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ESTRUTURA DA AGROPECUÁRIA ORGÂNICA NO ESTADO DO PARANÁ: ANÁLISE A PARTIR DO CENSO AGROPECUÁRIO 2017

STRUCTURE OF ORGANIC FARMING IN THE STATE OF PARANÁ: ANALYSIS BASED ON THE 2017 AGRICULTURAL CENSUS

ESTRUCTURA DE LA AGRICULTURA ORGÁNICA EN EL ESTADO DE PARANÁ: ANÁLISIS A PARTIR DEL CENSO AGROPECUARIO 2017

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RESUMO

Este estudo examina a estrutura de estabelecimentos de agricultura orgânica no Paraná, com base nos dados do Censo Agrícola de 2017. Foi realizada uma análise da representatividade da agricultura orgânica e interpretados os fatores que caracterizam sua estrutura no estado, bem como a distribuição e concentração desses estabelecimentos entre os municípios avaliados. Foi adotada uma abordagem metodológica quantitativa e exploratória, utilizando duas técnicas multivariadas, análise de fatores e análise de clusters. Os resultados indicam que a estrutura da agricultura no Paraná é predominantemente familiar, com quase três vezes mais estabelecimentos familiares do que não familiares. Embora o número de estabelecimentos que utilizam produção orgânica seja pequeno em comparação com a prática convencional, há uma homogeneidade na estrutura da agricultura orgânica entre os municípios do Paraná. Isso pode ser atribuído à descentralização da área de produção e à forte presença de gestão coletiva no apoio técnico e coordenação dos estabelecimentos locais.

Palavras-chave: Produção Orgânica; Agricultura familiar; Análise fatorial; Análise de cluster.

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ABSTRACT

This study examines the structure of organic farming establishments in Paraná, based on data from the 2017 Agricultural Census. An analysis of the representativeness of organic agriculture was conducted, and factors characterizing its structure in the state, as well as the distribution and concentration of these establishments among the evaluated municipalities, were interpreted. A quantitative and exploratory methodological approach was adopted, using two multivariate techniques, factor analysis and cluster analysis. The results indicate that the structure of agriculture in Paraná is predominantly familial, with nearly three times more family-owned establishments than non-family-owned ones. Although the number of establishments utilizing organic production is small compared to conventional practice, there is homogeneity in the structure of organic agriculture among the municipalities of Paraná. This can be attributed to the decentralization of the production area and the strong presence of collective management in providing technical support and coordinating local establishments.

Keywords: Organic production; Family farming; Factor analysis; Cluster analysis.

RESUMEN

Este estudio examina la estructura de los establecimientos de agricultura orgánica en Paraná, basado en datos del Censo Agrícola de 2017. Se realizó un análisis de la representatividad de la agricultura orgánica, e interpretaron los factores que caracterizan su estructura en el estado, así como la distribución y concentración de estos establecimientos entre los municipios evaluados. Se adoptó un enfoque metodológico cuantitativo y exploratorio, utilizando dos técnicas multivariadas, análisis de factores y análisis de clusters. Los resultados indican que la estructura de la agricultura en Paraná es predominantemente familiar, con casi tres veces más establecimientos familiares que no familiares. Aunque el número de establecimientos que utilizan producción orgánica es pequeño en comparación con la práctica convencional, hay homogeneidad en la estructura de la agricultura orgánica entre los municipios de Paraná. Esto puede atribuirse a la descentralización del área de producción y la fuerte presencia de gestión colectiva en el apoyo técnico y la coordinación de los establecimientos locales.

Palavras clave: Producción orgânica; Agricultura familiar; Análisis factorial; Análisis de cluster.

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1 INTRODUCTION

Significant adoption of technologies in the production process was observed during the period of modernization and development of farming. This phase resulted in scale gains, boosting crop yield, especially commodities destined for the export market. According to Zibetti *et al.* (2011), the food production model from 1950 onwards adopted an immediate perspective, using the technological package of the “Green Revolution,” which included mechanization, the use of chemical products, genetic improvement, and the introduction of monocultures, aiming to increase production.

On the other hand, the overexploitation of the base of natural resources associated with the lack of awareness regarding the environment allowed for major environmental changes and social implications, with increasing levels of soil degradation and depletion, water pollution, and intoxication and contamination of farmers by agrochemicals, in addition to the loss of biodiversity (Oliveira *et al.*, 2006; Hespanhol, 2008).

In contrast, several movements emerged in favor of more sustainable farming, turning to agricultural and livestock practices that sought to respect natural resources and traditional knowledge, standing out the organic, biodynamic, natural, regenerative, and permaculture movements, among others, each with its specificities (São Paulo, 2014).

A new paradigm of farming has been discussed and built given this concern with the problems generated by the conventional agricultural model, and sustainable practices of production have been incorporated. Consumers have influenced the production system through the demand for healthier products, produced with respect for the environment and the health of workers. In this context of increased demand for food with quality attributes, related both to aspects of health preservation and the environmental quality of production processes, organic systems of production have been gaining more and more attention (Novakoski; Wives, 2020; Souza *et al.*, 2021).

According to Souza *et al.* (2021), the number of establishments that practice organic farming in Brazil has reduced despite the increased demand for food safety and the growing concern for sustainability. Comparative studies of the 2006 and 2017 Census have shown a reduction in the number of establishments with organic production in Brazil from 90,498 to 64,690, respectively, that is, a 28.52% decrease in 11 years.

An increase in the number of certified properties has occurred despite the reduction in establishments. According to Corbari *et al.* (2019), the state of Paraná is the first in the number of rural establishments certified as organic among the federative units, with 3,053 certifications, which represents 15.8% of the total in Brazil. According to the National Register of Organic Producers (CNPO), this number increased to 3,838 producers with active certifications in January 2023, representing 25.71% of the number of certifications in Paraná and 16.4% in Brazil. In this period, Brazil presented a total of 23,380 active certifications (CNPO, 2023).

The South, Southeast, and Northeast regions have the highest presence of certified producers, standing out the states of Paraná (3,838 certifications), Rio Grande do Sul (3,535 certifications), Pará (2,179 certifications), São Paulo (1,825 certifications), Santa Catarina (1,553 certifications), Minas Gerais (1,007 certifications), Pernambuco (981 certifications), and Rio de Janeiro (516 certifications) (CNPO, 2023). According to the Brazilian Council for Sustainable Organic Production (ORGANIS), this significant number of producers is related to the dynamics of the consumer market, given that the consumption of organic products is twice the national consumption in the South of Brazil (Organis, 2017).

