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Resumo: As cadeias curtas de suprimento alimentar (SFSC) têm se expandido no Brasil como alternativa às cadeias longas baseadas em commodities; contudo, as evidências sobre seu desempenho ainda são fragmentadas, pois a eficiência costuma ser reduzida a métricas técnicas ou financeiras. Este artigo analisa a eficiência das SFSC sob uma perspectiva holística em Santa Terezinha de Itaipu (Oeste do Paraná, Sul do Brasil), onde agricultores familiares tem como alternativa de diversificação a produção de hortaliças. Adota-se o referencial de Belletti e Marescotti (2012), operacionalizado por meio de 33 atributos em escala Likert, agrupados em sete indicadores e quatro princípios (logístico-organizacional, informacional, distribuição de valor e ambiental). O desenho de métodos mistos combinou entrevistas não estruturadas com quatro informantes-chave para mapear as SFSC locais e apoiar a seleção dos casos, seguidas de questionário com 16 agricultores familiares produtores de hortaliças. Os escores de eficiência foram calculados como a média de cada atributo e agregados por indicador e princípio, permitindo comparar sistemas produtivos (convencional, manejo integrado e orgânico). Os resultados indicam maior eficiência global entre produtores orgânicos, impulsionada pela diversificação de canais (incluindo mercados locais e vendas digitais) e por práticas mais robustas de informação do produto. Sucessão familiar e planejamento coletivo das vendas apresentaram os menores valores em todos os sistemas. Os achados sinalizam gargalos acionáveis para políticas locais e ATER e oferecem um modo replicável de avaliar a eficiência de SFSC para além de medidas estritamente técnicas.

Palavras-chave: Análise de Eficiência, Agricultura Familiar, Sistema Agroalimentar, Cadeias Curtas de Suprimento Alimentar Concentração; Crédito Rural; Desigualdade; Índice de Gini.

Abstract: *Short food supply chains (SFSC) have expanded in Brazil as an alternative to long, commodity-based chains, yet evidence on their performance remains fragmented because efficiency is often reduced to technical or financial metrics. This article analyzes the efficiency of SFSCs from a holistic perspective in Santa Terezinha de Itaipu (Western Paraná, Southern Brazil), where family farmers have vegetable production as an alternative for diversification. We adopt the framework of Belletti and Marescotti (2012), operationalized through 33 Likert-scale attributes grouped into seven indicators and four principles (logistical–organizational, informational, value distribution and environmental). A mixed-method design combined unstructured interviews with four key informants to map local SFSC and support case selection, followed by a survey with 16 family vegetable farmers. Efficiency scores were computed as the meaning of each attribute and aggregated by indicator and principle, enabling comparison across production systems (conventional, integrated and organic). Results show higher overall efficiency for organic farmers, driven by greater channel diversification (including local markets and digital sales) and stronger product-information practices, whereas family succession and collective sales planning were the lowest-scoring attributes across systems. The findings identify actionable bottlenecks for local policy and extension services and provide a replicable way to assess SFSC efficiency beyond purely technical measures.*

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Keywords: *Efficiency Analysis, Family Farming, Agrifood System, Short Food Supply Chains.*

Resumen: *Las cadenas cortas de suministro de alimentos (SFSC) se han expandido en Brasil como alternativa a las cadenas largas basadas en commodities; sin embargo, la evidencia sobre su desempeño sigue fragmentada, ya que la eficiencia suele reducirse a métricas técnicas o financieras. Este artículo analiza la eficiencia de los SFSC desde una perspectiva holística en Santa Terezinha de Itaipu (Oeste de Paraná, Sur de Brasil), donde los agricultores familiares tienen la producción de hortalizas como una alternativa de diversificación. Adoptamos el marco de Belletti y Marescotti (2012), operacionalizado a través de 33 atributos en escala Likert agrupados en siete indicadores y cuatro principios (logístico-organizativo, informativo, distribución de valor y ambiental). El diseño de métodos mixtos combinó entrevistas no estructuradas con cuatro informantes clave para mapear las SFSC locales y apoyar la selección de casos, seguidas de una encuesta a 16 agricultores familiares productores de hortalizas. Los puntajes de eficiencia se calcularon como el promedio de cada atributo y se agregaron por indicador y principio, permitiendo comparar sistemas productivos (convencional, manejo integrado y orgánico). Los resultados muestran mayor eficiencia global en productores orgánicos, impulsada por la diversificación de canales (incluidos mercados locales y ventas digitales) y mejores prácticas de información del producto. La sucesión familiar y la planificación colectiva de ventas presentaron los valores más bajos en todos los sistemas. Los hallazgos identifican cuellos de botella útiles para políticas locales y extensión rural y ofrecen una forma replicable de evaluar la eficiencia de SFSC más allá de medidas puramente técnicas.*

Palabras clave: Análisis de Eficiencia, Agricultura Familiar, Sistema Agroalimentario, Cadenas Cortas de Suministro de Alimentos.

INTRODUCTION

In Brazil, up to the mid-19th century, family farming was diversified and sustainable, providing a variety of products to urban areas. However, the "Green Revolution", starting in the 1940s, promoted monoculture and mechanization, which led to a decrease in small family farms (Serra *et al.*, 2016). The increase in mechanization and monoculture has led to a shift from short food supply chains (SFSCs) to global food supply chains based on conventional, mechanized agriculture (Albergoni; Pelaez, 2007).

