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Agricultural modernization in the state of Mato Grosso

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Abstract

This study was developed to investigate the factors related to the agricultural modernization in the state of Mato Grosso (MT) and to determine the Agricultural Modernization Index of the municipalities of MT. The Exploratory Factor Analysis and the 2017 Brazilian Agricultural Census database were used. The main factors associated with agricultural modernization in MT were as follows: (a) adoption of technology, access to financial resources, and ownership of tractors on the property; (b) use of pesticides and the participation of rural producers in collective organizations; and (c) items of access to technical information and access to electricity service. There was heterogeneity in the level of agricultural modernization throughout MT, in which most municipalities have a low classification (94 municipalities, totaling 66.66% of all municipalities in the state). Thus, the development of public policies that expand access to technical assistance and credit services and the creation of collective organizations (associations, cooperatives, class entities, and trade unions) can contribute to reducing the of inequality in agricultural modernization in the municipalities of Mato Grosso.

Keywords: Exploratory factor analysis. Rural Development. Public policies.

Introduction

The world population is estimated to reach nine billion people in 2050. Moreover, the improvement in the standard of living of the population will further increase the demand for food and energy, regarding quantity and diversity. However, there is a decrease in the amount of productive land available (due to soil degradation in arable areas and the preservation of forests) for the expansion of food production. Thus, the growth of agricultural production must be based on the adoption of technologies that provide an increase in the use of productive factors, as well as the conservation of natural resources, especially the soil, aiming to promote food and nutritional security for the world population (REETZ, 2017).

Climate change can promote challenges for food production worldwide. Such variations can have natural origins, such as oscillations in the climate, which are represented by heat and cold waves, changes in rainfall cycles, and prolonged periods of drought; or anthropogenic sources, such as changes and complications caused by man, mainly by the emission of greenhouse gases (GHG) into the atmosphere (RUDDIMAN, 2015).

Thus, the Brazilian government created the program called "Agricultura de Baixo Carbono" (ABC) in 2009, related to the promotion of the use of technologies that reduce GHG emissions on rural properties. To this end, some types of financing are offered to farmers, so that they incorporate modern technologies in the fields. The implementation of modern technologies, along with good cultivation practices, such as Precision Agriculture, has improved agricultural production systems, optimizing resources and mitigating effects on the environment (OLIVEIRA *et al*., 2020).

Brazil has relevance in agricultural production worldwide. In the crop year of 2003/04, the national grain production was 119.11 million tons for 47.42 million ha. It expanded to 297.97 million tons (a 150.16% growth) in an area of 79.94 million ha (a 68.58% growth) in 2023/24 (CONAB, 2024). The national cattle herd was 238.62 million head in 2023 (IBGE, 2024). In the same year, the trade balance of Brazilian agribusiness was US$ 123.78 billion (MAPA, 2024).

Despite its relevance in global agricultural production, the Brazilian agricultural sector is characterized by the duality of realities in the living conditions and level of economic activity of rural producers. On the one hand, there is a group of producers who have highly technical production systems specialized in the production of food and raw materials for the processing industries and for the international market via export. On the other, a portion of Brazilian rural producers live in a situation of socioeconomic vulnerability and with their production intended for family survival (FORNAZIER, VIEIRA FILHO, 2012).

The national agricultural sector will need to follow a path of changes to meet, with increasing efficiency, the functions of world food supply, the balance of the agricultural market, the guarantee of income for rural producers, competitiveness, and the strengthening of the country's export capacity. Thus, the diffusion of technologies that enable an evolution of agricultural production systems among Brazilian regions is important (LOPES, 2017).

The state of Mato Grosso (MT) is relevant in food production nationally. In the crop year of 2023/24, grain production was 93.19 million tons (about 31.27% of the national total) in an area of 21.67 million ha (corresponding to 27.11% of the national total) (CONAB, 2024). The cattle herd in Mato Grosso was 33.99 million head (about 14.25% of the national total) (IBGE, 2024).

This study was developed to contribute to the measurement of the factors associated with the modernization of the agricultural sector in MT, to guide the elaboration of public policies for the promotion of rural development. Empirical evaluations of the process of diffusion of technologies in certain locations must consider the characteristics of the area (MUNGIA, LLEWELLYN, 2020).

