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Challenges and potential for small farm holders' organic production: insights from the experience of certified producers in Brazil

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Resumo
O uso de bioinsumos na agricultura orgânica e agroecológica tem apresentado um cenário positivo e promissor para sua expansão e consolidação, em contraposição ao uso de insumos químicos na agricultura convencional. Desta forma, o presente artigo tem como objetivo avaliar as potencialidades e dificuldades do sistema orgânico no Distrito Federal quanto ao uso e ao manejo de bioinsumos. Os dados utilizados neste trabalho são oriundos de planos de manejo de produtores orgânicos situados no DF, certificados pela OPAC Cerrado. Foram disponibilizados para acesso aos dados produtivos 118 Planos de Manejo. Os dados foram tabulados no software MS Excel® para, em seguida, serem realizadas análises estatísticas descritivas e de associação multifatorial em SAS®. Inicialmente, foi realizada uma Análise de Correspondência, técnica exploratória, por se tratar de dados categóricos. Também foi realizada uma análise de Pareto, técnica utilizada para priorizar os problemas com base no princípio de Pareto. Os resultados indicam a ausência de autonomia na obtenção de bioinsumos e/ou ingredientes para compor o produto. Dados gerais do contexto do DF indicam que uma das linhas de apoio da assistência técnica e dos órgãos de financiamento é

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fomentar a produção de bioinsumos on-farm, de forma individual ou coletiva, sendo esta última a que melhor favorece o ecossistema e os objetivos estratégicos da produção agropecuária orgânica local.

Palavras-chave: Agricultura sustentável. Autonomia dos agricultores. Desenvolvimento rural. Ecossistemas orgânicos.

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Abstract

The use of bio-inputs in organic and agroecological agriculture has created a positive, promising scenario for their expansion and consolidation, in contrast to the use of chemical inputs in conventional agriculture. Therefore, this article aims to evaluate the potential and challenges of the organic system in the Brazilian Federal District regarding the use and management of bio-inputs. The data used in this work come from management plans of organic producers located in the Federal District, certified by OPAC Cerrado. 118 Management Plans were made available for access to production data. The data were tabulated in MS Excel® and then subjected to descriptive statistical and multifactorial association analyses in SAS®. Initially, Correspondence Analysis, an exploratory technique, was performed because the data were categorical. A Pareto analysis was also performed, a technique used to prioritize problems based on the Pareto principle. The results indicate a lack of autonomy in obtaining bio-inputs and/or ingredients to compose the product. General data from the Federal District indicate that one of the lines of support from technical assistance and funding agencies is to promote the production of on-farm bio-inputs, individually or collectively, with the latter being the one that best supports the ecosystem and the strategic objectives of local organic agricultural production.

Keywords: Sustainable agriculture. Farmers' autonomy. Rural development. Organic ecosystems.

Desafíos y potencial de la producción orgánica de pequeños agricultores: lecciones aprendidas de la experiencia de productores certificados en Brasil

Resumen

El uso de bioinsumos en la agricultura orgánica y agroecológica ha creado un escenario positivo y prometedor para su expansión y consolidación, en contraste con el de los insumos químicos en la agricultura convencional. Por lo tanto, este artículo tiene como objetivo evaluar el potencial y los desafíos del sistema orgánico en el Distrito Federal de Brasil en relación con el uso y el manejo de bioinsumos. Los datos utilizados en este trabajo provienen de planes de manejo de productores orgánicos ubicados en el Distrito Federal, certificados por OPAC Cerrado. Se pusieron a disposición 118 planes de manejo para el acceso a los datos de producción. Los datos se tabularon en MS Excel® y luego se sometieron a análisis estadísticos descriptivos y de asociación multifactorial en SAS®. Inicialmente, se realizó un análisis de correspondencias, una técnica exploratoria, debido a la naturaleza categórica de los datos. También se realizó un análisis de Pareto, una técnica utilizada para priorizar problemas con base en el principio de Pareto. Los resultados indican una falta de autonomía en la obtención de bioinsumos y/o ingredientes para la composición del producto. Los datos generales del Distrito Federal indican que una de las líneas de apoyo de las agencias de

asistencia técnica y financiación consiste en promover la producción de bioinsumos en las explotaciones agrícolas, tanto de forma individual como colectiva, siendo esta última la que mejor apoya el ecosistema y los objetivos estratégicos de la producción agrícola orgánica local.

Palabras clave: Agricultura sostenible. Autonomía de los agricultores. Desarrollo Rural. Ecosistemas orgânicos.

