USE OF RESIDUE FROM THE PROCESSING OF BOVINE BLOOD IN PASTURE FERTILIZATION

https://doi.org/10.56238/sevened2024.032-002

Marcello Hungria Rodrigues[1], Danilo Corrêa Baião[2], Clarice Backes[3], Alessandro José Marques Santos[4], Arthur Gabriel Teodoro[5] and Danilo Augusto Tomazello[6]

ABSTRACT

Pasture in Brazil is of great importance for Brazilian cattle farming, due to its wide practice, but the current scenario of pastures is one of degradation. Due to the urgency of correcting it, fertility correction is extremely important. Chemical fertilization is commonly used for this purpose, however, due to the finite character of many of these sources, sustainable alternatives are sought. The use of agro-industrial waste, as long as it has a chemical composition of interesting agronomic interest and ease of transport, because, under these conditions, the use of these wastes becomes cheaper and allows environmentally correct disposal for these wastes that are often discarded in a harmful way. The meatpacking industry represents a major generator of organic waste, due to the high number of units in Brazilian territory. The blood generated from the red line is used to make blood meal, widely used in animal nutrition, and from this processing a waste is generated, which is treated and discarded under application in the soil.

Keywords: Fertilization. Fodder. Nitrogen.

[1] Master in Sustainable Rural Development - State University of Goiás - UEG
[2] Graduating in Animal Science - State University of Goiás - UEG
[3] Dr. in Agronomy – Profa. State University of Goiás – UEG
[4] Dr. in Agronomy – Prof. State University of Goiás – UEG
[5] Dr. in Animal Science – Prof. State University of Goiás – UEG
[6] Dr. in Animal Science – Prof. State University of Goiás – UEG

INTRODUCTION

Soil is considered a base ecosystem for any type of production system, whether for agriculture or livestock. Pastures make up about 20% of the country's area that is destined for agriculture (MOUZINHO et al., 2022). Its wide use is due to the fact of expressive animal production, exclusively on pasture in Brazil.

However, forage production in Cerrado regions suffers from challenges related to abiotic factors, especially the soil issue, since they are characterized by low natural fertility, with reduced levels of nutrients such as phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and sulfur (S), in addition to low water retention capacity due to low levels of organic matter (HUNKE et al., 2015; BECK et al., 2018).

In this way, to get around this situation, it is necessary to replace nutrients via chemical fertilizers. Fertilization of pastures is necessary in order to increase the capacity of pasture use in grazing systems (BATISTA and MONTEIRO, 2008). However, inorganic sources naturally have a high acquisition cost and, with the global crises caused by the pandemic scenario associated with wars, impact on exorbitant increases in the acquisition of these fertilizer sources, which can harm food security and the economic viability of the production system (ALLAM et al., 2022). According to Silva et al. (2011), it is important to use alternative fertilizers that present viable costs and sufficient supply, thus creating a new source of nutrients to be used in pastures, such as industrial waste.

According to Armstrong (2006), in a large part of human activities, waste is generated such as garbage production, sewage treatment, industrial treatments, among others, so the use of organic waste as a source of nutrients in crops is an important alternative for sustainable reuse of waste generated daily in the country.

An example of industrial waste widely produced in the country is that of the meatpacking industry, generated through the slaughter of animals with bloodletting. The blood from slaughter is processed to be used in animal feed, fertilization and by the pharmaceutical industry (ROCHA MARIA, 2008).

According to Brito and Santos (2010), the use of animal waste as a source of nutrients is an important alternative for preserving the environment, and slaughterhouse waste contributes to the addition of macro and micronutrients to the soil.

DEVELOPMENT

PASTURE SCENARIO IN BRAZIL

Brazil stands out on the world stage in terms of meat production, being one of the largest producers and largest exporter in the sector. Much of the production is based on pastures, as it is a practical and economical way to supply food to ruminants.