Considering this, the questions addressed in this research were as follows: (a) what are the main factors related to agricultural modernization process in the municipalities of Mato Grosso, given the relevance of the state in Brazil's agricultural production?; (b) which municipalities in Mato Grosso achieved the highest levels of intensity of agricultural modernization in 2017? This study was conducted to investigate the factors related to the agricultural modernization in Mato Grosso and to determine the Agricultural Modernization Index (AMI) of its municipalities in 2017.

Material and methods

Exploratory factor analysis (EFA)

This quantitative research uses factor analysis to identify common variability dimensions existing in a set of phenomena and using both exploratory (EFA) and confirmatory factor analysis (CFA). EFA is based on the lack of previous knowledge on the part of the researcher about the relationship of dependence between the observable variables and the factors. CFA, nevertheless, assumes that the researcher already has prior knowledge of the relationship between the observed variables and the latent factors (BEZERRA, 2007).

The cornerstone of EFA lies in the reduction of the original number of observable variables, by identifying independent factors, in order to enable these factors to explain the original parameters in a concise and simplified way (FERREIRA JUNIOR *et al.*, 2004). The limited number of factors consists of linear combinations of the original parameters, with minimal loss of information (MELO, PARRÉ, 2007).

The EFA was performed using principal component analysis, in which the first factor explains most of the total variance of the variables under analysis. Then the second factor concerns the second highest percentage, and so on, for the number of factors selected. It is important to emphasize that the calculated factors have no correlation between them (FERREIRA JUNIOR *et al*., 2004).

The EFA method can be mathematically represented via Equation 1 (BEZERRA, 2007):

$$X_i = \alpha_{i1} F_1 + \alpha_{i2} F_2 + \alpha_{i3} F_3 + \ldots + \alpha_{ij} F_j + \varepsilon_i \qquad (1)$$

In which: X_i represents the set of standardized variables; α_i are the factor loadings; F_j are the common factors not related to each other; and ε_i is an error that represents the portion of variation of the variable i which is exclusive to it and cannot be explained by one factor or by another variable of the analyzed set.

The measure known as *eigenvalue*, or characteristic root, was used to determine the amount of total variance explained for each selected factor (MELO, PARRÉ, 2007). The decision on the number of factors to choose depends on the value of the characteristic root, which must be equal to or greater than one unit (1.0). Orthogonal rotation was applied by the *Varimax* method to improve the interpretation of the factors extracted in the EFA. This approach aims to maximize the relationship of observable variables with only one factor (FERREIRA JUNIOR *et al.,* 2004).

The square of the factor loadings reveals the relative influence of each factor on the total variance of a variable chosen in the EFA. Nevertheless, the sum of the squares of the factor loadings of all parameters contributes to the estimation of the *commonality*. In turn, this represents the portion of the total variance of each variable, which is explained by the set of common factors selected based on the characteristic root criterion (FERREIRA JUNIOR *et al*., 2004).

The Kaiser-Meyer-Olkin (KMO) and Bartlett's sphericity tests were used to assess the sample adequacy for the factor analysis. The KMO test is an indicator that compares the magnitude of the partial correlation coefficients, with values ranging from 0 to 1, and it is recommended that such values be greater than 0.50. On the other hand, the Bartlett's test has the purpose of verifying the null hypothesis that the correlation matrix is an identity matrix. The conduct of the EFA is justified if this hypothesis is rejected (FERREIRA JUNIOR *et al.*, 2004).

After obtaining the factor loadings and identifying the factors, the factor scores were estimated using a method analogous to regression. Equation 2 shows that the score of each observation (in this case, municipality) was determined by multiplying the standardized value of the parameters by the corresponding coefficient of the factor score for all *J-th* factors, F_j (FERREIRA JUNIOR *et al.*, 2004).

$$F_j = W_{j1} X_1 + W_{j2} X_2 + W_{j3} X_3 + \ldots + W_{jp} X_p \qquad (2)$$

In which: W_{jp} are the coefficients of the factor scores; and p = number of variables.