1 Introduction

We are currently facing a socio-environmental crisis regarding food that is unprecedented in history. The problem of food insecurity has not only grown in proportions but also in complexity. It involves more than producing and distributing food; it involves questioning and knowing what food we have access to, what food we need, what food we want, how to access it, and above all how to produce it in a globalized mercantile logic in the so-called food empires (VAN DER PLOEG, 2008), where the agri-food industry dominates our choices and contributes greatly to the destruction of natural ecosystems. This crisis calls for a reevaluation of our food system and a shift towards more sustainable and organic practices.

Promoting food and nutrition security worldwide is the main challenge of SDG 2 (Sustainable Development Goals, UN, 2020), and, as a result, promoting healthy food produced ethically and with respect for nature is also a primary need. In this context, there are many challenges, including producing healthy, environmentally responsible food for both the city and the countryside. How have sustainable farming practices been developed and applied? There are many ways to reflect on this and many experiences worldwide.

Amid solutions and challenges, organic and agro-ecological production has grown worldwide at over 11% between 2000 and 2017 and in Brazil at an average annual rate of 19% between 2010 and 2018 (LIMA et al., 2020), indicating a promising market for this type of production. While the area under cultivation and gross organic production in Brazil are growing, there is still a lot to be done regarding the foundations of sustainable agriculture: production and access to bio-inputs. Having recently been regulated in Brazil (Decree No. 10.375 of May 26, 2020), bio-inputs are:

> (...) products, processes, or technologies of plant, animal, or microbial origin that positively interfere with the growth, development, and response mechanism of animals, plants, microorganisms, and derived substances and that interact with physical-chemical and biological products and processes (BRASIL, 2020, p. 105).

Although interest in the production and use of bio-inputs has grown recently, knowledge of them and the processes involved in their development on farms remains limited. We need to know more about the possible interactions between products developed in the laboratory and their subsequent action in the field (e.g., microorganisms), compatibility between products used on the same crop (MEYER et al., 2022), and above all, their handling and development in the field (on the farm) (VIDAL et al. 2021; MAZARO et al., 2022). On the one hand, we have public policies that reinforce support for reorienting so-called conventional production towards

organic and agroecological models, indicating institutionalization towards sustainable agriculture. On the other hand, access to products and knowledge about bio-inputs is challenging. Although registrations of active ingredients and products have grown in recent years, there are still challenges to biological products becoming a competitive alternative in the market and establishing themselves in a way that is accessible to those who need them. The first challenge is the durability and short shelf life of some products, and the second is the investment required to develop a suitable formulation for the market. But despite these difficulties, organic production has been expanding to varying degrees, amid international pressure to reduce its environmental impact. In addition to the production of organic crops, bio-inputs in agriculture are in an increasingly positive and promising phase of expansion and consolidation, as opposed to the use of pesticides in conventional agriculture.

Contrary to this trend, we have a well-established industry for conventional production inputs, accessible everywhere on the planet with well-structured distribution chains, whereas the same cannot be said for the (bio)inputs required in organic production. The challenge becomes even greater as the discussion deepens, and elements such as minimizing energy expenditure and exchanges with the external environment must be avoided, thereby encouraging the development of self-sufficient nutrient-cycling production systems (SOUZA et al., 2022). In this context, Vidal and Dias (2023) state that all those interested in this change, including academia, need to identify and to value the knowledge generated in the territories where we operate. This knowledge comes from the farmers' own experiences, both in maintaining the area's fertility and in controlling pests and diseases. According to the authors, what has happened most strongly so far is the reaction of the market, with the registration of new products that are feasible for use in organic production, which characterizes a movement that is much more about replacing synthetic inputs with organic ones, rather than changing the conception and orientation of our food systems. In short, the growth of the bio-inputs market has run counter to discussions of the circular economy, localized production, and accessibility for all farmers.

While there is a real need to understand the production processes and the use of bio-inputs in rural areas, public policies in this field are a great tool for adapting to changes in production systems. In the Brazilian Federal District (BDF), the Secretariat of State for Agriculture, Supply, and Rural Development of the Federal District, together with EMATER (the Public Technical Assistance Company), launched the Sustainable Rural Development Plan for the Brazilian Federal District in January 2023 (SEAGRI-DF, 2022), aimed at supporting the expansion of organic and agroecological production. The intention is for the Brazilian Federal District to become a showcase for organic production in the country. For this, we highlight the unique condition of a promising, stable market with high financial levels, based on the Pilot Plan - a central area of the Brazilian Federal District characterized by higher purchasing power. On the other hand, it must be ensured not only that the market itself is secure, but also that food systems achieve autonomy, food security, and sovereignty for producer families.

