the end of the nineteenth century, the largest ranches ranged between 100,000 and 400,000 hectares, and by the end of the twentieth century, the figures were from 1000 to 10,000 hectares for most of the ranches [10].

On the other hand, cattle have increased in the same period, from about 700,000 to over 5 million [10]. Cattle production is still the main economic activity in the

region, developed in more than 50% of the total area of the Pantanal, with the predominance of calf rearing. In this context, [11] reinforced that Pantanal is a provider of calves to other areas, concentrated on cow-calf farming, and with cattle management adapted to the flood regime. Sustainable intensification is seen by [11] as the way to increase cattle production efficiency.

2. Methodology

After the PROAPE decree in November 2018, systematic data collections were carried out between January 2019 and December 2022 on the number of slaughters in the two certification protocols. We considered the count of the number of animals slaughtered as the dependent variable. We used Loess regression methodology [12] to fit the trend curves. Non-parametric regression analysis, as the Loess local regression method, estimates a function without reference to a pre-defined functional form. In local regression, a change in perspective occurs. Since the functional form is not previously established, the estimated curve takes on the central role in the analysis. Therefore, a central aspect of local regression is visualization. In other words, the “data speak for themselves.” This characteristic is interesting because, often, theoretical analysis does not establish the structural form among the variables [12, 13]. The Gretl econometric analysis program was used to perform modeling using the Loess regression method [14].

In the period 2019–2022, in parallel, 78,533 head of cattle were slaughtered, distributed in 864 lots. We used data from nine slaughterhouses accredited by the Pantanal Sustainable Livestock Program. During the period, the total tax exemptions (premium in BRL) for each lot of animals slaughtered were also recorded. The data were organized and subjected to descriptive analyses to verify frequencies, trends, dispersions, and positions. The unsupervised K-means clustering method [15] was then used. The method aims to partition the observations into K groups, in which each observation belongs to the cluster with the closest mean (centroid). This results in groups in the data space, and the observed groupings minimize the variances within the cluster [15].

3. Results

Figure 2 shows the behavior of the number of slaughters and the tax exemption received by producers who chose to develop the certified Organic Protocol. The observed trend was growing until mid-2020. After this period, there was a progressive decrease, as observed in the Loess regression. The average premium per slaughtered animal was BRL 157.76.

Although the tax exemption for organic certification is 67% of the ICMS (greater than the exemption for the Sustainable Protocol, which is 50%), the number of animals in this certification has clearly been decreasing. The estimated Compound Growth Rate (CAGR) was negative, at -12.5% , meaning that there was a decrease in the number of slaughters. The conversion of traditional systems to the organic system for beef cattle in Spain, using the Global Conversion Index (GCI), and the legal requirement for European organic farming were analyzed by [2]. This author concluded that farms needed to introduce significant changes before starting the conversion process. He also showed that cross-cutting support measures are relevant,