While this model increased scale and standardized flows, it also reduced the space for diversified family farming and strengthened dependence on intermediate markets. In parallel, there is a trend towards returning to short food supply chains, motivated by people's interest in the origin and history of food (Cruz; Schneider, 2010), and by an increase in demand for freshness, traceability, and local identity, which has revitalized those chains as an alternative market arrangement. The SFSC is becoming important, especially in light of the high vulnerability of globalized markets in a pandemic scenario (Schabarum; Triches, 2019).

SFSC are an effort to connect producers directly to end consumers, shortening or removing intermediaries. Such chains value the direct relationship between rural producers and consumers, emphasizing local production. In addition, they have become increasingly important not only for researchers and public policymakers but also for producers.

These chains have been the subject of research demonstrating that direct access to the local market by farmers, without interventions by other actors in the supply chain, can lead to improved cost-benefit for consumers and additional income for producers. They also provide competitive advantages that farmers should exploit to maintain and increase profitability and quality in their activities. In addition, these supply chains enable family farmers to access different markets, whether in conventional food marketing systems, or alternative or institutional ones. This is possible provided if producers adapt to the new demands of the consumer market and have the infrastructure and minimum viability of the activity (QUEIROZ, 2021). Short supply chains also promote public health by providing fresh, high-quality food produced locally, improving cost-effectiveness for consumers, and increasing producers' income.

Despite the recognized benefits of the efficiency of SFSC, the concrete performance of SFSC is uneven across territories and production systems, and farmers still face bottlenecks related to logistics, organization, communication with consumers and generational continuity. From a research standpoint, an important gap remains: many assessments of ‘efficiency’ in agriculture rely on technical or cost-frontier approaches that are well suited to input–output optimization but do not capture key mechanisms through which SFSC create value (e.g., trust, information, territorial embeddedness, and environmental practices). For this reason, a holistic lens is necessary when the object of analysis is not only the farm, but also the relationship between production, commercialization and the territory, in addition to considering in the efficiency analysis aspects such as production, logistics, and environmental issues are still necessary.

To address this gap, we adopt Belletti and Marescotti’s (2012) holistic framework, which conceptualizes SFSC efficiency as a multidimensional construct expressed through four principles: (i) logistical–organizational, (ii) informational, (iii) value distribution, and (iv) environmental. Compared with methods focused

exclusively on technical performance, this framework is advantageous for diagnostic studies of SFSC because it makes explicit the trade-offs among distribution costs, communication of attributes, fairness in value appropriation, and environmental practices—elements that are central to short chains.

Empirically, we focus on Santa Terezinha de Itaipu, a municipality in the western region of Paraná (Southern Brazil) where commodity crops dominate land use, but a subset of family farmers has diversified into vegetables and participates in local SFSC (institutional markets, municipal market, farmers' markets, local retail, farm sales, and digital channels). The region has the potential to increase diversified food production through short supply chains; in this sense, studying these chains and their efficiency in this municipality can contribute not only to the development of public policies but also to advancing knowledge in this field. This setting offers a problem: How efficient are the SFSC in which family vegetable farmers participate in Santa Terezinha de Itaipu across the four principles, and which bottlenecks explain differences among production systems?

Thus, this study aims to analyze the efficiency of SFSC used by family vegetable farmers in Santa Terezinha de Itaipu based on the four principles of Belletti and Marescotti (2012). Specifically, we (a) map the local SFSC and their main actors, (b) operationalize the four principles into measurable attributes, (c) compare efficiency scores across conventional, integrated and organic production systems, and (d) identify critical constraints and implications for public policy and extension.

2 – SHORT FOOD SUPPLY CHAINS

Contemporary society is characterized by globalized relations and complex supply chains, but there is a growing demand for valuing local production, especially in the food sector (Cruz; Schneider, 2010). The expression "local food" has gained prominence by defining several regional markets worldwide, such as farmers markets and direct sales, which are all examples of short food supply chains. SFSC, also known as short marketing circuits, are characterized by the proximity between producers and consumers, often removing intermediaries found in global and long supply chains. School feeding programs demonstrate how public policies can foster, create, and maintain short supply chains (Lopes *et al.*, 2019).

The differences between food supply chains and short food supply chains are evidenced by several aspects. Food supply chains cooperate to achieve greater efficiency among the various links in the chain and to provide the most cost-effective food, from the raw material to the end consumer (Thomé *et al.*, 2021). In turn, short food supply chains integrate the links in the chain which aim to cooperate to create value. These links are often just producers and final consumers; thus, they create possibilities for regional development (Gazolla, 2019; Thomé *et al.*, 2021), in this sense, the SFSCs have a strategic function in territorial dynamism.

The configuration and relationships among the links within these short food supply chains also vary. SFSC consists of a set of members with close relations between producers and consumers, whether or not they are spatially proximate. This aspect differs from long food supply chains that revolve around a focal company, with diverse relationships among their links (Hincrichs, 2003; Thomé *et al.*, 2021).

