

Agroecological aptitude and dairy farming intensification in a family farm in Tocantins, Brazil

Aptidões e intensificação agroecológica da pecuária leiteira em propriedade rural de agricultura familiar do Tocantins, Brasil

Habilidades e intensificación agroecológica de la ganadería lechera en una finca familiar en Tocantins, Brasil

Received: 02/21/2022 | Reviewed: 03/01/2022 | Accept: 03/06/2022 | Published: 03/12/2022

Thaiana Brunos Feitosa

ORCID: <https://orcid.org/0000-0002-7731-955X>
Universidade Federal do Tocantins, Brazil
E-mail: thianabrunes@gmail.com

Victor Casimiro Piscoya

ORCID: <https://orcid.org/0000-0003-1875-9771>
Universidade Federal Rural de Pernambuco, Brazil
E-mail: victorcasimiropiscoya@gmail.com

Moacyr Cunha Filho

ORCID: <https://orcid.org/0000-0002-3466-8143>
Universidade Federal Rural de Pernambuco, Brazil
E-mail: moacyr2006@gmail.com

Renisson Neponuceno de Araújo Filho

ORCID: <https://orcid.org/0000-0002-9747-1276>
Universidade Federal do Tocantins, Brazil
E-mail: renisson@mail.uft.edu.br

Abstract

This study aimed to develop a diagnosis of land use suitability, growth prospects and milk production intensification in a family farm located in Conceição do Tocantins, Tocantins, Brazil. Data were obtained through interviews with employees and residents, cooperative members, analysis of productive activities and sources of income. To understand the milk production intensification, an experiment was carried out with the division of an area of 1 ha into 3 paddocks and pasture management. For soil aptitude characterization, vector data provided by Seplan were used. The division of the area into paddocks and pasture management allowed an increase in the animal load of 3 AUha⁻¹year⁻¹ and 48% in the daily milk production in the winter and 32% in the summer. In view of the results, it could be concluded that well-formed areas, rest and occupation period with grass reached animal load of 10 AUha⁻¹year⁻¹. Thus, the possibilities of agroecological intensification of pastures were promising and productive; however, investments were high. For professionals interested in these changes, it is necessary to invest in quality paddocks and cattle, in addition to professional training.

Keywords: Soil management; Family farming; Land use suitability; Dairy farming; Forage production.

Resumo

Este estudo teve como objetivo elaborar um diagnóstico da aptidão de uso do solo, perspectiva de crescimento e intensificação da produção leiteira em propriedade rural de agricultura familiar no município de Conceição do Tocantins, Tocantins, Brasil. Os dados foram obtidos através de entrevistas com funcionários e moradores da fazenda, associados de cooperativa, análise de atividades produtivas e fontes de renda. Para o entendimento da intensificação na produção leiteira, foi realizado um experimento, com divisão da área de 1 ha em 3 piquetes e gestão do pasto. Para caracterização da aptidão do solo foram utilizados dados vetoriais disponibilizados pela Seplan. Com divisão da área em piquetes e gestão do pasto, possibilitou um incremento na carga animal de 3 UAha-lano-1 e 48% na produção diária de leite no inverno e 32% no verão. Diante dos resultados foi possível afirmar que áreas bem formadas, período de descanso e ocupação com gramínea chegaram a uma carga animal de 10 UAha-lano-1. Sendo assim, as possibilidades de intensificação agroecológica dos pastos foram promissoras e produtivas, entretanto os investimentos foram elevados. Aos profissionais interessados nestas mudanças, é necessário investir em piquetes e gado de qualidade, aliados a capacitação.

Palavras-chave: Manejo do solo; Agricultura familiar; Aptidão de uso de solo; Pecuária Leiteira; Produção forrageira.