The evaluation of the relative position of each observation regarding the concept represented for each factor became possible by the factor scores (MONTEIRO, PINHEIRO, 2004). The factor scores should follow a symmetrical distribution around the zero average, in which half of the factor scores are negative, and the other half positive. A transformation of the factor scores was performed, according to Equation 3, to ensure that high negative factor scores do not distort the magnitude of the AMI, to restrict them to the range of 0 to 1 (LEMOS, 2001).

Table 1. Agricultural Modernization Index Classification

Classification	Criterion
Very High Modernization	Greater than the mean + two standard deviations
High Modernization	Between one and two standard deviations above the mean
Normal Modernization	Between the mean and one standard deviation above the mean
Low Modernization	Between the mean and one standard deviation below the mean
Very Low Modernization	Between the mean and one standard deviation below the mean

Source: Lobão and Staduto (2020).

$$F_{ji}=\frac{F_{ji}-F_{ji}^{min}}{F_{j}^{max}-F_{j}^{min}} \quad (3)$$

In which: F_{ji} are related to factor scores; F_{j}^{max} = maximum value of the j-th factorial score associated with the i-th municipality; and F_{j}^{min} = minimum value of the J-th factorial score associated with the I-th municipality. AMI was then developed from Equation 4 (LOBÃO, STADUTO, 2020):

$$IMA_{i}=\sum_{k=1}^{n}\frac{\lambda_{k}}{\sum \lambda_{k}}F_{ji} \quad (4)$$

In which: λ_k represents the kth root characteristic; n = number of factors selected with the characteristic root greater than one unit, and $\sum \lambda_k$ = sum of the characteristic roots referring to the n selected factors.

After calculating the AMI, the municipalities of Mato Grosso were hierarchized and classified regarding the AMI, considering five different types of classifications as shown in Table 1 (LOBÃO, STADUTO, 2020).

Description of variables and data sources

To assess the level of agricultural intensification in the municipalities of Mato Grosso, 17 variables related to the characteristics of the rural property, the use of technologies in the production system, the availability of services such as electricity, access to public policies (technical assistance and credit), as well as the participation of rural producers in collective organizations were considered (Table 2).

The observable variables were relativized regarding the area of the establishments (AE), the employed people (EP), or the total number of establishments (TE), as described by Lavorato and Fernandes (2016), Lobão and Staduto (2020), and Madeira *et al.* (2019). The data source used was the 2017 Agricultural Census, conducted by the Brazilian Institute of Geography and Statistics (IBGE), including the 141 municipalities of Mato Grosso[1]. To operationalize the statistical analyses and elaboration of the map, the Statistical Package of Social Science (SPSS) version 25 and GeoDa software were used®, respectively.

Results and discussion

The result of the KMO test was 0.835, which suggests that the data are appropriate for the construction of the AMI for the municipalities of MT. Note that the values of the KMO statistics must be greater than 0.50 (FERREIRA JUNIOR *et al.*, 2004; HAIR *et al.*, 2009). Using the Bartlett's test, the authors were able to reject the null hypothesis that the correlation matrix is an identity matrix. Therefore, based on all the tests performed, it was possible to verify that the selected parameters were appropriate for conducting the EFA.

Three factors with characteristic roots greater than one unit were extracted by applying orthogonal rotation with the Varimax method. The first factor (F1) stood out for explaining 61.10% of the total variance, followed by F2 with 6.96%

1 The data from the 2017 Agricultural Census were collected when the state of Mato Grosso had 141 municipalities. As of October 2023, the municipality of Boa Esperança do Norte was created, totaling 142 municipalities in Mato Grosso (IBGE, 2025).