In Brazil, SFSC are strongly connected to family agriculture. Such chains generally comprise producers who own small plots of land, rely on family labor, diversify production, and are usually located close to consumers, with whom they can establish relationships that are not purely commercial (Elias *et al.*, 2019). In addition

to their close relationship with family farming, SFSC also encompasses commercialization spaces such as family farming fairs, which operate as concrete alternatives to long and conventional chains, strengthening local markets, reducing intermediaries, and enabling producers to obtain better income conditions (Santos Alvaristo et al., 2022). Another characteristic of SFSCs in Brazil is that their construction depends heavily on state support and structuring public policies, such as PAA (Food Acquisition Program), PNAE (National School Feeding Program), agroecology and organic policies, and municipal and state programs to promote direct marketing (Gazolla, 2019).

There are different types of SFSC, such as face-to-face, proximate, and spatially extended. Each type has specific characteristics that affect interactions between producers and consumers and the potential to add value to products (Verano *et al.*, 2021). The face-to-face type is characterized by the closest relationship between producers and consumers. Therefore, this type of short chain favors the exchange of experiences between urban and rural areas, creating greater benefits for both actors. Consumers learn on the spot about the reality around them and learn to value food. In turn, producers get to know their consumers better and can learn about their preferences, which can be used to add value to their products (Kiyota *et al.*, 2021).

The spatial proximity type is characterized by the fact that there is no need for physical proximity between producer and consumer, and by possible intermediary links that carry out transformation or distribution. However, there is still some spatial proximity, i.e. consumers and producers are not located far apart and, thus, the food supply chain can be defined as short (Souza; Fornazier; Delgrossi, 2020). In the spatially extended type, even if consumers buy products with such a label on the other side of the world, they are still buying a bit of that locality along with the product. Therefore, it is spatially extended and brings the realities of producer and consumer closer together, hence a short food supply chain (Verano *et al.*, 2021).

2.1 – EFFICIENCY IN SHORT SUPPLY CHAINS

The concept of efficiency can vary according to the field of study in which it is applied. In agriculture, overall efficiency is defined in terms of pure technical analysis and assessed by comparing observed values with their maximum possible values, considering outputs and inputs (Gomes *et al.*, 2005). This definition allows for quantitative analysis, with Data Envelopment Analysis (DEA) being widely used for this purpose, as well as to understand whether there is efficiency or inefficiency in each rural activity (Vicente, 2004; Mangabeira, 2004; Gomes, 2008; Oliveira, 2019; Schütz; Souza Junior, 2019).

In addition to DEA, the stochastic frontier model has been used to obtain efficiency indices in agriculture (Lima, *et al.*, 2026; Santos Barbosa *et al.*, 2018; Martins, 2019; Luna, 2020). Using this model can provide flexibility in analyzing random variables that can attenuate or accentuate aspects of efficiency. These variables, such as bad weather conditions, are very common in rural areas. (Santos Barbosa *et al.*, 2018). However, the stochastic frontier model is a technical analysis method based on quantitative data and does not allow the conceptualization of efficiency to account for other factors in the analysis of rural activity.

However, when the unit of analysis is farmers' participation in SFSC, efficiency also depends on how commercialization is organized, how product attributes are communicated, how value is distributed along the chain, and how production practices interact with environmental outcomes. These elements are central to SFSC

competitiveness and legitimacy but are not directly represented by frontier-based models. Therefore, a multidimensional diagnostic framework is more appropriate for municipal-level studies, where the goal is to identify bottlenecks and opportunities rather than estimate a production frontier.

In this scenario, holistic efficiency analyses on farms or in rural activities connected to family farming have also been proposed as farm management models (Zachow; Plein, 2018). Based on this perspective, Belletti and Marescotti (2012) propose that the efficiency of short supply chains should be analyzed in four dimensions: logistical-organizational efficiency; informational efficiency; value distribution efficiency; and environmental efficiency.

Logistical-organizational efficiency is the ability to control distribution costs or to add value to the product to benefit the links at the end of the supply chain. In the case of SFSC, these links are farmers (Belletti; Marescotti,, 2012). Value distribution efficiency within the supply chain refers to the more equitable and fair distribution of value along the chain. In turn, information efficiency is linked to the ability to include attributes in a product so that the end consumer learns about them. It can occur informally or formally, as in the case of geographical indication, which requires a formal process and certification, or in direct sales at farmers' markets, where producers can present the characteristics and attributes of their products to consumers. Finally, the fourth criterion is the environmental efficiency of supply chains related to the production system used and the biodiversity (Belletti; Marescotti, 2012).

In this study, these principles were operationalized as 7 indicators and 33 attributes, measured on an 8-point Likert scale (1 = not relevant/absent; 8 = very relevant/strongly present). For each attribute, we computed the mean score within each production system (conventional, integrated, organic). Indicator scores correspond to the arithmetic mean of their attributes, and principal scores correspond to the meaning of their indicators. This aggregation provides a transparent ‘efficiency profile’ that supports comparison across systems and highlights the specific attributes that constrain SFSC performance in the territory.

3 – METHODOLOGY

This is an applied mixed-method study conducted in Santa Terezinha de Itaipu (western Paraná state, Southern Brazil). We employed a qualitative–quantitative (exploratory sequential) design: a qualitative phase mapped the local SFSC and refined the analytical categories, followed by a quantitative phase to describe and compare efficiency scores across production systems.

