Assessment of vegetable production in Ljubljana, capital of Slovenia

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Abstract

With Ljubljana's growing population, the question of how much food can be produced within the city is becoming increasingly important. Effective development of local policies on urban agriculture, sustainable supply chains, and food security requires a clear understanding of the current situation. However, data on self-sufficiency levels for specific agricultural products at the municipal level are not supported by appropriate models or analyses. The aim of this paper was therefore to develop a model and apply a methodological approach to assess the volume of production and the level of self-sufficiency in fresh vegetables in the Municipality of Ljubljana. Based on an adapted national model of production and consumption balances for agricultural products, we estimated average vegetable production for the period 2019–2023. The findings show that Ljubljana achieves around 22% self-sufficiency rate in fresh vegetables, which is below the Slovenian average (56%). The model relies on official data and does not include non-market production from household and community gardens, which supplement local supply but remain unassessed due to data gaps. The findings can serve as a professional basis for developing local policies and measures supporting urban agriculture and local food supply.

INTRODUCTION

Urban agriculture is a modern agricultural practice that encompasses crop cultivation as well as the livestock farming within urban areas with the aim of providing fresh food for the urban population. A key element of urban agriculture is the efficient use of limited urban areas, such as green areas, balconies, rooftops, and abandoned or degraded land, both within city centers and on their outskirts (De Bon et al., 2010; Teoh et al., 2024). Urban agriculture thus also includes farms located on the outskirts of cities that provide food to urban residents and offer various additional services, such as agritourism and the sale of local products (EFUA H2020, 2025). In Slovenia's capital city, Ljubljana, food production on agricultural land remains the dominant form of food provision, with the majority of locally produced food coming from agricultural holdings within the municipality (SRP MOL 2021–2027, 2020). Among crops, vegetable production is the most widespread in urban areas, primarily due to its suitability for small-scale cultivation and high demand for fresh vegetables in urban environments (Orsini et al., 2013; Edmondson et al., 2019).

This form of agricultural production provides numerous benefits, notably improved food security and public health, support for the local economy, social integration, and environmental sustainability. Due to relatively short supply chains, farms on the urban periphery have a competitive advantage over more distant suppliers, contributing to more efficient food provisioning for urban centers (Orsini et al., 2013; EFUA H2020, 2025). Many farms sell their products directly at farmers' markets or through on-farm stores, often complemented by additional activities such as agritourism, food processing, and similar.

Urban agriculture is globally widespread and includes a broad range of agricultural systems, from traditional practices to the most advanced technological approaches. It is estimated that between 25% and 30% of the global urban population is engaged in the agri-food sector (Orsini et al., 2013). Given the rapid trends of urbanization and the growing share of the urban population, which reached 55% of the world population in 2020 and is projected to rise to 60% by 2030 and 70% by 2050 (World Population, 2008), the development of urban food production is increasingly promoted. Following these global trends, data for Ljubljana also indicate continuous population growth (Rebernik, 2004; SURS, 2025).

Since 1945, Ljubljana has experienced dynamic population growth, primarily due to intense migration from rural and less developed areas of Slovenia and the former Yugoslavia. The population of the City Municipality of Ljubljana increased from 123,000 in 1948 to 265,000 in 1981 (Rebernik, 1999). After this period, a policy of polycentric development encouraged the growth of smaller urban and rural areas, thereby slowing migration to cities. As a result, Ljubljana's population growth slowed after 1981, but the city has remained a destination for newcomers. In 2024, the municipality had 297,575 residents, which is 12% more than in 1981 (SURS, 2025). The municipality includes 892 agricultural holdings, mostly located on its outskirts (SRP MOL 2021–2027, 2020). Over the past five years, their number has remained relatively stable despite strong pressures for changes in agricultural land use. These agricultural holdings cultivate just over 11,400 hectares of agricultural land, approximately half of which lies within the municipal boundaries. There are 399 farms with all their agricultural land located entirely within the municipality. About 2,400 hectares of arable land are found within Ljubljana, with around 10% of these areas used for vegetable production. Most vegetables are grown outdoors, with a smaller share produced in protected spaces.