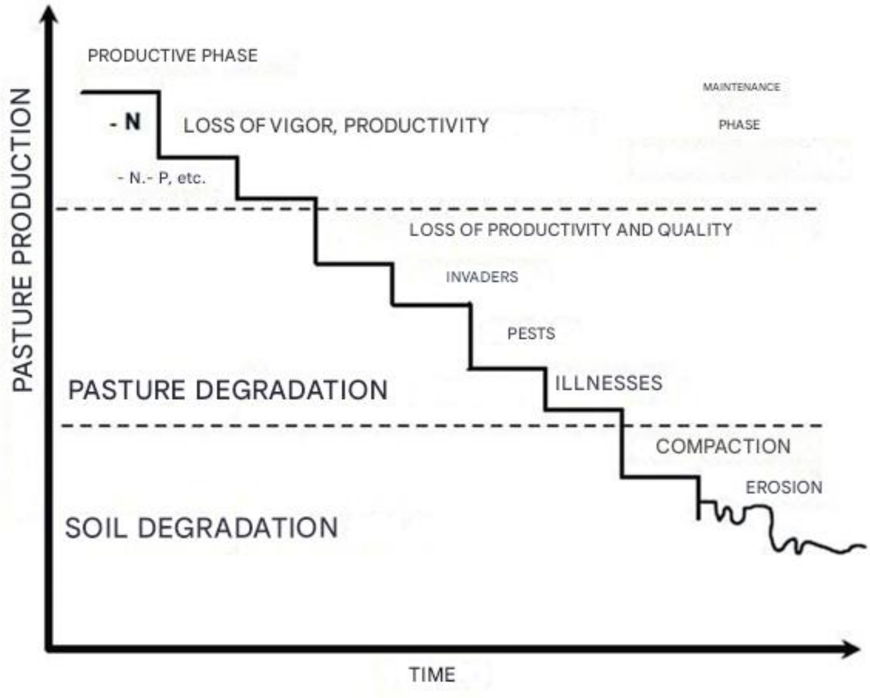
In the characterization of pastures managed and implemented in Brazil, *Uroclhoa brizantha* cv Marandu is widely used. *Uroclhoa* comes from tropical Africa that has excellent adaptation in Brazil due to its agronomic characteristics, having good acceptance by producers and its use is observed throughout the country. It is a perennial grass that has resistance to leafhoppers, high regrowth capacity, tolerance to drought, fire and cold, with better development in places whose temperature can vary between 20° and 30°C, and in relation to soil fertility it presents medium to high requirements (JUNIOR et al., 2015).

The productivity of Marandu grass varies around 8 to 20 t $^{\text{ha-1}}$ of dry mass per $^{\text{ha-1 year-1}}$ and can be recommended for sheep, buffaloes, goats and cattle for breeding, rearing and fattening, with good acceptability to rotational grazing strategies, silage techniques and hay production (SILVA et al., 2024). However, forage production in Cerrado regions suffers from challenges related to abiotic factors, especially the soil issue, since they are characterized by low natural fertility, with reduced nutrient contents, in addition to low water retention capacity due to low levels of organic matter (HUNKE et al., 2015; BECK et al., 2018), which is one of the causes of pasture degradation.

Peron and Evangelista (2004) reported in the early 2000s that approximately 80% of the pastures cultivated in the Cerrado presented some stage of degradation, compromising in addition to productivity the quality of the forage. However, this scenario has been changing over time. In the case of severely degraded pastures, there was a significant reduction, from 46.3 million hectares in 2000 to 22.1 million hectares in 2020. This improvement was seen in all biomes, with the Amazon (60%), Cerrado (56.4%), Atlantic Forest (52%) and Pantanal (25.6%) (MAPBIOMAS, 2020) showing the greatest retraction, but there are still large areas with some degree of degradation.

Pasture degradation can be understood as a continuous and degenerative process, with losses in vigor, which cause significant reductions in their productivity, culminating in soil degradation (Figure 1).

Figure 1. Scheme of the continuous process of pasture degradation. Source: Macedo (1999).



According to Macedo et al. (2015), the main causes of pasture degradation are related to improper management in their formation or the absence of management itself, with the main factors being the misuse of soil conservation practices, soil preparation, planting systems and methods, acidity correction and/or fertilization and the inadequacy of the stocking rate in the formation of pasture.

Nitrogen (N) deficiency in pastures is one of the main factors that can lead pasture to a state of degradation, since its availability is essential for the growth of forage plants. According to Werner (1994), N is one of the most important nutrients for forage plants, as it is responsible for the production of green matter in plants, participates in the constitution of proteins, and influences the photosynthetic process of plants due to its participation in the chlorophyll molecule.

Moreira et al. (2009) studying four doses of N applied to *Uroclhoa decumbens* Stapf grass. cv. Basilisk obtained results of 20.2 cm of pasture height for the dose of 150 kg $^{ha-1}$ and 20.4 cm for the dose of 300 kg ha1 of N, demonstrating that grass growth is influenced as a function of the dose of nitrogen fertilization.