To contribute to this reflection, this article sets out to answer the following questions based on the experience of the Participative Organic Certification Board (OPAC in Portuguese) in the Brazilian Federal District: Does the experience of organic farmers affiliated with the participatory system allow us to indicate the difficulties

and potential for the autonomy of the organic system regarding the use and management of bio-inputs? Can the data show that rural producers in the Brazilian Federal District are moving towards greater autonomy regarding bio-inputs? What can be gleaned from this experience regarding prospects for advancing organic production in the Brazilian Federal District, especially concerning the bio-inputs it uses?

2 Material and methods

1.1. Origin and nature of the data

The data used in this work come from the management plans of organic producers in the BFD who are certified by OPAC Cerrado. These management plans are required for OPAC certification. This local, participatory, certified organization (the OPAC) complies with Brazilian regulations governing organic certification. 118 Management Plan documents were made available for access to production data.

The management plans contain information on each property's production model, inputs used in plant nutrition and plant health management, types of crops grown, and size, among other things. From this universe, data for around 118 rural properties were analyzed and tabulated in MS Excel®, excluding sensitive data, such as personal information and the location of the property/farmer. In this study, we only analyzed information related to agricultural activities and farmers, from planting to marketing.

1.2 Data systematization and analysis

The data were tabulated using MS Excel® software, followed by descriptive and multifactor association analyses.

To classify the properties, we used the classification defined by the Brazilian Law 8.629 of February 25, 1993, amended by Law 13.465 of 2017 (MAPA, 2022), which establishes:

a. Mini Farm: rural property with an area less than the Minimum Fraction of Parceling;

b. Small Property: property with an area between the Minimum Fraction for Parceling and four fiscal modules;

c. Medium-sized property: rural property with an area greater than four and up to 15 fiscal modules;

d. Large-scale farm: rural property with an area greater than 15 fiscal modules.

In the Brazilian Federal District, the law stipulates that the minimum parcel size is 2 ha, and the fiscal module is 5 ha. This study initially conducted a Correspondence Analysis, an exploratory technique used given the categorical nature of the data (JOHNSON and WICHERN, 2007). The procedure aimed to identify a small number of dimensions that best represented the diversity in the data set

under study and, through graphical visualization, to display the relationship (association) between producer size and production and management systems.

A Pareto analysis was also carried out. This technique prioritizes problems based on the Pareto principle, which states that 80% of the consequences stem from 20% of the causes, to distinguish less serious problems from more serious ones (TAGUE, 2004). Its greatest usefulness is allowing easy visualization and identification of the most important causes or problems, making it possible to concentrate efforts on them.

3 Results

According to data from the Brazilian Ministry of Agriculture and Livestock (MAPA), there were 254 registered organic producers in the BFD in May 2023, just three more than in September 2022 (Figure 1). The type of certification by OPAC[1] brings the largest number of organic producers and seems to be the form that has grown in recent months, albeit timidly. On the other hand, the number of institutions registered for certification did not change in the two periods surveyed (Table 1).

Table 1: Number of institutions registered in the Federal District to certify organic products

Period	Certifying companies	OCS[2]	OPAC	All
September 2022	4	6	2	12
May 2023	4	6	2	12

Source: Mapa, elaborated by the authors.

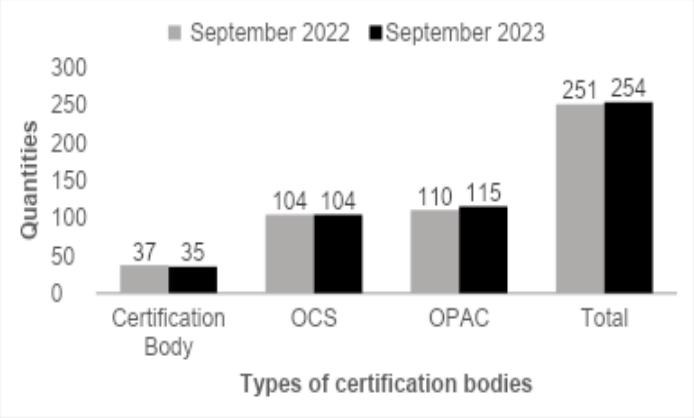
There were no sudden changes in the number of people served, either. The number served changed only in the certifier and OPAC categories, with the Cerrado OPAC continuing to have the largest number of organic producer registrations in the Brazilian Federal District (Figure 1).

[1] Participatory Organic Conformity Assessment Body (OPAC) for organic producers in the Federal District. This institution is one of the forms of participatory certification for organic production established by MAPA; it operates as a legal entity that evaluates and certifies production systems in accordance with current legislation.

