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Research Article

Budi Widianarko*, Inneke Hantoro, Novita Ika Putri, Probo Yulianto Nugrahedi

Transforming food systems in Semarang City, Indonesia: A short food supply chain model

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Abstract: Industrialized agro-food supply systems often negatively impact health, social relationships, and the environment. Short food supply chains (SFSCs) have emerged as a sustainable alternative, improving farmers' livelihoods and reconnecting producers with consumers. This study explores the potential of SFSCs to foster a healthier, more inclusive, and sustainable food system in Semarang City, a unique metropolis with significant agricultural characteristics. Specific objectives include assessing SFSC readiness, identifying key commodities and actors, defining success parameters, and proposing an institutional framework. The research employed desk studies and focus group discussions, utilizing official reports and relevant stakeholders to identify relevant components. Findings indicate Semarang City's readiness, as evidenced by an increase in farmer groups (FGs) (371 in 2017 to 406 in 2021) and urban farming initiatives (8 in 2015 to 113 in 2021). Key commodities include vegetables, fruits, cereals, and tubers, distributed through various channels like bazaars and e-commerce. Success relies on quality, consistency, market access, technology, government support, institutional strength, and consumer education. Challenges such as surplus harvests, logistical inefficiencies, and systemic barriers require stakeholder collaboration. Institutional models suggest FGs for market-oriented production and women FGs for community cohesion. Initiatives like farmers' markets and support from farmer-owned enterprises enhance producer-consumer connections. Improving the elements that support short food supply chains (SFSCs) can accelerate the transformation of Semarang's food system. This includes enhancing the city's environmental conditions, providing better nutrition, and encouraging active participation from both farmers and consumers, which in turn strengthens the connection between upstream and downstream processes. At the policy level, this study's results offer a promising framework for transforming Semarang's urban food systems. By utilizing available agricultural land and optimizing quality, market access, and technology, local institutions and government support can be strengthened, while engaging consumers and fostering collaboration to benefit both producers and consumers.

Keywords: short supply chain, food, agriculture, local, Semarang

1 Introduction

Industrialized agro-food supply systems (IAFSS) have demonstrated their effectiveness in providing food for global populations and addressing various food crises. However, these systems have been criticized for their negative impacts on health, social well-being, and the environment [1]. The mass production characteristic of IAFSS tends to favor large-scale agriculture, often at the expense of smallholder farmers, particularly in developing countries.

This conventional food supply chains increasingly conflict with evolving consumer preferences for sustainability and health [2–4]. From the farmers' perspective, while mass production previously offered competitive advantages, it now often results in thin profit margins due to rising costs [5,6]. To address concerns regarding sustainability and food security, alternative food supply systems, such as localized supply chains, have emerged.

Localized supply chains emphasize spatial, economic, and social relocation. Systems like community-supported agriculture aim to tackle sustainability challenges and improve farmers' incomes [6–8]. Short food supply chains (SFSCs) have gained attention as a promising alternative to IAFSS due to their sustainable nature, their potential to enhance farmers' livelihoods, and their ability to reconnect food producers and consumers [1].

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SFSCs have garnered attention as a promising alternative due to their sustainable nature and potential to enhance farmers' livelihoods by reconnecting food producers and consumers. According to the United Nations, two-thirds of the global population is projected to live in urban areas by 2050, consuming 75% of natural resources and contributing 60–80% of global greenhouse gas emissions [9]. Ideally, cities should not only consume resources but also produce a portion of their own food needs.

Semarang presents a unique opportunity for studying urban food system transformation, given its significant agricultural presence. Unlike other major cities in Java, Semarang retains a distinctive agricultural character [10]. However, between 2012 and 2017, the proportion of farmers and agricultural laborers in Semarang's workforce declined from 6.6 to 2.7%. This trend underscores employment challenges in the agricultural sector, pushing Semarang to adopt localized supply chains to improve urban farmers' livelihoods and attract younger generations to agriculture.

Furthermore, the growing connectivity among cities in Java has spurred a sharp rise in tourism in Semarang, with tourist numbers reaching 5,343,151 in 2022 – more than 100% increase compared to 2021. Consequently, the hospitality sector, encompassing accommodation and food services, has become Semarang's second-fastest-growing industry in 2022 [11]. A strategic opportunity exists to synergize the tourism, hospitality, and agriculture sectors, positioning Semarang as a foodscape – a city characterized by its diverse food outlets, ranging from street vendors to upscale restaurants and traditional culinary establishments [12].

Embracing the foodscape concept would enhance Semarang's status as a sustainable and eco-friendly culinary tourism destination. Developing localized supply chains could strengthen the hospitality sector and, more broadly, the tourism industry. This justification aligns with the findings of the sustainable healthy and inclusive food system transformation (SHIFT) study [10].