According to Koefender *et al.* (2020), the state provides free certification to small farmers through the More Organic Paraná Program, a partnership between the Paraná Institute of Technology (TECPAR) and the State Secretariat for Science, Technology, and Higher Education (SETI). This program is carried out through state universities and the Reference Center for Agroecology (CPRA), thus forming action centers.

Agricultural production must respect attributes of quality and social responsibility, increasingly demanding agrifood products that ensure proof and confidence for the market through structured and formalized systems with procedures for assessing conformity and identifying the origin and traceability of the adopted production processes. In this scenario, attributes that were undervalued in the past, such as organic production, have gained importance and become a value-adding factor for agricultural products (Buainain, 2014).

The universe that guides organic farming is directly related to the issues that guide the preservation of the environment and the aspect of health and social well-being. A reflection on this debate should make contemporary societies aware of how food has been produced. Thus, considering the economic importance of farming in Brazil and its federative units, this study intends to answer the following question: What is the structure of organic farming establishments in the State of Paraná?

Considering that the structures of organic farming establishments can vary in size and complexity due to the dynamic and diversified capacity of the productive structure and the insertion of institutional arrangements focused on the development of organic production concentrated largely in the hands of family farming, this study aims to analyze the universe and characteristics of organic farming in Paraná based on the 2017 Agricultural Census.

In this sense, a brief approach to organic farming, with some introductory aspects of the literature, is in the first part of this article. Next, the methodological procedures of the empirical research are described. Subsequently, the empirical analysis of this article is presented based on the research data, in addition to the conclusions reached.

2 GENERAL ASPECTS OF ORGANIC FARMING

Growing concerns both with the preservation of the environment and with the damage caused to human health and well-being due to the use of synthetic chemical inputs in food production have driven the growth of the market of organic products (Barbosa; Sousa, 2012). Organic production also presents itself as a sustainable option with requirements that align with the fulfillment of the Sustainable Development Goals (SDGs**)**, particularly goals 2 (Zero Hunger) and 12 (Responsible Consumption and Production**)**. Its significance extends globally due to the growing demand for safe and healthy food (Ghanghas *et al*. 2021).

Mazzoleni and Nogueira (2006) stated that the expression “organic agriculture” is widely used in several countries around the world. The authors highlight the importance of contextualizing the origin of the term and the changes it has undergone over time as a way to improve understanding of the concept of organic agriculture.

In a comprehensive comparative analysis between organic and conventional agriculture conducted by Ströbel (2024), one of the points addressed in their study is the difference in yield**s** and the land area requirements for individual crops. The yield of organic production corresponds to 40% to 80% of the yield per hectare compared to conventional production. However, when comparing crop rotations, "the high proportion of low-yield legumes and the need to cultivate green manure plants reduce the average yield to approximately 50%, which means that organic agriculture requires twice the land to produce the same volume" (Ströbel, 2024, p.2). Despite this, the author acknowledges that organic agriculture's merit lies in raising awareness about ecological issues compared to conventional methods, leading to necessary corrections and mitigating environmental damage.

In Brazil, the consolidation of organic agriculture is supported by Law n. 10,831, of December 23, 2003, in which Article 1 defines an organic farming production system as any system in which specific techniques are adopted to optimize the use of available natural and socioeconomic resources and respect for the cultural integrity of rural communities, aiming at economic and ecological sustainability and the maximization of social benefits (Brasil, 2003).

The principles of organic agriculture apply to any type of product, whether of animal or vegetable origin, allowing its production and use in the most different environments, and employing all available natural resources in a sustainable way (Zibetti *et al.*, 2011). In this perspective, organic farming production represents an alternative not only to solving economic problems of production systems but also to improve the quality of life of producers and consumers. For the rural sector, organic production emerges as an opportunity to alleviate poverty through the production of food for self-consumption and income generation for families (Rojas-Bourrillón, 2005).

The cultivation of organic products in recent years has become an increasingly relevant segment for family farmers in Brazil, both in economic and social terms. The growing importance of sustainable development and the existence of an increasingly demanding market made up of consumers concerned with environmental issues and interested in healthier products, have led to a strong incentive for family farmers to dedicate themselves to organic food production (Michellon; Silva, 2019).

Globally, from 2000 to 2017, there has been an increase in cultivable areas dedicated to organic production. This growth was driven by the rising consumption of organic products (both food and beverages) in North American and European countries. In terms of market dominance, the United States, Germany, France, and China hold prominent positions. During the same period, the average annual growth in retail sales of organic products worldwide exceeded 11%, demonstrating the economic viability of this sector. In 2017, organic products accounted for 5.5% of overall food sales in the United States, with fruits and vegetables leading the way at 14.1% of total sales (Willer; Lernoud, 2019; IPEA, 2020; Haumann, 2019).

The panorama of consumption of organic products in Brazil shows that the South region demands the highest consumption of organic products (23%), followed by the Northeast (20%), Southeast (19%), Midwest (17%), and North (14%). In addition, the main factor that leads people to consume organic products is related to health concerns (84%) and the most consumed foods are fruits (25%), leafy greens (24%), lettuce (21%), vegetables (16%), tomatoes (21%), and horticultural crops (8%), most of which are purchased at fairs and supermarkets (Organis, 2019).

According to Schmitt (2016, p. 41), the State presented "a growing permeability in the incorporation of sustainability principles to public policies aimed at family farming." The author pointed out that the creation of differentiated lines of credit in the specific case of the National Program for Strengthening Family Farming (PRONAF) was the main strategy to expand access to financing by farmers involved in the management of ecologically based systems or in "transition to agroecology," reaching limited results (Schmitt, 2016).

Lima *et al.* (2021) highlighted the main strengths and weaknesses (internal environment) and threats and opportunities (external environment) of organic production in Brazil. The strengths are related to the large territorial and agricultural extension, the high number of organic producers, historical agricultural aptitude, favorable climate conditions, regulation and legislation covering national specificities, and the possibility of direct sale to the consumer due to Social Control Organizations. Weaknesses occur mainly due to the lack of official data systematized at the national level, high costs of certification by external audit, distant or not very accessible technical assistance and rural extension, inequality in land distribution (land concentration), difficulties in accessing rural finance, access to organic products stratified in higher social classes, and poor teaching of organic agriculture and environmental education.