The aim of this paper is to present a methodological approach for estimating the self-sufficiency level of fresh vegetables, using an adapted version of the national model (agricultural production and consumption balances), tailored to the available statistical data for the Municipality of Ljubljana. This represents an innovative approach, as no model for assessing vegetable production and self-sufficiency levels has previously been applied at the municipal level in Slovenia. The obtained results on the vegetable production in Ljubljana can serve as a professional basis for developing strategies to support and strengthen the potential of urban food production beyond traditional farming

systems, including household gardens, community gardens, and cultivation on balconies and rooftops. Comprehensive knowledge of the current situation is a crucial foundation for targeted planning of future urban agriculture measures.

METHODS

There are several possible approaches to estimating vegetable production in the Municipality of Ljubljana. In this paper, however, we present a method based on adapted national production and consumption balance models. Data on production and consumption balances of agricultural products, including vegetables, are collected and compiled at the national level on an annual basis. The Agricultural Institute of Slovenia is responsible for preparing these balances. The models used are based on Eurostat methodology; detailed descriptions of the models can be found in the official documents: Manual to Compile Supply Balance Sheets, Vegetables, 1998, and Production and Consumption Balances of Agricultural Products, 2023. All data come from the Statistical Office of the Republic of Slovenia (SURS). The main data inputs include annual production figures for each agricultural commodity and detailed monthly foreign trade data (imports/exports), from which domestic consumption can be calculated. Based on domestic production and consumption requirements, the self-sufficiency rate is also determined. The model results produced by the Agricultural Institute are submitted to SURS, where the key indicators are used for various purposes such as monitoring market trends, analyzing the structure and development of individual markets, and supporting agro-economic decision-making. One useful and commonly used indicator is the self-sufficiency rate, which shows the extent to which domestic production can cover domestic consumption in the country. A self-sufficiency rate below 100% indicates a deficit and a need for imports, while values above 100% represent a surplus or export potential.

For this study, adapted national models were developed, taking into account the vegetable production areas and the population size within the municipality of Ljubljana. The entire municipal area (275 km²) was considered, not only the settlement of Ljubljana (164 km²). All other input data, such as losses, processing, imports, exports, and other factors, are based on national averages, as such data are not available at the municipal level.

Calculations are based on a five-year average of the most recent available final data (period 2019–2023). Theoretical assumptions about the structure of vegetable production areas in the municipality of Ljubljana (%) and average yields (t/ha) for individual vegetable types, both in open fields and protected spaces, are taken from national averages (see Figure 1). Only those vegetable types for which official yield data exist and which represent at least 1% share in the structure of vegetable production areas were included in the models. Data from long-term series at the Agricultural Institute of Slovenia (KIS) and own calculations based on annual crop production monitoring were also used. Based on these criteria, the model includes 19 different types of vegetables. Strawberries and potatoes were excluded as they are not classified as vegetables and therefore are not part of the national production and consumption balance models for vegetables.