Regardless of the nitrogen source, Santos et al. (2018) found an increase in dry matter, positively changing plant height and recovery of tiller density and other structural characteristics.

Nitrogen fertilization is one of the largest costs with fertilization of non-leguminous crops in the country (NUNES et al., 2015). Thus, the growing use of waste as an alternative for organic fertilization and low cost in plant production can be highlighted, which is specifically due to the high content of nutrients, carbon and organic compounds. Several types of residues can be used for crop fertilization, which in addition to reducing costs, can have a slow release and prolonged enrichment action on the soil (ABREU JUNIOR et al., 2005; JUNIOR et al., 2015).

GENERATION AND DESTINATION OF AGRO-INDUSTRIAL WASTE

Agroindustries have great representativeness, being responsible for processing primary products from agriculture, in products or by-products that are identified in the food industry, such as canned goods, slaughterhouses, biofuels, leather industry, textile production and several others (GONDIM, 2017), generating large amounts of waste every year (MAKRIS, 2007).

Waste generally has low levels of nutrients and biomass and high polluting capacity, which when disposed of or disposed of inappropriately in nature, in addition to polluting soils and water bodies, can cause public health problems. The high cost of treatment, disposal and transportation of this waste has a direct influence on the final value of the product or by-product generated by the agroindustry (ROSA et al., 2014).

Waste can be divided into two groups: organic and inorganic. Organic products are those obtained in industrial processing, or that contain organic raw material in one of the processing phases. The main organic waste generated by the agroindustry are animal waste, agricultural crop residues and wastewater sludge. Partially the waste is reused in the agricultural production cycle, but the vast majority is discarded in the environment without proper treatment, making it highly harmful to the environment (SIQUEIRA MELO et al., 2011).

In summary, the objectives of waste treatment between the year 1900 and the 70s were solid waste removal, biodegradable organic treatments and elimination of pathogenic organisms. However, from the 80s onwards, the focus was changed, emphasizing the characterization and elimination of constituents that cause prolonged effects on environmental impacts and public health (METCALF; EDDY, 2016).

The principles of the primary treatment of waste and effluents is the removal of solid particles and organic matter in a way that causes a decrease in the values of Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). BOD quantitatively represents the need for oxygen to balance the biodegradable organic matter (OM) present in the water by the activity of microorganisms. The COD quantitatively represents the oxygen required to balance the total OM in the water. High COD and BOD values represent highly polluting waste with complex treatment. In comparison examples, domestic sewage and pig manure have BOD values, respectively, 500 and 90,000 mg of oxygen per liter of waste (BERTONCINI, 2008).

Bertoncini (2008) also points out that primary treatments are flawed in relation to the removal of pathogens, N and phosphorus (P), whose levels must be within the standard for the discharge of waste into water bodies. Therefore, secondary treatments such as post-treatment and effluent disinfection are necessary.

In the mid-2000s, new technologies and knowledge were incorporating new sources of biomass in organic and organomineral fertilizers, such as agro-industrial waste, meeting part of the National Solid Waste Policy (PNRS) where it aimed to change from non-renewable sources to renewable sources. The PNRS also determines the treatment and exact destination of the waste produced during the production chains (CRUZ; PEAR TREE; FIGUEIREDO, 2017).

Normative Instruction No. 25 (MAPA) also refers to where each compound is defined within the organic fertilizer division, through the intrinsic characteristics and raw material of each compound. It defines the criteria for registration with the agency, and how each class can be arranged and restrictions on its use in agriculture (BRASIL, 2009).

In Brazil, the resolution of the National Council of Water Resources (CNRH) No. 54, puts into force the guidelines, modalities and general criteria for the practice of direct reuse of non-potable water throughout the national territory. According to the resolution, direct reuse is that in which water is taken to the point of use without being diluted in water bodies, underground or surface. In the third article, it contemplates the modalities for water reuse, such as reuse for urban, agricultural, environmental, industrial purposes, and in aquaculture (BRASIL, 2005).

Generation of waste in slaughterhouses

Brazil is known worldwide for its performance in agribusiness, being a major producer and exporter of grains and animal products such as meat and its derivatives. It is currently the world's largest producer of soybeans, coffee, sugar, and oranges, and also the largest exporter of beef and poultry in the world (CEPEA, 2024; SANTOS et al., 2023).