Resumen

Este estudio tuvo como objetivo desarrollar un diagnóstico de la idoneidad del uso de la tierra, las perspectivas de crecimiento y la intensificación de la producción lechera en una granja familiar en el municipio de Conceição do Tocantins, Tocantins, Brasil. Los datos fueron obtenidos a través de entrevistas a empleados y vecinos de la finca, cooperativistas, análisis de actividades productivas y fuentes de ingresos. Para comprender la intensificación de la producción lechera se realizó un experimento, con la división de un área de 1 ha en 3 potreros y manejo de pastizales. Para la caracterización de la aptitud del suelo se utilizaron datos vectoriales proporcionados por Seplan. Con la división del área en potreros y manejo de pastos, permitió incrementar la carga animal en 3 UAha-1año-1 y 48% en la producción diaria de leche en invierno y 32% en verano. A la vista de los resultados, se pudo afirmar que las áreas bien formadas, el período de descanso y la ocupación con pasto alcanzaron una carga animal de 10 UAha-1año-1. Así, las posibilidades de intensificación agroecológica de los pastos eran prometedoras y productivas, sin embargo, las inversiones eran altas. Para los profesionales interesados en estos cambios, es necesario invertir en potreros y ganado de calidad, aliados a la capacitación.

Palabras clave: Manejo de suelos; Agricultura familiar; Aptitud para el uso de la tierra; Ganadería lechera; Producción de forraje.

1. Introduction

The state of Tocantins has 139 municipalities with population of 1,383,445, with 78.81% of the population, which corresponds to 1,090,241 people, living in urban areas and 21.19%, representing 293,212 people, living in rural areas (IBGE, 2019). Pereira and Nascimento (2014) reported that the entire agricultural and livestock sector plays a relevant role in the sustainability of the state economy, because while the gross value added of agriculture has a share of 5.6% in the total gross value added of the Brazilian economy, in Tocantins, this share reaches 20.6%. According to IBGE (2019), 7.5 million hectares are occupied by livestock and 700 thousand hectares are occupied by agriculture, leaving, therefore, 5.7 million hectares for future expansion of the agricultural frontier of Tocantins.

These animal production systems are related to production capacity, management, social benefits and even the survival of families (Guerra et al, 2015) in situations such as the periodic droughts that affect southeastern Tocantins. Thus, production diversification is generally related to financial conditions, producer's personal characteristics and factors such as periods of water scarcity, soil aridity, distance from large input supply centers, among others (Silva et al., 2018).

Ferreira et al. (2020) points out that in the case of dairy farming, most production models are based on high consumption of external inputs related to food and medicines, mainly for better adaptation to the tropical climate of animals originally from temperate climates. Talking about agroecological systems leads to a reflection on the reduction of inputs used and on the complexity of the different systems currently in practice (Valenzuela, 2016; Nogueira, 2010).

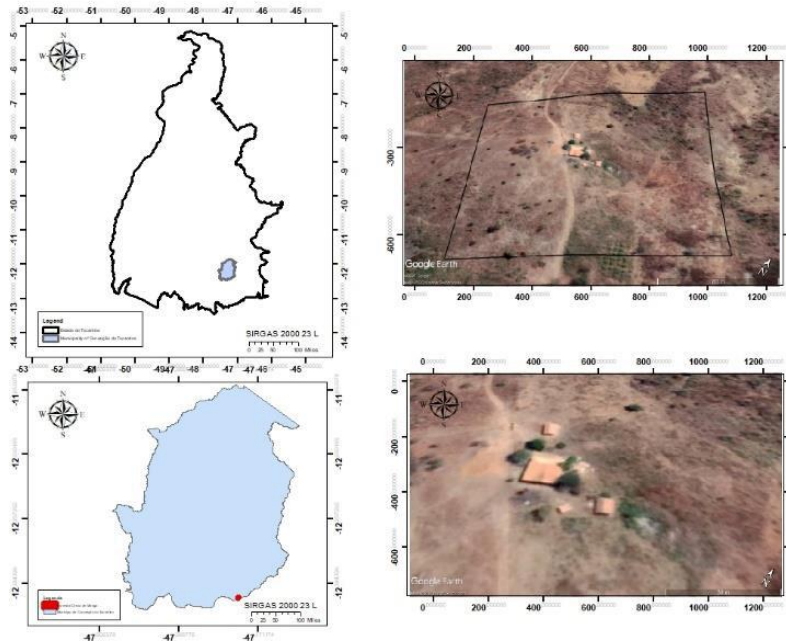
Thus, as in other developing regions, animal production stands out for its importance for food security, job and income generation (IBGE, 2019). This situation is worrying, since extensive cattle farming demands large areas, which are not available to most producers in the region due to the economic, technical, social and environmental unfeasibility of the activity, especially in small areas located on agricultural frontiers (Souza & Matos, 2019).