Regarding opportunities in organic farming, the authors highlighted the creation of a national system for recording and controlling information, expansion of institutional purchasing programs (PAA and PNAE), expansion of the number of resources allocated to organic production, and expansion of technical assistance and rural extension services. Finally, threats were related to the worsening of the global climate crisis and its effects on Brazilian agriculture, low-income level and low demand for organic products, and difficulties in accessing rural financing and promoting Technical Assistance and Rural Extension (ATER) (Lima *et al.*, 2021).

Thus, one of the ways to optimize organic farming production both for family farming and for conventional agriculture is through cooperative and/or associative organizations. These organizations offer benefits such as the establishment of quality standards, technology sharing, and support in the certification process, thus boosting the increase in income and wealth of families (Tomazzoni; Schneider, 2020). According to Caumo and Staduto (2014), the strategic participation of family farmers in organizations or networks promotes alternative marketing channels and the exchange of information and experiences.

According to Vieceli *et al.* (2020), the certification of organic products by control agencies is important to validate the guarantee offered to consumers. Santos *et al.* (2019) agreed with this view and emphasized that certification also helps to reduce uncertainty about product quality. Therefore, certification ensures that the product has gone through the entire regulatory process established by the laws in force, which results in credibility and differentiation relative to conventional farming products.

The Brazilian Organic Conformity Assessment System (SISORG) defines two certification systems: certification by audit and certification by the participatory body (Brasil, 2007). According to Fonseca (2009), alternative certification methods have been surpassing conventional audit certification, which can be more bureaucratic and costly for producers. Moreover, producers certified by participatory organizations are included in sociotechnical networks and receive technical assistance to promote sustainability in their activities (Santos, 2020). Importantly, Barbosa and Sousa (2012) highlighted that rural producers without land tenure represent the minority of certified organic producers, suggesting that land tenure influences the use of certification.

Lourenço *et al.* (2017) pointed out that the mean size of establishments with organic production ranges from 20 to 50 hectares, values ratified by Barbosa and Souza (2012), who identified that rural properties with less than 50 hectares concentrated most of the farming establishments that produced organically in Brazil. Another aspect related to the establishment is the transition process from conventional to organic production. Both technical assistance and certifiers require a minimum of three years without the use of agrochemicals. Therefore, during this period, the establishment is referred to as a rural in transition, and it cannot be considered an organic establishment (Candiotto; Meira, 2014).

In a study conducted by Alves, Schultz, and Oliveira (2022) on organic agriculture in Porto Alegre, guided by the three pillars of economic, social, and environmental sustainability, the results for each dimension indicated the following: organic farming demonstrates financial viability and contributes dynamically to the local economy due to diverse marketing channels; despite properties being distant from urban centers, farmers have access to healthcare**,** well-being**,** education**,** information, and recreational activities; the study observed that organic agriculture is particularly suitable for peri-urban areas, and it plays a role in environmental preservation. These findings highlight the multifaceted benefits of organic farming, emphasizing its positive impact on both local economies and the well-being of farmers and communities.

However, organic production has become an increasingly relevant segment for family farmers in Brazil, both in economic and social terms, and the State has increasingly incorporated sustainability principles into public policies aimed at family farming.

3 METHODOLOGICAL PROCEDURES

The methodological approach has a quantitative exploratory character, which is suitable for this study. Exploratory research, being associated with quantitative models, aims to examine the subject in question to obtain more in-depth knowledge. This type of research tends to be more flexible and seeks to fill research gaps. Exploratory research planning is quite flexible, considering several aspects related to the studied fact or phenomenon (Lozada; Nunes, 2018; Gil, 2022).

3.1 FACTOR ANALYSIS

Exploratory factor analysis with the maximum likelihood extraction method and varimax rotation was used to estimate and interpret the peculiarities of the organic farming production structure in the State of Paraná. The methodological procedures are based on the literature and correspond to the instrumental of multivariate techniques. This analysis refers to a set of statistical methods that allow the simultaneous analysis of multiple measures for each individual, object, or observed phenomenon (Fipecafi, 2017).

Initially, Cronbach's alpha test was performed to verify the reliability of the variables used in the study. According to Fipecafi (2017), Cronbach's alpha (α) can be calculated according to Equation (1).

$$\alpha = \frac{K(cov/var)}{1 + (K-1)(cov/var)} \qquad (1)$$

where K is the considered number of variables, *cov* is the mean of covariances, and *var* is the mean of variances. The main idea of the internal reliability measure is that the individual scale items or indicators should measure the same construct and thus be highly intercorrelated. Hair *et al.* (2009) treat α 0.7 as the ideal minimum but 0.6 can also be accepted for exploratory research.

Factor analysis allows for examining the interdependence between a large set of variables, each related to the others. The final objective is to summarize this set of variables into factors with a minimum loss of information, that is, group the data through the combination of variables and explain the relationship between them.

From this reasoning, the variations of a variable can be explained by a set of factors. According to Fipecafi (2017), a mathematical model of factor analysis can be expressed according to Equation (2).

$$X_i = \alpha_{i1}F_1 + \alpha_{i2}F_2 + \alpha_{i3}F_3 + \cdots + \alpha_{ij}F_j + e_i \qquad (2)$$

where X_i is the standardized variables, α_i is the factor loadings, F_j is the common factors not related to each other, and e_i is an error that represents the portion of variation of the variable i that is exclusive to it and cannot be explained by a factor nor by another variable of the analyzed set.

The number of factors can be estimated by a linear combination of the original variables. Thus, based on Equation (3), we have:

$$F_j = \omega_{j1}X_1 + \omega_{j2}X_2 + \omega_{j3}X_3 + \cdots + \omega_{ji}X_i$$

$$F_j = \sum_{i=1}^{i} \omega_{ji}X_i \qquad (3)$$

in which F_j is the unrelated common factors, ω_{ji} is the coefficients of factorial scores, and X_i is the original variables involved in the study. A factorial score is a number resulting from the multiplication of the coefficients (w_{ij}) by the value of the original variables (Fipecafi, 2017).