According to the Brazilian Association of Meat Exporting Industries (ABIEC), Brazil has the largest commercial cattle herd in the world, with approximately 197.2 million animals, representing about 12% of the global herd, distributed throughout the national territory. The states of the Midwest region, such as Mato Grosso, Mato Grosso do Sul and Goiás, together with Minas Gerais, are the ones that concentrate the largest herds in the country. In the 2023 annual report, ABIEC highlighted that Brazil recorded a total of 10.6 million tons of beef slaughtered (in carcass equivalent) and exported 2.29 million tons in the same period, most of which was composed of fresh beef, which corresponded to 89.93% of exports (ABIEC, 2024).

The slaughter of cattle in slaughterhouses implies the quality and added value of the meat, so humane slaughter is currently used, which is defined as a set of procedures that offer well-being to the animals from shipment to bleeding (GONÇALVES; SOUZA, 2017).

The first stage of cattle slaughter is stunning or stunning, which consists of bringing the animal to a state of unconsciousness so that it does not suffer from the bleeding process (SOBRAL et al., 2015). Bleeding consists of the section or cutting of the anterior aorta and the anterior vena cava, at the beginning of the carotid arteries and the end of the jugular veins located in the ventral region of the neck, so that the blood is drained from the animal's body (SILVA, 2011).

It is estimated that an adult bovine has 6.4 to 8.2 L of blood per 100 kg of live weight, and that an efficient bleeding should eliminate 50% of the total blood from the animal organism (KOLB, 1984). According to Alencar (1983), bovine blood is a physiological fluid composed of water, fat, carbohydrates, minerals and protein (17%).

Like most industries, with the slaughter of cattle, slaughterhouses are responsible for the generation of waste, which become serious environmental problems when they are released without any type of treatment into nature (ROCHA MARIA, 2008). The blood from the beheading of animals is characterized as a waste from the meatpacking industry, but it can be reused after treatment, such as dehydration of the blood to manufacture animal feed or fertilizers (ARAÚJO et al., 2016). For Pichek et al. (2014), the use of blood from slaughterhouses in agriculture can be a good alternative, given its high nutritional content, and stimulates the microbial activity of the soil, in addition to providing small producers with the opportunity to produce their own organic fertilizer.

FORAGE RESPONSES TO THE USE OF RESIDUES

Most industrial waste, when used correctly, can contribute to the physical, chemical and biological development of the soil, providing a favorable environment for plant development (MESQUITA et al., 2012). According to Pires and Mattiazzo (2008), for the use of residues in agriculture to be viable, it is important to know the agronomic efficiency of the residue used, and to observe the development of crops when some industrial residue is used as a source of fertilization.

The reuse of waste generated by the meatpacking industry in pastures can be an alternative for the use of by-products, which contributes to the improvement of economically viable techniques that protect the environment (DIM et al., 2010). Silva Neto et al. (2013) analyzed the application of liquid slaughterhouse residue (LPR) in a Quartzarenic Neosol cultivated with Marandu grass, and found a reduction in acidity and Al3+ contents and an increase in V% in the 0-10 cm layer and in the effective CEC in the 0.10-0.20 m layer.

Alonso and Costa (2017) verified the increase in the dry matter, green matter, height and bromatological characteristics of *Uroclhoa brizantha* cv. Xaraés, after the application of doses of dairy cattle manure, highlighting organic fertilization as a possible substitute for mineral fertilization, producing more sustainably.

Freitas et al. (2016) pointed out that bovine blood sludge (BSB) can be used as a soil corrector, mixed or not with carbonate and calcium oxide, but its use should be limited, due to the fact that its use can cause an exacerbated increase in pH; there was also a change in the contents of Ca, Mg, P and Al.

Dim et al. (2010) in an experiment with four doses of slaughterhouse residues applied to Mombaça grass, obtained an increase between the treatments in dry matter production, number of tillers and plant height with a production of 9.3 kg of DM $^{ha-1}$ per ton of residue applied.

Pereira et al. (2015) found an increase in bean yield with the use of 2,500 kg $^{ha-1}$ of slaughterhouse waste, and the application of the residue before sowing did not affect its yield.

Damaceno et al. (2018), studying bone meal in Brachiaria ruziziensis grass, found a significant increase in soil pH with the treatments in relation to the control (without application of bone meal) and an increase in dry matter production between the treatments studied.