One of the SHIFT study's recommendations is a vision for transforming Semarang's food system: "To become a city that produces food to meet part of its own needs through the application of inclusive smart agricultural technologies, based on education and literacy, and supporting a circular economy" [10]. This vision aligns with the potential of localized supply chains in transforming Semarang's food system. Based on production data and consumption surveys, these chains show significant potential, particularly for rice, vegetables, and fruits like papayas and bananas [11].

Cities worldwide are increasingly adopting food system transformations through innovations aligned with sustainability principles. Sustainable urban food systems are becoming a critical goal for cities globally, recognized by both the scientific community and urban policymakers [13]. Understanding the imperative of transitioning urban food systems toward sustainability is vital today [9,14–16].

Research interest in alternative food systems has grown recently, with case studies highlighting their potential social and economic impacts. Key actions to ensure SFSC success and the barriers to their implementation have been explored from diverse stakeholder perspectives [17–20]. However, most research has focused on developed countries, while studies on alternative systems in developing nations remain limited [21,22].

In developing countries such as Indonesia, the proliferation of IAFSS has frequently disrupted traditional food networks, fragmenting – and in some cases eradicating – localized supply chains. Therefore, the introduction SFSCs represents a reestablishment of these localized systems, which were predominantly in place before the advent of IAFSS. Nevertheless, reimplementing them requires a systematic transformation to ensure both farmers' welfare and consumers' access to safe and nutritious food. This study positions the development of a localized supply chain model as a critical social innovation to transform Semarang's urban food system and foodscape.

To ensure relevance, such a model must align with the city's unique agricultural potential and address key structural challenges. Specifically, the research aims to (1) assess the readiness for activating localized supply chains in Semarang based on current urban agriculture conditions, (2) identify commodities and stakeholders for involvement, (3) define parameters that align with the transformation of Semarang's urban food system, and (4) recommend an institutional model tailored to the urban agricultural context of Semarang.

2 Methodology

This study employs a two-part methodology: a desk study to explore the existing urban agriculture conditions that support SFSC activation in Semarang City, followed by four sequential focus group discussions (FGDs).

2.1 Desk study

The desk study aimed to identify potential commodities based on literature and official reports on agriculture and food systems in Semarang City. The study primarily utilized data from the Department of Agriculture (*Dinas Pertanian*), the Food Security Agency (*Dinas Ketahanan Pangan*), the Central Statistics Bureau (*Biro Pusat Statistik*)

of Semarang City, and the integrated data portal called *Portal Satu Data Indonesia* of Semarang City. Additionally, this research incorporated findings from the SHIFT project conducted by the research team in 2023 [10].

Among the available resources, the most comprehensive data for this study came from the 2023 Agricultural Statistics Report (*Laporan Pertanian dalam Angka*) published by the Semarang City Department of Agriculture in 2024 [23]. The desk study produced an initial identification of potential commodities, which were further confirmed and refined during FGDs. Simple descriptive statistics, such as range and average, were used to analyze the quantitative data from available statistics and reports.

2.2 FGDs

Data collection from key stakeholders in Semarang City's food system was carried out through four FGDs, each addressing specific research questions related to

i. Identifying potential commodities for SFSCs development.
ii. Determining key stakeholders for SFSCs activation.
iii. Establishing relevant parameters for SFSCs transformation.
iv. Proposing an institutional model for SFSCs.

Each FGD lasted approximately 3 h and followed a structured approach outlined by Rabiee, which uses in-depth group interviews with purposively selected participants to explore specific topics [24]. Stakeholders included government officials, farmer and women farmer groups (WFGs), consumers, food-related businesses, academics, and non-governmental organizations. They were selected based on their expertise and previous involvement in related studies such as SHIFT [10,25,26].

The discussions were facilitated by a researcher familiar with the study objectives and discussion questions to ensure the session's effectiveness [27]. Before the discussions, the facilitator provided an overview of the study's background, significance, objectives, and specific aims for each FGD, presenting the questions to be discussed [27,28]. Discussions on each question continued until responses reached saturation.

Consent: Stakeholders participated in consecutive FGDs following formal invitations, ensuring their consent to be interviewed and share their opinions. Before each FGD, participants were reminded to consent by reviewing the list of questions that would be addressed during the interview. This repeated solicitation of consent was implemented to maintain ethical standards in involving human subjects in the FGDs.

Ethical approval: The methods utilized in this research, which comprised a series of focus group discussions, were thoroughly reviewed and approved by the review team at the Institute of Research and Community Service at Soegijapranata Catholic University. This approval was subsequently endorsed by the Review Team of the Ministry of Education and Culture – Research and Technology, Republic of Indonesia, prior to the ministry's funding decision.