Table 2. Parameters used for the elaboration of the Agricultural Modernization Index of the municipalities of Mato Grosso

Identification	Description	Source:
X1	Total number of establishments that used crop protection (units) / TE	Procópio *et al.* (2023)
X2	Total number of establishments that fertilized (chemical and organic) (units) / TE	Procópio *et al.* (2023)
X3	Total number of establishments that made soil correction using lime and other soil pH correctives (units) / TE	Procópio *et al.* (2023)
X4	Total number of establishments that practice crop rotation (units) / TE	Procópio *et al.* (2024)
X5	Total number of establishments that use direct seeding method (units) / TE	Procópio *et al.* (2024)
X6	Total number of establishments with access to technical assistance (units) / TE	Procópio *et al.* (2024)
X7	Total number of establishments with the producer linked to a collective action entity (units) / TE	Procópio *et al.* (2023)
X8	Total number of establishments with access to technical assistance (units) / TE	Procópio *et al.* (2024); Souza Filho *et al.* (2011)
X9	Total number of establishments with tractors (units) / TE	Costa *et al.* Procópio *et al.* (2023)
X10	Total amount of expenses of the establishments (units) / TE	Costa *et al.* (2012); Lobão, Staduto (2020); Procópio et al. (2023)
X11	Total amount of expenses of the establishments (units) / AE	Costa *et al.* (2012); Lobão, Staduto (2020); Procópio et al. (2023)
X12	Total amount of expenses of the establishments (units) / EP	Costa *et al.* (2012); Lobão, Staduto (2020); Procópio et al. (2023)
X13	Total amount of production of establishments (units) / TE	Costa *et al.* (2012); Lobão, Staduto (2020); Procópio et al. (2023)
X14	Total amount of production of establishments (units) / AE	Costa *et al.* (2012); Lobão, Staduto (2020); Procópio et al. (2023)
X15	Total amount of production of the establishments (units) / EP	Costa *et al.* (2012); Lobão, Staduto (2020); Procópio et al. (2023)
X16	Total number of establishments with access to technical assistance (units) / TE	(2020); Lobão, Staduto (2020); Procópio et al. (2023)
X17	Total number of establishments that used financing to invest (units) / TE	Costa *et al.* Procópio *et al.* (2023)

Remark: AE – area of establishments in hectares, EP –employed people in units, TE – total number of establishments in units.

Source: Censo Agropecuário (2017).

and F3 with 6.74%. Together, these three factors explained 74.80% of the total variability of the selected variables (Table 3).

Commonality is the proportion of the total variance of each observable parameter and explained by the set of factors selected by the characteristic root criterion (FERREIRA JUNIOR *et al*., 2004). The higher the value of the commonality, the greater the influence of the parameter on the analyzed phenomenon (LOBÃO, STADUTO, 2020). The agricultural

Table 3. Characteristic root and percentage of variance explained in each factor

Factor	Characteristic root	Variance explained by factor (%)	Accumulated variance (%)
F1	10.387	61.102	61.102
F2	1.183	6.960	68.062
F3	1.146	6.740	74.802

Source: authors (2024).

modernization of the municipalities of Mato Grosso is strongly influenced by the parameters X2 (use of fertilizers), X3 (use of correctives), X5 (use of direct seeding), X12 (total expenses divided by employed personnel), and X15 (gross amount of production divided by employed people) (Table 4).

The factor loadings indicate the correlation between the variables and the selected factors. The higher the absolute value of the factorial loading, the greater the relevance of this load in the interpretation of the factorial matrix (HAIR *et al.*, 2009). Agricultural modernization is a complex and multifaceted process, in which the adoption of technologies, availability of financial resources, and productive infrastructure are important in sustainable intensification in crops (PROCÓPIO *et al.*, 2024). The first factor (F1)

Table 4. Factor loadings and commonalities of socioeconomic indicators related to agricultural modernization in the municipalities of Mato Grosso

Parameter	F1	F2	F3	Commonality
X1	0.224	**0.733**	0.217	0.634
X2	**0.850**	0.372	0.174	**0.892**
X3	**0.869**	0.332	0.135	**0.884**
X4	**0.833**	0.236	0.121	0.764
X5	**0.870**	0.337	0.036	**0.871**
X6	**0.725**	0.482	0.139	0.777
X7	0.186	**0.820**	-0.131	0.724
X8	0.146	0.066	**0.716**	0.538
X9	**0.830**	0.220	0.160	0.763
X10	**0.854**	0.107	-0.077	0.746
X11	**0.782**	0.161	0.171	0.666
X12	**0.886**	0.282	0.086	**0.871**
X13	**0.833**	0.055	-0.088	0.704
X14	**0.809**	0.109	0.205	0.709
X15	**0.905**	0.231	0.097	**0.882**
X16	0.021	0.004	**0.741**	0.550
X17	**0.650**	0.558	0.069	0.739