[2] A Social Control Organization can be formed by a group, association, cooperative, or consortium, with or without legal personality, of family farmers. The organic producer linked to a Social Control Organization must comply with the obligations and regulations governing organic quality under Law 10.831/2003 and its regulations.

The main difference between a Social Control Organization (OCS) and a Participatory Conformity Assessment Body (OPAC) lies in the certification and scope of commercialization: the OCS is a simplified registration for direct sales (without the SisOrg seal), while the OPAC is an accredited entity that issues participatory certificates, allowing the use of the organic seal and indirect sales.

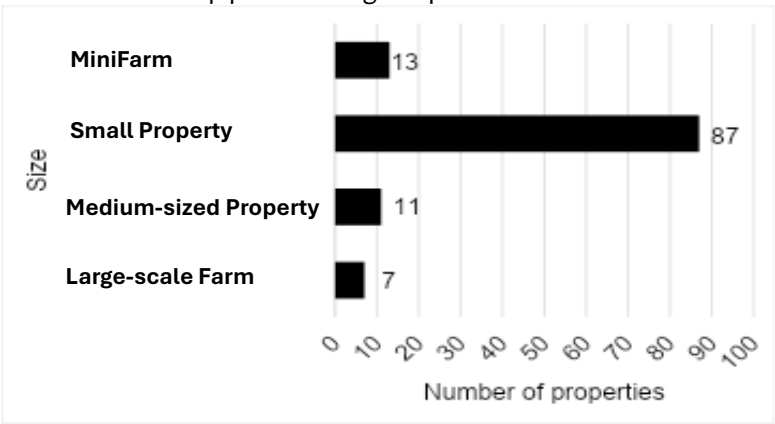
Figure 1. Forms of organic certification in force in the Federal District



3.1 Characteristics of organic producers in the Cerrado OPAC

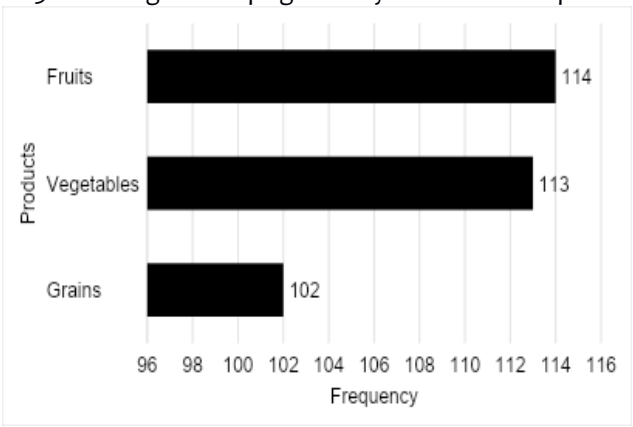
OPAC Cerrado, together with the BFD organic union, is a group that brings together producers from different land profiles (Figure 2). Most producers are families working on up to 20 ha, which are considered small producers, and mini farms when the area does not exceed 2 ha.

Figure 2: Land ownership profile of organic producers linked to the OPAC Cerrado



While the distances between producers are important for the total property area, with the smallest property at 0.22 ha and the largest at 245 ha, the same cannot be said of the production carried out. Across scales and combinations that vary greatly, the organic production of OPAC Cerrado producers focuses on vegetables, fruit, and grains (Figure 3), the latter including beans, corn, and soybeans.

Figure 3: Main organic crops grown by OPAC Cerrado producers



Another approximation across these land ownership categories is that large and medium-sized landowners, despite the extent of their land, allocate small areas to organic crops, bringing their organic production area close to that of small landowners and smallholdings (Table 2).

Table 2. The ratio between the total area and the area devoted to organic production

