Sentinels of Sustainability: Practices of Agricultural Farms Clustered in Hungary's Farmers' Markets

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The analysis of local farmers' markets (FMs) is an important part of sustainability issues, as the products they offer can guarantee both the proper functioning of local farms and healthy nutrition for inhabitants. The aim of this research is to identify the most important characteristics of FMs small-scale businesses related to agricultural activities based on a convenience sample in Hungary. The database obtained by the questionnaire survey was compiled based on the answers of a total of 220 farm owners/managers. The results were subjected to analysis using a K-means clustering method, which identified four distinct groups of farms with the highest weighting of turnover from agricultural activity. The clustering distinguished beekeeping, arable crop production, animal husbandry, and vegetable and fruit production, which were treated as a separate cluster. The observed differences between the groups indicate that farms primarily engaged in beekeeping and livestock farming have the highest turnover. These findings may be manifested by the group's member farms in terms of higher professional representation and high-quality products. A noteworthy distribution-related finding is that livestock products exhibit the greatest average distance from the point of origin to the FM, which can be attributed to the sparse geographical location of the production sites. The results could have a considerable consequence for policymakers in informing them about the design of support opportunities and the identification of beneficiary groups.

1. Introduction

With the rise of intensive production methods and traditional agriculture, small-scale producers have been increasingly excluded from the central arena of trade and production has been concentrated in the larger market players. This has increased the physical distance between producer and consumer, with many actors involved in the value chain, creating sustainability problems. However, agricultural production is inseparable from sustainability (Koltai and Gombkötő, 2023). Short Food Supply Chains (SFSCs) provide solutions to many problems. They reduce the physical distance between producers and customers and, unlike long supply chains, often integrate personal connections as a guarantee for quality, trust and organic qualification in the system, especially for locally produced products mainly made from natural resources (Réthy and Dezsény, 2013). According to Benedek (2014), this term covers a wide range of marketing/supply channels. Generally, the geographical, social and cultural distance between producers and consumers is typically small, and they often require environmentally friendly production methods. Marsden et al. (2000) emphasise the type of relationship between producers and consumers in these supply chains, stating that these relationships are not only the products themselves but also the role of value and meaning. Renting et al. (2003) also stated that the SFSC concept involves the interrelationship between actors directly involved. In addition, the European Commission's joint research centre developed a common definition of SFSCs based on some decisive literature on the topic: "The foods involved are identified by, and traceable to a farmer. The number of intermediaries between farmer and consumer should be 'minimal' or ideally nil" (Santini and y Paloma, 2013).

The adaptation capability of SFSCs to new situations and consumer needs is rather high. Acella et al. (2024), examining supply chains, found that consumers consider product authenticity as a key criterion and prioritise factors that benefit society when evaluating products. This finding is confirmed by the research of Milford et al.

(2023), which mapped the main motivations for local food production and distribution, with environmental sustainability, community building, supply chain transparency, direct support to farmers, and transfer of knowledge about food and agriculture to consumers as key factors. SFSCs include several distribution channels of which a given producer generally takes advantage of more than one – even conventional – at the same time (Brown and Miller, 2008). Within their research, Martinez et al. (2010) also came to similar conclusions; for the interest of increasing their profits, in many cases, the producers distribute their goods through several channels at a time. Local products are increasingly being marketed not only through direct marketing strategies such as the growing number of farmers' markets (FMs) and various forms of community-supported agriculture, but also through small and large retail stores, from farmers' cooperatives to supermarkets, and through new consumer demand and market potential initiatives (Dunne et al., 2010).

SFSCs have an undeniable role in the promotion and stimulation of the sustainable development of local communities in rural areas (Paraušić et al., 2023). In line with the Sustainable Development Goal (SDG), 2.3 addresses this situation with the aim of improving market access and value-addition opportunities for small-scale food producers as well as family farms, while SDG 2.c intends to secure the correct functioning of food commodity markets (United Nations, 2017). The European Union is also demonstrating a clear intent to continue supporting short supply chains in the Common Agricultural Policy 2023-27 to enhance farmers' position in the value chain and improve long-term food security (European Union, 2021).

FMs could be considered the historical form of SFSCs, and they could be the key to rebuilding local food systems. An FM is generally a temporary or permanent physical marketplace intended to sell goods directly by farmers to consumers. FMs may encourage the production of a greater diversity of products, which would be needed for a more localised food system. This larger diversity attracts a wide variety of shoppers and helps strengthen local farm operations. Economic interactions in FMs are also combined with various social interactions (Brown and Miller, 2008). According to Juhász (2012), although the importance of neo-traditional forms continues to increase, the market is the most essential direct distribution channel for producers in terms of income. The FMs' direct-to-consumer marketing approach allows urban consumers to connect with farmers while shopping for produce and products (Polimeni et al., 2022). This way of selling local products is highly popular among consumers. Wang et al. (2022), analysing their research results, also found that their respondents prefer the FM among SFSCs. In their research, Curtis and Hand (2024) collected and systematised the alternative food movement in the United States and identified 6 main forms of the movement, including FMs. They found their popularity to be unbroken, especially in urban areas.