Freitas et al. (2016) in a study with different doses of bovine blood dregs, intercropped with three sources of soil amendments, found a difference between the treatments with and without lime in the elevation of soil pH, thus concluding that blood dregs have the potential to correct the soil.

Carvalho (2018), evaluating the productivity of Marandu grass under biofertigation with slaughterhouse waste, found that up to certain limits, there was a positive correlation between dry matter production and biofertilizer doses, in addition to contributing to the increase of microorganisms in the soil.

Orrico Júnior et al. (2013) cultivated piatã grass under increasing doses of poultry slaughterhouse effluent, and observed that higher values of tillering and forage mass were obtained when high doses of organic fertilizer were supplied.

According to Rodrigues et al. (2024), it is plausible to recommend the use of organic fertilizers as strategic sources of fertilization from the meatpacking industry, since it favored the good morphological development of the tiller and impacted on significant increases in the forage production of Marandu grass.

FINAL CONSIDERATIONS

The use of agro-industrial waste in agriculture is a great alternative to achieve sustainable rural developments, as it comprises the production cycle as a whole, aiming at the sustainable use of all products and by-products.

They can meet resource shortages in seasonality regions and the rationalization of renewable resources, in addition to being great alternatives for increasing profitability in a production chain.

In addition to solving one of the biggest problems in Brazil today, which is the environmental damage of improper disposal of waste in receivers, depleting non-renewable sources of resources. However, one must be aware of current legislation and use agro-industrial waste with extreme rationality, due to the biological and sanitary risk factors presented by them, emphasizing that errors in use projects can lead to greater problems than improper disposal.

Finally, the greater use of agro-industrial waste in agriculture, unfortunately suffers obstacles, due to the lack of financial resources and policies on the part of the public power, however a greater investment in research and an understanding of the business community of how waste can become valuable co-products, can transform waste into a whooping cough of the new times, and achieve sustainable development, from an economic, social and environmental point of view.

REFERENCES

1. ABIEC - Associação Brasileira das Indústrias Exportadoras de Carnes. (2024). *Beef Report 2024*. São Paulo: ABIEC. Disponível em: https://www.abiec.com.br/publicacoes/beef-report-2024-perfil-da-pecuaria-no-brasil/. Acesso em: 17 de outubro de 2024.

2. Abreu Junior, C. H., Boaretto, A. E., Muraoka, T., & Kiehl, J. C. (2005). Uso agrícola de resíduos orgânicos potencialmente poluentes: Propriedades químicas do solo e produção vegetal. In P. V. Torrado, L. R. F. Alleoni, M. Cooper, A. P. Silva, & E. J. Cardoso (Eds.), *Tópicos em ciência do solo* (v. 4, pp. 391-470). Viçosa, MG: Sociedade Brasileira de Ciência do Solo.

3. Allam, Z., Bibri, S. E., & Sharpe, S. A. (2022). The rising impacts of the COVID-19 pandemic and the Russia-Ukraine war: Energy transition, climate justice, global inequality, and supply chain disruption. *Resources*, 11, 99. https://doi.org/10.3390/resources11090099

4. Alencar, F. A. (1983). *Estudos da recuperação das proteínas do plasma bovino por complexação com fosfatos e sua utilização em produtos cárneos* (Dissertação de mestrado, Universidade Estadual de Campinas, Faculdade de Engenharia de Alimentos e Agrícola, Campinas, SP).

5. Alonso, R. A., & Da Costa, L. V. C. (2017). Caracteres agronômicos de B. brizantha cv. Xaraés (MG5), sob diferentes doses de biofertilizante de dejeto bovino leiteiro. *Brazilian Journal of Biosystems Engineering*, 11(4), 400-411. https://doi.org/10.18011/bioeng.2017v11n4p400-411

6. Araújo, A. P., Nascimento, L. A. S., Santin, J. C., & Santos, N. B. (2016). Uso sustentável dos recursos naturais nas empresas frigoríficas de bovinos. *Nativa Revista de Ciências Sociais do Norte de Mato Grosso*, 5(1).

7. Armstrong, D. L. P. (2006). *Lodo de esgoto alcalinizado como fonte de nitrogênio no desenvolvimento inicial da cultura do arroz* (Dissertação de Mestrado, Universidade Federal do Paraná).