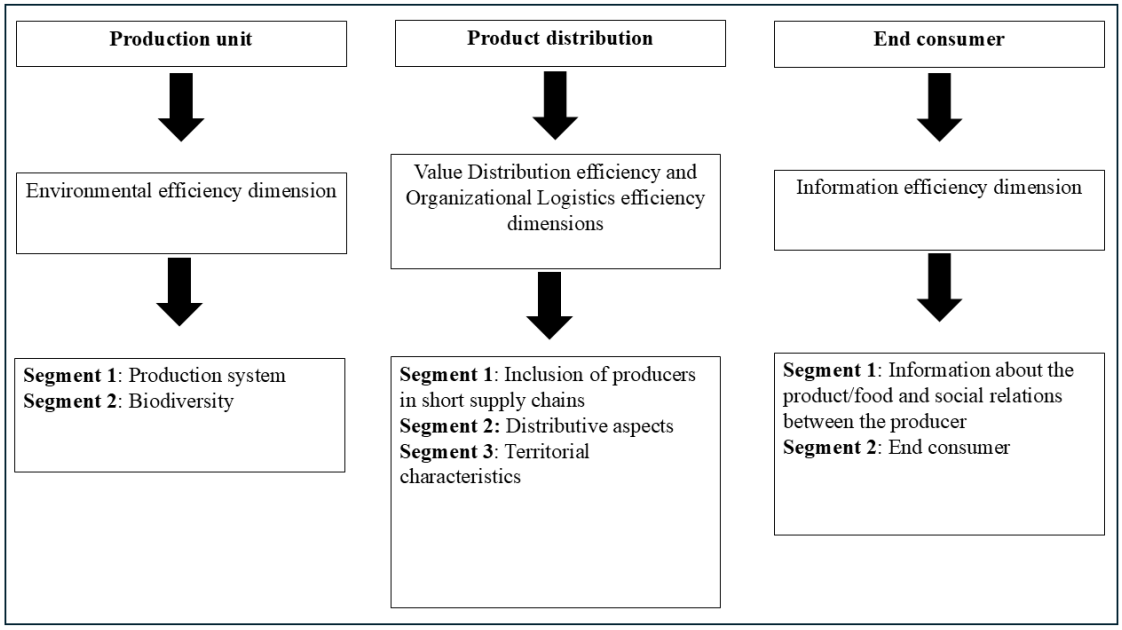
Step 1 – Qualitative mapping: Unstructured interviews were conducted with four key informants (Municipal Secretary of Agriculture and the Environment; Municipal Director of the Department of Agriculture; Treasurer of the Municipal Horticultural Association; and the Municipal Manager of the Rural Development Institute of Paraná). This phase aimed to (i) describe the structure, organization, and functioning of SFSC in the municipality, (ii) identify the main commercialization channels and intermediary actors, and (iii) support the identification of eligible family farmers. Interviews were recorded and transcribed, and later used for contextual interpretation and triangulation. The interviews were recorded and transcribed to enable triangulation and data analysis.

Step 2 – Survey with farmers: The quantitative phase surveyed 16 family farmers who (i) produce vegetables, (ii) participate in at least one type of SFSC

identified in Step 1, and (iii) have their rural property in the municipality. The sample was purposively selected, supported by qualitative mapping; data collection was conducted between April and June 2022. Theoretical saturation was used as a stopping criterion during recruitment, i.e., data collection was interrupted when new observations no longer added relevant variation to the mapped attributes.

We applied a multiple-choice questionnaire, divided into 3 sections, with an 8-point Likert scale, where 1 corresponds to no relevance and 8 to a lot of relevance, adapted from Camara (2020) and grounded in the conceptual dimensions of Belletti and Marescotti (2012). As illustrated in Figure 1, the instrument is organized into three blocks: (a) environmental efficiency (production system and biodiversity), (b) value distribution plus logistical–organizational efficiency (integration into SFSC, distributive aspects, and territorial characteristics), and (c) informational efficiency (product information and producer–consumer social relations). The adaptation preserved the original conceptual mapping while adjusting the wording to the local SFSC context; nonetheless, we recognize that, given the small sample size, we did not estimate internal consistency statistics.

Figure 1 – Questionary map



Source: author's figure.

The farmers responded freely according to their perspectives. The primary data were tabulated and analyzed using descriptive statistics. For each attribute, we computed mean scores by production system. We then aggregated means into indicator and principal scores (arithmetic averages), which are reported in Tables 1–3. Qualitative evidence from key-informant interviews was used to interpret the scores and to connect the observed patterns to territorial characteristics and institutional arrangements.

