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Brazilian municipal rural development index: a study based on the 2017 agricultural census

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Abstract
Rural development is a crucial aspect because it integrates new attributes and interdependencies with the development of localities. Based on this observation, this article aims to present an updated rural development index for the 5,570 Brazilian municipalities with data from the 2017 Agricultural Census. The method selected to carry out this proposal was factor analysis. The results presented significant elements to compose the explanatory factors of rural development in the municipalities. The contribution derives, firstly, from the composition of the index, which represents a set of variables with characteristics linked to the dimensions of economic development and associated with rurality, and, secondly, from producing a rural development index with the most recent set of data, which allowed the creation of a new index, composed of 4 latent factors, used to hierarchize the level of contemporary Brazilian municipal rural development.

Keywords: Rural Development. Rurality. Economic Development. Factor Analysis. Index.

Índice de desenvolvimento rural municipal brasileiro: um estudo a partir do censo agropecuário de 2017

Resumo
O desenvolvimento rural é um aspecto importante por integrar novos atributos e interdependências com o desenvolvimento das localidades. Com base nesta observação, o presente artigo objetiva apresentar um índice de desenvolvimento rural atualizado para os 5570 municípios brasileiros com dados do Censo Agropecuário de 2017. O método selecionado para realizar tal proposta foi a análise fatorial. Os resultados apresentaram elementos significativos para compor os fatores explicativos do desenvolvimento rural presente nas municipalidades. Isso posto, a contribuição decorre, em primeiro, da composição do índice a qual representa um conjunto de variáveis com características atreladas às dimensões do desenvolvimento econômico e associadas à ruralidade e, em segundo, ao se produzir um índice de desenvolvimento rural com o mais recente conjunto de dados, os quais permitiram constituir um novo índice, composto por 4 fatores latentes,

empregado para hierarquizar o nível de desenvolvimento rural municipal brasileiro contemporâneo.

Palavras–chave: Desenvolvimento Rural. Ruralidade. Desenvolvimento Econômico. Análise Fatorial. Índice.

Índice de desarrollo rural municipal brasileño: un estudio basado en el censo agropecuario de 2017

Resumen
El desarrollo rural es un aspecto importante porque integra nuevos atributos e interdependencias con el desarrollo de las localidades. A partir de esta observación, este artículo tiene como objetivo presentar un índice de desarrollo rural actualizado para los 5570 municipios brasileños utilizando datos del Censo Agropecuario de 2017. El método seleccionado para realizar esta propuesta fue el análisis factorial. Los resultados mostraron elementos significativos para componer los factores explicativos del desarrollo rural en los municipios. Sin embargo, la contribución proviene, en primer lugar, de la composición del índice, que representa un conjunto de variables con características vinculadas a las dimensiones del desarrollo económico y asociadas a la ruralidad y, en segundo lugar, de la elaboración de un índice de desarrollo rural con el conjunto de datos más reciente, que permitió crear un nuevo índice, compuesto por 4 factores latentes, utilizado para clasificar el nivel de desarrollo rural municipal brasileño contemporáneo.

Palabras clave: Desarrollo económico. Desarrollo Rural. Ruralidad. Análisis factorial. Index.

1 Introduction

The relevance of rural particularities for the human development of municipalities stands out as a result of new attractions and associations between the rural and the development process of localities. In this sense, the works that proposed producing rural development indexes did so with limited regional specificity or used outdated data. Therefore, this article aims to fill this scientific gap by proposing a new Rural Development Index (RDI).

To this end, data from the most recent Agricultural Census, specifically from 2017, were used. To estimate the intended rural development index, the multivariate method of factor analysis was used to select the relevant variables for the index's composition. Consequently, this index will be used to categorize municipalities into rural development levels, aiming to identify the dimensions of human development, specifically economic, social, institutional, environmental, and spatial.

From a practical point of view, the research is justified. It contributes to the development of a new analysis instrument composed of more recent data, thereby providing a more up-to-date portrait of regional inequalities related to rural aspects. Additionally, it presents a new set of interrelated indicators that represent an x-ray of the rural development of Brazilian municipalities, states, and regions in 2017.

In this sense, the article makes two significant and complementary contributions in addition to providing a current index. The first contribution is to explain which variables and how they represent the characteristics of the rural area and relate to the dimensions of rural development in the municipalities. The second

is a consequence of the first; in detail, the index produced will allow explaining regional differences with greater precision, depth, and contemporaneity.

To make the first proposed contribution, it will be necessary to employ the concept of rurality, a concept that has been discussed and utilized by several authors, including Veiga (2006), Bosworth and Somerville (2013), Carneiro and Sandroni (2018), and Torre and Wallet (2016). This concept will reference the selection of variables to comprise the initial database, which will then be used through factor analysis to identify the set of variables that make up the RDI. This set of variables will portray rural aspects and, even indirectly or partially, the characteristics and conceptual pluralities present in the dimensions of rural and human development.

The second contribution stems from the fact that, despite previous studies, including Kageyama (2008), Melo and Parré (2007), Stege and Parré (2011), and Renzi and Piacenti (2023), which used indexes to measure rural development. However, among those mentioned, only the article produced by the last-mentioned authors evaluated rural development based on aspects of rurality and developed an index composed of 42 variables, which enabled these authors to represent the attributes of rural development in the 5,570 Brazilian municipalities in 2006. At this point, we highlight the aforementioned second contribution, which involves creating a rural development index comprising 37 variables and representative of all national municipalities (5,570). This approach provides a more recent categorization and comparison of the identified regional inequality gaps[1].

Finally, in addition to this introduction, the article comprises four further sections: the theoretical and practical basis, the methodology, the third section corresponding to the results and discussions, and the conclusion.

2 Theoretical Basis

In Brazil, rural development was characterized by Kageyama (2008) as multi-actor, multifaceted and multi-level. The concept of multi-actors emphasizes the complex relationships between interrelated institutions in the rural development process, considering the relationships between local, regional, and global agents. The second characteristic, multifaceted, is related to the particularities of new rural products and services, specifically the direct sale of products with regional or local specificities, such as agroecological and/or organic products, services related to agrotourism, environmental conservation, and landscape management. Finally, the last multilevel analysis examines the concept of rural development at the first level, exploring its integration within the local sphere and its interconnections with agriculture and society. At the second, intermediate level, it assesses the synergistic relationships between local and regional ecosystems. Finally, at the third level, referred to as micro, it analyzes the new relationships and allocations of family labor in agricultural establishments, where the productive activities carried out, for the most part, are characterized by pluriactivity.

In addition to the idea developed by Kageyama (2008), according to Prieto-Lara and Ocaña-Riola (2010), Torre and Wallet (2016), a new paradigm was proposed

[1] Only 5,570 municipalities were used, and the operational state areas [Lagoa Mirin (RS) (4300001) and Lagoa dos Patos (RS) (4300002)] were excluded from the analysis.

in Europe to characterize the concept of rural development, in which, in addition to highlighting the importance of establishing synergies with local ecosystems and pluriactivity, it is proposed to value economies of scope to the detriment of economies of scale and the production of public goods.

Based on the conceptualization and characteristics presented regarding rural development, the identified difficulty is related to the method of measuring this phenomenon in geographic areas. This difficulty stems from the definition of 'rural,' which is historically associated with the idea of agrarianism, dealing with the social transformation of life in rural environments. That is, it analyzes the process of evolution in the production relations inherent in the combination of production factors involved (capital, labor, and land). Furthermore, there was no consensus on the definition of rural, as the non-homogeneity of the definition stemmed from historical and cultural factors in different countries and regions worldwide (Gomes, 2011; Bosworth & Somerville, 2013; Torre & Wallet, 2016; Pedroso & Navarro, 2019; Renzi & Piacenti, 2023).