Data adjustment for factor analysis was performed using the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity. The KMO test measures the degree of partial correlation between the variables (a measure of sampling adequacy). Bartlett's test of sphericity indicates whether the correlation matrix is an identity matrix, that is, whether there is zero correlation between the variables (Fipecafi, 2017).

The maximum likelihood method was used to extract the factors. Maximum likelihood finds the factor loadings that maximize the probability of the sample generating the observed correlation matrix. Furthermore, this is a method that assumes that the variables involved in the study follow a normal distribution (Matos; Rodrigues, 2019; Fipecafi, 2017).

3.2 CLUSTER ANALYSIS

In this study, the multivariate technique of cluster analysis was used to group the municipalities of Paraná based on their characteristics in the organic farming structure. This technique aims to combine objects based on their characteristics, being useful to verify similar behavior between observations, such as individuals, companies, municipalities, and countries, relative to certain variables. The objective is to create clusters that present internal homogeneity (Fávero, 2015).

The factor scores obtained from the factor analysis were used as variables to group municipalities into homogeneous clusters. Importantly, the variables must not present multicollinearity for the cluster analysis to be performed correctly. In this sense, factor scores meet this requirement by construction (Campos *et al.*, 2015; Hair *et al.*, 2009).

The dissimilarity measure used to classify the clusters was the Euclidean distance, which is the distance or correlation between two points and the length of the hypotenuse of a right triangle (Fipecafi, 2017). According to Pais, Silva and Ferreira (2012), this measure was used to group all municipalities in Paraná, represented in Equations (4) and (5) as points A and B.

$$Distance\ between\ A\ and\ B = D_{AB} = \sqrt{\sum_{j}^{p} = 1\ (X_{ja} - X_{jb})^2} \quad (4)$$

In matrix terms, this distance is given by:

$$D_{AB} = \sqrt{(X_a - X_b)'(X_a - X_b)}$$

The Wald method was used to develop clustering. This method is based on the loss of information resulting from the grouping of objects in a cluster, measured by the total sum of squares of the deviations of each object relative to the mean of the cluster in which the object was inserted (Fipecafi, 2017).

Two tests were performed to determine the exact number of clusters to be considered in the analysis (Pais; Silva; Ferreira, 2012): the Calinski-Harabasz pseudo-F stopping criterion and the Duda-Hart Index. Importantly, the indication of the number of groups to be adopted in both tests is given by the highest value of the index found.

Cluster analysis application allowed to gather of the most homogeneous municipalities in Paraná into the same group to form heterogeneous clusters with each other. This technique is useful for identifying clusters with similar characteristics and complements factor analysis.

3.3 SCOPE AND RESEARCH DATA

The scope of the study comprised 399 municipalities in the State of Paraná. Initially, 63 variables were used to perform the factorial and cluster analysis construct. The variables were collected from the 2017 Agricultural Census, made available by the Brazilian Institute of Geography and Statistics (IBGE, 2017), and were organized into eight dimensions: 1) Typology; 2) Use of organic agriculture or organic livestock; 3) Producer gender; 4) Producer age class; 5) Condition of the producer relative to the land; 6) Association of the producer to cooperatives and/or class entities; 7) Origin of the received technical support; and 8) Groups of total area. Chart 1 shows the variables used to build the analytical model.

Chart 1 – Variables in the model construct.

ID	**1 – Typology**	**2 – Use of organic agriculture or organic livestock**	
X1	Family farming – no	X8	Yes
X2	Family farming – yes	X9	Yes, plant production
X3	Family farming – Pronaf B	X10	yes, animal production
X4	Family farming – Pronaf V	X11	Yes, plant and animal production
X5	Family farming – without Pronaf	X12	No
X6	Pronamp – yes	**3 – Producer gender**	
X7	Pronamp – no	X13	Men
4 – Producer age class		X14	Women
X15	Under 25 years old	**5 – Condition of the producer relative to the land**	
X16	From 25 to less than 35 years old	X22	Owner
X17	From 35 to less than 45 years old	X23	Concessionaire or settler waiting for definitive title
X18	From 45 to less than 55 years old	X24	Tenant
X19	From 55 to less than 65 years old	X25	Partner
X20	From 65 to less than 75 years old	X26	Borrower
X21	75 years old and over	X27	Occupant
6 – Association of the producer to cooperatives and/or class entities		X28	Producer without area
X29	Associated		**8 – Groups of total area**
X30	Cooperative	X45	More than 0 to less than 0.1 ha
X31	Class entity/union	X46	From 0.1 to less than 0.2 ha
X32	Producer association/movement	X47	From 0.2 to less than 0.5 ha
X33	Homeowner association	X48	From 0.5 to less than 1 ha
X34	Not associated	X49	From 1 to less than 2 ha

7 – Origin of the received technical support		X50	From 2 to less than 3 ha
X35	Receive	X51	From 3 to less than 4 ha
X36	Government (federal, state, or municipal)	X52	From 4 to less than 5 ha
X37	Own or from the producer	X53	From 5 to less than 10 ha
X38	Cooperatives	X54	From 10 to less than 20 ha
X39	Integrating companies	X55	From 20 to less than 50 ha
X40	Private planning companies	X56	From 50 to less than 100 ha
X41	Non-governmental organization (NGO)	X57	From 100 to less than 200 ha
X42	S System	X58	From 200 to less than 500 ha
X43	Other	X59	From 500 to less than 1,000 ha
X44	Do not receive	X60	From 1,000 to less than 2,500 ha
		X61	From 2,500 to less than 10,000 ha
		X62	From 10,000 ha and over
		X63	Producer without an area

Source: Prepared by the authors based on IBGE (2017).

The software SPSS version 21 was used to obtain Cronbach's alpha, which provided a better interpretation and reliability of the variables used in the study. The software STATA version 12 was used to perform the factor and cluster analysis.

4 RESULTS AND DISCUSSION

Initially, an analysis of the representativeness of organic farming was carried out for municipalities, microregions, and mesoregions of the State of Paraná. For this purpose, a descriptive statistical analysis was performed based on absolute values and percentages. Subsequently, the interpretation of the results of the factor and cluster analyses is presented.