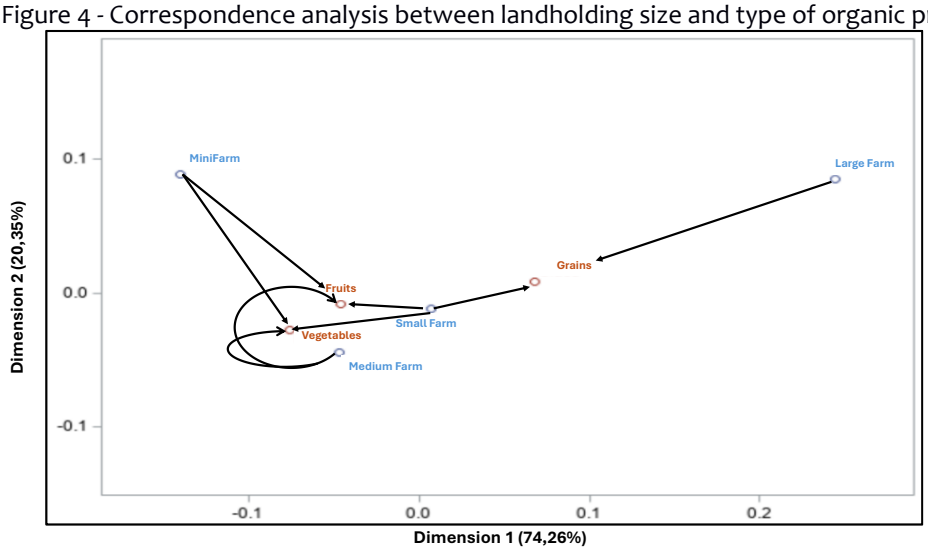
Category	N	Average	Minimum	Maximum
Mini Farm	13	0.71	0.44	1.00
Small Farm	86	0.69	0.12	1.00
Medium Farm	11	0.37	0.10	0.78
Large-scale Farm	7	0.21	0.04	0.41
Total	117	0.64	0.04	1.00

However, proportionally, when comparing total area and organic production area, small and mini farms tend to allocate most of their land to organic production and may even have the total area allocated to organic production (Table 2), while medium and large landowners range between 0.21 and 0.37. In other words, proportionally, the smallest properties are more dedicated to organic production.

3.2 Correspondence Analysis

When we conducted Correspondence Analysis between the landholding structure and the type of organic production, we observed that the point representing the Medium-size profile is closest to the Vegetable and Fruit production systems. The Small size is the closest to the Fruit production system, followed by Grains and Vegetables. The Mini farm is relatively close to the Vegetable and Fruit production systems, while large farms are closer to the Grain production system.

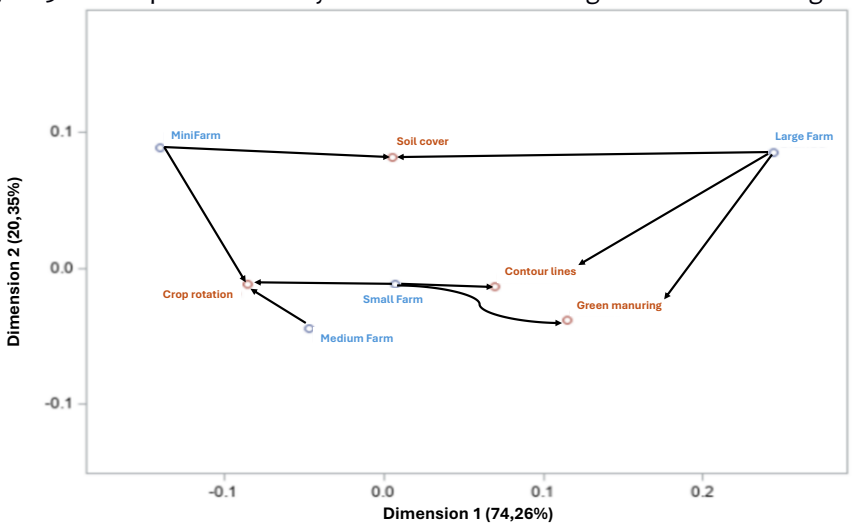
Figure 4 - Correspondence analysis between landholding size and type of organic production



The distances from the correspondence analyses suggest that smallholdings may be more associated with subsistence production than with commercial production, as analyzed here. On the other hand, large producers may not be directing their properties towards the productions declared in the management plans. These aspects would need to be analyzed more qualitatively in complementary research. As for small and medium-sized producers, the data suggests greater alignment between management plans and commercial production strategies, with small producers reporting greater diversity in their production systems.

In the correspondence analysis between landholding structure and soil conservation management systems, we observed that the Small-size profile point is closest to management systems that require "contour lines" and implement "green manuring" and "crop rotation". The Mini farm is closest to the management system, which keeps plant remains in the "soil cover" and uses "crop rotation". The Medium Estate is closest to the management system that uses "crop rotation". The large farm, far removed from all the options, is closest to the management systems with "Green manuring" and "Contour lines".

Figure 5 - Correspondence analysis between landholding size and soil management



The practices of smallholdings in soil cover and crop rotation are more closely related to the fact that they produce vegetables and leafy greens, which require plant cover and the renewal of raised beds. The differences between small and medium-sized producers, especially in the use of contour lines and green manure, are partly related to the location of the areas and to the degree of terrain ruggedness. The contour-line aspect can also indicate a significant difference, since it requires a greater investment in changes to the production system.