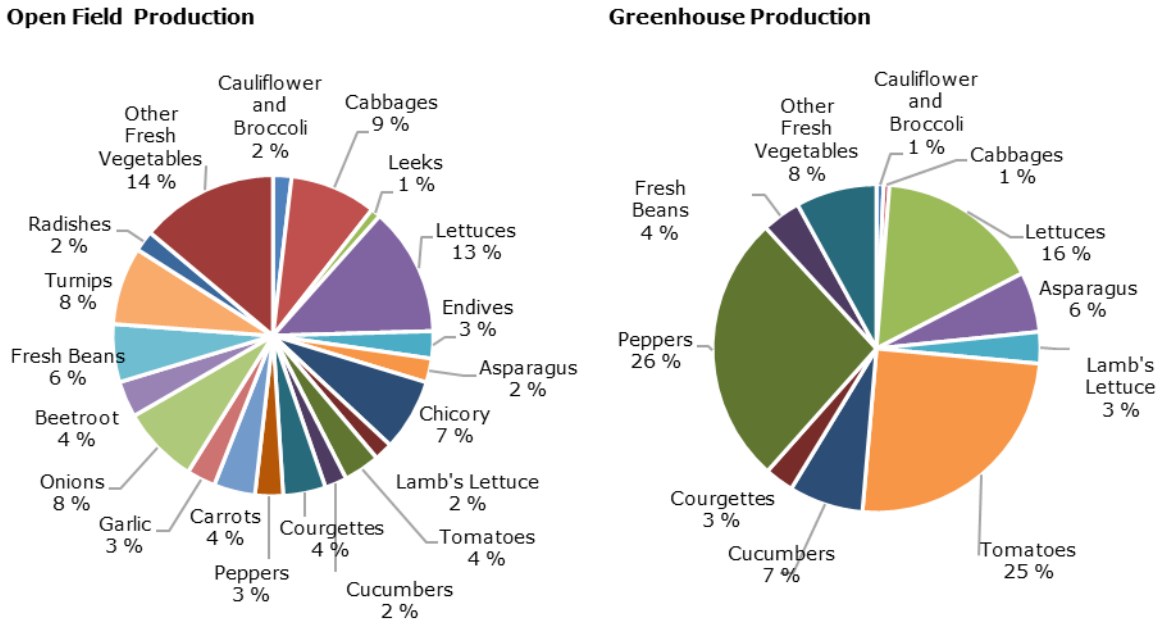

Figure 1. Structure of vegetable production in open fields and protected spaces (%; average 2019–2023)
Source: SURS, KIS databases, KIS calculations

The production and consumption balance model for fresh vegetables grown in open fields includes 19 vegetable types, which together represent 86% of the total vegetable production in open fields. According to SURS data, the area of open fields in the municipality of Ljubljana dedicated to vegetable production is estimated at 274 hectares. Production volume was estimated based on national average yield coefficients, including both market and non-market production (separated by vegetable type and for the group other fresh vegetables).

The model for production in protected spaces includes 17 vegetable types, which together represent 92% of the total vegetable production in protected spaces. According to data, the area of protected spaces dedicated to vegetable production in the municipality of Ljubljana is 16.1 hectares. Production volume was estimated using national average yields for market production in protected spaces (separated by vegetable type and for the group other fresh vegetables).
Using this approach, production volumes (in tons) of vegetables were calculated separately for open fields and protected spaces for the municipality of Ljubljana. In further calculations, instead of the entire population of Slovenia, only the population of the municipality of Ljubljana was considered, calculated as a five-year average for the period 2019–2023. Population data are sourced from SURS.

Results and Discussion

The results of the production and consumption balance of fresh vegetables grown in open fields show that the average annual production of vegetables on fields in the Municipality of Ljubljana during the period 2019–2023 was approximately 4,800 tons, which corresponds to 16.4 kg of fresh vegetables per capita. In the same period, the average annual production of vegetables in protected spaces was just under 1,000 tons, amounting to 3.4 kg per capita. The total annual agricultural production of fresh vegetables in the Municipality of Ljubljana thus amounts to approximately 5,800 tons or 19.8 kg per capita (Table 1). For comparison, the average fresh vegetable production per capita in Slovenia during the same period was 50.4 kg annually.
For assessing food security, the self-sufficiency rate is a more relevant indicator than the volume of production per capita, as it incorporates losses, processing, imports, exports, and other factors. The adjusted national food balance models indicate that the self-sufficiency rate for fresh vegetables in the Municipality of Ljubljana during 2019–2023 was 22.2%, while on the national level it was 55.6% in the same period. This means that Ljubljana reaches roughly 40% of the Slovenian average in terms of fresh vegetable self-sufficiency. The results focus on a five-year average; however, annual vegetable production is strongly dependent on weather conditions and fluctuated on the national level from 47% in 2023 to 61% in 2020 (Green report 2023, 2024).

Table 1. Vegetable production (average 2019–2023).

	Production (tone)	Fresh vegetables (kg per capita)	Self-sufficiency rate for fresh vegetables (%)
Slovenia	106,050	50.4	55.6
Municipality of Ljubljana	5,819	19.8	22.2