4.1 ORGANIC FARMING IN THE STATE OF PARANÁ

The data shown in Table 1 provide information on the production of organic farming by the number of establishments in the 10 mesoregions of Paraná in 2017. The organic plant and plant and animal productions are concentrated in the Center-South Paraná mesoregion, with the presence of 1,052 and 91 establishments, respectively (23.87% and 10.42%). Animal production is more concentrated in the West mesoregion of Paraná, with 322 establishments (18.14%). The combined production is relatively small in the State of Paraná, totaling 873 establishments, which represents 8.40% of the country's total. This situation reflects the national reality, in which organic plant and animal productions are also not very expressive, totaling 10,389 establishments.

Table 1 – Distribution of establishments by type of organic production in the geographic mesoregions of Paraná in 2017 (in absolute number and percentage).

Mesoregion	Production by typology					
	Plant	**(%)**	**Animal**	**(%)**	**Plant and animal**	**(%)**
Northwest	278	6.31	290	16.34	166	19.01
West-Central	103	2.34	144	8.11	18	2.06
North-Central	570	12.93	287	16.17	52	5.96
Pioneer North	365	8.28	119	6.70	45	5.15
East-Central	347	7.87	166	9.35	48	5.50
West	403	9.14	322	18.14	79	9.05
Southwest	340	7.71	122	6.87	64	7.33
South-Central	1,052	23.87	154	8.68	91	10.42
Southeast	495	11.23	92	5.18	220	25.20
Metropolitan Region of Curitiba	455	10.32	79	4.45	90	10.31
Total	**4,408**	**100**	**1,775**	**100**	**873**	**100**

Source: Prepared by the authors based on the Agricultural Census (IBGE, 2017).

According to the Brazilian Institute of Geography and Statistics (IBGE, 2017), there are 39 geographic microregions in the state of Paraná. Figure 1 shows the number of establishments that carry out organic farming in each microregion, as well as the proportion of establishments classified as family and non-family farming.

Figure 1 shows that only the Guarapuava microregion, located in the South Central region of the State, registered between 800 and 1,000 establishments that use organic farming. With 937 establishments (13.28%), this microregion leads relative to the other microregions.

The microregions of Umuarama and Toledo have between 400 and 800 establishments, occupying the second and third places, respectively, with 419 (5.94%) and 414 (5.87%) establishments. The microregions of Paranaguá, Floraí, and Porecatu have between 0 and 100 establishments that use organic farming, occupying the worst positions in terms of the number of establishments. These microregions have, respectively, 33 (0.47%), 15 (0.21%), and 14 (0.20%) establishments.

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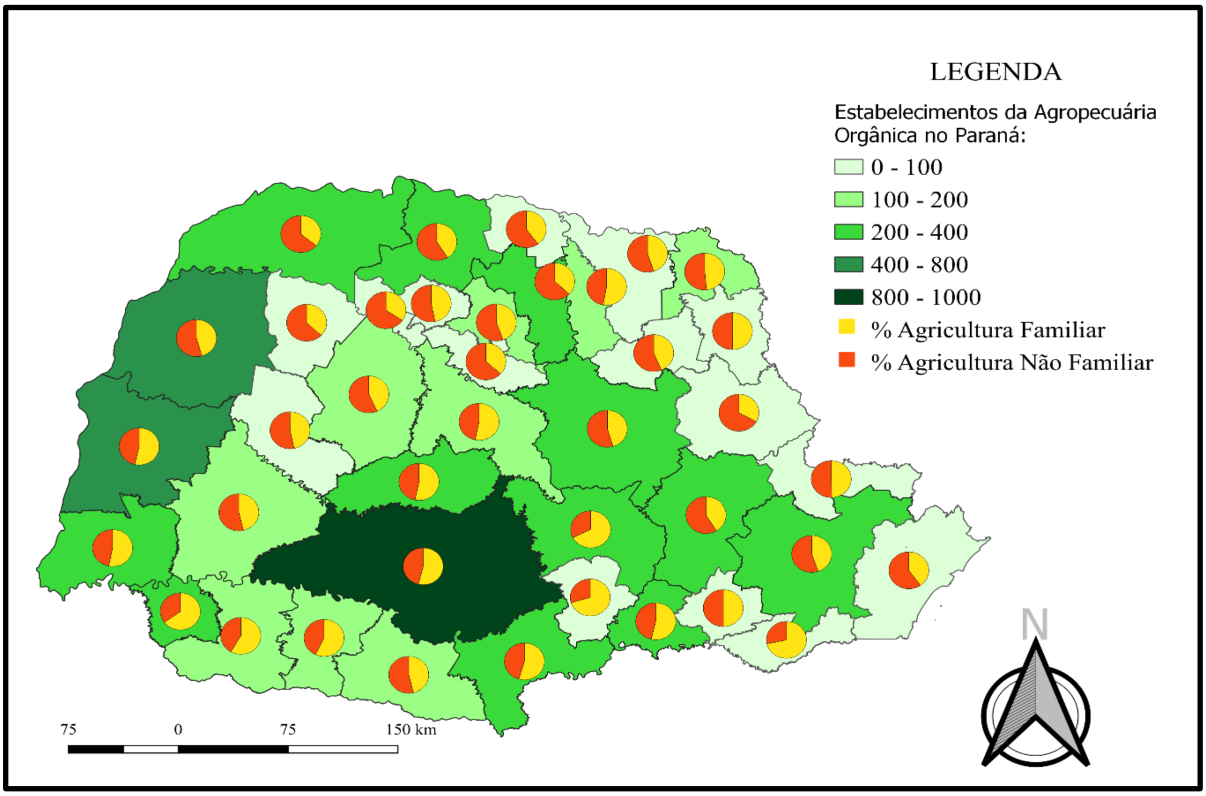
Figure 1 - Number of organic farming establishments and proportion of family and non-family farmers in the microregions of the State of Paraná in 2017.



Source: Prepared by the authors based on the Agricultural Census (IBGE, 2017).

Legend: Organic farming establishments in Paraná; % Family farming; % Non-family farming.

Family farming is responsible for most agricultural establishments in the State of Paraná. There are 228,888 family establishments and 76,266 non-family farmers. The number of family establishments is almost three times higher than the total number of non-family establishments in the state. This can be inferred, as pointed out by Schmitt (2016), from the state's mobilization starting in 2003, through public policies aimed at family farming, which incorporated sustainability principles.