3.3 Main bio-inputs used

For soil nutrition

When analyzing the bio-inputs used for plant nutrition on the different OPAC Cerrado properties, 226 products were recorded, with different combinations and compositions of use. *Yoorin* and *Bokashi* appear as products used on 13.3% of the properties. They can be found in local shops in the Brazilian Federal District, while *Bokashi* can also be made on the property. On the other hand, green manure, which could be a form of autonomy in production, is rarely used (Figure 5).

Table 3 shows the main products used in soil nutrition on the OPAC Cerrado properties, emphasizing the 16, which account for almost 50% of the products used.

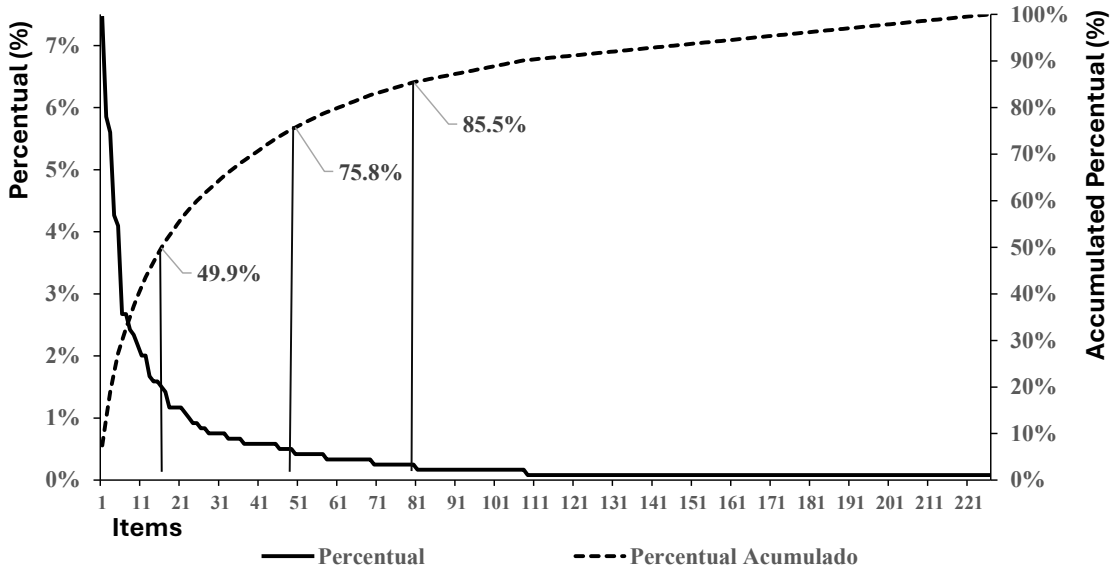
Table 3: Main products used in soil nutrition on OPAC properties

Product	**Occurrence**	%	**% Aggregated**
Yoorin	89	7.4%	7.4%
Bokashi	70	5.9%	13.3%
Composting	67	5.6%	18.9%
Chicken Litter	51	4.3%	23.2%
Limestone	49	4.1%	27.3%
K-Mag	32	2.7%	29.9%

Rock dust	32	2.7%	32.6%
Bone meal	29	2.4%	35.0%
Potassium sulfate	28	2.3%	37.4%
Castor bean cake	26	2.2%	39.5%
Biofertilizer	24	2.0%	41.6%
Cattle manure	24	2.0%	43.6%
Bio Bokashi	20	1.7%	45.2%
Alquifish Mel	19	1.6%	46.8%
Agricultural Gypsum	19	1.6%	48.4%
Magnesium Sulfate	18	1.5%	49.9%
Others	599	51,1%	

Figure 5 also shows that 75.8% of OPAC Cerrado properties use at least 50 products, while 85.5% use around 80 products.

Figure 5: Main products used in soil nutrition



Concerning the origin of the bio-inputs used to fertilize the soil, at least 70% of producers make some composition on the property, but only 3% use products exclusively from the property. This indicates a high dependence on marketable products, whether ready-made formulas or ingredients, to make up the mixtures on the farm. This is one of the support challenges to consider for public policies and projects aimed at supporting organic farmers in the Brazilian Federal District. This data already indicates that the local production of bio-inputs for soil fertilization is a potential challenge to supporting the expansion of organic systems in the BFD.

For phytosanitary control

In general, there is a wide diversity of products used in the biological control of pests and diseases, with 253 products or active ingredients registered. Among these, the most common were Bordeaux syrup, *Dipel*, and *Serenade*. The products *Dipel* and

Serenade can be bought in local shops in the Brazilian Federal District and abroad, while Bordeaux syrup can be made on the property or purchased from agricultural establishments in the BFD. As with soil nutrition products, there is a strong dependence on commercial products, too. There is still no autonomy among farmers to implement biological control of pests and diseases using resources from their production systems. This is a challenge for research and support for expanding the activity.