Table 1: List of resource persons in each FGD

FGD 1 Identifying potential commodities	FGD 2 Determining key stakeholders	FGD 3 Establishing relevant parameters	FGD 4 Proposing an institutional model
1. Agriculture Agency 2. Food Security Agency 3. Farmer groups (FGs) (3) 4. WFGs (3) 5. Consumer groups (3)	1. Agriculture Agency 2. Food Security Agency 3. Regional Development Planning Agency 4. FGs (3) 5. WFG (3) 6. Consumer groups (3) 7. Non-governmental organizations (2)	1. Conventional farmers (3) 2. Hydroponic farmers (3) 3. Retailers (2) 4. Food service entrepreneur (1) 5. Consumer groups (3)	1. Agriculture Agency 2. Food Security Agency 3. Department of Health 4. FGs (3) 5. WFGs (3) 6. Consumer groups (2) 7. Food enterprises (3) 8. Academics (2) 9. Farmer groups (3) 10. Woman farmer groups (3) 11. Consumer groups (2) 12. Food enterprises (3) 13. Academics (2)
Total = 11 persons	Total = 14 persons	Total = 12 persons	Total = 16 persons

2.2.1 FGD 1: Identifying potential commodities

FGD 1 was conducted on September 25, 2024, in the conference room of the Fransiskus Asisi Building, SCU BSB City Campus, involving 11 key stakeholders (Table 1). The primary objective was to identify commodities suitable for SFSC transformation in Semarang City.

Discussion questions were as follows:

i. For consumers

- What types of fruits, vegetables, tubers, and cereals do you most frequently purchase?
- Among these products, which are most easily available fresh?
- At what price range do you typically buy these products, and where can they be found at the lowest price?
- What are your opinions on locally produced fruits and vegetables?

ii. For producers

- What fruits, vegetables, tubers, and cereals are most commonly produced by farmers? What is the market reception, challenges, and opportunities for cultivating these commodities?
- At what price do farmers typically sell their harvested products?
- Who are the key players involved in selling products from farmers to consumers?
- At which stages do commodities risk quality degradation, leading to price reductions?

iii. For local government departments/organizations

- What types of fruits, vegetables, tubers, and cereals are most produced and consumed in each district of Semarang City?
- Are there any sales to other cities or regions?
- Which districts have the highest production levels of vegetables, fruits, cereals, and tubers in Semarang City?

iv. For all participants

- Among the listed products, are there any that are particularly susceptible to damage during distribution? If so, how much of these products are typically rendered unsellable?
- What happens to surplus harvests that exceed market demand and remain unsold?
- Conversely, what actions are taken when harvest yields are insufficient to meet market demand?
- Why do imbalances between supply and demand occur?

2.2.2 FGD 2: Determining key stakeholders

FGD 2 was conducted on September 25, 2024, in the conference room of the Fransiskus Asisi Building, SCU BSB City Campus, involving 14 key stakeholders (Table 1). The purpose was to identify stakeholders who can participate in transforming Semarang's food system and define their respective roles.

Discussion questions were as follows:

- What roles are required for establishing an SFSC for local fruits and vegetables in Semarang City? How important are each of these roles?
- Based on these roles, who are the key stakeholders that can be involved in developing an SFSC for local fruits and vegetables in Semarang City?
- Why are these stakeholders essential for forming the supply chain?
- What role should the government (city authorities/departments) play in supporting the establishment and operation of a well-rounded SFSC?
- What role should NGOs play in supporting the establishment and operation of a well-rounded SFSC?
- How can consumer groups contribute to supporting the establishment and operation of a well-rounded SFSC?
- What additional support (prerequisites and requirements) is needed to ensure the successful implementation and operation of an SFSC in Semarang City?

2.2.3 FGD 3: Establishing relevant parameters

FGD 3 was conducted on November 6, 2024, in the conference room of the Fransiskus Asisi Building, SCU BSB City Campus, involving 12 relevant stakeholders (Table 1). The objectives of this FGD session were (1) to describe existing SFSCs in Semarang City, (2) to identify factors supporting the realization of an ideal SFSC, (3) to seek recommendations for strengthening existing SFSCs, and (4) to identify alternative SFSC models based on farmers' and consumers' perspectives.

Discussion questions were as follows:

- For producers: How and where are your agricultural products marketed? Can you describe the current supply chain involving your activities?
- For buyers and traders: How and from where do you source the agricultural products you need? Can you describe the current supply chain involving your activities?
- Do you think existing SFSCs are ideal? What are their strengths and weaknesses?
- What are the existing supply chain pathways for the identified commodities, from producers/farmers to end consumers?
- What are the main barriers to increasing direct sales from farmers/urban agriculture to consumers through SFSCs?

– What factors discourage consumers from purchasing products directly from local farmers?
– What types of support do you expect from the government, local communities, and organizations to ensure the success of SFSCs in Semarang City?
– What role do you think technology (e.g., online platforms) can play in facilitating the adoption of SFSCs?
– What approaches should be taken toward consumers and producers in Semarang City to ensure the smooth implementation of SFSCs?
– What are your expectations regarding the quality, price, and availability of local commodities if SFSCs are implemented?