8. Batista, K., & Monteiro, F. A. (2008). Nitrogênio e enxofre nas características morfogênicas do capim-marandu em substituição ao capim-braquiária em degradação em solo com baixo teor de matéria orgânica. *Revista Brasileira de Zootecnia*, 37(7), 1151-1160.

9. Beck, M. H., Escosteguy, P. A., & Dick, D. P. (2018). Modifications of phosphorus in Latosol as a function of humic acids and acidity. *Revista Brasileira de Engenharia Agrícola e Ambiental*, 22, 488-492. https://doi.org/10.1590/1807-1929/agriambi.v22n7p488-492

10. Bertoncini, E. I. (2008). Tratamento de efluentes e reuso da água no meio agrícola. *Revista Tecnologia & Inovação Agropecuária*, 1(1), 152-169.

11. Brasil. Ministério da Agricultura Pecuária e Abastecimento – MAPA. Secretaria de Defesa Agropecuária - SDA. (2009). *Instrução normativa n° 25/2009*. Brasília: Diário Oficial da União, 28 de julho.

12. Brito, S. S., & Santos, A. C. (2010). Decomposição e mineralização de nutrientes em função da aplicação de diferentes fontes de matéria orgânica. *Enciclopédia Biosfera*, 6(10), 1-8.

13. Carvalho, J. J. (2018). *Biofertirrigação da cultura forrageira Brachiaria brizantha cv. Marandu com utilização de diferentes composições de água residuária de frigorífico de abate de bovinos no bioma cerrado* (Tese de doutorado, Universidade Federal do Tocantins, Programa de Pós-Graduação em Biodiversidade e Biotecnologia Rede Bionorte). Palmas, TO.

14. Cepea – Centro de Estudos Avançados em Economia Aplicada – ESALQ/USP. (2023). *Índices exportação do agronegócio: Primeiro semestre de 2024*. Coordenação: Geraldo Sant'ana de Camargo Barros; Andréia Cristina de Oliveira Adami. Piracicaba, SP. Disponível em: https://cepea.esalq.usp.br/upload/kceditor/files/ndices%20de%20Exporta%C3%A7%C3%A3o%20Agro_1semestre_2024(2).pdf. Acesso em: 17 de outubro de 2024.

15. Cruz, A. C., Pereira, F. S., & Figueiredo, V. S. (2017). Fertilizantes organominerais de resíduos do agronegócio: Avaliação do potencial econômico brasileiro. *BNDES Setorial*, 45, 137-187.

16. Dim, V. P., Castro, J. G. D., Alexandrino, E., Santos, A. C., & Silva Neto, S. P. (2010). Fertilidade do solo e produtividade de capim Mombaça adubado com resíduos sólidos de frigorífico. *Revista Brasileira Saúde Produção Animal*, 11, 303-316.

17. Damaceno, J. B. D., Ferreira, E., Oliveira, D. M., Guimarães, R. S., Gama, R. T., & Padilha, F. J. (2018). Produção de biomassa de Brachiaria ruziziensis adubada com farinha de ossos calcinada sob tratamentos ácidos. *Revista Agrogeoambiental*, 10(1), 83-93.

18. Freitas, G. A., Chagas, J. F. R., de Negreiro Neto, J. V., da Costa Leite, R., & da Silva, R. R. (2016). Resíduo orgânico bovino enriquecido com fontes de cálcio como corretivo da acidez do solo. *Global Science and Technology*, 8(3), 1-11.

19. Gonçalves, G. A., & Souza, B. M. S. (2017). Importância do abate humanitário e bem-estar animal na cadeia de produção da carne bovina. *Revista Científica de Medicina Veterinária-UNORP*, 1(1), 40-55.

20. Gondim, G. V. (2007). Potencial de geração de energia a partir dos resíduos sólidos orgânicos e efluentes líquidos gerados em uma unidade agroindustrial (Dissertação de mestrado, Universidade Estadual Paulista, Ilha Solteira).

21. Hunke, P., Mueller, E. N., Schröder, B., & Zeilhofer, P. (2015). The Brazilian Cerrado: Assessment of water and soil degradation in catchments under intensive agricultural use. *Ecohydrology*, 8, 1154-1180.

22. Júnior, M. R. R., Canaver, A. B., Rodrigues, A. B., Neto, F. J. D., & Spers, R. C. (2015). Desenvolvimento de Brachiaria brizantha cv. Marandú submetidas a diferentes tipos de adubação (química e orgânica). *Revista Unimar Ciências*, 24(1-2), 49-53.