Based on the complexity of defining the theoretical boundaries of rural areas, Veiga (2006) argues that these areas are no longer defined by parameters related to the unnatural or artificial level of ecosystems and/or by some indicator of anthropic pressure, which were used to measure the different levels between the most remote (natural) and the most urban (artificial) areas. Additionally, Gomes (2011, p. 160-1), supported by the Leibnizian idea, argues that rural areas contain particular economic, social, and cultural peculiarities, but not essentially exclusive ones. Therefore, rural areas can no longer be considered *continuous* or adjacent to urban areas.

In this sense, according to Gomes (2011), the concept of "rural" lacks sufficient elements to define the boundaries of rural areas empirically. Thus, the concepts related to the rural-urban dichotomy and the "rural renaissance," as presented by Bernard Kayser, have become inadequate or insufficient to represent the characteristics present in current rural areas[2].

To overcome, at least in part, this difficulty in capturing rural aspects as relevant factors for rural development, Veiga (2006) proposed the concept of "new rurality," which is based on three primary parameters: 1) activities related to services, tourism and other products originated by natural amenities; 2) efforts to preserve and conserve biodiversity and its consequences on landscapes and, lastly, 3) the essential need to develop new and accessible renewable sources of energy in rural areas.

In line with the concept of "new rurality," Sarraceno (1994) argues that this idea provides a more suitable theoretical framework for understanding spatial phenomena related to local and regional development processes. For this reason, this article will utilize the concept of "new rurality" developed by Veiga (2006) to capture the elements present in rural areas, thereby characterizing the level of rural development in Brazilian municipalities.

To this end, in agreement with Sarraceno (1994), Carneiro (2008, p. 35) defines the concept of rurality as a dynamic process that is recurrently updated by cultural and local factors, in which new techniques, customs, and values are added. This

[2] The objective of the article is not to define rural areas geographically but rather to capture the importance of rural characteristics in inferring the rural development of municipalities.

process causes a dynamic in two directions in which, on the one hand, there is a readjustment of the factors present in the local culture based on a possible reassessment resulting from the manifestation of new codes and, on the other hand, the appropriation by the inhabitants located in urban areas of the natural and cultural goods and services of the rural environment, thus creating a scenario that makes it possible to leverage sociability and reinvigorate ties with the place.

In agreement with Veiga (2006), the perspective of Bosworth and Somerville (2013) and Torre and Wallet (2016) define the idea of rurality through three interrelated aspects. The first associates rurality with a social construction, highlighting the moral and social values present in rural life as fundamental.

The second plays a role in identifying the concept, specifically a functional character, which characterizes the activities carried out in rural areas, such as environmental services and qualifications, as well as the intensive or extensive use of land and conduct related to the way of life in rural areas. Finally, the third aspect addresses the economic issue with a somewhat political bias, relating to structural characteristics that interfere with the lives of rural inhabitants, highlighting the tourist potential for certain consumer strata, such as retired individuals.

In short, just as Veiga (2006), Bosworth and Somerville (2013), Carneiro and Sandroni (2018) defended the concept of rurality as an analytical category, rural areas exhibit a gradual heterogeneity despite presenting some level of homogeneity in geographic sections. Consequently, this concept serves as a reference to identify rural characteristics in the variables present in the 2017 Agricultural Census corresponding to the municipalities to be analyzed. Thus, the objective of this article was to use the concept of rurality as a guide to identifying the variables that comprise the database and, later, through factor analysis, select the variables necessary to measure the level of rural development of Brazilian municipalities. In detail, a statistical interpretation was employed to identify the economic, social, institutional, spatial, and environmental dimensions as factors present in measuring the level of rural development in the 5,570 Brazilian municipalities.

Rural development: previously used indexes

Various studies have measured the importance of rural areas for regional development in different ways. They have used different geographic areas and developed indexes with variables selected arbitrarily or not to constitute and analyze the determinants, levels, and categorization of rural development. Multivariate techniques were used among such indexes, similar to those used in this article.

From an international perspective, Michalek and Zarnekow (2012) developed an index with a set of multidimensional indicators to measure the level of rural development and quality of life in the regions of Poland and Slovakia between 2002 and 2005. This work highlighted the authors' importance in portraying the level of rural development in geographic areas through several variables derived from secondary statistics, which represent the socioeconomic, environmental, demographic, administrative, and infrastructural dimensions. Therefore, it observed the dimensions of human and rural development in the analyzed regions.

In parallel, Pagliacci (2017) employed fuzzy logic to analyze 27 regions in Europe using a multidimensional and continuous rurality indicator. In this article, the

author utilized variables representative of the dimensions of human development, including agricultural functions and land-use characteristics. The author presents the regions' rurality levels as a relevant element to explain the differences in European areas concerning the level of socioeconomic development of rural environments.

In articles published in national journals, Stege and Parré (2011) were the first authors to analyze Brazilian microregions from a multidimensional perspective, measuring the level of rural development. Later, Melo and Silva (2014) developed a rural development index to classify municipalities in the southwest region of Paraná.

Finally, the article published by Renzi and Piacenti (2023) was the first to portray the level of rural economic development for the 5,570 Brazilian municipalities. These authors utilized the 2006 Agricultural Census and employed factor analysis to construct the Rural Economic Development Index (IDER), which was subsequently used to categorize Brazilian municipalities and regions in 2006.

From this perspective, when delimiting the theoretical boundaries and similar empirical studies, the next section will present the origin of the data, the scientific method, and factor analysis to be used in this work to compose the index. It will also describe the way of categorizing the municipalities according to the levels of rural development estimated for Brazilian municipalities.

3 Methodology

The research strategy adopted will utilize a database initially composed of 105 rural variables from the 2017 Agricultural Census (IBGE, 2017) to prepare the Rural Development Index (RDI) and classify the 5,570 Brazilian municipalities[3].

Due to the multidimensional characteristics of the phenomenon under study, rural and economic development, factor analysis (FA) appeared to be the most appropriate method for capturing the aspects of the mentioned phenomenon. This method enables the detection of common dimensions of variability in a set of events to observe existing structures that are not directly perceptible. Nevertheless, the use of principal component analysis (PCA) stands out as a method that is quite robust regarding the violation of the normality hypothesis (Melo; Parré, 2007; Stege; Parré, 2011)[4].

Additionally, to obtain the best result in terms of the factor analysis performed, the Varimax rotation method was used. This method is a type of orthogonal rotation that minimizes the number of indicators presenting high

[3] The factor analysis was carried out with 5,557 municipalities, as the 2017 Agricultural Census did not provide data for 13 municipalities, namely Tabocão (TO) (code. IBGE: 1708254); Ereré (CE) (code IBGE: 2304277); Campo Grande (RN) (code. IBGE: 2401305); Madre de Deus (BA) (code IBGE: 2919926); Dona Euzébia (MG) (code IBGE: 3122900); Pingo-d'Água (MG) (code IBGE: 3150539); São Tomé das Letras (MG) (code IBGE: 3165206); Nilopolis (RJ) (code IBGE: 3303203); Águas de São Pedro (SP) (code IBGE: 3500600); Barueri (SP) (code IBGE: 3505708); Carapicuíba (SP) (code. IBGE: 3510609); Jandira (SP) (code IBGE: 3525003); Praia Grande (SP) (code IBGE: 3541000). After conducting a factor analysis and producing the RDI for the 5,557 municipalities, the RDI values for these municipalities were estimated using the regional average obtained by averaging the RDI of the municipalities adjacent to each of the mentioned municipalities. Thus, the RDI for the 5,570 Brazilian municipalities was obtained.

[4] It is worth highlighting that the variables used were linearized using the Neperian logarithm to meet the linearity criterion.

loadings in a given common factor by redistributing factor loadings and maximizing shared variance in factors related to eigenvalues with lower values (Fávero; Belfiore, 2017).