2.2.4 FGD 4: Proposing an institutional model

FGD 4 was conducted on December 19, 2024 in the conference room of the Fransiskus Asisi Building, SCU BSB City Campus, involving 16 relevant stakeholders (Table 1). The objective was to refine the SFSC model based on feedback and finalize recommendations for initiating SFSC implementation.

Discussion questions were as follows:

– For initiating SFSCs in Semarang City, what are your thoughts on starting with fruits (melon, papaya), vegetables (oyster mushrooms, hydroponic vegetables), cereals (rice), and tubers (sweet potatoes) identified in previous FGDs? Do you have any additional ideas?
– What is your opinion on the supply chain models developed in earlier FGDs? Which model do you think is most feasible in terms of market potential, technical ease, and replicability for the specified commodities?
– What factors act as barriers or enablers for the implementation of the SFSC model discussed earlier?

These FGDs provided the foundation for actionable insights into the development of a comprehensive SFSC model tailored to Semarang City's unique urban agricultural and economic landscape.

To ensure that FGD 1 effectively identifies potential commodities, the views of the local government were represented by senior officials from the Agriculture Agency and the Food Security Agency. Farmer perspectives included two male farmers, three female farmers in their 50 s, and a young farmer in his mid-20s. Consumer groups were represented by three individuals aged 30–40.

For FGD 2, aimed at determining key stakeholders, local government input was provided by senior officials from the Agriculture Agency, the Regional Development Planning Agency, and the Food Security Agency. Farmers included two males, three females in their 50s, and a young farmer in his mid-20s. Non-governmental organizations and consumer groups were each represented by three individuals aged 30–40.

In FGD 3, which seeks to establish relevant parameters, both conventional and hydroponic farmers contributed views through three participants in their 50s and three in their 20s–30s, respectively. Retailers were represented by managers from a hypermarket and a wholesale fruit shop, along with one food service entrepreneur and three consumer group members aged 30–40.

FGD 4 aims to propose an institutional model for the short food supply chain (SFSC) in Semarang City. Government perspectives were provided by senior officials from the Agriculture Agency, the Regional Development Planning Agency, the Health Agency, and the Food Security Agency. Farmers included two males, three females in their 50s, and a young farmer in his mid-20s. Additionally, three food service entrepreneurs and two consumer group members aged 30–40 participated, with two academics also agreeing to join FGD 4.

To ensure that the FGD 1 meets its objective of identifying potential commodities, the local government's views were represented by senior officers from the Agriculture Agency and the Food Security Agency. Additionally, the perspectives of farmers were represented by two male farmers, three female farmers in their 50s, and a young farmer in his mid-20s. Consumer groups were represented by three individuals in their mid-30s to mid-40s.

To ensure that FGD 2 meets its objective of determining key stakeholders, the local government's views were represented by senior officers from the Agriculture Agency, the Regional Development Planning Agency, and the Food Security Agency. Farmers' perspectives were provided by two male farmers, three female farmers in their 50s, and a young farmer in his mid-20s. Non-governmental organizations and consumer groups were each represented by three individuals in their mid-30s to mid-40s.

For FGD 3, which aims to establish relevant parameters, the views of both conventional and hydroponic farmers were represented by three individuals in their 50 and in their 20s–30s, respectively. Retailers were represented by managers of a hypermarket and a wholesale fruit shop. Additionally, one food service entrepreneur and three members of consumer groups in their mid-30s–40s participated in FGD 3.

FGD 4 aims to propose an institutional model for SFSCs in Semarang City. The government perspective was represented by senior officials from the Agriculture Agency, the Regional Development Planning Agency, the Health Agency, and the Food Security Agency. Farmers contributed valuable insights, including two male farmers, three female farmers in their

50s, and a young farmer in his mid-20s. Additionally, three food service entrepreneurs and two consumer group members in their 30–40s participated in the discussion. Two academics in their 60s also agreed to join FGD 4.

2.3 Data collection and analysis

Information exchange during each FGD was documented in two formats: audio recordings and written notes. The notes were prepared by three researchers with Master's and Doctoral qualifications, assisted by four senior undergraduate research assistants. The audio recordings were transcribed and aligned with the written notes to ensure accuracy and completeness.

The FGDs were designed to facilitate an in-depth exploration of SFSC topics in Semarang City and to identify specific issues, opportunities, and challenges related to the research topic [27]. The collected data were analyzed by focusing information on specific objectives of each FGD and, more broadly, the overarching research goals [24]. The qualitative data derived from FGDs were analyzed through a structured, iterative process aligned with the study's objectives and the principles of thematic analysis.

Given the exploratory nature of the research, the Scissor-and-Sort technique [27], a manual, inductive method, was used to categorize and interpret participants' responses flexibly while ensuring reliability. The analysis proceeded through four phases:

2.3.1 Familiarization and transcription review

Raw audio from FGDs was transcribed verbatim for accuracy. Transcripts underwent multiple reviews to fully engage researchers with the data. Annotations highlighted patterns, contradictions, or emphatic statements pertinent to the study's objectives. To improve reliability, a portion of the transcripts were independently coded by two researchers, resolving discrepancies through discussion.