Figure 1 shows that the Guarapuava microregion leads both in the number of family and non-family establishments (with 8.16% and 6.98%, respectively). The Umuarama and Toledo microregions also have similar characteristics, with 4.64% and 6.17% of family establishments and 5.50% and 5.34% of non-family establishments, respectively. On the other hand, the Paranaguá, Floraí, and Porecatu microregions show little expression relative to the proportion of establishments under the control of family farmers, with 0.55%, 0.39%, and 0.63%, respectively, compared to 0.82%, 0.74%, and 0.95% under the control of non-family farmers.

Table 2 shows the ranking of 20 municipalities with the largest number of establishments that use organic farming in Paraná. Quedas do Iguaçu ranks first with 5.43% (383 establishments). União da Vitória is ranked second, with 2.96% (209 establishments), followed by Nova Laranjeiras, with 2.15% (152 establishments). The 379 municipalities below the ranking represent together 4,599 establishments (65.18%) that use organic farming. However, the analysis of the type of farming practiced by the establishments shows that 88.49%

(71,572 establishments) do not use organic production (plant and animal origin or both simultaneously).

Table 2 – Ranking of the 20 municipalities in Paraná standing out the organic farming by the number of establishments in 2017 (in absolute number and percentage).

Rank	Municipality	Use of organic agriculture or organic livestock			
		Yes	**(%)**	**No**	**(%)**
1st	Quedas do Iguaçu	383	5.43	726	0.90
2nd	União da Vitória	209	2.96	251	0.31
3rd	Nova Laranjeiras	152	2.15	565	0.70
4th	Francisco Alves	120	1.70	160	0.20
5th	Capanema	119	1.69	251	0.31
6th	São Mateus do Sul	117	1.66	802	0.99
7th	Castro	116	1.64	1,312	1.62
8th	Londrina	116	1.64	464	0.57
9th	Palmeira	116	1.64	153	0.19
10th	Tibagi	113	1.60	219	0.27
11th	Guarapuava	101	1.43	629	0.78
12th	Santa Maria do Oeste	100	1.42	490	0.61
13th	Prudentópolis	96	1.36	739	0.91
14th	São José dos Pinhais	93	1.32	302	0.37
15th	Arapongas	92	1.30	62	0.08
16th	Rio Bonito do Iguaçu	89	1.26	457	0.56
17th	Paranavaí	87	1.23	629	0.78
18th	Pitanga	82	1.16	592	0.73
19th	São João do Triunfo	79	1.12	101	0.12
20th	Lapa	77	1.09	409	0.51
Ranking total		**2,457**	**34,82**	**9,313**	**11.51**
Other municipalities		**4,599**	**65.18**	**71,572**	**88.49**
State total		**7,056**	**100**	**80,885**	**100**

Source: Prepared by the authors based on the Agricultural Census (IBGE, 2017).

A study carried out by Caumo and Staduto (2014) pointed out that the conversion from conventional to organic production is one of the main barriers faced by family farmers in the West of Paraná when starting the activity, as the transition can generate distrust in consumers regarding the product quality. Although certification can minimize this distrust, obtaining certification is a bureaucratic and costly process for producers.

Other aspects make it difficult for them to remain in business after the conversion, such as prices (an obstacle to expansion) and the lack of a market for sales. The production process also demands labor, which raises costs and makes it difficult to expand production due to the low scale of production (Caumo; Staduto, 2014). Although the study is limited to a specific region of Paraná, these difficulties are similar for other producers in the state, which may explain the low adherence to organic farming production.

4.2 FACTOR AND CLUSTER ANALYSIS ESTIMATES

Initially, the descriptive results of Cronbach's alpha reliability test are presented. This test pointed to the internal consistency of the set of variables since Cronbach's alpha, based on the standardized items, presented a value of 0.978. The values obtained are higher than the minimum limit allowed, considered ideal at 0.7 (Hair *et al.*, 2009).

Subsequently, factor analysis (FA) was used by the maximum likelihood method to parsimoniously estimate and interpret the data. Nine variables were excluded from the analysis due to multicollinearity problems: X5: Family farming – without Pronaf; X6: Pronamp – yes; X11: Yes, plant and animal production; X16: From 25 to less than 35 years old; X28: Producer without area regarding land use; X29: Associated; X35: Receive technical support; X61: Area group of 10,000 ha and more; and X62: Producer without area regarding the number of hectares.

Although the Kaiser-Meyer-Olkin (KMO) adequacy test showed a low value (KMO=0.5724), it is still considered acceptable for exploratory analysis. According to Fipecafi (2017), a measure of sampling adequacy (MSA) value indicating a degree of explanation lower than 0.50 means that the factors found in the factor analysis cannot satisfactorily describe the variations of the original data. Bartlett's sphericity test resulted in χ^2 (892) = 9881.22 Prob>chi2 = 0.0000 (p-value < 0.05), which indicates significance for the use of factor analysis.

Eleven factors were extracted after the factor analysis procedure. Factor rotation by the varimax orthogonal method was used to obtain a better interpretation of the set of variables. This method prevents the variables from having high factor loadings for different factors. Table 3 summarizes the factors extracted after rotation.

Table 3 - Estimate using the varimax orthogonal rotation method.

Factor	Variance	Difference	Proportion	Cumulative
Factor 1	**23.34263**	**18.72362**	**0.5644**	**0.5644**
Factor 2	**4.61900**	**0.77165**	**0.1117**	**0.6761**
Factor 3	**3.84735**	**1.28384**	**0.0930**	**0.7691**
Factor 4	**2.56351**	**0.35259**	**0.0620**	**0.8311**
Factor 5	**2.21092**	**0.47540**	**0.0535**	**0.8846**
Factor 6	**1.73552**	**0.55052**	**0.0420**	**0.9265**
Factor 7	**1.18500**	**0.56694**	**0.0287**	**0.9552**
Factor 8	0.61806	0.10493	0.0149	0.9701
Factor 9	0.51313	0.05098	0.0124	0.9825
Factor 10	0.46215	0.20139	0.0112	0.9937
Factor 11	0.26076	.	0.0063	1.0000

Source: Prepared by the authors.