Note: The observable variables are related to the following aspects: X1 – use of pesticides; X2 – use of fertilization (chemical and organic); X3 – use of limestone and other correctives to correct soil pH; X4 – use of crop rotation; X5 – use of direct seeding method; X6 – access to technical assistance; X7 – producer linked to a collective action entity; X8 – access to technical information; X9 – tractor ownership; X10, X11 and X12 – total amount of expenses; X13, X14 and X15 – total amount of production; X16 – access to electricity; and X17 – use of financing to invest.

Source: authors (2024).

was called "*Adoption of technology, access to financial resources, and tractor ownership on the property*", and was composed of the parameters X2, X3, X4, X5, X6, X9, X10, X11, X12, X13, X14, X15, and X17 (Table 4).

The increase in food production in the agricultural sector should be based on the use of technologies that increase yield, such as fertilizers (X2) and correctives (X3) (ARTUZO *et al.*, 2017; OLIVEIRA *et al.*, 2010; REETZ, 2017); and in soil conservation, such as crop rotation (X4) and the direct seeding method (X5) (FOLONI *et al.*, 2023; N'DAYEGAMIYE *et al.*, 2017; VOLSI *et al.*, 2022). Moreover, technical assistance (X6) to assist rural producers in the proper use of technologies is important (SOUZA FILHO *et al.,* 2011).

Tractor ownership (X9) in rural establishments is important to assist rural producers in the implementation of production practices (crop rotation and direct seeding) and in the use of inputs (fertilizers and correctives) in the crops (PANNELL *et al.*, 2006). The existence of tractors on rural establishments was associated with agricultural modernization in other Brazilian locations, like the state of Mato Grosso do Sul (PROCÓPIO *et al.,* 2023) and in the MATOPIBA region (states of Maranhão, Tocantins, Piauí, and Bahia) (BATISTA *et al.,* 2023).

The availability of financial resources is important to assist the adoption of technology and the financing of productive activities on rural establishments (PROCÓPIO *et al.*, 2024; WEERSINK, FULTON, 2020). The financial flow variables were represented by total expenses (X10, X11, and X12), comprising expenses with productive inputs (agricultural – correctives, fertilizers, seedlings, seeds, etc.; livestock – medicine, feed, supplements, etc.), fuels and lubricants, electricity, freight, wages, among others (IBGE, 2017); gross amount of production (X13, X14, and X15); and use of rural credit (X17) to make investments in the property.

The total expenses and the gross amount of the production of the agricultural activity were associated with its modernization in states of the Amazon region (LOBÃO, STADUTO, 2020), in MATOPIBA (BATISTA *et al.*, 2023) and in Mato Grosso do Sul (PROCÓPIO *et al.*, 2023). Access to credit (X17) provides the necessary financial resources so rural producers can incorporate technology into the production system of the property and to invest (KUMAR *et al.*, 2021).

Access to credit was a parameter that contributed to the adoption of post-harvest technology (machinery and equipment for processing the product) among coffee producers in Minas Gerais (PEREIRA *et al*., 2010), fertilizer use in Ethiopia (TADESSE, 2014), and the use of management software among beef and dairy producers in Ireland (LÄPPLE *et al.*, 2015).

The second factor (F2) was named "*Use of pesticides and the participation of producers in collective organizations*", composed of the parameters X1 (use of pesticides) and X7 (producer linked to a collective organization) (Table 4). In the context of climate change, it is relevant to use technologies (such as pesticides) that promote the maintenance of the crop yield and minimize the risk of loss of production due to the diseases, pests, and weeds in the crops (PROCÓPIO *et al.*, 2024). In this sense, the use of this input should be conducted with the technical recommendation, according to the characteristics of the soil and the plants cultivated on the property (AKTAR *et al.*, 2009; REYNA *et al.,* 2020). The use of pesticides (X1) was associated with agricultural modernization in the states that make up the MATOPIBA region (BATISTA *et al*., 2023) and in Mato Grosso do Sul (PROCÓPIO *et al*., 2023).