This study aimed to develop a diagnosis of land use aptitude, growth prospects and milk production intensification in a family farm located in the municipality of Conceição do Tocantins, Tocantins, Brazil.

2. Methodology

The research was carried out at Chuva de Manga Farm, rural area of Conceição do Tocantins, Tocantins, Brazil. The property is located in the Cana Brava community, with 5 ha, located in the southeastern region of the state at altitude of 325 m a.s.l., with geographic coordinates 12° 25' 28.22" S and 47° 13' 29.675" W (Figure 1).

Figure 1. Location map of the experimental area, municipality of Conceição do Tocantins, Tocantins, Brazil.



Source: Authors (2021).

The climate of the region is humid and sub-humid with moderate water deficit – C2wA'a', precipitation of 1300 mm, temperature of 27 °C and average annual potential evapotranspiration of 1,500 mm (Seplan, 2019).

Currently, the municipality has 4182 inhabitants, according to IBGE data (2010). It borders the municipalities of Almas and Dianópolis (North), Taipas do Tocantins (East), Paraña and Arraias (South) and Natividade (West), having an area of 2,500,733 km², density 1.7 inhab./km² and HDI 0.65. The agricultural and the third sector move the local economy, moving R\$ 5.090.518,00, which represents 20.24% of the Conceição do Tocantins GDP (Municipal City Hall, 2021).

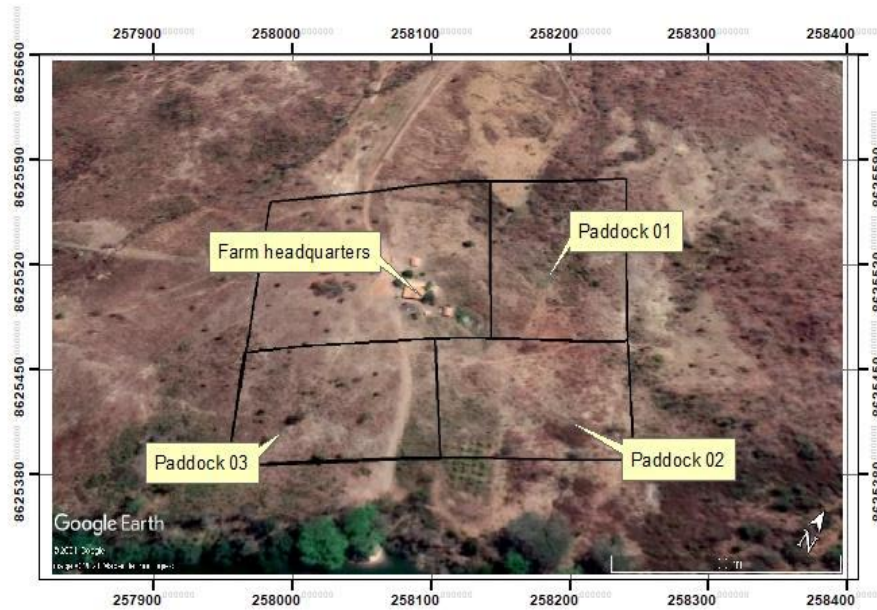
To meet the food demand of the 12 residents and 2 employees, the property develops some agroecological activities. Its particularity and main demand is milk production, and the property has 6 female cattle, and other activities developed are: swine farming, focused on crossbreeding and laying poultry, in addition to a well-established agroforestry system. The characterization data of production systems were obtained through fieldwork from January to December 2020. Data were collected as follows: interview with employees and residents, cooperative members, analysis of productive activities and sources of income.

2.1 Milk Production Intensification And Forage Production

This case study was carried out, dividing the area into 3 paddocks and pasture management, respecting an occupation and rest period of 21 days for brachiaria (*brizantha Hochst Stapf*), massai (*Panicum maximum*) and mombaça (*Megathyrsus maximus*) forages (Figure 2), thus being able to verify if the low production was due to lack of management and if there is possibility of milk production intensification.