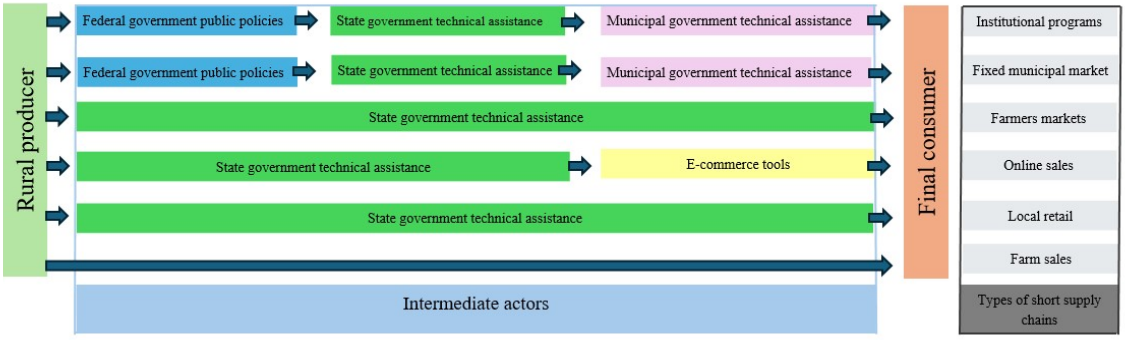
4 – RESULTS

Agriculture in Santa Terezinha de Itaipu and the surrounding region is based on soy, corn, and wheat. These crops provide few income opportunities for farmers who own or rent little land, a category which family farmers generally fall into. Only a small percentage of farmers diversify their production, for example by growing vegetables, which can generate higher income on a small plot of land (Freitas; Wander, 2017).

The municipality has around 16,500 hectares of soy production, all of which is grown conventionally, with mechanization and pesticide use. This monoculture occupies almost the entire area of temporary crops, according to the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística - IBGE, 2017). Soybean production yields significantly higher income than the main vegetables produced, which occupy 10 hectares for lettuce and tomato production (Department of Rural Economy - DERAL, 2021), an example of vegetable diversification in agriculture. This is mainly due to the small area designated for crop diversification in the municipality (DERAL, 2021). According to data from the 2017 Census of Agriculture (IBGE, 2017), the municipality has only 23 horticultural farms, mostly family farms with little or no technology.

The types of SFSC identified by the authorities in the interviews were: institutional programs (Food Acquisition Program - PAA and National School Feeding Program - PNAE), the fixed municipal market, farmers markets in the municipality and surrounding areas, online sales (via WhatsApp and Facebook), local retail sales, and, lastly, farm sales. The actors involved in the structuring and dynamization of such chains enable the development of a basic model of how they articulate from the rural producer to the final consumer, with intermediary actors that vary according to the type of SFSC (Figure 2).

Figure 2 – The main SFSC identified and their basic structure



Source: author's figure.

The role of public authorities is evident across most of the identified types of short chains, underscoring the importance of these agents in promoting this supply chain model. Their role reflects the same scenario found in other Brazilian regions (Cunha *et al.*, 2017 Schabarum; Triches, 2019; Verano *et al.*, 2021). In addition, the public authorities in the municipality are particularly active in promoting the farmers market and the National School Feeding Program (PNAE).

Public Technical Assistance and Rural Extension (Assistência Técnica e Extensão Rural - ATER) was an intermediary link in most of the SFSC identified. Interviews frequently cited it as an essential link in maintaining and improving such

chains. Thus, ATER is regarded as a fundamental element in short supply chains (Kasmin et al., 2019), and its absence is seen as a contributing factor to the precariousness of their development (Souza-Amaral *et al.*, 2020).

There are three types of SFSC with less involvement of public authorities as intermediary links: online sales, local retail sales, and farm sales. These short supply chains provide producers with greater independence from their final consumers. Local authorities view such chains as an important alternative for adding value and increasing the income of family producers.

Among the profiles of the interviewed farmers, three distinct management methods were identified: conventional, integrated, and organic. Conventional management is characterized by reliance on agricultural pesticides (agrochemicals), primarily chemical fertilization in each production cycle (Berri; Pelisser, 2016). In turn, integrated management is technically defined as the use of integrated pest and disease management techniques, which aim to rationally combine agricultural pesticides and chemical fertilization with biological management to control phytosanitary problems (Francisconi; Bonaldo, 2022). Finally, organic management is based on an opposite philosophy to conventional production and is characterized by the non-use of pesticides and conventional chemical fertilization (Alvares Spagnuolo *et al.*, 2021).

As for producers' participation in social organizations, 43.75% do not participate in any of them, 37.5% participate in associations, and 18.75% are members of cooperatives. Most producers own their lands, with an average area of 5 to 6 hectares and an average agricultural income of around R$76,000.00 per year. On average, 1 to 2 family members work in the business. All participants are family farmers, i.e. they fall within the parameters of the National Program for Strengthening Family Farming (Programa Nacional de Fortalecimento da Agricultura Familiar - PRONAF). Most of the farmers interviewed do not use protected cultivation techniques, such as plasticulture or greenhouses, and identify themselves with the "conventional farming" production model.

4.1 – ANALYSIS OF THE LEVEL OF EFFICIENCY OF SHORT FOOD SUPPLY CHAINS IN SANTA TEREZINHA DE ITAIPU

Environmental efficiency comprises production systems and biodiversity indicators. The organic production systems (Org.) stood out for their highest efficiency rates, particularly in the production base and the water source (Table 1). Organic and agroecological producers are more likely to seek environmentally friendly alternatives to ensure a clean, adequate source of water for agriculture. This approach helps to avoid waste and promote a sustainable water cycle. Furthermore, such producers strive to be free of agrochemicals and pesticides and to align with the natural productive balance. Whenever possible, they use plants within the agricultural area that do not always have direct commercial potential, such as cover crops and repellent plants. In addition, organic certifications require environmentally responsible practices.