2.3.2 Coding and categorization

The analysis employed two qualitative coding techniques, i.e., open coding and axial coding, to systematically categorize and interpret the data. Open Coding: Text segments received descriptive codes that mirrored their content (e.g., "market barriers" for farmers' challenges). Axial Coding: Codes were grouped into broader categories (e.g., "institutional constraints," "agricultural capacity") to identify recurring themes linked to the study's objectives. A codebook documented definitions and decision rules for consistency.

2.3.3 Cutting, sorting, and thematic mapping

Coded excerpts were categorized thematically using affinity diagrams, revealing relationships between categories (e.g., intersections of "institutional constraints" and "agricultural capacity").

Themes were iteratively refined, discarding redundant categories to focus on dominant patterns aligned with research goals.

2.3.4 Interpretation and triangulation

Findings were interpreted within the theoretical framework and local context (e.g., urbanization, agricultural policies). Validity was enhanced by triangulating results with secondary data and member-checking with FGD participants. Finally, themes were synthesized and mapped to the study's objectives to inform actionable recommendations for the institutional model and priority commodities in Semarang City.

3 Results

The synthesis of findings from the desk study and FGDs is presented in this section. The sequential nature of the FGDs, with closely related topics and a largely consistent group of participants, allowed for clear patterns to emerge. Many participants repeated similar information, indicating data saturation [24]. The results are structured according to the study's four research objectives: (1) readiness for activation, (2) commodities and stakeholders, (3) parameters, and (4) institutional models.

3.1 Readiness for SFSC activation

The number of farming enterprises in Semarang has been increasing. Between 2017 and 2021, the number of FGs grew from 371 to 406 [10]. Similarly, the membership of urban farming communities surged from 8 members in 2015 to 113 members in 2021 [10].

Based on production data and consumption surveys in the holistic food system assessment (SHIFT) for Semarang,

potential SFSC commodities were identified and categorized into four groups: vegetables, fruits, grains (cereals), and tubers [10]. Key commodities included rice, various vegetables (e.g., water spinach, spinach, lettuce, and eggplant), and various fruits (e.g. papaya, banana, mango, *rambutan,* and durian) [10].

Despite a slight declining trend, rice production has remained stable at approximately 30,000 tons per year since 2019 [23]. Based on the production number, corn is the second most produced grain in Semarang. Semarang has consistently produced around 2,000 tons of corn annually since 2019 [23]. Desk study also reveals that 11 types of seasonal vegetables are produced in significant quantities in Semarang. The vegetables are listed in Table 2 ranking from highest to lowest production volume in 2023.

These findings demonstrate that Semarang possesses the foundational readiness to activate SFSCs, supported by a growing number of farming enterprises and urban farming communities, as well as diverse and consistent agricultural production. This readiness aligns with the identified priority commodities that form the core of the city's food supply chain transformation. As an example, rice produced by one of the FGs, *Sumber Rejeki* FG, reached the consumers through three supply chains, i.e., (1) direct from farmer to consumers that live in Purwosari Village, Mijen District, Semarang, (2) through bazaar held by various organizations, and (3) through retailers who bought from the Toko Tani. Toko Tani is an e-commerce platform accommodating business to business transaction developed by the Department of Agriculture to shorten the supply chain of rice [29]. Through Toko Tani, rice from Sumber Rejeki farmer group also reached outside of Semarang. Another example is vegetables from Dahlia, a WFG, reached the consumers through two chains, i.e., directly to the consumers (villagers in Pedalangan, Banyumanik District) and through Arjuna vegetable shop, which has a contract with the WFG.

Table 2: Production of vegetables in Semarang (ton/year)

No.	Vegetable type	Annual production (ton/year)
1	Oyster mushroom	474.1
2	Water spinach	251.5
3	Long bean	237.9
4	Thai chili (cabbage variety)	227.7
5	Eggplant	211.6
6	Tomato	75.1
7	Cucumber	31.0
8	Spinach	31.0
9	Shallots	25.6
10	Mustard greens (Sawi)	20.0
11	Curly red chili (Cabai Keriting)	17.6

Source: Pertanian Dalam Angka 2023, Agriculture Agency of Semarang.

3.2 Commodities and stakeholders

Urban agricultural commodities are generally categorized as organic or non-organic. In the fruit sector, Semarang has been producing various types, including melons, papayas, and watermelons. However, certain commodities, such as crystal guava and bananas, face cultivation challenges, particularly due to plant diseases.