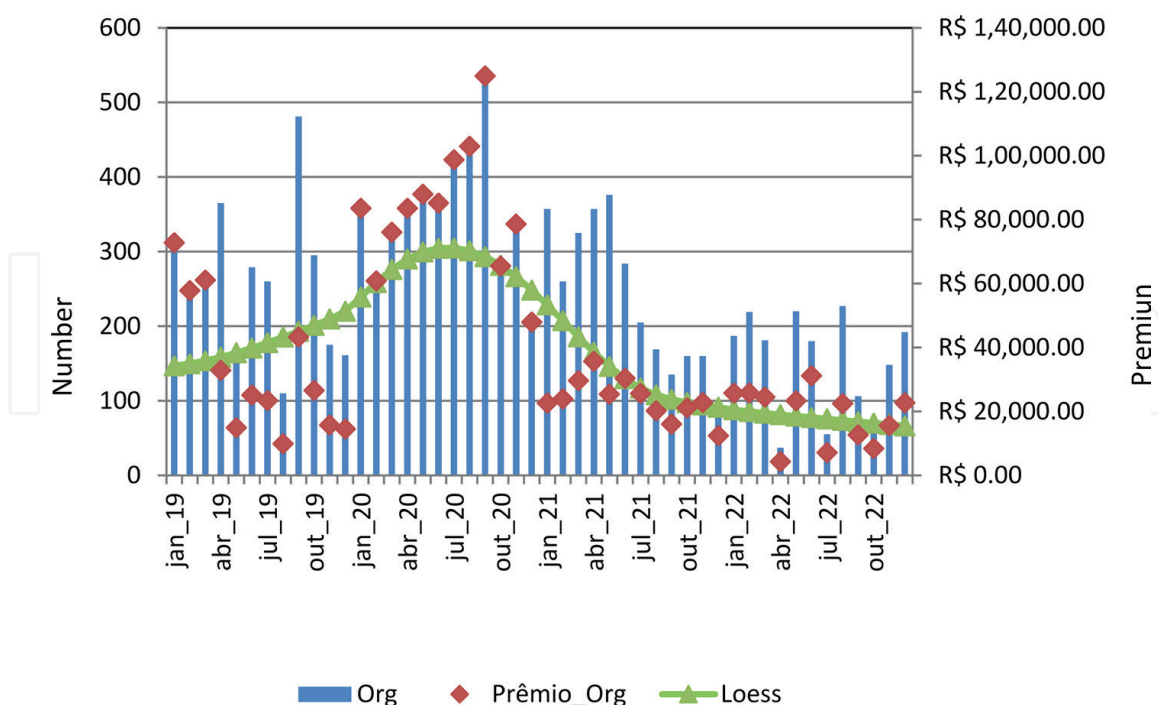


Figure 2. Number of animals slaughtered (*Org*), tax exemption obtained (*Prêmio_Org*), and the trend over time (verified by the non-parametric Loess regression methodology) of the organic protocol in the Pantanal. Source: Developed by the authors.

such as raising consumer awareness of organic food and willingness to pay premium prices. On the other hand, in Mexico, [16] found that the complicating factors for adherence to the organic system were sustainable pasture management and ecological management, since producers do not receive consultancy and/or training for the implementation of organic process management on the property.

In the Pantanal, the increase in the scale of production will probably also be adhered to with better communication of the product to consumers and with the arrival of technological information to a greater number of producers. This is despite this protocol being stricter, especially with the prohibition of the use of urea in nutritional inputs and the obligation not to use transgenic grains. The slaughter of animals with the Pantanal sustainable meat protocol has seen a marked upward development, probably because of its flexibility in relation to veterinary and zootechnical practices, as can be seen in **Figure 3**.

After the period of organization of the production chain by producers and slaughterhouses and the pandemic period (2020 and 2021), it was possible to observe the growth of the scale of production and slaughter. The total accumulated exemption reached the value of BRL 14,597,206.75. There was an increase in slaughters in the periods of 2020, 2021, and 2022, with a total of 9265, 37,796 and 76,593, respectively. The positive CAGR was calculated at 102.2%. The average premium received by producers per animal slaughter was BRL 115.29.

The total value of the exemption passed on to the producer was BRL 8,495,587.53, with two groups observed: C1 with 716 lots of 42,871 head of cattle, and C2 with 148 lots with 35,662 head of cattle. Considering the variables number of animals and the total exemption in each lot, the two groups can be graphically observed in **Figure 4**.