Research carried out by Maneschy et (2005) in Pará verified that pastures formed with Brachiaria, brizantha cv Marandu did not meet the requirements of P, Na and Cu for beef cattle in the lactation phase.

Figure 2. Scheme of paddock division.



Source: Authors (2021).

In addition, as recommended by Embrapa (2012), approximately 62.5 liters of water per day were provided to lactating cows.

2.2 Agroecological Aptitudes

Spatial analyses were performed in a geographic information system, using Arcgis 10.5 software to compile and cross reference spatial information in shape format. Pedological data, land use and cover and priority areas were analyzed. Based on results generated by the crossings between files, simple descriptive statistics regarding the extension of areas in each property were managed, and vector data used were from the Seplan database (2019).

3. Results and Discussion

The community in the region develops different productive activities linked to own consumption, and also for marketing and exchanges, characterizing well the family farming profile.

Magne et al. (2019) highlight that the autonomy of peoples and territories is both favored by agroecology in animal production systems and brings positive points in terms of sustainable development. Among activities, the dairy activity stands out, both for income composition and consumption (Figure 3), (Figure 4) and (Figure 5).

Figure 3. Installed paddocks.



Source: Authors (2021).

According to Figure 3, paddocks were installed for the experimente.

Figure 4. Nellore cattle.



Source: Authors (2021).

Size of the animal raised in the system adopted by the community, Figure 4.

Figure 5. Experimental grass.



Source: Authors (2021).

The Figure 5 presents the forages used in the experiment: *brachiaria (brizantha Hochst Stapf)*, *massai (Panicum maximum)* and *mombaça (Megathyrsus maximus)*.

Currently, milk is the main source of income in the farm, where 50 liters of milk are produced per day by 6 animals, 3 of which are mixed breed (SRD) and 3 Nellore, which is not enough to meet the daily demand for consumption and marketing. The milk produced is destined for the AP-Leite association, founded in 2015 with 25 members. Souza (2019) states that extremely extensive practices reach productions above 10 l milk/cow/day.

This milk is sold for R\$ 1,40 a liter. According to IBGE (2019), the national average price of a liter of milk is R\$ 2,0344. The low added value to the milk produced is due to the fact that the milk is not processed, only refrigerated. Since the school and the association have no structure for milk pasteurization, the milk is sold outside the community for a much lower price compared to the market. The daily production capacity to meet this demand is 200 liters of milk per day, because in addition to consuming milk, cakes, breads and other products are made to feed the students. In addition to milk production, the school could invest in dairy products such as milk cream and artisanal cheese.

Another difficulty identified was the genetic quality of animals, which in addition to not having a defined breed, are old, having 6, 7 and 13 years. According to Embrapa (2021), the ideal period of lactation is from 10 months among the most productive milk breeds: Holstein, Jersey, Pardo Suiço, Girolando and Gir. It would be advisable to replace these for Jersey animals, used mainly as dairy cattle, given the quality of their milk in terms of fat and non-greasy solids, in addition to lower food consumption due to their small size and easier adaptation than Holsteins, which are more demanding in terms of climate, comfort and handling. According to Embrapa (2012), under ideal conditions, the Jersey cow produces approximately 25 liters of milk per day.

In addition, it is important to train farmers and employees on how to produce milk in an adequate and organized way, adding value to production.

Milk production drastically reduces in the driest period. In general, productivities obtained are low, even if in some herds there are animals with good performance, lactations range from 5000 to 6830 liters/cow/year. Animals are raised solely on pasture, without supplementary food, only mineral salt, in different compositions, supplied irregularly. The fenced area where animals graze has 1.4 ha, with no division of paddocks, with animal load around 2.15 AU/ha/year.

The occupation and rest periods of pasture plots are not respected in the management, which leads animals to feed sometimes on very fibrous material, when the grass grew too much, sometimes on too rich material, when the grass just sprouted.

This way of managing leads to forage wear and the dominance of the area with adventitious plants, affecting production as a whole, triggering a process of forage degradation, damaging the original soil characteristics.