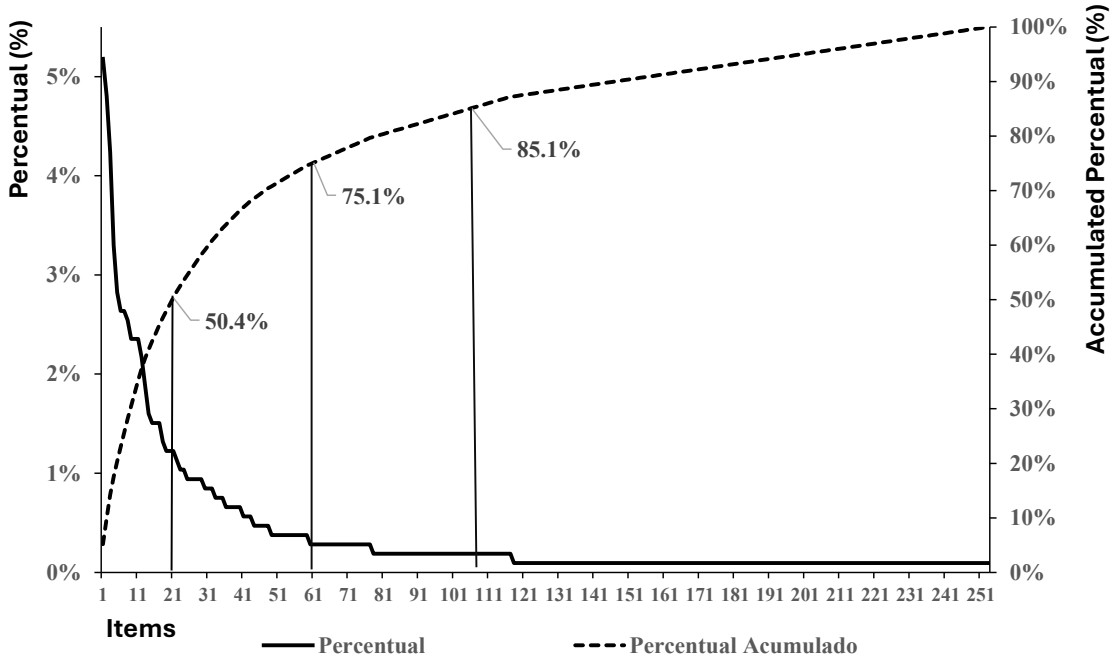
Table 4 shows the main products used for phytosanitary control on OPAC Cerrado properties, highlighting the 21 most commonly used, which account for 50.4% of all products.

Table 4: Main products used for phytosanitary control in PCAOs

Product	**Occurrence**	%	% **Aggregated**
Bordeaux Mixture	55	5.2%	5.2%
Dipel	51	4.8%	10.0%
Serenade	45	4.2%	14.2%
Kumulus	35	3.3%	17.5%
Supera	30	2.8%	20.3%
Azamax	28	2.6%	23.0%
Sulfocalcic Solution	28	2.6%	25.6%
Agree	27	2.5%	28.2%
Bioisca	25	2.4%	30.5%
Boveril	25	2.4%	32.9%
Metarril	25	2.4%	35.2%
Garlic Extract	23	2.2%	37.4%
Azact CE	20	1.9%	39.3%
Pepper Mixture	17	1.6%	40.9%
Capone	16	1.5%	42.4%
Pepper Extract	16	1.5%	43.9%
Tracer	16	1.5%	45.4%
Neutral Soap	14	1.3%	46.7%
Bordasul	13	1.2%	47.9%
E.M.	13	1.2%	49.2%
Trichodermil	13	1.2%	50.4%
Others	527	49,6%	

Figure 6 also shows that 75.1% of the properties in the Cerrado OPAC use 61 products for phytosanitary control, while 85.1% use 106 products.

Figure 6: Products most frequently used for phytosanitary control



The total number of products used is 527, demonstrating a wide dispersion of phytosanitary control practices in our data sample.

4 Discussions: challenges and potential to support a plan for Agroecology and Organic Production in the researched territory

The Sustainable Rural Development Plan for the Brazilian Federal District (PDRS-DF), presented by SEAGRI and EMATER in 2023, among several strategic objectives, establishes the expansion and consolidation of organic production in the territory based on the creation of an organic market space and the preparation of the District Plan for Agroecology and Organic Production. To this end, understanding the production and management aspects can provide the necessary support to make the scenario of a territory producing healthy food a reality.