To make the interpretation explicit, Tables 1–3 report the attribute means (1–8) by production system and their averages by indicator. Higher scores indicate that the attribute is more strongly present/relevant in the producer's participation in SFSC, thus signaling higher efficiency for that specific principle in the local context.

Table 1 – Environmental efficiency indicators

Dimension	Indicator	Variable	Production systems		
			Conv.	I. M.	Org.
Environmental Efficiency	Production systems	Production base	4	4,17	8
		Type of production	5,77	4,46	6
		Post-harvest cleaning	7,17	5,25	5
		Water source	8	7,04	8
	Average		6,23	5,23	6,75
	Biodiversity	Cultivated species	5,83	4,42	8
		Intercrops	1	1,33	8
		Direct Planting System for Vegetables (SPDH - Sistema de Plantio Direto de Hortaliças)	1	1,5	1
	Average		2,61	2,42	5,67

Note: Conv.= conventional production system; I. M. = conventional production system with integrated management techniques; and Org. = organic production system.
Source: author's datas.

Within the scope of biodiversity, the high efficiency of organic management in terms of the number of cultivated species aligns with agroecological and organic practices that promote crop rotation in vegetable production, including among native and exotic species, such as unconventional food plants (UFPs). Thus, these two types of vegetable production result in a greater abundance of flora and microfauna in the production area and naturally reduce the impact of diseases and pests on the production system (Sediyama *et al*., 2014).

This bottleneck matters for SFSC because the environmental principle is not restricted to the absence of agrochemicals; it also involves soil-cover practices and on-farm biodiversity that stabilize production and reduce risks. The very low scores for intercropping and DPSV among conventional and integrated producers suggest that 'greening' efforts remain centered on input substitution rather than on system redesign, which helps explain why organic producers differentiate more easily in local direct markets.

In addition to the higher overall efficiency of organic cultivation in terms of environmental aspects, the analysis of the efficiency of SFSC indicated a significant bottleneck: the almost absence of the Direct Planting System for Vegetables (DPSV), a production model that is expanding with the help of agronomic techniques promoted by Embrapa (Brazilian Agricultural Research Corporation) and other public and private institutions. DPSV improves soil and water quality management and enhances the environmental efficiency of the production site. Environmental factors with high scores associated with organic production align with consumers' SFSC preferences and an environmental production orientation (Lovatto *et al*., 2021). Lovatto et al. (2021) demonstrate that proximity to farmers increases the importance of environmental attributes in purchasing decisions, with a preference for products from local farms that follow organic or agroecological practices.

Regarding effectiveness in the value distribution and organizational dimension, organic production systems also performed better than the other systems. In this context, the inefficiency of conventional and integrated management systems in diversifying sales in the digital environment is noteworthy (Table 2).

Table 2 – Value distribution and organizational efficiency indicators

Dimension	Indicator	Variable	Production systems		
			Conv	I. M.	Org.
Value distribution and organization efficiency	Integration into short food supply chains	Types of food supply chains	3,33	5,13	8
		Digital diversification	1	3,25	8
		Commercialization in the supply chains	6,67	5,96	8
		Supply chain maintenance	3	2,83	8
	Average		3,5	4,29	8
	Distributive aspects of commercialization	Pass on costs	5,33	5,83	6
		Expenses in short supply chains	1,67	2,03	2
		People involved in the commercialization	4	3,25	2
		Existence of intermediaries	7	5,29	8
		Sales transportation	3,33	2,5	2
		Distance from consumer	5,67	5,67	6
	Average		4,5	4,1	4,33
	Territorial characteristics	Defining what to plant	2,67	3,79	8
		Marketing activities	0	0,17	0
		Institutional markets	5,67	3,15	2
		Regional production drives the consumer	3	5,71	8
		Promotion through short chains	4,33	4,88	8
	Average		3,13	3,54	5,2

Note: Conv.= conventional production system; I. M. = conventional production system with integrated management techniques; and Org. = organic production system.
Source: author's datas.

Digital e-commerce tools have proven to be an excellent option for increasing income and expanding customer bases in the local markets of SFSC (Gazolla; Aquino, 2021). This indicates that producers of conventional and integrated management systems are missing the opportunity to increase their income and generate more value for their products. Producers who use the organic production system and choose to diversify their sales digitally evidence the trend towards the strengthening of the demand for healthier products in digital purchases on the local market, facilitated by delivery services, as observed by Oliveira *et al.* (2011), and reinforcing what was said by Gazolla and Aquino (2021) increasing the customer base of these producers.

From the logistical–organizational perspective, the sharp contrast in digital diversification indicates differences in managerial capabilities and market orientation. While organic producers use SFSC channels to actively manage demand and delivery, conventional producers tend to rely on established outlets, which reduces flexibility and weakens their bargaining position. In practice, digital channels function as both a logistics tool (order aggregation, route planning) and an informational device (ongoing communication of quality attributes), linking two principles of the model.