The next step after the factor analysis is completed is to create the Rural Development Index (RDI), which will enable the ranking of national municipalities. To estimate the index, the value of each latent factor was used, weighting it by its respective variance. Therefore, the RDI for the i-th municipality is given by equation 1 below:

$$\boldsymbol{IDR_i} = \frac{\sum_{j=1}^{\rho} \boldsymbol{\theta_i F_i}}{\sum \boldsymbol{\theta_i}} \qquad (1),$$

where $\boldsymbol{RDI_i}$ refers to the rural development index of municipality i;θ_i are the proportions of variance explained by each factor (*Fi*) of the RDI; ρ is the number of factors used in the analysis of the i-th municipality; and $\sum \theta_i$ represents the sum of the proportions of the explained variances referring to the ρ factors extracted from the set of variables that make up the RDI.

After completing the preparation of the index for the 5,570 municipalities, the method used to categorize the level of rural development is presented in Frame 1.

Frame 1 – Method for categorizing Brazilian municipalities with the rural development index (RDI), Brazil, 2023.

Position	Classification	Relationship with the RDI
1	Extremely High	Greater than 2.5 standard deviations above the mean
2	Very High	Between 2 and 2.5 standard deviations above the mean
3	High	Between 1 and 2 standard deviations above the mean
4	Regular High	Between the mean and 1 standard deviation above the mean
5	Regular Low	Between the mean and 1 standard deviation below the mean
6	Low	Between minus 1 and minus 2 standard deviations below the mean
7	Very Low	Between minus 2 and 2.5 standard deviations below the mean
8	Extremely Low	Less than 2.5 standard deviations below the mean

Source: Prepared by the author based on Renzi and Piacenti (2023)[5] .

The use of the 2017 Agricultural Census allowed the production of a Rural Development Index (RDI) with updated data, contributing to representing the different levels of economic and rural development of the 5,570 Brazilian municipalities and, therefore, contributing with a different index to that proposed by Renzi and Piacenti (2023) in which the authors above produced an index of economic development of rurality for Brazilian municipalities with data from the 2006 Agricultural Census. Following the RDI categorization, the results found for the 5,570 Brazilian municipalities will be discussed.

[5] The symmetry achieved in the division of rural development levels is intentional. This criterion enables an equidistant subdivision of the average RDI value, providing a perspective on the differences between municipalities in terms of the characteristics present in the composition of the common factors that comprise the RDI.

4 Results Analysis

From the 105 variables collected and after employing factor analysis, the KMO test (0.955) and the Bartlett test (p-value = 0.00) validate the factor analysis result as adequate. **Table 1** below presents the results of the aforementioned tests (Fávero; Belfiori, 2017) .

Table1 – Kaiser, Meyer, and Olkin (KMO) test and Bartlett test

Kaiser-Meyer-Olkin measure of sampling adequacy.		0.955
Bartlett's test of sphericity	Approx. χ 2	310764.482
	df.	666
	Sig.	0.000

Source: Prepared by the author using SPSS software and data from IBGE (2017).

Additionally, the correlation reproduction matrix indicated that the model has 12% (83) of non-redundant residues and absolute values greater than 0.05%. Thus, it presented a value lower than 50%, and, as pointed out by Sarstedt and Mooi (2019), it meets the criterion for selecting suitable models.

Using the Kaiser criterion, the extraction result produced four latent factors, which employed a set of variables representative of rural development. From this, Table 2 presents the four factors along with their respective eigenvectors and variances, which were used to weigh the factors in the production of the index.

Table 2 – Variance explained and accumulated by factors with normal and rotated characteristic roots for the 9 established factors

LATENT FACTORS	INITIAL EIGENVALUES			VARIMAX ROTATION		
	Total	% Variance	% Cumulative	Total	% Variance	% Cumulative
1st	15.699	42.429	42.429	12.377	33.452	33.452
2nd	7.611	20.571	62.999	8.239	22.267	55.719
3rd	2.669	7.213	70.213	4.190	11.324	67.043
4th	2.101	5.680	75.892	3.274	8.849	75.892

Source: Prepared by the author using SPSS software and data from IBGE (2017).

Table 2 presents the four factors, along with their respective variances, which total an accumulated variation of 75.89% and are composed of 37 indicators of rural development in national municipalities. Next, Frame 2 presents the four factors. In this table, the first column contains the variable codes, and the second column represents the commonalities. Those with values greater than 0.6 were selected, except for variables X105 (Rural Agroindustry) in factor 1 and X104 (Horticulture) in factor 4. They were maintained because they were relevant to explaining the factors mentioned and because they presented factor loadings higher than the reference value of 0.6. Thus, it can be stated that the indicators exhibit strong correlations with the respective factors and, therefore, present sufficient consistency to categorize Brazilian municipalities based on the level of rural development. This is because

commonality represents the variance of each indicator; therefore, the greater the commonality, the greater the correlation between the variable and the factor, that is, the greater the explanatory capacity and sensitivity of the variable within the mentioned factor (Hair et al., 2009).

It is worth noting that 14 variables among the 37 indicators have values ranging from 0.826 to 0.935. Variables with commonality values greater than 0.8 have a greater degree of influence on the factors in which they are contained. This criterion explains the order of the variables present in each latent factor, as represented in Frame 2 (Fávero; Belfiori, 2017).

The third column represents the factor loadings, which correspond to the Pearson correlations between the initial variables and the latent factors in which they are present. This analysis established the criteria for use in the factor analysis model of the variables inserted in each latent factor, with a factor loading equal to or greater than the absolute value of 0.6. As expected, the result presented 37 variables with positive factor loadings (Sarstedt; Mooi, 2019).

The latent factors were individually subjected to Cronbach's alpha test (α) using the variables selected based on criteria related to commonality and factor loading. This test assesses the degree of reliability associated with the behavior of the correlations between the selected, previously standardized variables that make up each factor. In detail, in Frame 2, α allows us to examine the reliability of the extraction of a latent factor concerning the variables that compose it. Therefore, α is considered a measure capable of evaluating the intensity with which a factor participates in the original variables, and, in this way, a set of data with variables that make up a latent factor tends to present a α greater than 0.7. In Frame 2, the four factors exceed the value mentioned as a criterion and, thus, present a sufficient degree of reliability (Sarstedt; Mooi, 2019).

Factor 1 (F_1) was named Employment, Infrastructure, Institutions and Production integrated with Agroindustry constituting 33.45% of the total accumulated variance and is formed by seventeen indicators, namely: (X76); (X85); (X97); (X39); (X73); (X33); (X84); (X102); (X9); (X34); (X45); (X7); (X68); (X82); (X87) and (X105).

The analysis of Factor 1 was subdivided into four blocks of indicators consistent with the name of Factor 1. The first block corresponds to the indicators related to the traditional configuration. Corroborating the results of Renzi and Piacenti (2023), the variable representing those employed with a family relationship with the producer (X9) still maintains its relevance in the activities carried out in agricultural establishments. Another observed aspect corresponds to the participation of variables related to human capital, specifically literate brown (X9) and black (X7)[6] men, but differentiated by racial criteria observed as positively correlated with the rural development of Brazilian municipalities in 2017[7]. These

[6] In the results obtained, the variables corresponding to black and brown women who can read and write appeared to be correlated with the variables representing men. However, the variables related to the male gender were chosen based on the commonality criterion to adjust the model, yielding the best result in terms of the factor analysis used.

[7] It is worth noting that the variable representing white men who know how to read and write was identified as relevant; however, this variable was excluded because it did not meet the selection

variables represent the importance of the social dimension in the rural population, conferred by the variables that identify the ability to read and write in black and brown rural subpopulations. Furthermore, these variables are linked to the importance of education in determining the level of human development and in explaining inequalities between regions (Freitas, Bacha and Fossatt, 2009; Cunha; Heckman; Schennach, 2010; Renzi et al., 2022; Renzi and Piacenti, 2023).

Frame 2 – Presentation of variables, commonalities, and factor loadings in the composition of latent factors: a representation of the dimensions of rural development for Brazilian municipalities in 2017.