Based on the analysis of the data, one of the reflections we can draw from the experience of the OPAC Cerrado is that organic production in the Brazilian Federal District is a reality for the different social categories of agriculture, whether family or business, with diversified products, but with an emphasis on the vegetable and fruit value chains. Given that the Cerrado OPAC has the largest number of registered organic producers in the BFD, we can infer that these results reflect the situation across the area. Institutional actions to support this production should focus on the two value chains highlighted in these terms.

Regarding property size, we can infer that the potential for expanding organic production is mainly concentrated in large properties, as they allocate small areas to organic production. On the other hand, for mini farms and smallholders, the question is no longer how to expand or what to expand but how to improve management, performance, and the system's self-sufficiency.

There is a high diversity of bio-inputs used for soil fertilization and biological control of pests and diseases. Most come from outside the property, indicating the farmers' dependence on the input market for their production. Although the products can be found in shops in the Brazilian Federal District, this dependence exposes the producer to market price fluctuations. For example, organic strawberry producers in the Chapadinha settlement in Brasília were unable to maintain production during the COVID-19 pandemic due to the high cost of chicken litter used to fertilize the crop.
Although the products used can be found in shops, we see it as a challenge to support and develop organic production in the Brazilian Federal District by setting up bio-input production units tailored to the local needs of the crops grown and the specific characteristics of the cerrado biome. Local units, with standardized products in terms of the nutrients they provide, can simultaneously reduce input costs and maximize the effectiveness of product combinations. This is because the quantity of phytosanitary products used, according to studies by Primavesi (2016), indicates unbalanced soil and, consequently, plants.

The diversity of products used needs to be better analyzed in their combinations to get an idea of whether, from a technical and operational point of view, excessive applications of certain elements, overlapping or unnecessary, are occurring. We need to look into this information further with OPAC Cerrado in future research.

Recent studies have shown that the presence of an organization with strong technical leadership and a commitment to developing sustainable agriculture can catalyze and coordinate organic production and marketing flows, including promotion (FERRARI et al., 2023). Concurrently, it was found that some Brazilian organic value networks are not cohesive and exhibit low centrality, which may lead to difficulties in their value chains (BARRETO et al., 2024). In the research carried out, no coordination or orchestration behavior was observed in the organic production ecosystem, which could be due, for example, to the detection of a wide range of products (Figures 5 and 6), indicating a lack of convergence in producers' value chains. An effort to orchestrate this network, usually carried out by private companies (TATE et al., 2019) but also by third-sector organizations, as in the case presented by Ferrari et al. (2023), can contribute to the development of the organic ecosystem in the BFD, as analyzed here.

5 Final considerations

The experience of organic-producing families affiliated with the OPAC Cerrado participatory system tells us that a wide variety of products are used and combined for soil nutrition and biological control of pests and diseases among organic producers in the BDF. The data show that most of these inputs do not come from the property or the community itself but are either purchased from specialized stores in the Brazilian Federal District or directly from chicken farms. These results allow us to infer that the greatest difficulty in organic production for these families lies in the availability and access to the organic inputs necessary to conduct production. Although available in the local market, industrialized products are produced

elsewhere, which increases their price. And chicken litter, which is available in the local market, saw its price increase significantly during the COVID-19 pandemic and later during the war in Ukraine.

This situation demonstrates the lack of autonomy among farmers, whether large or small, in obtaining organic inputs. On the other hand, as a potential towards family autonomy, we see that knowledge in the use and handling of organic inputs, combined with engagement in this type of production, are the basis for the implementation of policies that encourage the production of *on-farm* bio-inputs, individually or collective, the latter being the one that best favors the ecosystem and the BFD's strategic objectives for local organic agricultural production.

The production of on-farm bio inputs is a vast field for technical assistance and financing institutions to work on, but it is also ready for implementation and expansion. Some experiences outside the OPAC Cerrado have been developed from this perspective. Unlike the research literature (FERRARI et al., 2023), OPAC Cerrado does not aim to orchestrate organic production for its associates, which is consistent with the study by Barreto et al. (2024). Our data suggest that this would be a more appropriate way to support organic production in the BFD towards meeting the objectives and goals established in the Brazilian Federal District sustainable rural development plan and to comply with the United Nations Sustainable Development Goals.

The main limitation of our paper is its focus on a single certification body in our research area, which also limits our scope. The exploratory scope of our research can support hypotheses for large-scale studies, ranging from whole-region to nation-based, to understand value chains in organic production.

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