In the vegetable sector, Semarang exhibits substantial production, with key commodities including water spinach, chili, tomatoes, and oyster mushrooms. Accurate data collection on production is difficult due to the short lifecycle of these crops and the diversity in land size and distribution of urban farming plots owned by local residents. For grains, rice and corn remain the primary commodities. Additionally, there are ongoing pilot efforts to cultivate biosaline rice in brackish coastal lands in Semarang.

Based on the discussion outcomes, it was agreed that the development of SFSCs should not be limited to specific commodities. The selection of commodities should be localized, aligned with regional characteristics – considering both cultivation potential and market demand – as well as local farming practices, technological capacity, and existing expertise.

The actors identified as playing a critical role in the urban agricultural supply chain in Semarang include farmers, distributors, and the government. These three actors are key to developing an efficient and sustainable food supply system in Semarang. Additionally, there is a growing recognition of individual entrepreneurs, particularly from the younger generation with sufficient educational backgrounds, who are professionally engaging in urban agriculture.

To empower FGs and WFGs, as well as urban farmers in general, the government is expected to play a role in setting minimum selling prices as an alternative to input subsidies. Moreover, the government should ensure the absorption of urban agricultural products. Government intervention is deemed essential to stabilize prices and support farmers in mitigating the risks of financial losses.

Synthesis of desk research and FGDs reveals significant agricultural expansion in Semarang between 2017 and 2021. Key findings include a 9.4% rise in registered FGs and a remarkable 1,313% surge in urban farming participation. Both methods identified rice, water spinach, and fruits as staple commodities, but diverged in their emphasis

on vegetables. Desk research highlighted specific leafy vegetables, whereas FGDs prioritized chili, tomatoes, and oyster mushrooms. Similarly, while rice and corn were consistently recognized as core grains, vegetable selection strategies lacked consensus. Common challenges included data inconsistencies, pest outbreaks, and disease management. Supply chain strategies also differed: desk research cited digital platforms like Toko Tani as successful models, while FGDs advocated for regionally tailored distribution systems.

Rice, stabilizing at approximately 30,000 tons annually since 2019, and corn, at around 2,000 tons per year, are vital for local food security and demonstrate the city's agricultural strength. Rice's consistent production underscores its role as a household staple and cash crop, bolstered by platforms like Toko Tani that improve market access and price stability. Local expertise in irrigation and pest management further enhances rice cultivation, allowing farmers to balance subsistence and commercial needs.

3.3 SFSCs parameters

Several farmers face challenges in marketing their harvest, particularly during peak harvest periods when overproduction occurs. Unsold produce is often sold at lower prices to vendors, while the surplus is processed into other products. The price disparity between local markets and larger marketplaces also presents a challenge, particularly for products that fail to meet quality standards.

Imbalances between supply and demand frequently disrupt the stability of food supply chains. Maintaining consistent production is crucial for attracting buyers, such as businesses in the hotel, restaurant, and café (HoReCa) sectors. Irregular and unpredictable harvests make it challenging for distributors to collaborate with farmers to meet market demands.

A representative from the Sumber Tani farmer group highlighted the importance of economic institutions in shaping local food systems. Administrative barriers often impede farmers' access to more efficient markets. The representative proposed the establishment of local institutions to assist with data management and regulations, which would support agricultural development policies and enhance government involvement in food supply chains.

One of the recommendations that emerged from the FGDs is to establish urban agriculture clusters based on regional zones. These clusters can aggregate farmers' production capabilities, improving continuity and production volumes. Institutions such as Farmer-Owned Enterprises could act as hubs within these clusters, as demonstrated by PT. Lumpang Semar in Semarang, an enterprise which successfully consolidated rice production from local farmers.

The owner of Sandi Buana Farm, an urban farming entrepreneur, highlighted the high demand for rice and catfish, which is constrained by productivity and operational costs. He emphasized that conventional farmers often struggle to meet the quality standards and supply continuity required by modern retail environments. Despite innovations in hydroponic cultivation, supply uncertainty remains a significant obstacle in securing long-term contracts with retailers.

A representative from Indogrosir, a company with chains of retail and wholesale stores, shared insights into the provision of local products and their economic benefits, which not only support regional economies but also meet consumer demand for fresh and high-quality goods. However, he noted challenges in maintaining consistent quality from local farmers, which necessitates improved logistics and better storage solutions. Without clear regulatory guidelines, retailers are often reluctant to source local products, highlighting the need for coordination between government bodies and agricultural producers.

From the retailer's perspective, a representative from *Istana Buah* underscored the challenges of obtaining consistently high-quality local products, often leading to reliance on imports. She pointed to high demand for ready-to-eat products, such as California papayas, and noted that the short shelf life of certain products requires an efficient supply chain. Participants agreed that local production is essential for meeting the demand while maintaining quality, though logistical challenges remain a major barrier.

A representative from Svarnaloka, a non-government organization, expressed concerns about consumer preferences and suggested the need for greater education on the benefits of locally produced food. She proposed community initiatives to promote local products, which could shift consumer habits and increase demand for regionally sourced food.