We decided to analyze seven factors, which individually presented a better percentage of explanation of the total variance of the variables (value higher than 1). The other factors showed a low percentage of explanation relative to the total variance. Therefore, they were excluded from the analysis to avoid errors in interpretation.

After factor rotation, the factorial matrix allowed a more precise classification of the indicators in each of the factors. Each of the factors was named based on the variables classified by the maximum likelihood method, the factor loading, and the percentage of explained variance, as shown in Chart 2.

Chart 2 – Name of the factors from the rotated factorial matrix.

Variables	Name	Literature
X1: Family farming – no; X2: Family farming – yes; X3: Family farming – Pronaf B; X4: Family farming – Pronaf V; X7: Pronamp – no; X12: Do not use organic farming; X13: Men; X14: Women; X15: Under 25 years old; X17: From 35 to less than 45 years old; X18: From 45 to less than 55 years old; X19: From 55 to less than 65 years old; X20: From 65 to less than 75 years old; X21: 75 years old and over: X22: Owner; X24: Tenant: X25: Partner; X26: Borrower; X34: Not associated; X44: Do not receive technical guidance; X46: From 0.1 to less than 0.2 ha; X47: From 0.2 to less than 0.5 ha; X49: From 1 to less than 2 ha; X50: From 2 to less than 3 ha; X51: From 3 to less than 4 ha; X52: From 4 to less than 5 ha; X53: From 5 to less than 10 ha; X54: From 10 to less than 20 ha; X55: From 20 to less than 50 ha; and X56: From 50 to less than 100 ha.	Factor 1 explains 23.34% of the total variance and contains 30 items with a factor loading above 0.50. This construct is formed by a set of elements that characterize the production unit. The factor in this model is named "Profile of Agricultural Establishments." Organic farming in the municipalities of Paraná is predominant in family farming and Pronaf B is the most used public policy. The activity predominates among men (86.61%), with only 13.39% of women. Organic cultivation is carried out in the vast majority by producers aged between 35 and 65 years. The factor load showed that 83.15% of the producers own the establishments and that 54.94% of the producers do not receive any type of technical support. Most establishments have less than 100 hectares.	Michellon and Silva (2019), Caumo and Staduto (2014)
X57: From 100 to less than 200 ha; X58: From 200 to less than 500 ha; X59: From 500 to less than 1,000 ha; X60: From 1,000 to less than 2,500 ha; and X61: From 2,500 to less than 10,000 ha.	Factor 2 explains 4.62% of the total variance and has five items with a factor loading above 0.50. This construct is related to the extent of the size of the production area. The second factor is named as being indicative of "Land Decentralization," given that organic production was considered negligible in strata from 100 to less than 10,000 ha (24,884 establishments) and 10,000 ha and over (35 establishments). This situation is justified because organic production is concentrated in smaller strata (from 2 to less than 100 ha).	Lourenço *et al.* (2017), Barbosa and Souza (2012)
X30: Associate in cooperative; X38: Receive technical guidance from Cooperatives; and X40: Receive technical guidance from private planning companies.	Factor 3 explains 3.85% of the total variance and contains three items with a factor loading above 0.50. This construct is related to the type of organization and support received by organic producers in the municipalities of Paraná. This factor was named "Cooperatism," as most producers are members of cooperatives (83.41%) and receive technical support from them (46.12%). The private extension also presented a positive factor load, indicating that public power actions still have room to advance. On the other hand, some capitalized producers can pay for technical support from private companies.	Tomazzoni and Schneider (2020), Caumo and Staduto (2014)
X8: Use organic agriculture or organic livestock; X9: Yes, plant production; and X10: Yes, animal production.	Factor 4 explains 2.56% of the total variance and contains three items with a factor loading above 0.50. This construct is related to establishments that use organic production. By nature, we named this factor "Organic Growing." Organic plant production in the municipalities of Paraná represents 62.47%, while animal production represents 25.16%. Plant and animal production simultaneously is	ORGANIS (2017)

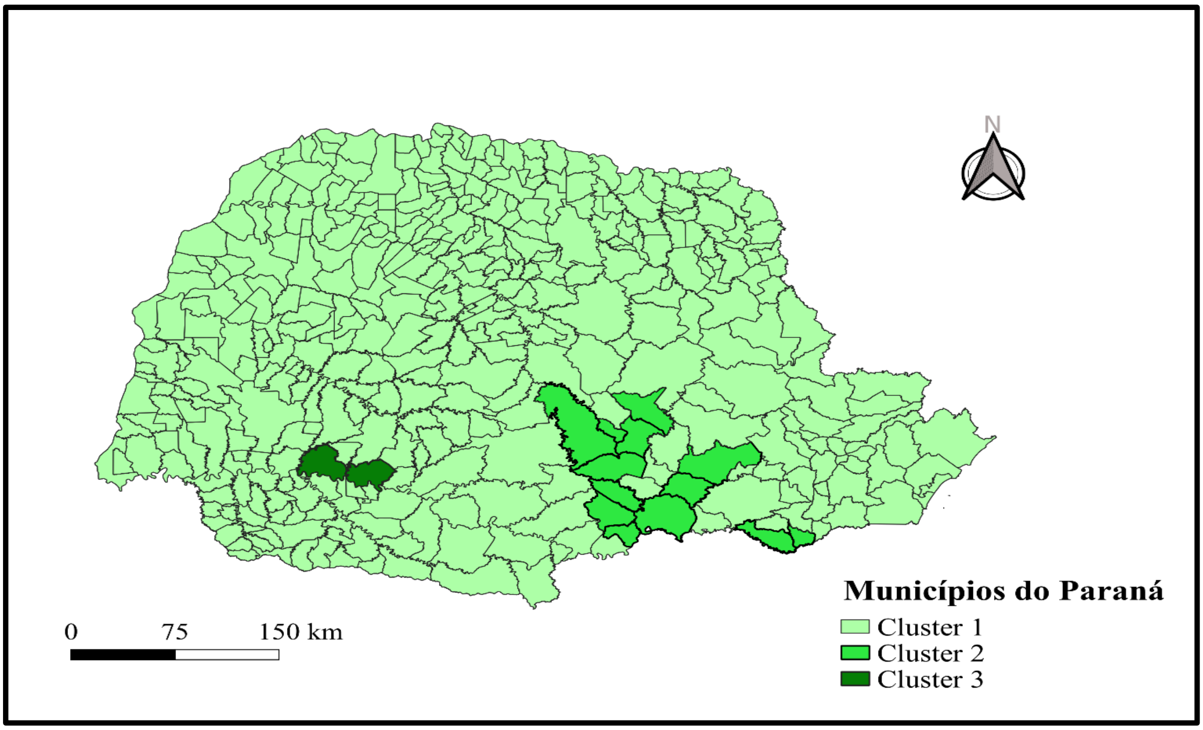
	negligible, with 12.37% relative to the total.	
X23: Concessionaire or settler waiting for definitive title and X27: Occupant.	Factor 5 explains 2.21% of the total variance and contains two items with a factor loading above 0.50. This construct is related to the land issue of the productive structure of agricultural establishments that produce organic products in the municipalities of Paraná. For this reason, it can be interpreted as "Land Regularization." This situation demonstrates that despite the vast majority of establishments having an owner, there is still a significant number of producers awaiting regulation regarding land use (17,424 establishments).	Barbosa and Sousa (2012)
X39: Integrating companies.	Factor 6 explains 1.74% of the total variance and has one item with a factor loading above 0.50. This construct is related to private technical support received by a portion of organic producers in the municipalities of Paraná (19.07%). This factor was named "Specialized Consultancy," as it is a formal governance signed between producers and integrating companies (agroindustries). This type of partnership in the case of organic production is fundamental to assisting the producer in acquiring organic certification (organic seal). In addition, the integrating company subsidizes the producer (e.g., supplies and technology) so that it ensures continuous supply in the production stage of raw materials.	Santos (2020)
X31: Class entity/union.	Factor 7 explains 1.19% of the total variance and has one item with a factor loading above 0.50. This construct is related to representative class entities. We named this factor "Collective Organization." A total of 23.94% of establishments are unionized in the municipalities of Paraná. It shows that, in addition to cooperatives, rural unions have a high influence in articulating demands presented by organic producers in the municipalities of Paraná.	Tomazzoni and Schneider (2020), Caumo and Staduto (2014)