3.1 Milk Production Intensification And Forage Production

In a field experiment, dividing the area of 1 ha into 3 paddocks and pasture management, respecting the rest period for *Brachiaria*, *Massai* and *Mombasa* grass, present for 21 days, allowed an increase in animal load of 6 AU/ha/year and a 300% increase in the daily milk production in the period of winter and 220% in the dry/summer period, obtained by 6 lactating cows.

According to Embrapa (2021), these increments are the result of green and well-managed pasture, represented by the following variables: leaf life span, leaf appearance rate and leaf extension rate. The recommended entry height for grazing is based on the point where the plant has the highest presence of leaves, few stalks and little dead material, since nutrition is the determining factor to maximize the genetic potential of the herd (Michel, 2019).

Darnet et al (2021), in an experiment carried out in settlements in the Brazilian Amazon, obtained increase in animal load of 4 AU/ha/year and increase of 57% in daily milk production in the winter period and of 36% in the dry/summer period, obtained by nine lactating cows.

This experience allows us concluding that it is possible to carry out an agroecological milk production intensification only with the division of pasture areas and management of their use in a rotated way. With well-formed areas, that is, homogeneous forage cover and rest and occupation period respected for the grass used, in addition to supplementation, with proper fertilization, it is possible to reach animal load of 10 AU/ha/year, ideally with 22 paddocks, each paddock measuring 45.5 m². This means tripling the current animal load.

Bastos et al (2018) states that in terms of feeding and pasture management, there is an emphasis on the works that point out the Voisin Rational Shepherding (PRV) as the best alternative.

3.2 Other Agroecological Productions

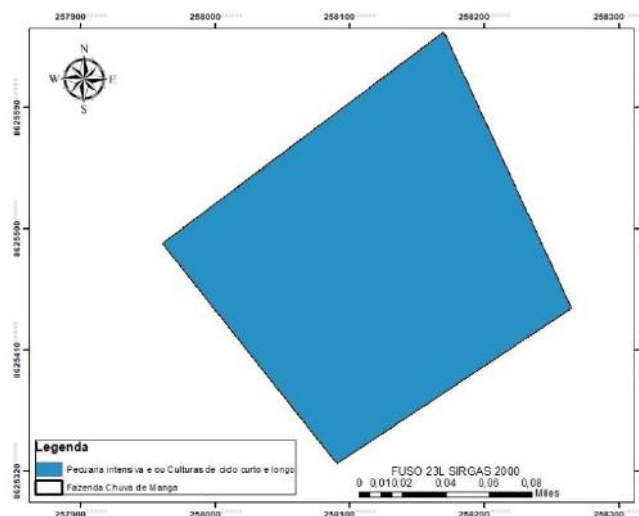
In addition to milk production aimed at own consumption and marketing, there are also small poultry, swine, fish and sheep activities.

In perennial and annual crops, there is production of pineapple, corn, eucalyptus, scarlet eggplant, okra, tomato, cassava, banana, sweet potato, gherkin, in addition to spices and some medicinal herbs, all aimed at own consumption. Less frequent, but also present, there is tilapia fish farming, with low production, also aimed at consumption. The area of the property in general is considered small for the reality of the region, since the tax module of the municipality is 320 ha. In terms of land use, in 2015, out of a total of 5 ha, 100% were still forested areas. Currently, 80% of the farm is consolidated and productive.

3.3 Agroecological Aptitude

The study area has aptitude for intensive livestock and planted pasture, slightly undulating relief and is not susceptible to erosion due to the absence of eutrophic soils and is easily mechanized, (Figure 6).

Figure 6. Land use potential, Chuva de Manga Farm – Conceição do Tocantins, Tocantins, Brazil.

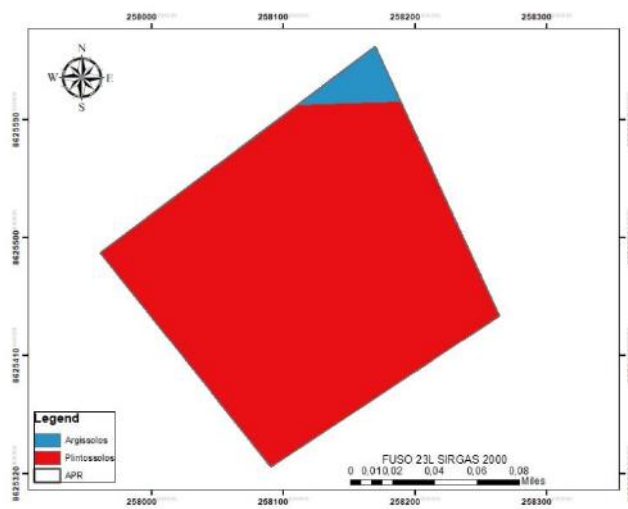


Source: Authors (2021).