Based on the series of FGDs, several parameters have been identified as critical for the success of SFSCs:

i. Quality and consistency: Most farmers lack the resources and technology needed to ensure consistent product quality. This limits their competitiveness in modern retail markets, where consumers expect high standards.
ii. Market access: Conventional farmers face significant barriers to accessing retail spaces, especially due to stringent quality requirements and the need for consistent product supply. Without appropriate support, it is difficult for them to penetrate wider markets.
iii. Technology: Investments in modern agricultural technologies are essential for improving productivity and

quality. Sorting, grading, and quality control tools can enhance product consistency. Additionally, digital solutions such as blockchain can improve supply chain transparency and efficiency, with smart contracts simplifying transactions and fostering trust between producers and consumers.

iv. Strengthening local institutions: Establishing agricultural cooperatives and local institutions can streamline administrative processes and improve market access for farmers. Policies prioritizing the promotion of local products and financial support for infrastructure, such as storage and transportation facilities, are vital for enhancing farmers' bargaining power and productivity.

v. Government support: Stronger government support is urgently needed to boost agricultural productivity and improve market access. Local authorities should actively bridge the gap between producers and consumers by creating supportive policies, offering financial incentives, and facilitating farmers' access to modern retail sectors.

vi. Consumer engagement: Public initiatives that educate consumers about the benefits of local products can increase demand for regionally sourced food. Strategies such as clear product labeling and educational campaigns can strengthen local food supply chains and support sustainable farming practices.

vii. Collaboration: Encouraging partnerships among local stakeholders – including farmers, retailers, government bodies, and academic institutions – is key to building a resilient food system. Collaborative efforts ensure that resources are shared effectively, and challenges in production, distribution, and consumer education are addressed in a coordinated manner.

These parameters underscore the multifaceted approach needed to develop robust and sustainable SFSCs, ensuring both economic and social benefits for all stakeholders involved.

3.4 Institutional model

The phenomenon of existing SFSCs in Semarang City has been clearly identified. Several FGs and WFGs involved in urban farming have successfully marketed their produce directly to local residents and, when production volumes are sufficient, through distributors.

The challenges faced by urban farming operations differ between the FG and WFG. FGs are generally more market-oriented, focusing on cultivating specific commodities such as rice (including organic rice), Hawaiian papaya, melons, and edamame. They are better prepared to partner with distributors who act as intermediaries between them and consumers or retail businesses (e.g., fruit and vegetable vendors). On the contrary, WFGs tend to grow a wider variety of commodities at smaller amounts due to limited land availability and community needs. On smaller plots, WFGs cultivate diverse vegetables, fruits, and herbs. Their focus lies more on community engagement through farming activities and self-produced healthy food consumption. Nonetheless, some WFGs have generated benefits through social and recreational activities.

From the perspective of producers, the food supply chain in Semarang is complex and multifaceted, with farmers playing a crucial role. The Director of the farmer-owned enterprise shared insights into their operations, which facilitate the buying and selling of agricultural products through a network of food reserve or *lumbung*. Currently, 102 lumbung are operational across Semarang. However, significant challenges remain in engaging local governments and communities to optimize the effectiveness of these systems.

In addition to FG and WFG, urban farming initiatives led by young entrepreneurs are pivotal in transforming food systems. These ventures are more adaptive to market challenges and consumer demands. Several young urban farming practitioners have successfully addressed key parameters for success in their operations. For instance, the owner of Sandi Buana Farm identified systemic barriers in urban farming, such as the separation of roles between producers and distributors due to financial and technical constraints, including business management, financial planning, and marketing. He emphasized the need for robust management systems to support farmers in overcoming these challenges and ensuring more effective connections between production and distribution.

A representative from Agriculture Agency of highlighted ongoing initiatives aimed at shortening supply chains, such as the establishment of farmers' markets that enable direct transactions between producers and consumers. These initiatives are critical for enhancing access to local food and fostering closer relationships between farmers and the communities they serve.

4 Discussion

While IAFSS are highly effective in ensuring food supply, they often overlook social impacts and sustainability concerns [1]. In Semarang, there is a significant opportunity to transition into a more sustainable SFSCs due to the prevalent agricultural activities [4]. SFSCs emerge as a promising alternative, driven by increasing consumer awareness of

sustainability and health [6]. For consumers, SFSCs become a preferable alternative to the long supply chain, as reported in a study from Spain, where product quality and welfare of food producer become the focus [30]. SFSCs support the livelihoods of urban farmers and strengthen connections between producers and consumers [8].

Data indicate a decline in the proportion of farmers in Semarang, highlighting labor issues in agriculture. Consequently, developing SFSCs become critical for improving farmer welfare and attracting younger generations to farming. Despite this, the number of farming enterprises in Semarang appears to be increasing [10]. Similarly, the membership of urban farming communities is growing [10]. Furthermore, the rising number of tourists visiting Semarang and the expansion of the hospitality industry create opportunities for synergy between tourism and agriculture [31].