The dominant role of FMs in the various SFSC solutions for the trade of produced and sold local products in Hungary is undeniable. Like the simplified rules for small-scale production, the conditions for setting up local FMs are less complicated than those for traditional markets. Due to the simplifications, not all requirements for setting up and maintaining local FMs need to be met, but the distance from the market, the products to be sold, and the range of distributors are limited. Thus, in Hungary, as in other Central and Eastern European countries in terms of numbers, traditional SFSC types play a decisive role, particularly the local FMs. The number of such organisations indicates an increasing tendency in Hungary in accordance with their ever-rising role in the trade of local products. Based on the available data it can be concluded that FMs appear in almost all parts of the country, but it is true that it is not prevalent in the most backward regions. Since their legal recognition in Hungary (2012), local FMs have gained momentum, and their number has been increasing year by year. However, the pandemic period temporarily halted the growth trend. In terms of the distribution of the number (307 units in 2023) of FMs, the central region of Hungary (Budapest and Pest County) is the largest, with approximately 20 % of them operating in this area, in line with the distribution of consumers (Hungarian Chamber of Agriculture, 2024).

Based on the relevant literature, the research questions were formulated as follows: What are the characteristics of typically small-scale businesses operating and selling on local FMs, with different activity directions, in the Hungarian agricultural market? What types of future-oriented mindsets can define farmers with different characteristics? The importance of this research direction is reinforced by the fact that the lack of a comprehensive analysis of the definition of characteristics and different future perceptions related to the main agricultural activity is a research gap in Hungarian studies. However, this type of research can provide useful insights and recommendations for policymakers, both in the field of support and contribution. This study attempts to fill this research gap with a properly designed methodology, contributing to the scientific potential of measuring agricultural activities in the framework of FM.

2. Material and methods

The survey was conducted by questionnaire and consisted of two main stages. Statistical analyses were performed using the IBM SPSS Statistics 25 software package. In the first stage of the study, respondents were required to provide answers to 14 items pertaining to the companies in question. These questions were designed

to measure variables on a continuous scale and focused on the age of the owner, the establishment of the company, and questions concerning the operation of the company. Due to the disparate units of measurement utilised by the continuous scales, standard values were applied in the analysis. These variables formed the basis for the subsequent group construction. In the case of a high sample size, the use of the Two-Step clustering method (Artim-Esen, 2014) was recommended. However, the basic idea was to create five clusters, as this was the number of different types of activities (arable crop, fruit, vegetable, livestock, bees) distinguished in the questionnaire. The two-step method was implemented independently of the previous idea, with the objective of grouping the elements of the sample according to their similarity. The method forms sub-clusters in a single run and then gradually reads them into progressively larger clusters using hierarchical clustering to form the recommended number of clusters. The final cluster number was constructed using K-means clustering, which begins with randomly initialising a random cluster centre and then categorises all items to the nearest mean. Subsequently, the average values are continuously updated, and this process is repeated until the final clusters are formed. In the second stage, Likert-scale questions (25 items) were answered, focusing on future goals (e.g., producing high-quality products, supporting the environment by producing local products, using new technologies). The second stage questions were utilised to explore the differences between the groups' thinking about the future, based on the first stage. The paper's underlying premise is that the disparities between the means of the groups formed by K-means clustering can be quantified using HSD statistics. The selected method was Tukey's HSD test, which is well-suited for comparing means between groups within a sample (Toothaker, 1993) by comparing the significance levels resulting from the Likert scale questions that guarantee each mean. The application of this method is recommended for continuous measurement (Sepanek et al., 2022), and for the present study, this should be treated as an analytical limitation due to the ordinal measurement scale of the second stage. The methodology provides an opportunity to determine for which of the established clusters the Likert scale variables in the questionnaire differ significantly from each other.