When interpreting these results, it is important to emphasize that the model, like the national model, covers only agricultural production. While this is the main source of food production and supply for urban areas, in the context of urban agriculture it would be beneficial to also assess the quantities of vegetables grown in household gardens, which in urban environments like Ljubljana can represent an important but under-researched source of local self-sufficiency (Vadnal et al., 2010). Numerous studies have shown that vegetable production in household gardens and other urban areas can significantly contribute to fulfilling the nutritional demands of urban populations (Bengtsson and Haller, 2025; Hume et al., 2021; CoDyre et al., 2014).
A literature review revealed that many studies address food production in household and community gardens (Bengtsson and Haller, 2025; Algert et al., 2014; Ghosh, 2021; Hume et al., 2021; Saha and Eckelman, 2017), mostly focusing on estimating production potential (i.e., possible vegetable production based on assumptions and average yields and/or GIS analyses) or empirical monitoring of actual yields compared to conventional production. However, we did not find approaches evaluating the production or potential of urban agriculture using national models such as agricultural production and consumption balances.
In the context of urban agriculture, a comprehensive assessment of local food supply requires including all sources of production, including self-supply from household and community gardens (Bengtsson and Haller, 2025; Gittleman et al., 2012). Despite growing interest in urban agriculture and the importance of self-sufficiency potential in cities, this field remains under-researched and lacks comprehensive data. Currently, there is a lack of systematically collected data and appropriate methodological approaches to monitor and evaluate production on these smaller but potentially important areas. Similar findings have been reported by other studies (e.g., Edmondson et al., 2019; Bengtsson and Haller, 2025), which highlight the lack of quantitative data sources needed to enable realistic assessments of the contribution of self-produced food in cities from all production sources.
Local self-sufficiency has been promoted in Ljubljana for many years (Vadnal and Alič, 2008; SRP MOL 2021–2027, 2020). According to data from the Municipality of Ljubljana, community gardens cover just under 5 hectares, representing less than 2% of all agricultural land in the municipality. The greater unknowns are household gardens, whose number and area are not officially recorded, but rough estimates suggest that their total area exceeds that of Ljubljana's community gardens. This indicates an important but insufficiently explored potential for assessing locally grown food in the urban area.
Due to these data limitations, the currently presented adjusted food balance model for vegetables in the Municipality of Ljubljana likely underestimates the actual volume of local production. This is especially true for the share of household and community gardens, which are not included in the model. In the future, it would therefore be sensible to develop supplementary data collection methods, such as participatory research, spatial analyses, or targeted household surveys. For a more accurate assessment of local food supply in the urban environment, a comprehensive

research project should be undertaken, including an inventory of agricultural land, household and community gardens, external trade data, and a detailed analysis of vegetable consumption at the municipal level. Such information would allow for upgrading existing analytical models of production and consumption balances, thereby providing a more complete picture of local self-sufficiency.

Nevertheless, we assess that the presented model, based on national averages and adjustments according to municipal data on land areas and population, reflects the situation in the Municipality of Ljubljana with a sufficiently high degree of reliability. We believe that the differences between estimates calculated using the current methodology and those based on more detailed data would be relatively small and would not significantly affect the main findings of the study.

Conclusion

In the context of increasing urbanization and the associated challenges to food security, urban agriculture is becoming an important component of urban development, as it can significantly contribute to improving food self-sufficiency and strengthening the resilience of urban communities, particularly during crises and disruptions in supply chains. The study of vegetable production and self-sufficiency in the Municipality of Ljubljana presented in this paper sheds light on the current situation and highlights methodological and data-related gaps that need to be addressed in order to comprehensively assess the potential of urban agriculture.

The results show that Ljubljana, with a self-sufficiency rate of around 22% for fresh vegetables, lags behind the national average, confirming that the city meets most of its vegetable needs through imports or supplies from other regions. The analysis points out that important data sources remain underexplored, particularly those related to household and community gardens, which are not captured in the applied model, despite their contribution to local food self-sufficiency.

One of the key findings is that existing models, based on national averages and official data, offer a valuable starting point, but are unable to reflect all dimensions of urban food production. This is particularly true for non-market forms of production, such as household gardens, whose scale and contribution remain largely unknown. Based on this, we conclude that the actual level of local self-sufficiency in fresh vegetables is likely somewhat higher than the results presented suggest.

To effectively plan and monitor measures related to urban food systems, it would therefore be advisable to develop enhanced data collection methods, such as spatial analyses, participatory research, or targeted household surveys. Such an approach would provide a better understanding of the role of non-market food production in urban settings and strengthen the evidence base for decision-making in spatial planning, sustainable development, and food security.

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