According to Figure 6, Livestock has influenced life in the southeastern regions of the state since its colonization, animal production systems, in general, are based on conventional methods that include burning, deforestation and overgrazing. Thus, it is necessary to redefine the activity, and these changes influence work relationships, social reproduction strategies of groups of family farmers, land occupation and use of natural resources (Nunes, 2013).

The predominant soil in the study area is plintossols, Figure 7, soils composed of mineral material, with plinthic, lithoplastic or concretionary horizons, all from the localized iron segregation, which acts as a cementing agent (Embrapa, 2021). They are strongly acidic, and may present low (dystrophic) or high (eutrophic) base saturation, with predominance of low saturation. There are also soils with solodic and sodic properties, (Figure 7).

Figure 7. Pedology of the Chuva de Manga Farm – Conceição do Tocantins, Tocantins, Brazil.



Source: Authors (2021).

According to Seplan (2019), the region is suitable for intensive livestock and short- and long-cycle crops. The area is located in flat to gently undulating relief, with slope of 0-10%, which facilitates mechanization. They are deep, porous, well drained, well permeable even when very clayey, friable and easy to prepare. Despite the high potential for agriculture, part of its area must be kept as a reserve for the protection of the biodiversity of these environments. Fidalski (2015) corroborates that this soil does not have porosity limitations for soybean and forage cultivation. França et al (2019) reinforces that the indication of use is dependent on the level of management, and the more technified the production, the greater the alternatives for using the area, also taking into account the type of soil. These two parameters are closely related to indicate the soil aptitude.

In a study carried out by Balem and Machado (2019), farmers observed the difference between extensive management and Rational Shepherding Voisin, in relation to tick infestation. The understanding of the system is evident and the farmers realize the advances that the Rational Shepherding Voisin provides. In all properties it was reported that mastitis and the incidence of ticks decreased with the agroecological transition process.

4. Conclusion

The study area has aptitude for livestock activity, the main activity carried out by the community. The possibilities with the agroecological intensification of pastures are promising and much more productive than the current situation;

however, investments are also high. For professionals interested in these changes, it is necessary to invest in quality paddocks and cattle, allied to professional training and qualification.

The land use limitations must be known and respected so that the soil is used in a more sustainable way, especially in small properties, all the soil resource must be preserved to maintain maximum productive capacity, maximizing the economic return for producers, who depend on it for their survival.

For future work, it is suggested to verify the increase in milk productivity in a Crop-Livestock-Forest integration system.

Acknowledgments

The authors wish to thank the Federal University of Tocantins for the financial support.