Regarding technologies that might be used in rural properties, it is possible to categorize them as: (a) automation and computerization; (b) weed and pest control; and (c) sustainable intensification (PROCÓPIO *et al.*, 2024). Thus, it is relevant for rural producers to participate in collective organizations (associations, cooperatives, class entities, state unions, etc.) to have access to technical information that can improve the production process on the establishment, as well as access to technical assistance and credit services (SOUZA FILHO *et al.*, 2011).

Collaboration via cooperativism is important in agriculture, especially regarding rural producers classified as family farms. In rural communities with limited resources, these kinds of organization make it possible to share resources, knowledge, and equipment among farmers, resulting in more efficient and cost-effective production at the scale level (PIRES, 2003). The participation of rural producers in collective organizations (X7) was important for the adoption of coffee processing technology among rural producers in Minas Gerais (PEREIRA *et al.*, 2010) and the use of genetically improved seeds and fertilizers among farmers in Kenya (MULWA *et al.*, 2021).

The third factor (F3) was called "*Items of access to technical information and access to electricity service*", consisting of the observable variables X8 (access to technical information) and X16 (access to electricity) (Table 2). Technical information, related to the prices of inputs and products and new production practices, may be relevant to assist in the decision-making process of rural producers (SOUZA FILHO *et al.*, 2011). The availability of electricity on the rural property is essential for the use of machinery and equipment to assist the process of managing economic activity (OLÍMPIO *et al.*, 2022). Access to electricity was associated with agricultural modernization in Mato Grosso do Sul (PROCÓPIO *et al.*, 2023).

Agricultural modernization in the municipalities of Mato Grosso in 2017 was then associated with three components: (a) adoption of technology, access to financial resources and ownership of a tractor on the property; (b) use of pesticides and the participation of rural producers in collective organizations; and (c) items of access to technical information and access to electricity service.

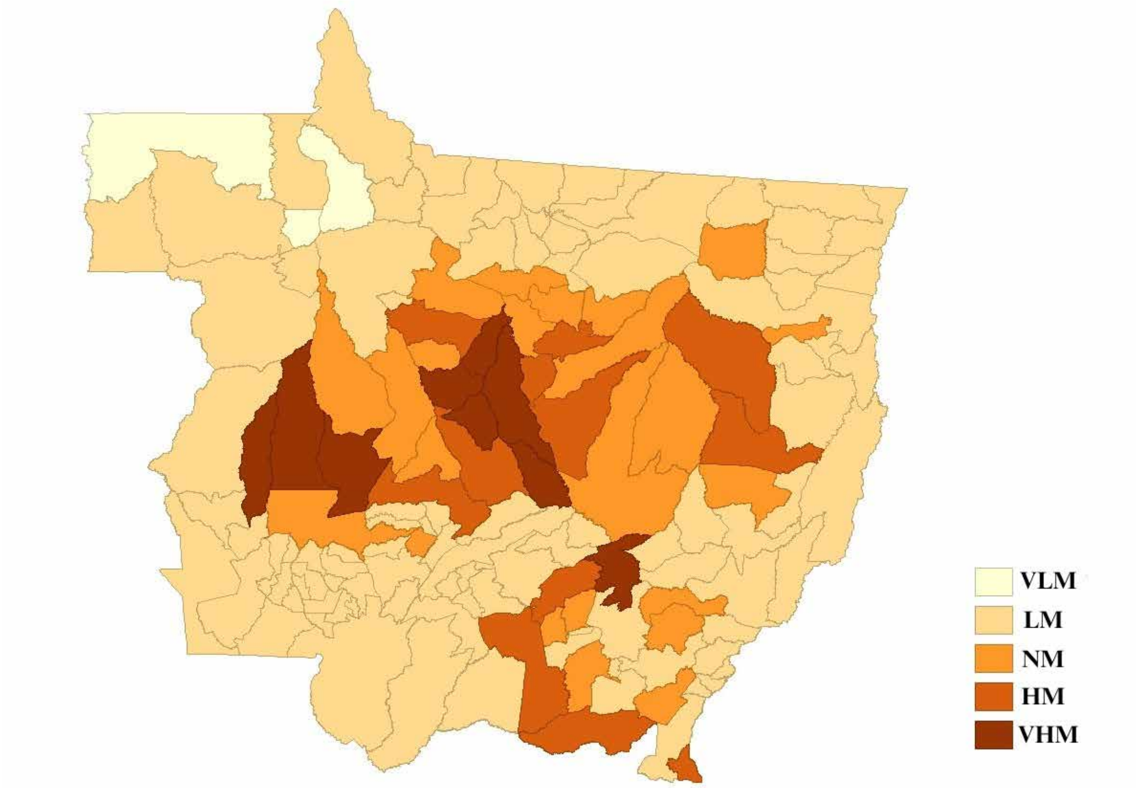
The mean AMI of the municipalities of Mato Grosso was 0.26, and the coefficient of variation (CV) was 52.18%, indicating a heterogeneity in the level of agricultural modernization throughout the state. This heterogeneity represents an inequality in agricultural technological intensity, also observed in other Brazilian states, such as Minas Gerais (CAMPOS *et al.*, 2014; FERREIRA JUNIOR *et al.*, 2004), Rio Grande do Sul (PINTO, CORONEL, 2015), Paraná (LOBÃO *et al.*, 2016), Ceará (MADEIRA *et al.*, 2019; SANTOS; CAMPOS, 2021), Mato Grosso (BECKMANN, SANTANA, 2017), Mato Grosso do Sul (PROCÓPIO *et al.*, 2023), Pará (REBELLO *et al.*, 2011), and Bahia (SANTOS *et al.*, 2018).