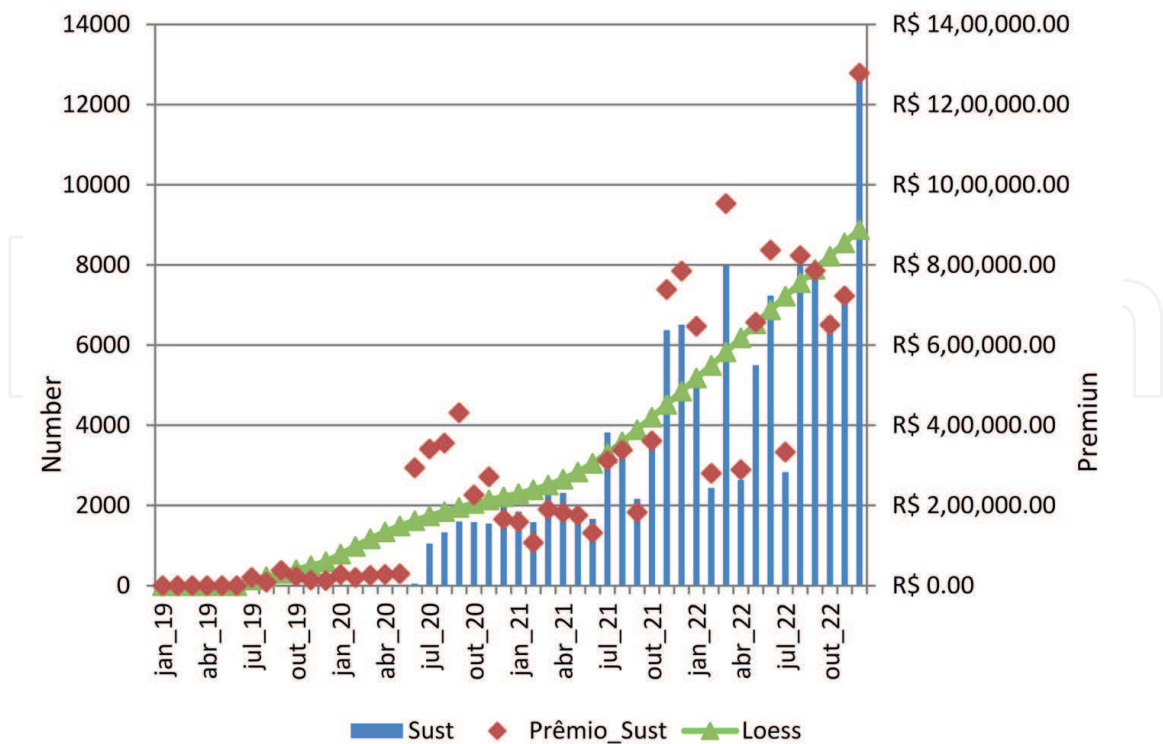


Figure 3. Number of animals slaughtered (Org), tax exemption obtained (Prêmio_Org), and the trend over time (verified by the non-parametric Loess regression methodology) of the sustainable protocol in the Pantanal. Source: Developed by the authors.

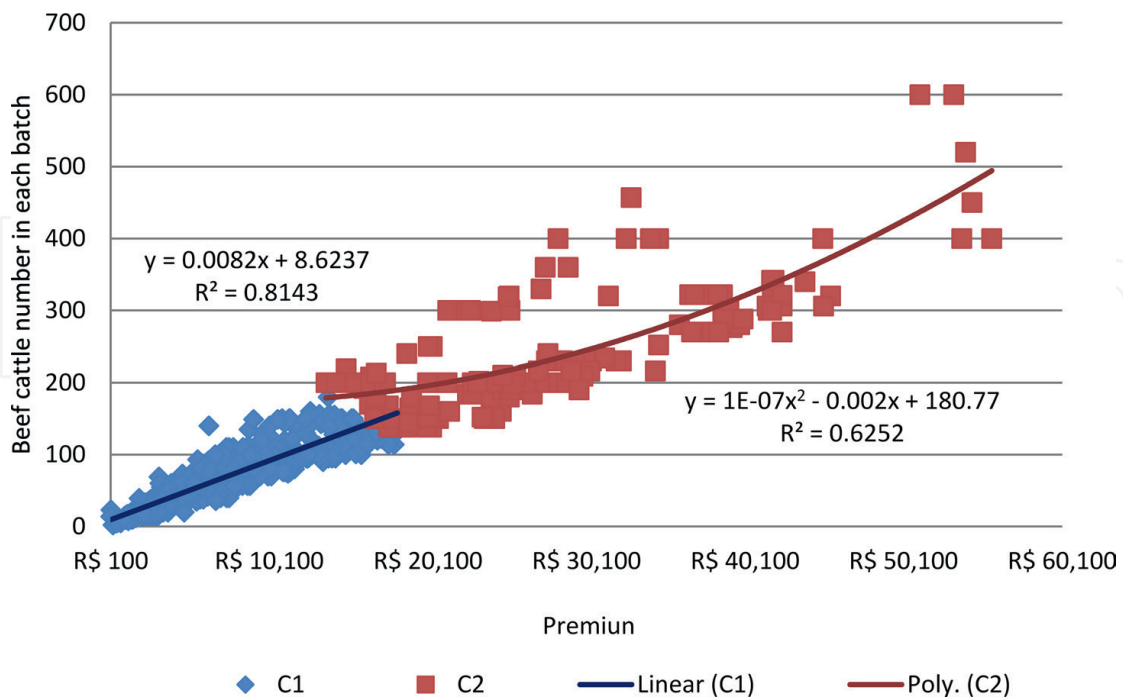


Figure 4. Graphical representation of the two groups (C1 and C2) of lots of animals slaughtered in 2022, according to the number of heads of cattle in the lot and the premium received for each lot. Source: Developed by the authors.