Semarang holds great potential to implement SFSC models, particularly in the production of rice, vegetables, and fruits. Recommendations from the SHIFT study emphasize the need for an inclusive and technology-driven food system transformation. By promoting local products through SFSCs, Semarang can strengthen its position as a sustainable culinary destination while supporting a circular economy [10].

On a global scale, research on SFSCs has demonstrated positive social and economic impacts, though attention has been mostly concentrated in developed countries [21,22]. In developing countries like Indonesia, reintroducing SFSCs requires a systematic approach to balance farmer welfare with consumer needs for nutritious food. Thus, social innovation through SFSC models in Semarang could transform the food system and create a better "foodscape."

The food supply chain in Semarang reveals significant complexity, with farmers as key actors within a system involving diverse groups, including farmers groups, women farmers groups, farmer-owned enterprises, and young entrepreneurs. A study by Acella et al. on 20 cases reveals similar diversity and complexity, both in the dimension and organization of the SFSCs [32].

The presence of SFSCs in Semarang reflects efforts to improve access to local food and foster closer relationships between producers and consumers [1,3]. Product quality and consistency are critical factors for the success of SFSCs. Despite the potential of SFSCs to improve sustainability and farmer livelihoods in Semarang, persistent quality control challenges hinder progress. Many smallholder farmers lack access to post-harvest technologies (e.g., cold storage, sorting tools) necessary to meet retail standards, leading to inconsistent product quality and exclusion from formal markets [33]. Huang and Wang found that limited access to modern technology hinders farmers' ability to meet retail market standards [34].

Therefore, investments in training and technology are essential for enhancing the competitiveness of local products. The importance of agreement on food quality perception between producer and consumer were also emphasized on the study of Acella et al., which demonstrate differences between them on the 20 cases in Europe [32].

Market access poses a major challenge for local and small-scale farmers. According to Biénabe et al., local farmers often struggle to access retail spaces due to stringent quality requirements [35]. In Semarang, appropriate support from government and local institutions is crucial to help farmers penetrate wider markets. Initiatives such as government-led farmers' markets represent a positive step toward improving accessibility.

Investments in modern agricultural technology are key to improving productivity and quality. Nazarov et al. noted that using advanced sorting and quality control tools can enhance product consistency [36]. Furthermore, digital technologies like blockchain can improve supply chain transparency, streamline transactions, and build trust between producers and consumers [37].

Strengthening local institutions, such as agricultural cooperatives, can simplify administrative processes and improve market access. Policies supporting the promotion of local products are vital. Research by McElwee and Annibal and Purnawan et al. highlight that financial support for infrastructure, such as storage facilities, can enhance the productivity and competitiveness of local farmers [38,39]. Another study by Pato demonstrates the importance of marketing strategy and good communication between the producer and consumer [40].

Stronger government support is urgently needed to boost agricultural productivity. Government policies, while aiming to modernize agriculture, often prioritize compliance over capacity-building, disproportionately marginalizing resource-limited farmers [41]. According to a report by FAO and IFPRI, governments must play an active role in creating supportive policies, providing financial incentives, and facilitating farmer access to modern retail sectors [42]. Government involvement in developing SFSC-focused policies will significantly contribute to the success of local food systems.

Educating consumers about the benefits of local products is vital to increasing demand for locally sourced food. Research by Ma and Chang in Taiwan shows that clear labeling and educational campaigns can strengthen local food supply chains [43]. Consumer engagement in supporting local products is critical to the sustainability of food systems.

Collaboration among local stakeholders – including farmers, retailers, government, and academic institutions – is key to creating a resilient food system. Gajdić et al.

demonstrated that collaborative efforts ensure effective resource sharing and address challenges in production and distribution in a coordinated manner [44].

5 Conclusion

The presence of SFSCs in Semarang has been clearly identified, involving various stakeholders such as FGs, WFGs, farmer-owned enterprises, and young entrepreneurs. The regular operation of farmers' markets represents a promising initiative to shorten the food supply chain in Semarang, which should be further developed. The local food system and SFSCs in Semarang hold significant potential for growth through collaboration among producers, consumers, academics, and government entities.

Seven parameters have been identified as key determinants for the success of SFSCs in Semarang: quality and consistency, market access, technology, strengthening local institutions, government support, consumer engagement, and collaboration. Additionally, systemic barriers such as the separation of roles between producers and distributors in urban agriculture must be addressed. By optimizing these seven parameters and eliminating systemic obstacles, an effective framework can be established that benefits both producers and consumers within the SFSC system.

Lessons from Semarang present a significant opportunity to transform the local food system by actively engaging diverse stakeholders, including farmers and young entrepreneurs. To capitalize on this success, we propose piloting the SFSC model in other cities across Java, focusing on optimizing key parameters such as quality, market access, and technology.

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