The objective of this research is to cluster small-scale farmers to identify distinctive features that can be used to inform the implementation of their future plans. This group of farmers was selected for the purposive sample because it represents the most relevant area for selling at FMs. To achieve this, it was relevant to survey the member companies of the Hungarian Chamber of Agriculture (HCA), which, through its members, covers the entire domestic food chain, agricultural production and rural development. The organisation helped distribute the questionnaire in newsletter format to members, who could contribute anonymously by completing the survey. In addition, two other major agricultural institutions were involved, including the Hungarian National Rural Network and the Ministry of Agriculture, which shared the questionnaire with agricultural businesses on social media platforms and websites to reinforce the letter-based solution. The questionnaire was based on a previous survey (Kacz and Varga, 2018), supplemented with minor adjustments and a comprehensive review of the literature. The list of questions was finalised after a pilot survey with 10 respondents in September 2023 to ensure the integrity of the conversions. The questionnaire, which could be completed online via Google Forms, was sent by email to the members of the HCA. The questionnaire was to be completed between October and December 2023. A total of 220 responses were received during this period, which is considered a purposive but reasonable sample for a national survey, although its limitations must be considered. Three main stages of the data cleaning process were carried out: the first stage (exclusion of non-sellers at FMs), the second stage (exclusion of outliers) and the third stage (exclusion of identical responses and sample completions). For the continuous scales, values below 3 and above -3 were excluded from the standardised values due to their significant deviation from the mean. Following the data cleaning process, a sample of 195 respondents was obtained, with a validity rate of 88.64 %. The valid sample size with the relevant settings (f = 0.25; α err. prob.: 0.05; sample size: 195; no. of groups: 4) had 0.838 power, which exceeded the literature suggested value of 0.8 (Brooks and Johanson, 2011) and was deemed acceptable. The gender distribution of respondents revealed that 65.6 % were male and 34.4 % were female. In terms of education, 4.1 % had completed primary education, 50.3 % had completed secondary education, and 45.6 % had completed tertiary education. In terms of age, the youngest respondent was 21 y old, while the oldest was 82 y old. The average age of respondents was 50.09 y. Based on descriptive statistics, sample units with quite different basic characteristics were analysed. The international nature of the research makes regional distribution important, although most responses come from the most agriculturally affected areas: Little Hungarian Plain and Great Hungarian Plain. Approximately 60 % of the responses were provided by owners of companies that were located in the indicated areas of high agricultural intensity.

3. Results

The two-step clustering process identified 3 clusters. However, subsequent research indicated that 4 clusters were more appropriate. (It should be noted that vegetable and arable crops are currently included in one cluster.) The five-cluster solution was also attempted, but the results were not acceptable. Accordingly, the four-cluster

solution was selected for further analysis. The separation of these clusters by F-values was primarily based on the main agricultural activity generating the turnover: Beekeeping (F = 515.49); Fruit production (F = 21.19); Vegetable production (F = 17.14) and Arable crop production (F = 150.63); Animal husbandry (F = 435.87). Consequently, the four clusters were named according to the activity generating the most revenue (Table 1).

Table 1: Clusters formed based on the analysis (standardised values)

Factors	Beekeeping	Arable corps production	Vegetable and fruit production	Animal husbandry
Age of owner	-0,27284	0,67419	-0,25772	-0,45506
Y of foundation	-0,21927	0,70312	-0,43509	-0,45352
Land owned (ha)	-0,34267	0,12107	-0,24311	-0,16735
Size of leased land (ha)	-0,15364	0,05207	-0,13584	-0,07079
Turnover vegetable production	-0,39858	-0,42209	0,49716	-0,45865
Turnover from fruit production	-0,52983	-0,48807	0,48207	-0,53203
Turnover from livestock farming	-0,34687	-0,24790	-0,36028	2,69868
Turnover from beekeeping	2,91503	-0,22581	-0,32758	-0,37388
Turnover from arable crops	-0,66873	1,18207	-0,55672	-0,64469
Farmers' market distances	-0,27087	-0,30994	-0,05952	0,17296