23. Kolb, E. (Ed.). (1984). *Fisiologia veterinária* (4ª ed.). Rio de Janeiro, RJ: Guanabara Koogan.

24. Macedo, M. C. M. (1999). Degradação de pastagens: Conceitos e métodos de recuperação. In *Sustentabilidade da pecuária de leite no Brasil* (Anais..., pp. 137-150). Juiz de Fora, MG.

25. Macedo, M. C. M., Zimmer, A. H., Kichel, A. N., Almeida, R. G. de, & Araújo, A. R. (2015). Mitigação da degradação de pastagens: Alternativas de recuperação e renovação. Embrapa Gado de Corte. https://www.embrapa.br/busca-de-publicacoes/-/publicacao/944360/degradacao-de-pastagens-alternativas-de-recuperacao-e-renovacao-e-formas-de-mitigacao. Acesso em 18 out. 2024.

26. Makris, D. P., Boskou, G., & Andrikopoulos, N. K. (2007). Polyphenolic content and in vitro antioxidant characteristics of wine industry and other agri-food solid waste extracts. *Journal of Food Composition and Analysis, 20*(2), 125-132. https://doi.org/10.1016/j.jfca.2006.04.001

27. Matos, A. T. (2014). Tratamento e aproveitamento agrícola de resíduos sólidos. In A. T. Matos (Ed.), *Viçosa-MG* (pp. 241). Ed. UFV.

28. Mapbiomas. (2020). Pastagens brasileiras ocupam área equivalente a todo estado do Amazonas. https://brasil.mapbiomas.org/2021/10/13/pastagens-brasileiras-ocupam-area-equivalente-a-todo-o-estado-do-amazonas/#:~:text=Dados%20espec%C3%ADficos%20sobre%20o%20ava. Acesso em 16 out. 2024.

29. Mesquita, E. F. de, Chaves, L. H. G., Freitas, B. V., Silva, G. A., Sousa, M. V. R., & Andrade, R. (2012). Produção de mudas de mamoeiro em função de substratos contendo esterco bovino e volumes de recipientes. *Revista Brasileira de Ciências Agrárias, 7*, 58-65. https://doi.org/10.5039/agraria.v7i1a866

30. Metcalf, L., & Eddy, H. P. (2016). Evolução do tratamento de esgotos. In L. Metcalf & H. P. Eddy (Eds.), *Tratamento de efluentes e recuperação de recursos* (5ª ed., pp. 4-5). McGraw-Hill.

31. Moreira, L. M., Martuscelllo, J. A., Fonseca, D. M., Mistura, C., Morais, R. V., & Ribeiro Júnior, J. I. (2009). Perfilhamento, acúmulo de forragem e composição bromatológica do capim-braquiária adubado com nitrogênio. *Revista Brasileira de Zootecnia, 38*(9), 1675-1684. https://doi.org/10.1590/S1516-35982009000900006

32. Mouzinho, J. S. N., Giocondo, J. F. de S., & Aguiar, T. S. N. da S. (2022). Recuperação de pastagens degradadas na Amazônia no sistema agrossilvipastoril. *Revista Ibero-Americana de Humanidades, Ciências e Educação, 8*(10), 4698-4710. https://doi.org/10.21723/riahce.v8i10.10947

33. Nunes, P. H. M. P., Aquino, L. A., Santos, L. P. D., Xavier, F. O., Dezordi, L. R., & Assunção, N. S. (2015). Produtividade do trigo irrigado submetido à aplicação de nitrogênio e à inoculação com Azospirillum brasilense. *Revista Brasileira de Ciência do Solo, 39*, 174-182. https://doi.org/10.1590/01000683rbcs20140411

34. Orrico Júnior, M. A. P., Centurion, S. R., Sunada, N. S., & Vargas Júnior, F. M. (2013). Características morfogênicas do capim-piatã submetido à adubação com efluentes de abatedouro avícola. *Ciência Rural, 43*, 58-163. https://doi.org/10.1590/S0103-84782013000300006

35. Peron, A. J., & Evangelista, A. R. (2004). Degradação de pastagens em regiões de Cerrado. *Ciência e Agrotecnologia, 28*(3), 655-661. https://doi.org/10.1590/S1413-70542004000300008

36. Pereira, L. B., Arf, O., Santos, N. C. B., Oliveira, A. E. Z., & Komuro, L. K. (2015). Manejo da adubação na cultura do feijão em sistema de produção orgânico. *Pesquisa Agropecuária Tropical, 45*(1), 29-38.