Among the production systems, the scores were more homogeneous in the distributive aspects of commercialization in SFSC. In the different systems, producers seek to absorb part of the costs before passing them directly to consumers. Additionally, there are also few or no intermediaries, such as distributors or representatives, which is a characteristic of SFSC. Similar patterns have been documented in studies of family farming fairs, which serve as important mechanisms for strengthening producers' autonomy and reducing dependence on intermediaries. By providing direct access to consumers, these commercialization spaces enhance

income distribution in SFSC and support territorial development through the valorization of local production (Santos Alvaristo et al., 2022).

There is a geographically close distribution of the production to the consumer, mainly directed at the market of the city or its neighboring city. Thus, the city functions as a green belt, a common trend in urban centers across the country characterized by the presence of SFSC, such as said by Baratelli and Raoul (2018). In turn, the high cost of entering and remaining in local SFSC, coupled with the low participation of family members in commercial activity, emerge as bottlenecks. Similar results have been found in other studies on family farming (Bischof, 2018; Freitas; Wander, 2017) and relate to another finding of this work that deals with problems with property succession, which reinforces the low participation of family members, especially the younger ones.

Although low intermediation is a defining characteristic of SFSC, Table 2 shows that costs and labor remain a constraint for all systems. This result suggests that 'short' is not synonymous with 'low-cost': in small-scale horticulture, transaction costs can shift from intermediaries to farmers (time for selling, packing, and transportation). Therefore, organizational arrangements (collective logistics, shared points of sale, and coordinated calendars) are decisive to convert proximity into efficiency gains.

In the evaluation of territorial characteristics, organic systems exhibited a higher average but also demonstrated inefficiency concerning the variable of marketing activities. These are supplementary activities in which the producer could engage to involve the consumer in the productive context. Thus, the producer could integrate the consumer into the rural reality, facilitate the addition of value to agricultural products, and apply commercial value to these activities, such as rural tourism. In this sense, rural tourism can be developed by local family farms to favor SFSC and encourage the consumption of local products (Riva *et al.*, 2017).

Organic producers demonstrated low efficiency regarding participation in institutional markets, despite the active involvement of public agents and the expectation that public policies will direct the organic production system towards supplying the local market of public entities. The low efficiency of organic farmers in institutional markets also indicates that policy instruments may not be fully aligned with local supply conditions (volume, regularity, certification costs) or with procurement routines. Strengthening value distribution efficiency in this channel requires not only demand-side policies, but also local coordination mechanisms (planning, collective delivery and technical assistance) that reduce compliance and transaction costs for small producers.

The organic production system has the highest level of efficiency when it comes to consumer demand for local products, demonstrating a greater relationship between producer and consumer, likely due to the shared interests that foster trust in SFSC chains. This result is supported by the findings of Conceição *et al.* (2018) who assert that shared values, along with transparency, direct communication, and the circulation of information about origin and production practices, present in short supply chains especially when they utilize technology, contribute to building trust relationships. Aligned with Schneider e Ferrari (2015), they say that organic short supply chains favor stronger and more symbolic relationships between producers and consumers, as they share values (quality, ethics, sustainability). This increases commercial efficiency, including in terms of demand. Trust appears as a structuring element of these interactions, fully aligned with the original statement.

Padilha *et. al* (2019)'s study, also supports this finding by showing that the organic system stands out for its efficiency in responding to the demand for local products, since fairs strengthen short supply chains with greater involvement between producer and consumer. Face-to-face interactions increase trust, reinforcing the idea of shared interests and values. We can see that organic products generate a greater symbolic connection, since they involve shared values (health, sustainability, support for local farmers), which increases loyalty and demand.

The conventional production system displayed low efficiency in boosting regional production. This indicates that the system is more reliant on the market established and controlled by intermediaries and distribution centers (CEASA) since it is unable to establish a relationship of trust as efficiently as that of the organic production system (Moraes; Pires, 2019; Schabarum; Triches, 2019). The low efficiency of the conventional production system is reinforced by the lack of digital diversification in its commercialization.

Correspondingly, the organic system performed better in information efficiency (Table 3) than the other systems. In this context, the product information indicator is noteworthy. This indicator is related to the direct contact producers have with the consumer, either by selling their products at the farmers market or through mobile phone apps. Aligned with Conceição, Doula & Vieira (2018)'s findings, which highlight that the internet acts as a tool for bringing farmers and consumers closer together, contributing to relationships of trust.

Another significant factor is how the producer defines commercial production, which is linked to commercial crops pertaining to local and family traditions. This aspect represents an incentive for greater efficiency in SFSC, satisfying consumers and fostering connections through quality regional products (Cruz; Schneider, 2010).

Table 3 – Information efficiency indicators

Dimension	Indicator	Variable	Production systems		
			Conv.	I. M.	Org.
Information efficiency	Product information	Type of product in direct contact with consumers	2	2,43	8
		Consumers know how it is produced	5,17	3,88	8
		Direct contact at points of sale	5,33	4,04	8
		Production methods are related	6,33	3,46	8
		Digital sales groups	1	1,88	6
	Average		3,96	3,13	7,6
	Social relations	Support from public entities	8	7,04	8
		Cooperatives and associations	2,67	3,46	8
		Sales control groups	1	1,29	1
		Demand at farmers markets or at the farm	4	5,46	8
		Regular agreement with consumer	1	1,58	1
		Family succession	5,67	4,04	4
	Average		3,72	3,81	5

Note: Conv.= conventional production system; I. M. = conventional production system with integrated management techniques; and Org. = organic production system.
Source: author's datas.