The calibration was conducted using standardised values derived from data collected on a continuous scale. This approach ensures that a value of 0 represents the overall sample mean and that standard values represent the deviation from it. The results of the clustering analysis can be used to develop insights into the characteristics of the sample. The findings indicate that the owners of arable crop production farms are the oldest, and that these farms have been established for the longest time. In terms of land, members of the groups utilize a comparable amount of land. It is also typical for farmers to use their own land rather than leased land. In this respect, beekeepers are a special group, as their activity does not require their own land area. (The positive externalities of this activity mean that farmers welcome bees on their land, in most cases free of charge.) Nevertheless, the results indicate that farmers who are most involved in beekeeping in terms of turnover may, in fact, own land, but in this case, they typically also engage in other types of agricultural activity on this land. The area used for arable land is higher than the sample average, but this is a specific feature of Hungary, where almost 80 % of agricultural land is used for this type of agricultural activity. The distribution of turnover shows that farmers who are in the Arable crop production group do not only generate turnover from this activity but also generate more visible turnover from the other categories (fruit production: 9 %; animal husbandry and beekeeping: 4 - 4 %). In terms of the distance to the FM, it is essential to note that the following order of distance between the groups has been established: Arable crop production (AVG: 37.57 km), Beekeeping (AVG: 41.39 km), Vegetable and fruit production (AVG: 62.04 km), Animal husbandry (AVG: 84.76 km). The sale of animal products (cheese, smoked meat, etc.) occurs within the widest radius because these items have the highest added value during production, allowing their pricing to cover greater transportation distances. Consumers are willing to purchase such products, even at higher prices, because FMs often offer higher quality, less processed items that are typically free from the chemicals and additives used in industrial production. Furthermore, smaller farms often employ more sustainable practices, such as organic farming or free-range animal husbandry, which place less strain on the environment. The products of the first category do not require long-distance transportation due to their national importance (produced in many locations) and the typical assurance of their availability. For fruit and vegetables, long-distance transport is not recommended to preserve freshness and quality. In the case of honey, transportation may be challenging due to the difficulty of storage and movement for the farmer, and it may be advantageous and cost-effective for the farmer to sell at nearby markets. In the context of animal production, the transportation of products (e.g., meat, milk, eggs) is becoming increasingly important for the promotion of a healthy lifestyle and social acceptance. This is due to the growing societal demand for organic products. Consequently, the availability of these products in distant markets is becoming a crucial factor, which may motivate producers to transport them to more distant locations.

In the first stage of the analysis, the potential groupings within the sample were identified. To illustrate the significant differences between the groups, the outcomes of Tukey's HSD test are presented in Table 2. It is noteworthy that no response on the Likert scale of 5 has a mean value below 3. This indicates that all respondents expressed a positive attitude. Nevertheless, there is a discernible discrepancy in the perceptions of ownership between the groups engaged in agricultural activities. The owners of the farms perceived vegetable and fruit production as a more pleasant activity than work with arable crops. This can be explained by the concrete physical embodiment of the work. The respondents perceived arable farming to be more monotonous

than fruit and vegetable production. As Pépin et al. (2022) stated, in general, vegetable farms are typically diverse. However, neither activity can be considered work done under constraint.

Table 2: Tukey's HSD test results (average values)

Factor	Group 1	Group 2
Finding pleasure in work	Vegetable and fruit production (4.47)	Arable crop production (4.02)
Favorable representation of the profession	Vegetable and fruit production (3.86)	Beekeeping (4.72) Animal production (4.67)
Production of high-quality products	Arable crop production (4.17)	Beekeeping (4.89) Animal production (4.90)
Support the protection of environment by producing local products	Animal husbandry (4.71)	Arable crop production (3.86) Vegetable and fruit production (3.90)

In the case of livestock farming, it is worth noting that, according to the owners of most of these farms, this agricultural activity has the highest added value, both in terms of professional representation, quality and environmental protection. This could be due to the increasing global demand for animal products, making it a critical task for governments and society to improve the productivity of animal production. In many countries (especially in the least developed and low and middle-income countries), development policies do not provide equal treatment to livestock producers, making it difficult for them to adopt technological improvements and sustainable production practices (Pradere, 2014). This requires a commitment to basic agricultural activities, but it can also be an important factor in animal production, since selling on local markets does not mean factory farming, but rather the production of small quantities of good quality products, which reinforces a mindset compatible with sustainability. In addition, processed animal products are more durable products, and this type of production is territorially less frequent and more visible agricultural activity than the other groups, so that externalities that are less important for other producers are more important in this form.

4. Conclusions

The results confirm the success of the applied methodology, as 4 significantly distinguishable clusters (beekeeping, arable crop production, vegetable and fruit production, and livestock production) were created by considering the business-specific data of several FMs. These FM operators differed in several characteristics, which allowed to distinguish the dimensions specific to the activities and to identify the directions and attributes associated with the Hungarian-specific FMs. The results of the questionnaire survey should be treated with caution due to its limitations, lack of representativeness, and cross-sectional nature (opinions at one point in time). Although some of the questions were measured on a continuous scale and others on a Likert scale, the farmers' responses to the questionnaire survey cannot be considered generalisable. Consequently, the results are limited in their ability to broaden the perspectives of government decision-makers and help shape agricultural support and assistance programs and policies in line with the real FM framework, but it does provide a new perspective on agriculture. The extension of the research to a larger representative sample should be considered as a future plan, as this would be very important in terms of generalizability. In this context, it would be beneficial also to focus on the consumer side in parallel with the producer side. This could also contribute to a better understanding of the customer expectations of companies and governments towards agricultural activities.

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