37. Pichek, D. B., Matt, M. P., Silva, R. W., Boni, T. P., Lara, O. Q., Boni, D., Porto, M. O., Cavali, J., Ferreira, E. (2014). Avaliação do enriquecimento de compostos orgânicos com sangue de bovinos e seu uso na cultura do milho verde. In *Reunião de Ciência do Solo Da Amazônia Ocidental*. Anais...

38. Pires, A. M. M., & Mattiazzo, M. E. (2008). Avaliação da viabilidade do uso de resíduos na agricultura. Jaguariúna: EMBRAPA. (Circular Técnica, 19).

39. Rocha, M. (2008). Avaliação da eficiência no tratamento de efluentes líquidos em frigoríficos. UDC. Foz do Iguaçu.

40. Rodrigues, M. H., Backes, C., Santos, A. J. M., Rodrigues, L. M., Teodoro, A. G., Resende, C. C. F., Ribon, A. A., Giongo, P. R., Fernandes, P. B., & Costa, A. B. G. (2024). Agronomic performance of palisade grass under different doses of liquid blood waste and chemical composition of soil. *Revista Mexicana De Ciencias Pecuarias, 15*, 49-68.

41. Rosa, M. F., Souza Filho, M. S. M., Figueiredo, M. C. B., Morais, J. P. S., Santaella, S. T., Leitão, R. C. (2011). Valorização de resíduos da agroindústria. II 24 Simpósio internacional sobre gerenciamento de resíduos agropecuários e agroindustriais–II SIGERA, 15, 98-105.

42. Santos, M. M., Presotto, E., Silva, J. J., & Rodrigues, M. I. (2023). Padrão de comércio de produtos do agronegócio entre o Brasil e a ASEAN. *Observatório de la Economía Latinoamericana, 21*(11), 22768-22786.

43. Santos, M. E. R., Ávila, A. B., Carvalho, A. N., Oliveira Rocha, G., Van Cleef, F. D. O. S., Segatto, B. N., Pereira, R. S. (2018). Marandu palisade grass management strategies at the beginning of the deferment period and effects on tillering. *Semina: Ciências Agrárias, 39*(4), 1617-1626.

44. Silva Neto, P. S., dos Santos, A. C., Cavalcante da Silva, J. E., Dim, V. P., & dos Santos Araújo, A. (2013). Atributos químicos de um Neossolo Quartzarênico sob capim marandu adubado com resíduo líquido de frigorífico. *Semina: Ciências Agrárias, 34*(3), 1090-1110.

45. Silva, V. R., Quintans, N. J., Andreatta, W. V., & Catânio, J. V. F. (2024). Uso de biofertilizante de dejeto suíno como alternativa à adubação fosfatada em capim Urochloa brizanta cv. Marandu no município de Colorado do Oeste – RO. *Revista Brasileira de Desenvolvimento, 10*(10), e73385.

46. Silva, M. R., Menezes, C. S. M., Oliveira, D. F. P., Reis, T. A., Luna, U. V., & Pierangelli, A. P. (2011). Avaliação da eficiência de resíduos agroindustriais como fonte de nutrientes para pastagens. *PUBVET, 5*(17), ed. 164.

47. Silva, M. K. (2011). O abate humanitário de animais. Trabalho de Conclusão de Curso, Curitiba-PR.

48. Siqueira Melo, P., Boone, B. K., Tiveron, A. P., Massarioli, A. P., Cadorin, O. T. L., Zanus, M. C., & Alencar, S. M. D. (2011). Composição fenólica e atividade antioxidante de resíduos agroindustriais. *Ciência Rural, 41*(6), 1088-1093.

49. Sobral, N. C., Andrade, E. N., & Antonucci, A. M. (2015). Métodos de insensibilização em bovinos de corte. *Revista Científica de Medicina Veterinária, 25*, 1-10.

50. Werner, J. C. (1994). Adubação de pastagens de Brachiaria spp. In *Simpósio sobre Manejo da Pastagem, 11* (pp. 209-222). Piracicaba: Fundação de Estudos Agrários Luiz de Queiroz.