Regarding social relations, the support of public entities stands out. All production systems achieved a high level of efficiency, reinforcing the perception of quality public assistance in the municipality among producers. Technical assistance and rural extension are promoters of quality rural development, especially in family farming and local markets in SFSC.

The inefficiency generated by the absence of informal or formal sales control groups, as well as the lack of regular sales agreements with consumers in the three production systems, are notable in terms of social relations. The malfunctioning or absence of sales control groups negatively impacts the management of SFSC, as it isolates producers and marginalizes them within the formal market. In this context, producers encounter obstacles that are harder to overcome, becoming more fragile in the face of strategies of the conventional and extensive market of intermediaries, supermarket chains, and distribution centers (Moraes *et al.*, 2018).

The lack of regular sales agreements, on the other hand, impacts sales forecasting, increasing the producers' uncertainty regarding demand. Regular sales agreements, usually linked to digital sales tools, are positive and efficient options to guarantee regular sales to certain consumers, create trust and stable relationships between the two ends of the supply chain, and provide greater financial and commercial security for rural producers (Gazolla; Aquino, 2021). Considering the COVID-19 outbreak, digital tools such as WhatsApp and Facebook have enabled an increase in commercial relationships in local SFSC, fostering loyalty between producers and consumers (Schwanke *et al.*, 2022).

Rural-to-urban migration, and currently to a greater extent rural youth migration, are major indicators of productive inefficiency and market integration and, specifically in this study, of integration into short food supply chains (Kischener *et al.*, 2021). This efficiency indicator reflects other indicators, since inefficiencies in the production, commercial, or social relations processes influence the rural youth's perception of the potential of rural activity, impacting their decision to stay in the business or not. As for the producers interviewed, the results indicated average efficiency in the three production systems, as evidenced by the results of the other indicators. The lack of access to the SFSC market, transportation difficulties, fragile social relations, and the absence of technical assistance have an impact on young people's willingness to succeed the previous generations in rural farming.

The results represent the productive context in which the producers included in this study reside. The large-scale intensive agriculture in the municipality and its surrounding region presents a challenge for family farmers seeking to diversify their production by cultivating vegetables. Generally, the development of SFSC is inversely proportional to intensive agriculture (Souza *et al.*, 2020), which is based on monoculture. Therefore, territorial characteristics, in general, make it difficult to increase the efficiency of producers' participation in short supply chains.

In the efficiency analysis of regional SFSC, the value distribution and organizational indicator achieved superior scores in organic cultivation. This data is associated with greater acceptance and demand for this niche market from consumers seeking SFSC that offer higher quality and healthier products (Lovatto *et al.*, 2021). Conventional producers frequently prioritize standardization and distribution over integration into SFSC which explains their lower score in the variable.

Overall, organic farmers score higher because their participation in SFSC combines (i) environmental practices that act as credible quality signals, (ii) diversified channels that reduce dependence on a single outlet, and (iii) closer producer–consumer interactions that enable communication of attributes. Conversely, the lowest-scoring attributes (family succession, collective planning and digital organization) reveal that SFSC efficiency is constrained by social reproduction and coordination—dimensions that would remain invisible in purely technical efficiency assessments.

FINAL CONSIDERATIONS

SFSC are a significant avenue for sales and generation of income for family farmers, especially those who produce vegetables. This is mainly due to their inability to serve long and complex food supply chains, given the volume of production. Bearing this in mind, this study sought to evaluate the efficiency of these producers' participation in SFSC in Santa Terezinha de Itaipu, a municipality in the western region of Paraná state.

The analyses provided an understanding of the efficiency of vegetable producers' participation in SFSC, especially in the context of family farming. The results indicated that producers in the organic production system exhibited higher levels of efficiency than those who employ conventional and integrated management systems. Regarding the environmental efficiency indicator, questions concerning the production system performed better than the biodiversity variable. This can be attributed to the fact that most properties that use conventional systems and integrated management rely on soybean monoculture and do not employ the Direct Planting System for Vegetables (SPDH).

Concerning value distribution and organization, the better performance of the organic production model may be aligned with the fact that people opt for short supply chains in search of higher quality and healthier products, resulting in a preference for organic products in this market niche. In addition, producers in conventional production models prioritize standardization and distribution to the detriment of integration into short supply chains, which directly impacts value distribution.

Regarding the evaluation of informational efficiency among all the production systems, participation in sales control groups in order to organize the participation in SFSC and direct sales agreements with consumers were rarely identified. This evidence demonstrates that being part of SFSC in the local context seems to be facilitated by proximity and sales practices rather than by a clearly defined structure that promotes such chains.

In conclusion, this study reinforces other studies on the subject that show that efficiency in SFSC is not only economic, but also social, given the proximity and reciprocity between producers and consumers, cultural due to the appreciation of the local, and also environmental, especially when it comes to the organic system given the sustainable and conscious production of this system. It also contributes to the understanding of the dynamics of SFSC in family farming, emphasizing the importance of the organic production system. Furthermore, this study indicates the need for measures designed to promote efficiency and sustainability in the identified production systems, benefiting producers, consumers, and the environment.

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