Source: Prepared by the authors.

Cluster analysis of the municipalities in the state of Paraná was performed after the factor analysis procedure, using the factor scores determined by the first technique employed in the study. The Calinski-Harabasz and Duda-Hart pseudo-F stopping tests indicated the grouping of municipalities into three dissimilar groups, as shown in Figure 2.

A homogeneous behavior of organic farming was observed in the State of Paraná, as most municipalities (384) belonged to the same group. The second group consisted of 13 municipalities, most of which are located in the mesoregion of Southeast Paraná, except for the municipalities of Piên and Rio Negro, belonging to the Metropolitan mesoregion of Curitiba, and the municipality of Palmeira, in the East-Central mesoregion of Paraná. The third and smallest group was formed by only two municipalities, Rio Bonito do Iguaçu and Quedas do Iguaçu, both located in the South-Central region of Paraná.

Figure 2 – Cluster of municipalities in Paraná.



Source: Prepared by the authors based on the Agricultural Census (IBGE, 2017).

The cluster analysis evidenced that organic farming production is conducted in all mesoregions of the State of Paraná, which suggests a homogeneity in the productive structure of most municipalities. However, the results indicate that a deeper investigation of municipalities that do not belong to group 1 (i.e., groups 2 and 3) can be beneficial to obtain specific information about local production and its peculiarities. This information can be useful to support actions that aim to strengthen and encourage organic production, especially in areas where the practice is not very expressive.

5 FINAL CONSIDERATIONS

This article aimed to analyze the structure of organic farming establishments in the state of Paraná based on the 2017 Agricultural Census. The representativeness of organic farming present in the State of Paraná was initially investigated to achieve the study proposition.

The South-Central mesoregion of the State of Paraná has the highest number of establishments that use organic farming. The number of establishments with organic plant and plant and animal production is 1,052 and 91, respectively. Animal production is concentrated mainly in the West mesoregion of Paraná. Joint production is not very expressive in the State of Paraná, which is similar to the reality in Brazil, in which organic plant and animal productions are also not very expressive.

In the state, family farming concentrates on the largest number of establishments that use organic farming. On the other hand, 88.49% of them do not use organic production (plant and animal origin or both simultaneously). The option for not joining the organic activity is related to the barrier of converting from conventional to organic, bureaucracy, and the high cost of obtaining certification.

The Guarapuava microregion stood out in the number of establishments that use organic farming, with 937 establishments (13.28%), leading in terms of the total number of microregions present in the state. This microregion also played a leading role relative to the type of agriculture practiced in the establishments, standing out both in the proportion of family and non-family areas, with 8.16% and 6.98%, respectively.

The municipality of Quedas do Iguaçu had the highest number of establishments that use organic farming, with 383 establishments (5.43%), followed by União da Vitória, with 209 establishments (2.96%), and Nova Laranjeiras, with 152 establishments (2.15%).

Factor analysis allowed extracting seven factors that individually presented the best percentage of explanation of the total variance of the variables. The first factor presented 23.34% of the total explained variance, being interpreted as "Profile of Agricultural Establishments." This factor revealed that organic farming in the municipalities of Paraná is predominantly performed by family farmers and that Pronaf B is the public policy most used by producers. In addition, the activity is dominated by males (86.61%), and cultivation is carried out mainly by producers between 35 and 65 years of age, of which 83.15% own the establishments and 54.94% receive no technical support. Moreover, most establishments have less than 100 hectares, suggesting that the productive structure of organic products in the State of Paraná is decentralized.

Cluster analysis was used to evaluate the distribution and concentration of organic farming in the municipalities of Paraná, indicating a homogeneous behavior of the activity in the state since the largest number of municipalities (384) belong to the same group.

Finally, the results of the study recommend a more detailed investigation of the municipalities belonging to the two dissimilar groups identified in the analysis. This type of investigation would allow gathering information about the upstream and downstream peculiarities of local production, helping public and private agents in planning actions that make organic production possible in Paraná. The study also identified research gaps that can be clarified through an on-the-spot investigation of local productive structures. We believe that studies of this type will provide elements to contribute to the growth and strengthening of organic production in the municipalities of Paraná.

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