As expected, the lots with the highest number of heads of cattle at slaughter were the ones that received the most tax exemption. In other words, 82.9% were slaughters with the lowest number of animals in the lot (C1), in contrast to lots C2, which represented 17.1% of the total lots in which there were heads of cattle slaughtered. On the other hand, despite the difference in the number of lots between the two groups, the total value of the tax exemption in the two groups was 52.6 and 47.4% for groups C1 and C2, respectively. This means that, despite the much larger number of lots in group C1 compared to C2, the exemptions are relatively similar, probably due to the greater number of animals slaughtered in each lot, especially males (**Table 1**).

In lots with male slaughter, in which there is a greater burden of slaughter, the financial return from the public policy of exemption was much higher (64.2%) when compared to the slaughter of females (35.8%). This fact can be a direct consequence of PROAPE. As reported [17], organic certified slaughters were mainly of females from 2013 to 2016, before the decree of November 2018. Therefore, there was a complete change in the profile of certified producers, with a significant slaughter of males; 54.1% of the slaughters occurred in the period evaluated, totaling 42,498 males (**Table 1**), in relation to the total of females (36,035 animals, 45.9%).

The marketing strategy of slaughter lots also has its own characteristics. The lots of females are smaller but more numerous. Groups C1 and C2 presented 363 and 52 lots, with 62.2 and 258.79 animals per lot and 22,578 and 13,457 head of cattle, respectively. For males, the situation is the opposite, as groups C1 and C2 presented 353 and 96 lots, with 57.49 and 231.3 animals per lot and 20,293 and 22,205 head of cattle, respectively. In group C1, there was a great number of lots with few animals, especially females. In C2, we may see the opposite: a great number of animals per lot, but a smaller number of lots, especially males. This fact may be a function of the producers' marketing strategy, which, considering the greater weight of males, opted to sell in larger lots and, thus, achieved higher premium values.

The November 2018 decree was instrumental in establishing the system for producing beef cattle with sustainable and organic certification. In 2019, producers began organizing the production chain. Despite all the changes caused by the COVID-19 pandemic, which affected all links in the agricultural production chain, the Pantanal's sustainable and organic meat chain performed well in 2020 and 2021. Even though the uncertainties experienced by economic agents led to tensions with imbalances in the market, farmers adjusted, adapting demand throughout the process. In 2022, it was possible to verify the organization and maturity of the production chain. In this sense, it is already possible to identify points that need changes to promote the

Cluster		Premium	N	Batch	N/Batch
C1	F	BRL 1,919,533.71 (22%)	22,578	363	62.20
	M	BRL 2,547,870.05 (30%)	20,293	353	57.49
C2	F	BRL 1,123,900.67 (13%)	13,457	52	258.79
	M	BRL 2,904,283.10 (34%)	22,205	96	231.30
Total		BRL 8,495,587.53	78,533	864	

Source: Developed by the authors.

Table 1.

Sex of slaughtered animals, total tax exemption (Premium), number of animals (N), lots and number of animals per lot (N/lot) by groups (Cluster).

continuous improvement in efficiency. One possibility is deepening the analyses in the future, for example, using the input-output matrix method to observe the growth and decline rates of the economic aggregates of beef cattle farming with certification (inputs, agriculture, agroindustry, and agroservices) and thus design scenarios and better management practices [18].

4. Conclusions

The sustainable and organic meat production system in the Pantanal showed significant growth after the 2018 state decree. And despite the difficulties during the pandemic (2020–2021), in 2022 producers organized the links of the chain, and the public policy implemented strengthened and provided a new option for the development of Pantanal livestock farming. However, the two certifications that have tax exemptions through PROAPE have quite different adoption by ABPO producers. The Sustainable Protocol showed significant growth in the period analyzed. This was diametrically opposite to that seen with the Organic Protocol. This is probably because the Organic Protocol presents more restrictions regarding the use of veterinary and zootechnical inputs.

Protocols are dynamic processes and must incorporate sustainability strategies and policies for livestock farming that promote system certification, protect natural resources, do not harm the environment in the long term, and can offer effective and scalable solutions. The future of sustainability and food security faces many challenges. To succeed, they must not be focused on one but on several strategies, and livestock farming itself must be part of the solution.

Conflicts of interest

The authors do not declare any conflicts of interest.

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