Code	COMMONALITY	FACTOR LOADING	VARIABLE NAME
FACTOR 1: Employment, Infrastructure, Institutions, and Production integrated with Agroindustry (α = 0.976)			
X76	0.935	0.919	Personnel employed in agricultural establishments with family ties to the producer (People).
X85	0.935	0.939	Number of hens, roosters, pullets, chickens, and chicks per establishment (Units).
X97	0.935	0.939	Value of sale of heads of hens, roosters, pullets, chickens, and chicks in agricultural establishments (Thousand Reais).
X39	0.926	0.871	Electric Energy - Number of establishments that have this infrastructure.
X73	0.904	0.880	Number of establishments with water depths, tanks, lakes, dams, public water areas for aquaculture, buildings, improvements or paths, degraded land and unusable land (Units).
X16	0.890	0.870	Work is managed by the owners - Number of establishments (Units).
X33	0.876	0.861	Work is managed directly by producers - Number of establishments (Units).
X84	0.850	0.854	Pigs - Number of establishments with production (Units).
X102	0.847	0.895	Temporary farming - Number of establishments (Units).
X9	0.763	0.710	Brown men who can read and write - Number of establishments with people (Units).
X34	0.735	0.821	Productive activity managed by the couple (co-management) - number of establishments (Units)
X45	0.698	0.721	Soil preparation system - Number of establishments that used some system (Units)
X7	0.664	0.682	Black men who can read and write - Number of establishments with people (Units).
X68	0.646	0.661	Pastures planted in poor conditions - Number of establishments that presented these areas (Units).
X82	0.643	0.719	Goats - Number of establishments (Units).
X87	0.631	0.783	Ducks, geese, mallards, partridges, and pheasants - Number of establishments (Units).
X105	0.553	0.719	Rural agroindustry - Number of establishments (Units).
FACTOR 2: Physical Capital, Technical Guidance, and Soil Management (α = 0.955)			
X61	0.875	0.873	Seeders/planters - Number of establishments that used this implement (Units).
X63	0.874	0.872	Fertilizer spreaders and/or limestone distributors - Number of establishments that used this implement (Units).
X60	0.841	0.837	Tractors - Number of establishments that used this implement (Units).
X62	0.826	0.877	Harvesters - Number of establishments that used this implement (Units).
X44	0.764	0.768	Limestone - Number of establishments that applied it.
X23	0.724	0.719	Technical Guidance - Number of establishments that received some type (Units).
X27	0.697	0.823	Technical guidance provided by integrating companies - Number of establishments that received this type of technical guidance (Units).
X40	0.687	0.727	Performed fertilization - Number of establishments that performed chemical fertilization (Units).
X71	0.666	0.808	Planted forests - Number of establishments with areas where woods or forests were planted (Units).
X26	0.664	0.807	Technical guidance provided by cooperatives - Number of establishments that received this type of technical guidance (Units).
X48	0.624	0.743	Direct planting in straw - Number of agricultural establishments that used this type of soil management (Units).
FACTOR 3: Livestock (α = 0.912)			
X78	0.890	0.845	Buffaloes - Number of establishments (Units)
X80	0.771	0.771	Donkeys - Number of establishments (Units)

criteria in the factor analysis. This was probably because the leaders, landowners, and producers were, for the most part, white and could read and write. Thus, this characteristic is indirectly contained in the variables X16 and X33.

X93	0.761	0.807	Value of sale of cattle heads for slaughter in establishments with more than 50 heads (Thousand Reais)
X92	0.681	0.783	Value of sale of heads of cattle matrices and bulls in establishments with more than 50 heads (Thousand Reais)
X95	0.650	0.636	Cows milked in establishments (Heads)
FACTOR 4: Irrigation and Horticulture (α = 0.842)			
X50	0.751	0.833	Micro-sprinkler irrigation - Number of establishments (Units).
X49	0.690	0.762	Drip irrigation - Number of establishments (Units).
X57	0.625	0.757	Conventional sprinkler irrigation - Number of establishments (Units).
X104	0.590	0.664	Horticulture - Number of establishments (Units).

Source: Prepared using data from the Agricultural Census (IBGE, 2017) and using SPSS software.

The second block of indicators is related, firstly, to the importance of the infrastructure present in rural establishments; that is, the analysis carried out on the data from the 2017 Agricultural Census also indicates as a differential in rural development, the establishments that have electricity (X39) and some infrastructure related to the water surface, tanks, lakes, dams, public water areas for aquaculture, buildings, improvements or paths, degraded land and unusable land (X73).

The third block of variables, a component of Factor 1, is related to institutional issues; that is, it was identified that rural development in municipalities is still tied to traditional forms of management, ownership, and production in agricultural establishments. In detail, the correlation between the direction of activities by owners (X16) and producers (X33) was identified, as well as the importance of co-direction of productive activities (X34). These variables confirm the significant participation of owners, together with their spouses, in general, who are themselves responsible for productive activity; that is, they do not delegate this activity to third parties or partners.

Finally, the fourth block, belonging to factor 1, represents the activities produced by agricultural establishments and, to some extent, related to agroindustry (X105). According to Brandão (2012), the ideal integration between agricultural production and industry tends to promote the rural development of municipalities through the effects of propulsion (*forward linkages*) and drag (*backward linkages*). In this sense, corroborating the results found by Renzi and Piacenti (2023), the level of rural development in municipalities that exhibit a greater degree of integration between agroindustry (X105) and animal and plant production (X85, X87, and X102) tends to be categorized at higher levels compared to municipalities lacking this characteristic. Following the same logic and consolidating this argument, Stege and Parré (2011) observed a similar positive relationship between animal and plant production and the level of rural development in Brazilian microregions.

In this sense, Ramos and Garagorry (2019) identified the relevance of goat production to assess the transformations that have occurred in agricultural output in MATOPIBA. Subsequently, Renzi and Piacenti (2023), using data from the 2006 Agricultural Census, found that such production was relevant for measuring the level of local and rural economic development of Brazilian municipalities.

In addition, Graziano da Silva (2002) had already argued that the new rurality presupposed a new sectoral configuration of productive activities, in which current agriculture is characterized by a crucial aspect, the greater integration between the links in the production chains of agricultural products and the respective agro-industries.

Finally, ratifying the results found by Almeida Mendes *et al*. (2018) and Renzi and Piacenti (2023), the progress of agricultural and agro-industrial activities promotes human development in Brazilian municipalities, particularly small ones.

Factor 2 (F_2), called *Physical Capital, Technical Orientation, and Soil Management*, corresponds to 22.27% of the total accumulated variance and integrates the correlation of 11 variables, ordered by the magnitude of the commonality, which are X61, X63, X60, X62, X44, X23, X27, X40, X71, X26, and X48. Of these 11 variables, 10 are included in the economic dimension and demonstrate a direct relationship with rural development, specifically related to the use of physical capital and inputs employed in primary production activities. Among these ten variables, the first four, seeders/planters (X61), fertilizer spreaders and/or limestone distributors (X63), tractors (X60), and harvesters (X62) present extremely high commonalities, greater than 0.8, and, therefore, indicate their greater power of influence over this second factor. The positive relationship between physical capital and economic development has already been empirically proven because it is incorporated into technology and, consequently, the crucial element for boosting labor productivity (Freitas; Bacha; Fossatt, 2009; Gasques *et al*., 2014).

Still, on the second factor, only variables X23, X27, and X26 are classified in the social dimension and are directly related to education. These variables are closely related to the transfer of knowledge and learning to utilize the physical infrastructure of rural establishments, as well as the management of inputs, such as limestone application methods (X44) and fertilization (X40). Technical guidance optimizes the use of physical productive resources in rural establishments, an argument supported by Freitas, Bacha, and Fossatt (2009).

Macedo *et al*. (2013) found that more than 70% of cultivated pasture areas exhibit some level of deterioration. This fact originates from the inadequate nutritional restoration of the land and/or inappropriate management of animals, such as the number of animals per area exceeding sustainable capacity. The most concerning consequence of pasture deterioration is related to environmental degradation, specifically the increase in negative impacts on water resources and greenhouse gas emissions. Thus, to contain or at least slow down the aforementioned degradation, the direct planting system (X48), *Factor* 2 (F_2), according to Franchini *et al*. (2007), tends to promote greater land productivity while efficiently preserving the environment and therefore, generates better effects for production sustainability when compared to conventional forms of planting.