References

- Balem, T. A., & Machado, R. L. (2019). Sistemas de produção de leite de base ecológica: a construção das variáveis a partir de uma experiência de extensão rural em Santa Maria (RS). *Rev. Brasileira de Agroecologia*, 14(1), 16-30.
- Bastos, Sintia Barboza et al. (2018). Transição agroecológica da pecuária em Cunha - SP e região. *Cadernos de Agroecologia*. v. 13, n. 1.
- Darnet, L. A. F., Pocard Chapuis, R. J. M., Claudino, L. S. D., & Carvalho, S. A. (2021). Aptidões biofísicas e intensificação agroecológica da pecuária leiteira em assentamentos da Amazônia brasileira. *Geog Ens Pesq*, 25, e01, <https://doi.org/10.5902/2236499444204>.
- Embrapa. (2021). *Latossolos*. http://www.agencia.cnptia.embrapa.br/Agencia16/AG01/arvore/AG01_96_10112005101956.html.
- Embrapa Gado de leite. (2012). *O produtor pergunta, a Embrapa responde*. Editores técnicos, Oriel Fajardo de Campos, João Eustáquio Cabral de Miranda. (3a ed.).
- França, B. B. da, Lima, J. J. M., Sousa, K. A., Lima, L. F. A., Santos, M. A. dos, Carmo, S. S. do & Ramos, M. R. (2019). Capacidade de uso e aptidão agrícola de uma fazenda em São Domingos do Araguaia (PA). *Revista Geonorte*. 10(36), 134-153.
- Ferreira, L. A., Claudino, L. S. D., Carvalho, S. A. de, Maneschy, R. Q., & Pocard Chapuis, R. (2020). Caracterização da pecuária leiteira de base familiar no Estado do Pará: reflexões sobre práticas agroecológicas. *Agricultura Familiar: Pesquisa, Formação e Desenvolvimento*. 14(1), 126-140.
- Fidalski, J. (2015). Qualidade física de Latossolo Vermelho em sistema de integração lavoura-pecuária após cultivo de soja e pastejo em braquiária. *Pesq. agropec. bras.*, 50(11), 1097-1104.
- Guerra, M. P., Rocha, F. S. & Nodari, R. O. (2015). Biodiversidade, recursos genéticos vegetais e segurança alimentar em um cenário de ameaças e mudanças. In: Veiga, R. F. de A.; Queiróz, M. A. de (Ed.) *Recursos fitogenéticos: a base da agricultura sustentável no Brasil*. Ed. UFV, 32-40.
- IBGE. (2019). Instituto Brasileiro de Geografia e Estatística. *Sistema de dados de recuperação automática (Sidra)*. Brasília/DF, 2012. <http://www.ibge.gov.br>.
- Magne, M. A., et al. (2019). An Integrated Approach to Livestock Farming Systems' Autonomy to Design and Manage Agroecological Transition at the Farm and Territorial Levels. In: *Agroecological Transitions: From Theory to Practice in Local Participatory Design*. Springer, Cham, p. 45-68.
- Maneschy, R. Q., Cardoso, E. C.; Veiga, J. B.; McDowell, L. R. (2005). Effect of season on mineral concentration of Braquiarião (*Brachiaria brizantha* cv. Marandu) dairy cattle production in the Eastern Amazon. I. Macrominerals. *Journal of Animal and Veterinary Advances*, 4, 123 - 126.
- Michel, P. (2019). *Pontos Críticos que vão mudar sua visão sobre Pastejo Rotacionado*. <https://prodap.com.br/pt/blog/sucesso-de-manejo-do-pastejo-rotacionado>.
- Nogueira, S. S. (2012). Intensificação ou diversificação? A pecuária leiteira em questão. 2012. 153f. Dissertação (Mestrado em Agriculturas Familiares e Desenvolvimento Sustentável) - Universidade Federal do Belém, Pará.
- Nunes, A. M. B. (2013). (Re)pecuarização e família no semiárido nordestino: um estudo sobre diferenciação social entre agricultores familiares no Sertão do Pajeú (PE). *Revista Brasileira de História & Ciências Sociais*. 5, 88-104.
- Pereira, E. L., & Nascimento, J. S. (2014). Efeitos do Pronaf sobre a produção agrícola familiar dos municípios tocantinenses. *Revista de Economia e Sociologia Rural*. Brasília/DF: Editora UNB, 52, 139-156.
- Prefeitura Municipal de Conceição do Tocantins. (2021). <https://www.conceicaodotocantins.to.gov.br/>.
- Secretaria da Fazenda e Planejamento. (2019). *Indicadores socioeconômicos do Estado do Tocantins*. Tocantins. 2 p.
- Souza, J. O. (2019). O uso do controle leiteiro como ferramenta de análise da produção leiteira familiar: O caso da Comunidade Nova Jerusalém em Paragominas - PA. Trabalho de Conclusão de Curso (Graduação em Medicina Veterinária) - Universidade Federal do Pará, Castanhal. p.25.
- Souza & Matos. (2019). Agronegócio e ambiente no Cerrado tocantinense: um panorama dos municípios com base em indicadores. *Ateliê Geográfico*. 13(1), 124-149.
- Valenzuela, H. (2016). Agroecology: a global paradigm to challenge mainstream industrial agriculture. *Horticulturae*, 2(1), 2.