Most o municipalities in Mato Grosso were classified as low modernization (LM – 94 municipalities), with a share of 66.66% of the total in the state (Figure 1). The low level of agricultural modernization was also representative in most municipalities in the North region (LOBÃO, STADUTO, 2020) and for the state of Ceará (SANTOS, CAMPOS, 2021).

The other classifications were normal modernization (NM – 23 municipalities, 16.31% of the total state), high (HM – 12 municipalities, 8.51% of the total state), very high (VHM – six municipalities, 6.38% of the total state), and very low (VLM – three municipalities, 2.12% of the total state) (Figure 1). The municipalities with the highest levels of agricultural modernization were Sapezal, Ipiranga do Norte, Santa Rita do Trivelato, Campos de Júlio, Lucas do Rio Verde, Sorriso, Campo Novo do Parecis, Tapurah, and Primavera do Leste. Colniza, Juruena, and Nova Bandeirantes were classified as VLM.

The municipality of Sapezal had the best level of rural modernization. The municipalities of

Figure 1. Geographical distribution of the Agricultural Modernization Index among the municipalities of Mato Grosso for 2017.



Note: VLM – very low modernization; LM – low modernization; NM – normal modernization; HM – high modernization; VHM – very high modernization.

Source: authors (2024).

Ipiranga do Norte, Santa Rita do Trivelato, Campos de Júlio, Lucas do Rio Verde, Sorriso, Campo Novo do Parecis, Tapurah, and Primavera do Leste were also noteworthy, showing, respectively, the best levels of agricultural modernization in the state. In turn, the municipalities of Colniza, Juruena, and Nova Bandeirantes had, respectively, the worst levels of agricultural modernization in Mato Grosso in 2017.

Conclusions

The main factors associated with agricultural modernization in Mato Grosso were: (a) adoption of technology, access to financial resources, and ownership of tractors on the property; (b) use of pesticides and the participation of rural producers in collective organizations; and (c) items of access to technical information and access to electricity service. Heterogeneity regarding the level of intensity of modernization of the agricultural sector throughout Mato Grosso in 2017 was observed.

Most municipalities in Mato Grosso have a low level of agricultural modernization, and technology was an important element in this process. Among the types of technologies selected, the productive practices of crop rotation and direct seeding stand out, as well as the inputs of correctives, pesticides, and fertilizers. Thus, the elaboration of public policies that encourage technological diffusion in Mato Grosso can contribute to reducing the inequality level between its municipalities.

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