Finally, the planted forests variable (X71) represents the importance of the environmental dimension and corroborates the indicative positive correlation between human and environmental development. This variable positively interferes with the categorization of municipalities in terms of their level of rural development. This fact confirms Gurgel *et al*. (2009) ideas. These authors identified that areas of reforestation and/or forest production promote more suitable socio-environmental scenarios and, consequently, are likely to foster a more lasting human development dynamic.

Factor 3 is composed of variables representing the economic dimension. This factor corresponds to 11.32% of the total accumulated variance and integrates the correlation of 5 variables, ordered by the magnitude of the commonality, namely: Buffaloes (X78); donkeys (X80); value of the sale of heads of cattle for slaughter

(X93); value of the sale of heads of cattle matrices and breeding animals (X92) and milk cows (X95). This positive correlation between animal production and the level of rural development of Brazilian microregions has already been identified by Stege and Parré (2011). Regarding the variable X80, donkeys, it is worth noting that Renzi and Piacenti (2023), using data from the 2006 Agricultural Census, found results similar to those presented in this article. Additionally, Ramos and Garagorry (2019) observed that the productive activity of donkeys is an important factor in explaining the transformations that occurred in agricultural production in MATOPIBA.

Additionally, Crespolini dos Santos *et al.* (2014) observed a significant evolution in productivity indicators in beef cattle farming, namely mortality rates, slaughter age, and stocking rates per area. However, according to these authors, this evolution did not have a significant impact on the profitability of this activity.

Factor 4 (F_4), called *Irrigation and Horticulture*, accounts for 8.85% of the total accumulated variance and integrates the correlations of four variables, ordered by the magnitude of the commonality, which are: (X50) Micro-sprinkler irrigation, (X49) Drip irrigation, (X57) Conventional sprinkler irrigation, and (X104) Horticulture.

After interpreting the results regarding the latent factors obtained, the following section analyzes the categorization of the RDI for the 5,570 Brazilian municipalities using data from the IBGE Agricultural Census (2017).

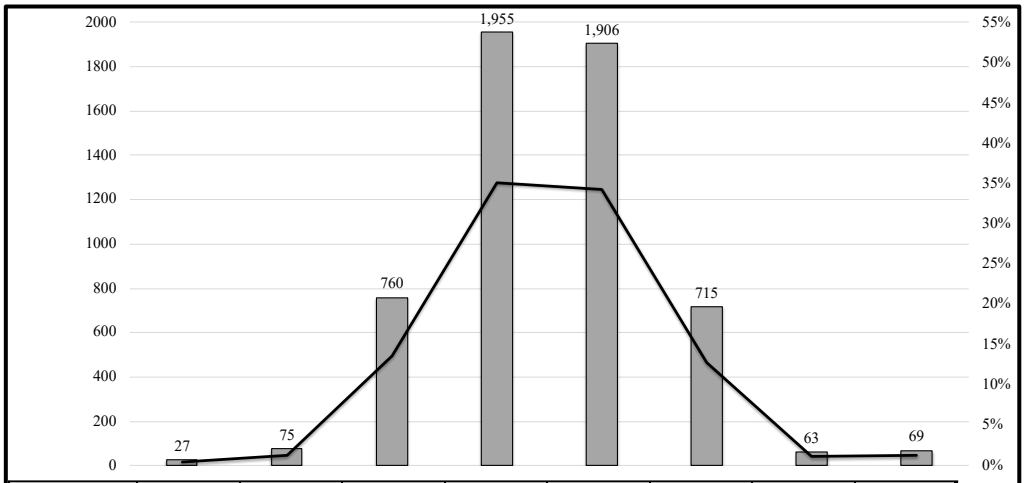
4.1 Categorization of Brazilian municipalities

In the previous section, the four resulting common factors were analyzed, enabling the classification of the 5,570 Brazilian municipalities using the RDI. To this end,

Graphic1 presents the results obtained, classifying municipalities into eight categories. These categories are duly supported by the methodology presented in Frame 1 (p. 8) and are related to the level of rural development of each municipality.

After interpolating the index, the average RDI value obtained was 0.5171, highlighting the presence of 2,817 (50.57%) municipalities with an RDI equal to or greater than the national average. Additionally, the results indicate a standard error of 0.0017, which is extremely low, indicating a low dispersion between municipalities in terms of the level of rural development. Concerning the standard deviation of 0.1258, it is observed that the distribution of Brazilian municipalities approaches a normal distribution, with 95.80% of municipalities falling within an interval of two standard deviations from the mean. Another notable finding is the coefficient of variation of 24.32%. This result indicates that the average is a good measure to represent the data because the data used are reasonably homogeneous, as evidenced by the value found being less than 30%. Regarding shape measurements, a Fischer asymmetry of -0.2228 was found, indicating a negatively asymmetric distribution, and a Fischer kurtosis coefficient of 0.3759, indicating that the curve is leptokurtic (Fávero & Belfiore, 2017).

Graphic1 – Classification of Brazilian municipalities using the Rural Economic Development Index (RDI) in 2015 17



	Extremely High	Very High	High	Regular High	Regular Low	Low	Very Low	Extremely Low
Municipalities	27	75	760	1955	1906	715	63	69
Participating	0.48%	1.35%	13.64%	35.10%	34.22%	12.84%	1.13%	1.24%

Source: Prepared by the author based on data from the Agricultural Census (2017).

Based on the results obtained, it is concluded that the rural development of Brazilian municipalities was characterized by two distinct sets of municipalities located at the extremes. In other words, as shown in Graphic 1 (p. 16) and Frame 1 (p. 8), the most significant portion of municipalities is concentrated in the regular high (RA) and regular low (RB) categories, accounting for 69.32%. Therefore, it is inferred from

Graphic1 that significant dissimilarities concerning the level of rural development are highlighted at the extremes. Consequently, scientific research on the classification of municipalities has focused on these extremes, or rather, the extremely high (EA), very high (MA), and high (A) categories, which correspond to 15.48%, while the very low (MB), low (B), and extremely low (EB) categories account for another 15.21%.

Assessments of these rural development categories enable the identification of the best and worst Brazilian municipalities, providing evidence for and about public actions and policies.

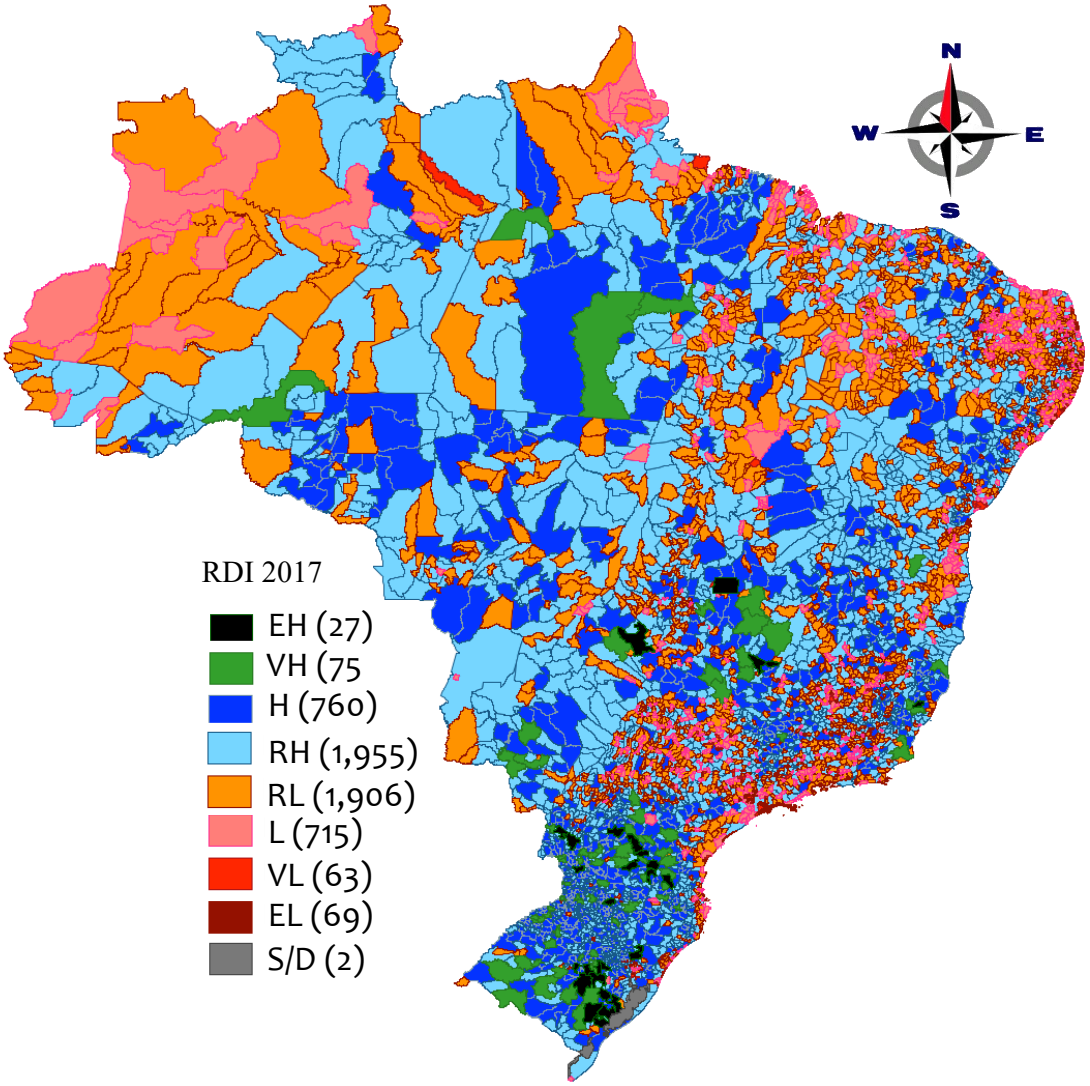
4.2 Main notes on the RDI

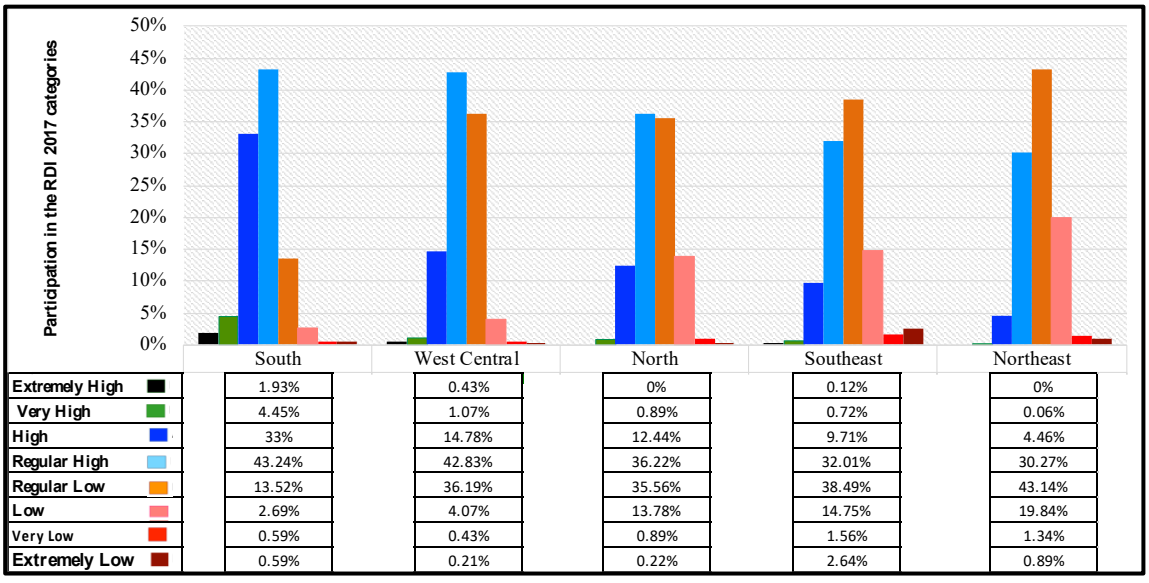
Following the classification carried out based on the eight categories of rural development (RDI), this section will discuss the factors that explain the differences between municipalities and Regions and, consequently, the main conclusions obtained. Firstly, in Figure 1, the municipalities are observed by Region, highlighted positively or negatively. To this end, as a criterion for classifying the Regions (presented in order from right to left), we opted for the sum of the results obtained in the three highest levels: extremely high (EA), very high (MA), and High (A) in terms of the level of rural development of the municipalities present in the respective Regions.

When analyzing Figure 1, considering the national RDI average of 0.5171 as a reference, the South Region achieved the best performance, containing 82.62% of municipalities above this average. Among the municipalities located in this Region, 33% (393) presented a high level (A), 4.45% (53) a very high level (MA), and 1.93% (23) municipalities were categorized at the extremely high level (EA) by the index. At the opposite end, there were 7 municipalities in the very low (MB) and extremely low (EB) categories.

The second region with the best results was the Central-West Region. It presented 275 (59.01%) with RDI above the national average. Considering all municipalities, the Central-West Region concentrates 33% (69) at the high level, 1.07% (5) at the very high level (MA), and two municipalities at the extremely high level (0.43%) of the RDI. At the opposite extreme, it presented only two municipalities with a very low level (MB) and one with a low level (B). Still in Figure 1 below, in an intermediate situation is the North Region, with only 49.56% (223) of its municipalities having an RDI above the average for Brazilian municipalities. On the one hand, based on all the municipalities present in this Region, only 12.44% (56) presented a high level (A), 0.89% (4) a very high level, and none an extremely high level (EA). In contrast, 13.78% (62) had a low level (B), 0.89% (4) had a very low level (MB), and only one (0.22%) had an extremely low level (EB) of the same RDI. The prevailing categories for this Region were intermediate, with 71.78% (RA and RB). Therefore, it is concluded that activities related to rurality have less determining power in this Region. This conclusion does not necessarily mean that aspects of rural economic development are not relevant to this Region but that they are relatively less influential compared to other Regions in the nation.

Figure 1 – Distribution of RDI categories by Region in 2017





	South	West Central	North	Southeast	Northeast
Extremely High	1.93%	0.43%	0%	0.12%	0%
Very High	4.45%	1.07%	0.89%	0.72%	0.06%
High	33%	14.78%	12.44%	9.71%	4.46%
Regular High	43.24%	42.83%	36.22%	32.01%	30.27%
Regular Low	13.52%	36.19%	35.56%	38.49%	43.14%
Low	2.69%	4.07%	13.78%	14.75%	19.84%
Very Low	0.59%	0.43%	0.89%	1.56%	1.34%
Extremely Low	0.59%	0.21%	0.22%	2.64%	0.89%

Source: Prepared by the author based on data from the Agricultural Census (2017).

The Southeast and Northeast regions, in contrast, when observed in Figure 1, stand out negatively for presenting the highest participation in the low (B), very low

(MB), and extremely low (EB) levels of economic development in rural areas. Regarding the Southeast Region, it has 57.43% (958) municipalities below the national RDI average. Among all municipalities in this Region, 14.75% (246) were classified at low level (B), and 1.56% (26) at very low level (MB), and 2.64% (44) presented extremely low level (MB). In contrast, concerning the other extreme, only 9.71% (162) municipalities have a high level (A), and 0.72% (12) were categorized as high level (MA), and only two (0.12%) municipalities presented an extremely high level (EA).

Finally, the last Region to be analyzed in Figure 1, which presents the worst result in terms of the concentration of municipalities below the national average of the RDI, is the Northeast Region. In this region, 65.22% (1170) of the municipalities are below the national average, and among these municipalities, 19.84% (356) presented a low level, 1.34% (24) a very low level, and 0.89% (16) an extremely low level (MB). At the other extreme, 4.46% (80) of the municipalities were classified at the high level (A), one (0.06%) at the very high level (MA), and no municipalities at the extremely high level (EB).

In comparison to the Southeast and Northeast Regions, the superiority shown by the RDI of the South, Central-West, and North Regions can be, in part, explained by the greater concentration of physical and human capital stocks existing in these Regions. Additionally, there is a greater probability of interaction with greater efficiency between the existing capital in agriculture and agroindustry in such Regions, in terms of the results obtained with greater efficiency resulting from technical guidance and the possible consequences on productivity, soil conditions, and management, related to environmental aspects, and the results of the primary productive crops observed, such as livestock (dairy and beef), horticulture, linked to irrigation infrastructure, and forestry production.

The results obtained in this article contradict, in part, the results found by Freitas, Bacha and Fossatt (2009), who observed a capital-labor ratio below unity for the states of the North and Northeast Regions in the period between 1980 and 1996. This is because our results indicate that the North Region has a greater relevance in terms of physical and human capital in agricultural and agro-industrial production, with the Southeast Region being the superior region. These signs can be interpreted, in part, as an indication of the greater weight of agricultural and agro-industrial activities in the North Region and/or the replacement or transfer of part of these activities mentioned from the Southeast Region to other Regions, likely related to the implementation of agro-industries near the production of raw materials.

Furthermore, the process of technification and mechanization of the agricultural sector, which was concentrated in the Southeast, South, and Central West Regions between 1980 and 1996, has not yet had the same effect on the Northeast Region. However, concerning the North Region, our data indicate the evolution of this Region through the RDI.

In addition, another argument used by Freitas, Bacha and Fossatt (2009) to illustrate the contrasts between the Regions stems from the fact that the average level of education of Northeasterners employed in the agricultural sector was relatively lower when compared to the national average in the 1980s and 1990s. This fact can still be used to support the result of this article.

Another relevant factor to partially expose the differences between the Regions is related to the provision of human and physical capital, which, if

insufficient, tends to maintain or extend the permanence of these municipalities at lower levels of rural development, particularly in regions where there is predominantly subsistence agriculture and where the majority of the population is in conditions of vulnerability to poverty (Navarro; 2019; Renzi; Piacenti, 2023).

In short, Figure 1 illustrates the high accumulation of municipalities categorized at lower levels of rural development. When compared to the results obtained by Stege and Parré (2011), the results presented in this article, using the RDI, contribute an indicator with a greater capacity to identify the municipal particularities present in the phenomenon of rural development. Thus, through the greater composition of variables used, it is capable of supporting and generating more consistent interpretations of regional inequalities related to rural characteristics.

5 Conclusion

This article achieved the objective of constructing a new rural development index, using the concept of rurality and rural development as foundations to initially support the construction of the database originating from the 2017 Agricultural Census, the selection of the variables used, and, subsequently, their selection through factor analysis. After producing the index, the 5,570 Brazilian municipalities were categorized. Although the data used present a significant time lag, they represent current data for the Brazilian agricultural sector and, therefore, allow this work to provide, as its main contribution, a rural development index representative of the most recent characteristics of a vital sector for the Brazilian productive sector. Furthermore, the RDI was created from a database with 105 variables, of which 37 variables constituted the four common factors, thereby composing the RDI as a set of characteristics capable of identifying aspects of rural development in Brazilian municipalities and regions with greater depth and precision.

Apparently, the results presented in this article diverge from those of other authors, who used data from the 2006 Agricultural Census regarding the characteristics of rural development in Brazilian municipalities. However, it is not possible to state whether there was evolution or not concerning the results obtained, because the factor analysis employed does not allow such an interpretation. Still, it does enable us to state that the characteristics and results were different. This result contributes to a recent x-ray of the level of rural development in national municipalities, which can provide essential elements for analysis or elaboration of public policies related to the topic discussed. Furthermore, the four latent factors can indicate the relevant guidelines to be considered for achieving better results in policies aimed at boosting human development, particularly in rural development in Brazilian regions.

These guidelines correspond to the factors identified and composed of indicators related to the following characteristics: 1) incentive to increase the level of employment, expand and improve the infrastructure of agricultural establishments, strengthen institutions related to property rights, improve productive activities concerning poultry production and trade, and improve the integration between primary production and agroindustry; 2) encourage the updating and expansion of mechanized production (physical capital), stimulate and improve the technical guidance of agricultural activities, foster the expansion of forest planting and

propagate soil management techniques; 3) consolidate the production and marketing of livestock products; and, finally, 4) intensify horticulture production and the infrastructural means that allow the support of this activity, that is, the appropriate irrigation systems and environmentally efficient techniques.

In summary, public policies constructed following the proposed guidelines are likely to increase the likelihood of minimizing socioeconomic inequalities between Brazilian municipalities and regions. Obviously, public policy proposals can consider the proposed guidelines as an initial reference; however, it is beneficial to observe the potential of each Region and its municipalities to suggest actions that are more in line with local reality, thus maximizing the results to be obtained in terms of increasing the level of human and rural development.

REFERENCES

ALMEIDA MENDES, W.; FERREIRA, M. A. M.; ABRANTES, L. A.; FARIA, E. R. A influência da capacidade econômica e da formação de receitas públicas no desenvolvimento humano. Revista de Administração Pública, Rio de Janeiro, v. 52, n. 5, p. 918-934, 2018. Available on: https://doi.org/10.1590/0034-761220170004 . Access: 05 Dec. 2019.

BOSWORTH, G; SOMERVILLE, P. (Ed.). Interpreting rurality: Multidisciplinary approaches. New York: Routledge, 2013.

BRANDÃO, C. Território & desenvolvimento: as múltiplas escalas entre o local e o global. Campinas: UNICAMP, 2012.

CARNEIRO, M. J. "Rural" como categoria de pensamento. RURIS (Campinas-online), Campinas, v. 2, n. 1, p. 9-38, 2008.

CARNEIRO, M. J.; SANDRONI L. Tipologias e significados do "rural": uma leitura crítica. In: LEITE, P. S.; BUNO, R (Org.). O rural brasileiro na perspectiva do século XXI. Rio de Janeiro: Garamond, 2019. p. 43-58.

CRESPOLINI DOS SANTOS, M.; BELIK, W.; DE ZEN, S.; ALMEIDA, L. H. A rentabilidade da pecuária de corte no Brasil. Segurança Alimentar e Nutricional, Campinas, v. 21, n. 2, p. 505-517,2014. Available on: https://periodicos.sbu.unicamp.br/ojs/index.php/san/article/view/8634589. Access: 22 Sept. 2019.

CUNHA, F.; HECKMAN, J. J.; SCHENNACH, S. M. Estimating the technology of cognitive and noncognitive skill formation. Econometrica, New Haven, v. 78, n. 3, p. 883-931, 2010. Available on: https://doi.org/10.3982/ECTA6551. Access: 26 Sept. 2017.
FÁVERO, L. P.; BELFIORE, P. Manual de análise de dados. 1. ed. Rio de Janeiro: Elsevier, 2017.

FRANCHINI, J. C.; TORRES, E.; GONÇALVES, S. L.; SARAIVA, O. F. Contribuição de sistemas de manejo do solo para a produção sustentável da soja. Embrapa Soja-

Circular Técnica (INFOTECA-E), p. 1-4, 2007. Available on: https://www.infoteca.cnptia.embrapa.br/bitstream/doc/470324/1/circtec46.pdf. Access: 06 Dec. 2019.

FREITAS, C. A.; BACHA, C. J. C.; FOSSATT, D. M. Avaliação do desenvolvimento do setor agropecuário no Brasil: período de 1970 a 2000. Economia e Sociedade, Campinas, v. 16, n. 1, p. 111-124, 2007. Available on: https://doi.org/10.1590/S0104-06182007000100006. Access: 22 Sept. 2019.

GASQUES, J. G.; BASTOS, E. T.; VALDES, C.; BACCHI, M. R. P. Produtividade da agricultura: resultados para o Brasil e estados selecionados. Revista de Política Agrícola, Brasília, v. 23, n. 3, p. 87-98, 2014. Available on: https://seer.sede.embrapa.br/index.php/RPA/article/view/943/836. Access: 16 Oct. 2016.

GOMES, I. O espaço rural em questão: o caso dos municípios rurais de Minas Gerais. Revista Eletrônica da Associação dos Geógrafos Brasileiros, Três Lagoas, n. 13, ano 8, p. 155-178, 2011. Available on: https://periodicos.ufms.br/index.php/RevAGB/article/view/627. Acess: 20 Dec. 2022.

GRAZIANO DA SILVA, J. O novo rural brasileiro. 2. ed. Campinas: UNICAMP, 2002. Available on: http://www.eco.unicamp.br/images/publicacoes/Livros/pesquisa/O-novo-rural-Brasileiro.pdf. Access: 10 Aug. 2018.

GURGEL, H. C.; HARGRAVE, J.; FRANÇA, F.; HOLMES, R. M.; RICARTE, F. M.; DIAS, B. F.; RODRIGUES, C. G. O.; BRITO, M. C. W. Unidades de conservação e o falso dilema entre conservação e desenvolvimento. Boletim Regional, Urbano e Ambiental. Rio de Janeiro, IPEA, n. 3, p. 109–120, 2009. Available on: http://repositorio.ipea.gov.br/bitstream/11058/5490/1/BRU_n3_unidades_conservacao.pdf. Access: 19 Nov. 2019.

HAIR, J. F.; BLACK, W. C.; BABIN, B. J.; ANDERSON, R. E.; TATHAM, R. L. Análise Multivariada de dados. 6·ed. Porto Alegre: Bookman, 2009.

IBGE – INSTITUTO BRASILEIRO DE GEOGRAFIA. Censo agropecuário 2017. Rio de Janeiro: IBGE, 2017. Available on: https://www.ibge.gov.br/estatisticas-novoportal/economicas/agricultura-e-pecuaria. Access: 25 Jul. 2023.

KAGEYAMA, A. Desenvolvimento rural: conceito e aplicações ao caso brasileiro. Porto Alegre: Editora da UFRGS: Programa de Pós-Graduação em Desenvolvimento Rural, 2008.

MACEDO, M. C. M.; ZIMMER, A. H.; KICHEL, A. N.; ALMEIDA, R. G.; ARAÚJO, A. R. Degradação de pastagens, alternativas de recuperação e renovação, e formas de mitigação. In: Embrapa Gado de Corte-Artigo em anais de congresso (ALICE). In: ENCONTRO DE ADUBAÇÃO DE PASTAGENS DA SCOT CONSULTORIA-TEC-FÉRTIL, 1., 2013, Ribeirão Preto, SP. Anais... Bebedouro: Scot Consultoria, 2013. p. 158-181., 2013.

Available on:
https://www.alice.cnptia.embrapa.br/bitstream/doc/976514/1/DegradacaopastagensalternativasrecuperacaoMMacedoScot.pdf. Access: 02 Dec. 2019.

MELO, C. O.; PARRÉ, J. L. Índice de desenvolvimento rural dos municípios paranaenses: determinantes e hierarquização. Revista de Economia e Sociologia Rural, Brasília, v. 45, n. 02, p. 329-365, abr./jun., 2007. Available on: https://doi.org/10.1590/S0103-20032007000200005. Access: 30 Mar. 2017.

MELO, C. O.; SILVA, G. H. Desenvolvimento rural dos municípios da região sudoeste paranaense: uma proposta de medida através da análise fatorial. Organizações Rurais & Agroindustriais, Lavras, v. 16, n. 1, p. 33-45, 2014. Available on: http://www.redalyc.org/pdf/878/87831144004.pdf. Access: 12 Apr. 2018.

MICHALEK, J.; ZARNEKOW, N. Application of the rural development index to analysis of rural regions in Poland and Slovakia. Social Indicators Research, Rome, v. 105, n. 1, p. 1-37, 2012. Available on: https://doi.org/10.1007/s11205-010-9765-6. Access: 30 Mar. 2019.

NAVARRO, Z. S. Meio século de interpretações sobre o rural brasileiro (1968-2018). Revista de Economia e Sociologia Rural, Brasília, v. 57, n. 3, p. 472-489, 2019. Available on: https://doi.org/10.1590/1806-9479.2019.219449. Access: 05 Dec. 2019.

PAGLIACCI, F. Measuring EU urban-rural continuum through fuzzy logic. Tijdschrift Voor Economische en Sociale Geografie, Utrecht, v. 108, n. 2, p. 157-174, 2017. Available on: https://doi.org/10.1111/tesg.12201. Access: 10 Dec. 2019.

PEDROSO, M. T. M.; NAVARRO, Z. S. O Brasil Rural–do passado agrário ao sistema agroalimentar global (1968-2018). COLÓQUIO-Revista do Desenvolvimento Regional, Taquara, v. 17, n. 1, p. 1-15, 2019. Available on: https://doi.org/10.26767/1575. Access: 20 Dec. 2019.

PRIETO-LARA, E; OCAÑA-RIOLA, R. Updating rurality index for small areas in Spain. Social Indicators Research, Rome, v. 95, n. 2, p. 267, 2010. Available on: https://doi.org/10.1007/s11205-009-9459-0. Access: 24 Jun. 2019.

RAMOS, M. Y.; GARAGORRY, F. L. Mudanças espaciais na produção agropecuária da região do MATOPIBA, Brasil: uma aplicação da análise de redes. Cadernos de Ciência & Tecnologia, Brasília, v. 36, n. 3, p. 1-22, 2019. Available on: http://dx.doi.org/10.35977/0104-1096.cct2019.v36.26516. Access: 23 Nov. 2019.

RENZI, A. .; JUNIOR, A. P.; PARRÉ, J. L. ; PIACENTI , C. A. Economic Growth in the Municipalities of Paraná-Brazil: An Analysis with Spatial Econometrics. Revista Portuguesa de Estudos Regionais, Angra do Heroísmo, n. 61, p. 151–167, 2022. Available on: https://doi.org/10.59072/rper.vi61.537. Access: 15 Aug. 2021.

RENZI, A.; PIACENTI, C. A. Índice de desenvolvimento da rural das municipalidades: um estudo a partir do Censo Agropecuário de 2006. Redes, v. 28, n. 1, 12 abr. 2023. Available on: https://doi.org/10.17058/redes.v28i1.17153. Access: 9 Aug. 2023.

SARACENO, E. Recent trends in rural development and their conceptualisation. Journal of Rural Studies, Loughborough, v. 10, n. 4, p. 321-330, 1994. Available on: https://doi.org/10.1016/0743-0167(94)90042-6. Access: 15 Dec. 2022.

SARSTEDT, M.; MOOI, E. Concise Guide to Market Research: the Process, Data, and Methods Using IBM SPSS Statistics. 3. ed. Berlin: Springer, 2019.

STEGE, A. L.; PARRÉ, J. L. Desenvolvimento rural nas microrregiões do Brasil: um estudo multidimensional. Revista Teoria e Evidência Econômica, Passo fundo, v. 17, n. 37, 2011. Available on: https://doi.org/10.5335/rtee.v17i37.4227. Access: 16 Feb. 2019.

TORRE, A.; WALLET, F. Regional development in rural areas: Analytical tools and public policies. Switzerland: Springer, 2016.

VEIGA, J. E. Nascimento de outra ruralidade. Estudos Avançados [online], São Paulo, v. 20, n. 57, p. 333-353, 2006. Available on: https://doi.org/10.1590/S0103-40142006000200023. Access: 18 Dec. 2022.